Proceedings

1993 Governor's Conference On the Management Of the Illinois River System

Fourth Biennial Conference
September 21-22, 1993
Hotel Père Marquette
Peoria, Illinois

Prepared by Holly Korab, editor, University of Illinois Water Resources Center.
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Proceedings

OPENING ADDRESS

Robert W. Frazee
Extension Educator, Natural Resources Management

University of Illinois Cooperative Extension Service
727 Sabrina Drive
East Peoria, IL 61611

Good Morning and Welcome to the 1993 Governor's Conference on the Management of the Illinois River System. I'm Bob Frazee, an Extension Educator specializing in natural resources management for the University of Illinois and co-chair for this conference. I would first like to introduce our distinguished guests at the head table: beginning at my far left is Becky Doyle, Director of the Illinois Department of Agriculture; Brent Manning, Director of Illinois Department of Conservation; Roberta Parks, Conference Co-chair and Vice President of Government Relation for Heartland Partnership; David Koehler, Councilman and Mayor Protem for City of Peoria; George Saal Jr., Chairman Tazewell County Board; and the honorable Bob Kustra, Lt. Governor of the State of Illinois. Mr. Kustra will receive further introduction in a few moments.

This morning as I mingled and visited with people in the hallways, it was really exciting to be a part of the interest and enthusiasm that is being generated by holding this fourth biennial conference on the Illinois River System. I'm very pleased to report, that as of a few minutes ago, we now have over 200 individuals registered for this conference. In looking over the registration list, we have a very diverse group of participants in terms of their backgrounds and the groups or agencies they represent. This is great! With this diversity in mind, I would like to encourage each of you, throughout this two-day conference, to actively seek out individuals with different opinions and viewpoints on river management. Share your thoughts and concerns with each other, open your mind to new perspectives, and explore the opportunity for compromise.

The Flood of 1993--what a catastrophic event in terms of loss of life and property and destruction! For the first time in U.S. history, the Mississippi River, flooding, and breaking levees commanded national headlines on the evening news for most of the summer.

The Illinois River, being a part of the Upper Mississippi River Basin, incurred significant flooding and damages, especially in it's lower section. For the most part, the Upper Illinois River Watershed was fortunate that these major storms did not occur 75 miles further east than they did. Even though the Upper Illinois River did not incur the massive flooding that the Mississippi River experienced, it is important to note that according to National Weather Service records in Peoria, the Illinois River has been above the 18-foot flood stage for 151 days out of the past 265 days, or more than 57 percent of the time since the beginning of 1993. Although most media attention has been devoted to the impact of the downstream flooding, it is important to note that the Flood of '93 was responsible for massive damage to upstream property in terms of losses to soil erosion, streambank erosion, and washed out terraces, waterways, bridges and highways. Unfortunately, as the flood waters recede, the silt that is left behind will be the only reminder of the devastation that has occurred to the land and water resources upstream in the watershed.

The Flood of '93 has also required the River Conference Planning Committee to make some adjustments to this program. The initial program was finalized and went to press in June. However after the floods came, the planning committee felt it was essential to alter our agenda and include a session to address the impact of the Flood of '93. I'm very pleased to announce that Stanley Changnon, Chief Emeritus and Scientist with the Illinois State Water Survey, will be our luncheon speaker today. He has recently returned from a two-week assignment as part of the National Flood Disaster Task Force and will share this committee's recommendations with us.

The Illinois River System is indeed 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 must acknowledge, the Illinois River System is in jeopardy. Only through efforts like this conference, will solutions to the river's problems be found.

The Governor of Illinois, Mr. Jim Edgar, recognizes the tremendous importance of the Illinois River System to our state and further realizes that it also provides Illinois with a key environmental challenge. Consequently, the 1993 Conference on the Management of the Illinois River System has been designated a Governor's Conference. 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.

Unfortunately, Governor Jim Edgar is unable to attend this Illinois River Conference because of other scheduled committments. This morning, we are very pleased that Mr. Bob Kustra, our Lieutenant Governor, will be able to serve as our featured speaker in this opening session to provide the Administration's perspective and direction to managing the future of our Illinois River System.

Two years ago, following the 1991 Illinois River Conference, a statewide planning committee was formed to begin making plans for the conference convening here today. These committee members, who can be identified by the blue committee ribbon on their name tags, have done an outstanding job of developing the program and making the necessary arrangements. Would these planning committee members please stand and be recognized.

I am also pleased to announce that we have over 50 co-sponsoring agencies and organizations who have assisted in promoting this conference and are committed to protecting and preserving the Illinois River System. We welcome each of you and thank you for helping to make this conference a success!

This year, our Illinois River Conference is especially indebted to the Illinois Department of Energy and Natural Resources for providing a grant to help defray the cost of printing both the abstract and speaker information booklet and the conference proceedings. Each registered participant will receive a copy of the proceedings through the mail in approximately 3 months.

At this time, I would like to specifically recognize the efforts of four individuals and groups who have made significant contributions to the organization of this conference. First is the co-chair of this conference, Roberta Parks or better known to many of us as "Rob."

With Rob and I serving as co-chairs, the planning committee has sometimes, jokingly, referred to this conference as the "Rob and Bob Show." Roberta is Senior Vice-President of Governmental Relations for the Heartland Partnership and will be chairing the conference sessions tomorrow. Roberta, thank you for the excellent leadership you have provided to this conference.

Next, I would like to recognize the Heartland Water Resources Council of Central Illinois, which has been serving as the local administrative entity for handling the many arrangements necessary to make this a successful conference. Mike Platt is the Executive Director and Sue Alexander is the Office Manager for the Heartland Water Resources Council. Please join me in thanking Mike and Sue for their efforts in organizing this conference. While you are at this conference, if you should have questions or need local information, the members of the Heartland Water Resources Council will be pleased to help you, and they can be identified by the special ribbon on their name tags.

The third individual I would like to formally recognize is Jon Hubbert, District Conservationist with the Peoria County Soil Conservation Service. Jon was responsible for organizing the Pre-Conference Conservation Farm Tour that was held yesterday afternoon. This tour provided an excellent opportunity for participants to see, first-hand, the many conservation practices which are being applied to agricultural land throughout the Illinois River Watershed. Thank you, Jon, for an outstanding tour.

The fourth group I would like to recognize is the office staff from the local chapter of The Nature Conservancy who have taken the responsibility for organizing our Exhibit and Display Room. These individuals include Michael Reuter - Project Coordinator, Jeanne Barbieur, and Ruth Belowe. The Exhibit Room is located immediately to your left and will be the site for the refreshment breaks and tomorrow's continental breakfast. On Page 18 of your program booklet is a listing of the Exhibitors. Please take time during the conference to visit the displays and learn about the many diverse projects that are occurring throughout the Illinois River System.

In turning to the revised program agenda in your packet, you will note that this year's conference will feature panel sessions that address specific components related to the long-term management of the Illinois River System. These include: Citizen Initiative Reports, Main River Issues, River Valley Issues, Watershed Issues, and the Legislative Panel. On behalf of the planning committee, I hope that you will find this conference to be exciting, informative, stimulating, and enjoyable.

At this time, it is my pleasure to introduce to you, Mr. George Saal, Jr., Chairman of the Tazewell County Board. Mr. Saal will welcome you to this friendly Tri-County area, situated midway on the Illinois River between Chicago and Grafton.

Thank you, Mr. Saal, for this cordial welcome. It is now my pleasure to introduce our moderator for this opening session, Mr. David Koehler. Mr. Koehler is a councilman and mayor pro-tem for the city of Peoria and will introduce our featured speaker for this morning's session, Lieutenant Governor Bob Kustra.

CHAMPAIGN COUNTY PHEASANTS FOREVER FILTER STRIP SEEDING PROGRAM

Mark Cender, Champaign County Pheasants Forever
Jane Kietzman, Champaign County SWCD

365 County Road 3300N, Fisher, IL 61843

The Champaign County Chapter of Pheasants Forever (CCPF), in cooperation with the Agricultural Stabilization and Conservation Service (ASCS), the Soil Conservation Service (SCS), and the Champaign County Soil and Water Conservation District (SWCD), developed and implemented a filter strip seeding program. This program has resulted in almost 1000 acres of filter strips being seeded in Champaign County in 1993, the first year of the program.

The SCS/SWCD developed an information and education program to target area farm owners and operators. These agencies were concerned with helping Champaign County farmers reduce erosion, increase habitat, and improve water quality. The campaign took advantage of new restrictions that regulate Atrazine application near streams and ditches. They also capitalized on the fact that ASCS had recently waived minimum size requirements for set-aside acres if the area was at least 33 feet wide and was seeded to perennial cover.

The CCPF produced a four-color brochure to promote the campaign. The brochure was mailed, by the SWCD, to every ag landowner and operator having land along streams and ditches in Champaign County. Some Drainage Districts sent their landowners a separate letter encouraging them to take advantage of this program.

When the landowners/operators came to the ASCS office last spring to sign up for the Farm Program and to designate the location of the land for set-aside, they were encouraged to use long, narrow strips along the streams and ditches. The minimum allowable strip width was 33 feet, however, most producers enrolled much wider areas, often over 100 feet wide. The ASCS personnel also advised them that no-cost seeding was available through the Pheasants Forever chapter and provided them with a copy of the brochure. As a service to Pheasants Forever, the ASCS staff compiled duplicate photographs with the areas to be seeded clearly marked.

CCPF applied for, and received, additional funding from the "Pheasant Stamp" Program with which to purchase seed and equipment, and for wages. They recruited four custom drill operators to perform the actual seeding. Every landowner/operator was contacted, the program was again explained, and a habitat agreement was signed.

The original game plan called for seeding the greatest portion of the project in the spring of 1993. Unfortunately, due to an excess of wet and rainy weather, most of the seeding has had to be postponed until the fall seeding season. This resulted in a common resource crunch -- too much to do and not enough time!

In this instance, the Illinois Department of Conservation has come to the rescue. The Roadsides for Wildlife Program has been seeding roadsides and terrace systems throughout central Illinois for many years. They have an experienced work crew and their equipment is well suited to the job. Seeing the need, they volunteered to deploy part of their work force, and equipment, to assist with the seeding efforts. They have seeded almost 200 acres of filter strips throughout Champaign County during the past six weeks!

Everyone involved in this project has been delighted with the result. A great deal of time, energy, and money have been devoted to the project. Fortunately, there are many players on the team to share the load! It has truly been a win-win situation for everyone involved.

The CCPF:
- has had an opportunity to increase habitat by 1000 acres,
- has been able to work with a larger group of landowners, and
- has made contact with many new people.

The Landowners:
- received free seed and seeding of set-aside ground,
- have the opportunity to reduce erosion and improve water quality,
- are able to maintain compliance with the new chemical application restrictions,
- improve wildlife habitat, which will increase the potential for establishing fee hunting operations, and
- reduce the danger factor from being too close to the open ditch with farm equipment.

ASCS:
- has the opportunity to utilize an existing government program to capture more environmental benefits for the public without spending additional money,
- is developing a positive, involved relationship with the community and the public, and
- has more agricultural acres of set-aside ground seeded to permanent cover.

Drainage Districts:
- will experience less siltation and streambank degradation that translates into less maintenance, and
- have in place an area from which to perform maintenance as necessary and to conduct their annual inventories.

Illinois Department of Conservation:
- is helping to establish hundreds of additional acres of habitat for the state and its citizens, and
- is developing working relationships with many new cooperators, organizations, and agencies.

SWCD and SCS:
- are helping improve the condition of all our resources--soil, water, air, plants, animals, and humans,
- are enjoying the opportunity to work with many more owners and operators throughout the county, and
- have the satisfaction of meeting our charge to promote the wise use of the natural resources of Champaign County while meeting our customers' needs.

SITE M: THE RESOURCE, THE OPPORTUNITY AND THE PLAN

James R. Reynolds, Illinois Department of Conservation

Illinois Department of Conservation, Division of Planning,
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ABSTRACT

The Illinois Department of Conservation recently purchased Site M, located in east-central Cass County. Comprising some 15,574 acres, or 24.3 square miles, in one contiguous holding, it was originally acquired by Commonwealth Edison Company to develop a new facility.

Site M is gently to strongly rolling countryside--a mosaic of cropland, pastureland and forestland--dissected by Panther Creek, Cox Creek, and tributaries. It comprises over fifty percent of the Panther Creek watershed. Its abundant and diverse habitat supports excellent wildlife populations. Also, the site is rich in both natural and cultural heritage resources.

The Department believes that Site M, by virtue of its size, location and resources, has tremendous potential as a major new facility.

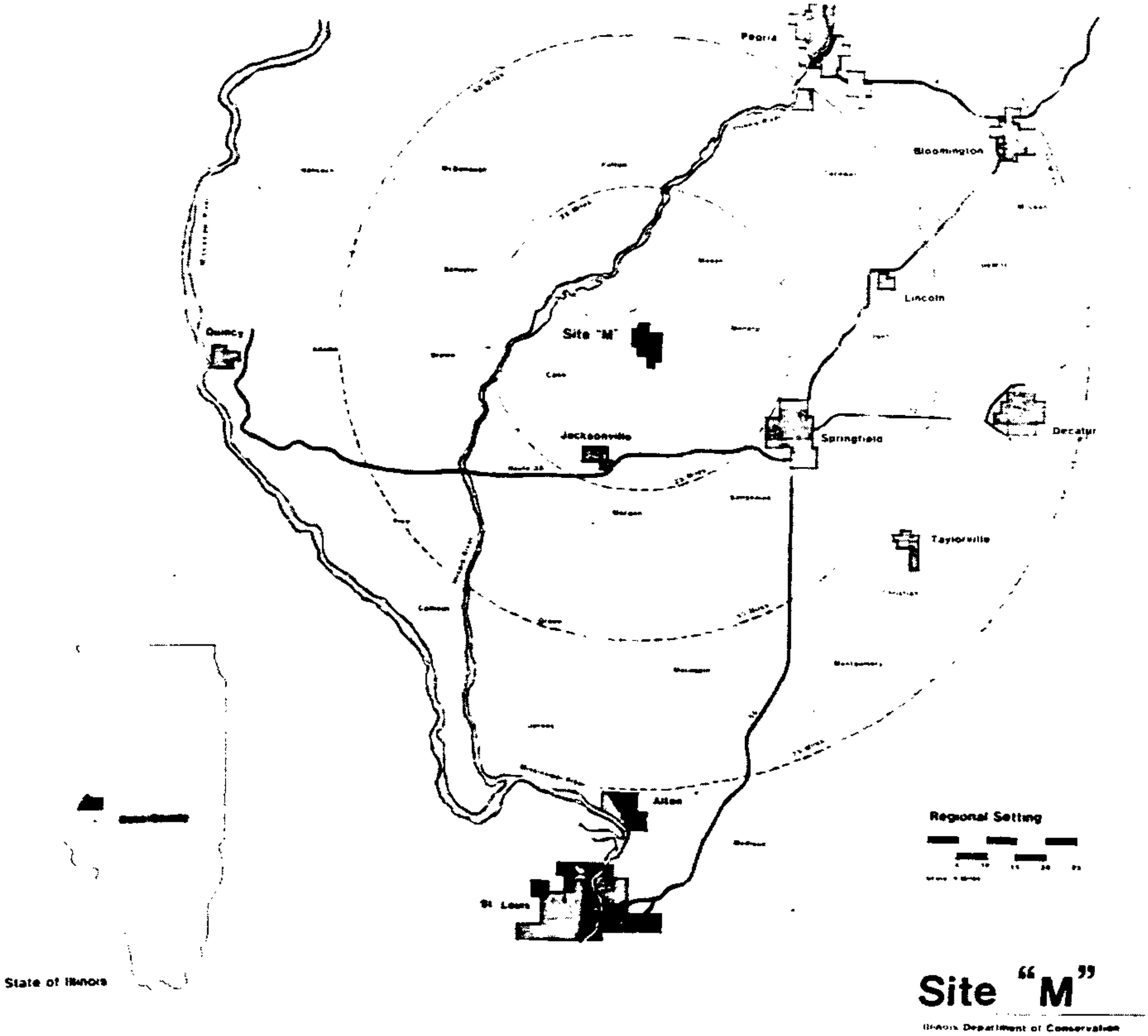
To realize Site M's full potential as a conservation and recreation resource, the Department has initiated a comprehensive site planning process, which utilizes a multi-disciplinary task force approach and public participation.

THE RESOURCE

Regional Context

Site M is located in east-central Cass County, about two miles southeast of Chandlerville and a half mile to the east of Panther Creek State Fish and Wildlife Area. It lies twenty-five miles northwest of Springfield, and fifty miles southwest of Peoria. This acreage encompasses portions of Chandlerville, Newmansville, Ashland, Philadelphia and Panther Creek townships. Its strategic location in rural west-central Illinois is close to numerous central Illinois metropolitan areas and readily accessible to residents of northeastern Illinois.

Panther Creek, the main year-round watercourse dissecting Site M, flows into the Sangamon River just northwest of Chandlerville. The site lies about fifteen miles east of the confluence of the Sangamon and Illinois rivers. It comprises over half, the lower part, of Panther Creek watershed.



Site M lies in rural west-central Illinois.

Site History

Comprising some 15,574 acres, or 24.3 square miles, Site M was acquired between 1968 and 1974 by Commonwealth Edison Company to develop a coal-fired electric power generating plant and 5,000-acre cooling lake. The decrease in electricity demand eliminated the need for such a facility. Following acquisition, the Company leased the entire acreage for agriculture. However, for the past sixteen years, under a cooperative agreement between the

Department and Company, it also provided limited upland and forest game hunting opportunities, including fee hunting for pheasant and quail, and non-fee hunting for pheasant, rabbit quail, woodcock, snipe, squirrel, dove, turkey, and deer. Only occasional nuisance trapping of beaver and muskrat has been permitted to date.

The Department had long been interested in acquiring a major upland holding in west-central Illinois, and, therefore, when the property became available, the agency decided to pursue acquisition. This effort culminated on June 28, 1993, when the State of Illinois, acting through the Department of Conservation, added this 15,574-acre tract to the public trust. It was easily the largest tract ever acquired by the Department, and, as such, presents a unique opportunity and challenge.

Natural Features

This exceptional acreage is gently to strongly rolling countryside–a mosaic of cropland (50%), pastureland (20%) and mature, high quality forestland (30%). It is dissected by Panther Creek, Cox Creek, and tributaries, which create a pronounced dendritic drainage pattern. The terrain is most undulating at the northwestern corner where Cox Creek merges with Panther Creek. Of the cropland, about 4,500 acres are considered prime.

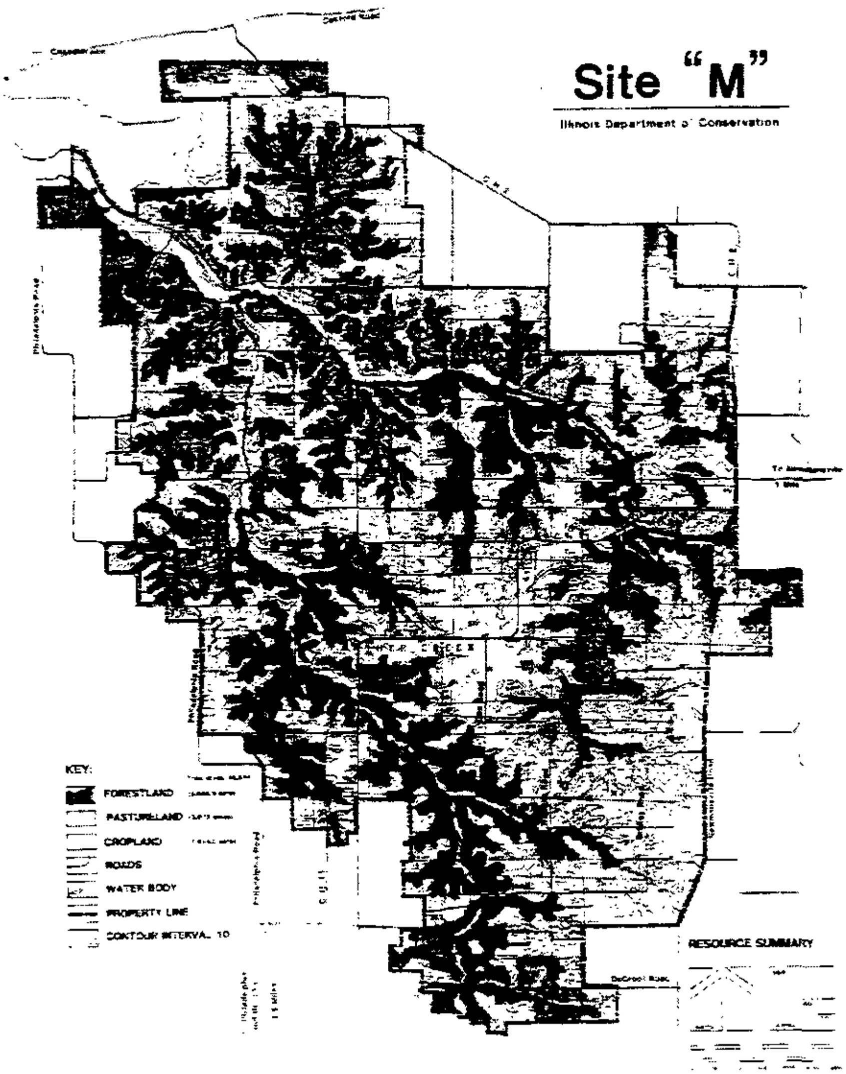
The timber resource, primarily upland hardwoods, is largely confined to ravines separating irregular fields. Having benefited from selective harvesting during the last decade, it is regarded as a high quality mature forest. Representative species include red, white, black, shingle, bur and chinkapin oak, black walnut, hackberry, sugar maple, green and white ash, osage orange, hickory and hawthorne. Sycamore, cottonwood, silver maple, box elder and river birch typify the bottomland complement found along the site's watercourses.

In addition to the two year-round creeks and intermittent tributary streams, numerous small ponds dot the landscape. All thirty-three (33) impoundments were built at least twenty-five years ago and are relatively small, ranging from one tenth to two acres in size.

Given Site M's abundant and diverse habitat, wildlife abounds. Game species include wild turkey, white-tailed deer, coyote, red and gray fox, rabbit, mink, muskrat, raccoon, opossum, beaver, squirrel, groundhog, pheasant, quail, woodcock, snipe, mourning dove and woodduck. Non-game animals include badger, several hawk, woodpecker and owl species, turkey vulture, eastern bluebird, lark sparrow, and numerous other songbirds.

Bass, catfish, carp, darters, minnows, suckers, bluegill and green sunfish inhabit the two creeks.

Important natural heritage resources include the 167-acre Cox Creek Hill Prairies Illinois Natural Area Inventory site, brooding habitat for the federally endangered Indiana bat, a stand of the State-endangered white lady's slipper orchid, and a stand of the State-threatened blazing star. Also, six known stands of Hill's thistle, a plant on the federal watch list, are found onsite.



Site M encompasses significant natural and cultural resources.

Cultural Resources

The area is also rich in archaeological resources. A recent survey of 7,500 acres of Site M by the Illinois State Museum revealed 560 archaeological sites, both historic and prehistoric, including a number that could qualify for the National Register of Historic Places. The potential for additional sites in the unsurveyed portion is high.

THE OPPORTUNITY

Site M, by virtue of its size, location and resources, has tremendous potential as a major new Departmental facility for several reasons. It presents an unparalleled opportunity to address both critical conservation and pressing outdoor recreation needs in this region of the State. Further, once the facility is operational, it should be an economic boon to Cass County, enhancing the County's overall revenue picture. Finally, as the major landowner within the Panther Creek Watershed, the Department will have the opportunity to demonstrate good watershed stewardship, by employing "environmentally-sensitive" farming practices. As such, despite fiscal constraints, it was an opportunity the State couldn't afford to ignore.

Public sentiment, as expressed in letters and statements from individuals and organizations, both local and statewide, strongly echoes this perspective. Frequent stewardship recommendations are:

- conserve and restore native flora (especially tallgrass prairie) and fauna;
- provide multiple, low-impact, recreational opportunities, including fishing, upland/forest game hunting, field trialing, furbearer trapping, camping, canoeing, hiking and nature study; and
- avoid or limit development.

THE PLAN

As steward of thousands of acres in the public trust, the Department has developed a comprehensive and systematic approach to planning its varied facilities throughout the State. It is designed to realize a given site's full potential as a conservation and recreation resource. The site planning process and product, as related to Site M, are summarized below.

Process

Once a site is targeted for a planning project, a task force is assembled. It comprises the various disciplines within the Department, including land management, natural heritage, fisheries, forestry, wildlife, engineering, law enforcement, land acquisition, and archaeology. The Division of Planning is charged with coordinating the planning process and preparing the actual document. If necessary, additional professional expertise is obtained from other public agencies, or private experts in the various fields.

The task force-prepared draft is reviewed, and revised, as necessary, to resolve all issues and concerns. Eventually, it is submitted for executive review and approval.

The Department recently initiated such a planning effort for Site M. As a first step in the public-participation process, the agency hosted a public meeting in Virginia, Illinois to air its plans to acquire Site M. As a departure from the traditional public hearing it utilized an "open-house" approach. This format gave each attendant an opportunity to:

- discuss particular areas of concern with appropriate IDOC staff;
- hear a concise overview presentation at several times throughout the evening; and
- make a formal oral or written statement.

The Department is progressing in other planning areas as well. Ongoing efforts include:

- assemblying necessary base and background materials;
- reconnoitering the site;
- assembling the agency task force;
- drafting task force assignments;
- establishing liaisons with selected public and private entities, such as school districts, county officials;
- developing the crop year 1994 farm lease program;
- scoping a lake feasibility study; and
- soliciting suggestions for renaming the site through the Kids for Conservation program.

Product

The approved plan will serve as the Department's official policy statement for Site M. As a planning tool, it has several essential components:

- a resource summary section, which characterizes the site and its environs, and addresses major site concerns as well;
- a proposed program section, which names and classifies the site, articulates a major site objective, delineates a land use concept, and outlines future land acquisition (if any), capital development and resource management;
- a program implementation section, which phases each proposed element, and estimates the cost of each; and
- a follow-up section, which identifies and assigns miscellaneous work items necessary to successfully implement the program.

Without the benefit of such a plan, it is somewhat speculative to suggest how Site M will be developed and managed. However, one could foresee the following elements as proving feasible:

- a variety of consumptive and nonconsumptive outdoor recreation pursuits, including upland/forest game hunting, sportfishing, camping, picnicking, field trialing, and trail usage, e.g., hiking, bicycling, horseback riding, and nature study;
- one or more smaller impoundments within the northern portion of the site (versus the single 5000-acre lake proposed by CEC);
- selective pond rehabilitation/enhancement as an additional fishery resource;
- both day-use and overnite recreational facilities as well as administrative support facilities;
- extensive restoration of native forest and prairie vegetation;
- continued farming by lease as an integral component of site management for conservation and fiscal purposes;
- "retiring" some of the existing, internal public road system; and
- accessing the site from more than one location around its periphery.

ECONOMIC IMPACT OF BASSMASTERS SUPERSTARS TOURNAMENT

Lynn Uphoff, Peoria Convention & Visitors Bureau

Peoria Convention & Visitors Bureau
403 N.E. Jefferson St.
Peoria, IL 61603

When the bureau first announced it was trying to land the BASS Masters Classic tournament, it said incentives of about $300,000 would be needed to land the event that had been called the World Series of fishing. One study prepared for the Bureau said the Classic could bring $8 million to the local economy. A Peoria Journal Star columnist commented at the time: Pam Carrington of the Baltimore Convention Bureau says BASS Masters attracted 2,000 to 3,000 people a day, instead of the projected 5,000 to 8,000 visitors when that city had the Classic last year (1992). Using BASS Masters' own numbers, that would cut the yield from $8 million for $300,000 to $4 million for $300,000.... It's still a pretty good deal, and the (Peoria) city council will probably bite. Well, they tried but were beat out by Birmingham, Alabama, which is closer to the organization's headquarters.

However, Peoria and the Illinois River did land a major event of the Bass Anglers Sportsman Society, a new competition, the first annual BASSMASTER SuperStars Tournament, held June 10-12, 1993. The field featured 28 competitors, previous B.A.S.S. tournament winners, past Classic champions and former B.A.S.S. Angler-of-the-Year title holders. Followers of competitive bass fishing recognized the field as the cream of the crop.

Similar in many respects to the BASS Masters Classic Championship, the BASSMASTER SuperStars Tournament permitted anglers one day of practice on the Illinois River. Each day of the tournament, the angler pros launched from Detweiller Marina at 5:30 a.m. to swarm the eligible fishing waters spanning 140 miles of the Illinois River from the LaGrange Lock and Dam south of Beardstown to Starved Rock Lock and Dam. They fished with observers each day and weigh-ins for the three competition rounds were in the Peoria Civic Center Arena, beginning at 2:45 each afternoon. At the final weigh-in on June 12, Denny Baurer was proclaimed the first-prize winner and received $50,000 of a total prize purse of $150,000. Even the last-place finisher took home $1,000.

In addition to the tournament, a three-day Outdoor Show was held in the Peoria Civic Center Exhibition Hall. The latest of boats, RVs, motors, tow vehicles, fishing tackle and lures, plus outdoor gear and accessories were on display. The show ran from 9:00 a.m. - 9:00 p.m. during the three days of competition and shut down only when the 2:45 p.m. weigh-in started each day. All events were free to the public.

What was the economic impact from the BASSMASTER SuperStars Tournament here in the Peoria area? According to figure from a study by Dr. Hopson Brian of the University of Alabama, the last two days' economic impact was $3,537,920 a day.

Based on Dr. Brian's study, the Peoria area hosted 7,458 people from out of the fishing area. They travelled an average of 205.7 miles and each group averaged 2.8 people. They spent $174.38 per person per day for a total of $1,300.526.00. This breaks out to:

$24.83 on food
$56.39 on lodging
$32.90 on entertainment
$60.26 on other items including: souvenirs, gambling, etc.

There were 6,431 people encompassing a 100-mile radius of the Peoria area who attended the tournament. These area residents spent $72.84 per person per day for a total of $468,434.00. Which breaks out to:

$12.36 on food
$29.19 on entertainment
$31.29 on other items including: souvenirs, gambling, etc.

The Grand Tour for these two days was $7,075,840. Additional money was spent four days prior to the tournament (Monday through Thursday) and 1/2 day on Sunday, and is estimated to total a minimum of $1,000,000.

The 1993 BASSMASTER SuperStars Tournament can translate into benefits much further down the road than the actual three days of the event. Largemouth and smallmouth bass are thriving in the Illinois River. That's a turnaround from years past and could represent a bonanza for hotels, motels, restaurants, cinemas, nightclubs and other entertainment spots in the Greater Peoria area and State of Illinois. Few local people and even fewer people from out-of-state are aware the Illinois River presently holds a solid largemouth bass population. The extensive media coverage before, during, and after the SuperStars, and interest by the general public created literally world-wide interest in the SuperStars Tournament and the Illinois River.

The fact the Illinois River can support a major tournament like the BASSMASTER SuperStars gives us an opportunity to show what kind of recreational opportunity the river provides. Plus it's good for the river itself. As the river is recognized as a natural recreational resource, programs will be developed by scientists, government officials, educators, students, corporate representatives, agricultural and environmental organizations and private citizens with a plan for the present and future restoration of the Illinois River and its surrounding ecosystem.

As this evolves, Illinois and the Illinois River will be viewed not only as a competitive fishing area, but as a final destination point for families taking fishing vacations who will not only fish the river, but visit other attractions as well. The Peoria Area, Illinois and the Illinois River, as well as the attractions in the area, have become ingrained in the minds of millions of people who heretofore have had little if any awareness of what the state and the river had to offer. Positive image, recognition of the quality and value of the fishery, new and repeat visitation to the area, and the facilitation for holding of future events of a similar nature could be in the offering as a result of the 1993 SuperStars Tournament.

The improved condition of the Illinois River increases our competitiveness with other communities, and the Peoria Convention & Visitors Bureau is aggressively marketing this heightened capability to host major meetings, events and large numbers of guests based on our natural resource. The Bureau continues to strive for improvement in its effectiveness and leadership of efforts to promote the Greater Peoria Area, the Illinois River, and State of Illinois as a destination site for visitors, conferences and special events, thereby impacting the economic growth of the area. The BASSMASTER SuperStars Tournament was and will be a major event for the State of Illinois, Greater Peoria Area, and the Illinois River, and a two-day economic impact of over $7 million make it a keeper.

NEIGHBOR TO NEIGHBOR PROGRAM

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The Neighbor to Neighbor program was started in the 12 county Platte Territory of Northwest Missouri and has since become a model for future programs (Fields, 1990). This grass roots outreach program utilizes volunteers to act as hosts for people who want to observe various conservation practices applied to the land. Visitors can walk the land with their hosts or they can take self-guided tours.

The basic concept is nothing new--people always observe their neighbors doing something new, see how it works and then try it themselves. Neighbor to Neighbor adds the element of communication. It sets up an opportunity for person to person, farm to farm, and neighbor to neighbor conversation about the advantages and disadvantages, costs and profitability of various conservation practices that have been implemented. It provides a no obligation opportunity for people to seek out conservation information on their own time from experienced operators without any pressure from agencies.

STEP BY STEP-START YOUR OWN PROGRAM

There are many approaches one can take in setting up a Neighbor to Neighbor program. The following are some suggestions based on experience.

1. Identify and contact potential conservation hosts. They may be farmers, ranchers or urbanites who are applying a variety of conservation practices to their land. Hosts should be willing to discuss their experiences with a wide variety of people.

2. Invite these contacts to a meeting, perhaps an informal breakfast meeting sponsored by your agency or other cooperators. Invitations can be personal, or by phone, but should be followed up with letters.

3. At the meeting, discuss the Neighbor to Neighbor philosophy and how it can be implemented. Each farm will have an eye catching sign legible from the road and Neighbor to Neighbor Directories will be distributed with information about the host farms and maps for self-guided tours. The sign is put in place by the sponsoring agency and does not need to be maintained by the host. Explain that there is no cost to the host, other than their time. People who are interested will contact them for information.

4. Each sign should be uniform. A 4'x4' weatherproof sign mounted between 2-4"x4"x12' poles is very sturdy. A logo for your program will help catch peoples attention. Signs should have the title of the program, farm name, operator, owner, the conservation practices applied, the sponsoring agency's name and phone number, and a list of sponsors.

5. You may want to start small the first year with at least four hosts. Choose these sites for the widest variety of conservation practices possible. In subsequent years add additional hosts to the program and/or rotate the sites.

6. Create a Neighbor to Neighbor directory. This will include a map to host farms and various host information. The directory will have the same information as the signs (farm name, operator, owner, the conservation practices applied) as well as the length of time their conservation practices have been implemented, pesticide regime, type of equipment, crop rotation and the hosts phone number. Include a quote about each operators conservation philosophy.

7. Distribute the directories at local coffee shops, banks, elevators, farm service businesses, grain dealers. Farm Bureau, Soil and Water Conservation District, Agriculture Stabilization and Conservation Service, Cooperative Extension, or where ever your audience would be found.

8. Contact sponsoring agencies for donations to cover costs. Obtain as much donated time and materials as possible.

9. Information meetings are an option when you have your program in place. Tours can be organized around a small nucleus of sites or they can be self-guided.

10. Once the sponsoring agency has the initial program set up it's possible that it can become self maintained by the volunteer group. Volunteers would be responsible for all aspects of the program, including maintaining and updating the signs, directory and obtaining sponsors.

THE FUTURE

Neighbor to Neighbor programs can be adapted to a broad spectrum of topics. For example, a river water quality project would easily emphasize the profound effects of upstream and downstream neighbors. Once examples of improvements to water quality are in place not only would others follow suit, but those issuing negative impacts on the water system would be under greater pressure to follow suit.

Neighbor to Neighbor programs have enjoyed great success where they have been implemented. The concept is simple, the organization is relatively easy and it does not require a great deal of time once the program is in place. The communication between neighbors brings understanding of the issues, pride in successes and inspiration for others. As urbanization advances toward our rural communities, programs like Neighbor to Neighbor become of increasing importance to bridge the gap of understanding and educate neighbors.

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A PLAN FOR AN ILLINOIS RIVERWATCH NETWORK USING CITIZEN VOLUNTEERS

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ABSTRACT

This paper summarizes the vision and plan adopted by Illinois Lt. Governor Bob Kustra for creation of a RiverWatch Network in Illinois using citizen volunteers.

Because most of the state's rivers and streams are degraded, and because state government is limited in its capacity to monitor surface water quality, the plan provides for use of an extensive network of volunteers to help monitor and restore the water quality, biological diversity, habitat, and scenic resources of Illinois' polluted and endangered river systems.

Key goals and objectives of the volunteer program are identified. They include assisting citizen watershed organizations and state agencies in their efforts to collect environmental data and implement effective programs to protect and restore surface water quality and biological integrity in Illinois.

BACKGROUND

In 1991, at the Governor's Conference on the Management of the Illinois River System, I presented a paper entitled "RiverWatch Network: A Model Volunteer Stewardship Program for Illinois."

The paper outlined the degraded condition of Illinois' 35,350 miles of rivers and streams, and the state's limited ability, due to limited staff, to adequately monitor surface water quality and implement programs to protect and restore the biological integrity of public waterways.

It described state-wide volunteer programs operating in Ohio, Maryland, and Massachusetts: programs organized by the Friends of the Fox River in northeastern Illinois; and it called for organizing a state-wide volunteer program in Illinois called "Riverwatch" that would achieve two major objectives: (1) provide citizen watershed organizations with a uniform set of volunteer programs and protocols, and (2) provide state and local agencies with credible, low-cost water quality data.

Like any organizational effort, creating an Illinois RiverWatch Network involves assembling a steering committee that would be responsible for organizing and funding the program, and hiring a RiverWatch Coordinator.

During 1992, leaders representing five citizen watershed organizations, the Committee for River and Stream Protection, and the Illinois Environmental Council developed a 46 page plan with a benefit-cost analysis describing how an Illinois RiverWatch Network could be organized and funded.

On November 20, 1992, we presented this plan to Illinois Lt. Governor Bob Kustra at a meeting in Chicago. Bob Kustra adopted the plan and agreed to chair a non-partisan steering committee. In June 1993, the steering committee held its first organizational meeting and formed six work groups.

The organizers believe that Bob Kustra is committed to restoring the biological integrity of Illinois' polluted waterways, and is dedicated to building the diverse public/private partnership needed to implement a meaningful and cost-effective state-wide volunteer program.

PROBLEM DESCRIPTION

During the past century, over half of Illinois' riparian habitat has been destroyed or severely degraded by agricultural and urban development, and today only one-third of the state's waterways are in good to excellent biological health. The result is poor water quality and the loss of living resources in many of Illinois' rivers and streams (1990 report, *The IEC Green Papers: Agenda for the Nineties*).

In its 1990-1991 water quality report to Congress, the Illinois Environmental Protection Agency estimated that of the state's 35,350 miles of rivers and streams, only 9,137.7 miles or 25.8 percent were monitored for degree of designated overall use support, based on aquatic life use.

Of the 9,137.7 miles monitored, 5,569.6 stream miles (60.1%) were rated as substandard or threatened in terms of their intended uses. Though point source pollution is a serious problem, in about 78 percent of these streams the major cause is nonpoint source pollution which results from such things as contaminated stormwater runoff, poor erosion control at construction sites, accidental or intended spills of polluting materials, and similar sources.

The dispersed and sporadic nature of nonpoint source pollution from a variety of sources makes it difficult if not impossible for a single agency or government to police or control. More fundamentally, nonpoint source pollution originates with land uses and land management practices throughout a community's watersheds that are primarily the local community's responsibility to guide and control. As a result, an effective program to protect streams from nonpoint source pollution requires that local governments and citizens assume an active role.

THE NATIONAL VOLUNTEER MOVEMENT

Nationwide, there is a burgeoning citizen volunteer environmental monitoring movement. In its first directory of environmental monitoring programs, published in 1988, the

US Environmental Protection Agency (EPA) listed 43 entries of which 16 were state-coordinated programs. In 1992, EPA listed 33 volunteer programs coordinated by the states, and over 4,500 volunteer organizations monitoring environmental quality. Of these 33 programs, 21 utilize citizen volunteers to help monitor water quality and biological diversity of their state's river systems.

In Illinois, the state can only afford to maintain 208 permanent ambient surface water quality monitoring stations for all of its 14 major watersheds. Without more water quality data, the state is unable to adequately identify pollution sources, measure pollution impacts, initiate remedial actions, or evaluate the effectiveness of instituted best management practices.

However, beginning in 1989, several grass-roots watershed organizations emerged in Illinois to help fill the information gap by involving citizen volunteers in programs to monitor the water quality and biological health of their river systems.

Currently, these "RiverWatch Networks" annually involve about 8,000 volunteers, and each network continues to grow and develop new volunteer programs which empower citizens with opportunities to restore the quality of Illinois' rivers and streams.

THE ILLINOIS RIVERWATCH VISION

RiverWatch offers a holistic, watershed-based approach to environmental education, stewardship and citizen action by working to link citizens and communities together on a watershed basis to monitor and restore their own river systems.

This philosophy is based on the premise that "we all live downstream," and that restoring any river is the responsibility of all watershed residents and communities.

The authors of the plan to create an Illinois RiverWatch Network recognized the tremendous improvements in environmental quality and cost-savings that would accrue to Illinois taxpayers by organizing an Illinois RiverWatch Network that would unify citizen watershed organizations and bring a uniform set of volunteer programs to citizens living within every Illinois watershed.

The Friends of the Fox River know that people readily engage in volunteer programs if you provide them with an important mission and structured opportunities to become involved.

Probably the strongest motivation for volunteers involved in our RiverWatch Network is they know they are working to save a polluted and endangered river system through local action, and that they are part of a basin-wide team. They understand that what happens in one part of the watershed affects communities downstream, and that saving a river or local stream requires a watershed approach.

For the volunteers there is great satisfaction in knowing that they are contributing to a watershed database, and that they belong to a coordinating watershed organization. A newsletter and annual congress provide recognition and information exchange for the volunteers, and opportunities to learn new skills and make new friends.

They also realize that the Friends of the Fox River represent their interests at another level as well, as our volunteer scientists and other professionals monitor and evaluate major Clean Water Act permit applications and poorly planned development proposals, and work to protect public trust assets.

THE RIVERWATCH MISSION

The mission of the Illinois RiverWatch Network is to assist watershed organizations in the development and delivery of volunteer programs which facilitate the restoration of the water quality, biological diversity, habitat, and scenic resources of Illinois' polluted river systems:

First, by assisting citizen watershed organizations in the delivery of their volunteer programs, these organizations will increase their ability to empower local citizen and student groups with the knowledge, skills, and confidence they need to take active and responsible steps to monitor, protect, and improve the quality of their adopted waterways. At the same time, a new generation of adult decision-makers will be trained to solve complex, socio-environmental problems.

Second, participating watershed organizations and concerned local officials within each watershed will be empowered with the constituency they need to introduce improved public policies and best management practices to restore water quality at the local level.

Third, volunteer activities will increase state and local government data collection, and complement their environmental protection programs.

Citizens will be trained to provide credible scientific data, and serve as the eyes and ears and early warning systems needed to effectively monitor, protect and restore the health of community waterways. Data collected by the volunteers will be used to help determine baseline conditions and trends, and thus be used to help evaluate environmental management decisions, set priorities,and determine and support budgetary needs.

Fourth, state elected officials will be empowered with the constituencies they need to sponsor protective legislation, and state environmental protection agencies will be empowered to develop and implement meaningful nonpoint source pollution prevention programs.

THE RIVERWATCH PLAN

Steering Committee

The steering committee represents a broad-based partnership of leaders from environmental groups, business and industry, and state and federal agencies. The committee functions similar to a board of directors and is responsible for reaching firm agreement on the program's mission, goals and objectives, and the stewardship activities needed to achieve program objectives.

Committee members have been carefully selected to provide technical expertise and program resources, and are responsible for hiring a RiverWatch Coordinator and providing program evaluation and guidance.

At its first organizational meeting held on June 3, 1993, the committee formed the following six work groups to begin the implementation process: Organizational Development and Fundraising, Curriculum Development and Training, Volunteer Activities Development, Technical Coordination, Facilitator Recruitment, and Interstate Programming and Coordination.

Volunteer Programs

It is the goal of the Illinois RiverWatch Steering Committee to develop the best, most successful volunteer programs in the nation; and it is envisioned that RiverWatch programs will be founded on an inexpensive, easily learned biological water quality monitoring activity, and evolve to include an Illinois Clean Rivers Project and a variety of Adopt-A-Stream activities.

The Friends of the Fox River have learned that once a local group adopts a river or stream to monitor, they usually want to go beyond monitoring water quality and engage in additional stewardship activities to help improve environmental quality--from planting trees along streams to participating in an annual river and stream clean up day to stenciling storm drains with the message "Dump No Waste-Drains to River."

Additionally, about half of the 315 groups involved in our RiverWatch Network, during 1992, were not involved in the water monitoring program. These groups selected an adopt-a-stream activity to implement or participated in our annual basin-wide clean up day called "Fox Rescue."

Role of the RiverWatch Coordinator and Watershed Organizations

The Illinois RiverWatch network would, in effect, be a network of watershed organizations. Essentially, the plan calls for hiring an Illinois RiverWatch Coordinator who will work to: (1) facilitate the success of citizen watershed organizations, (2) assist in the organizational development of new citizen watershed and subwatershed organizations, and (3) recruit and contract with these watershed organizations to implement and manage a uniform set of RiverWatch programs within their watersheds.

Participating watershed organizations will be responsible for recruiting, training, equipping, and coordinating networks of citizen volunteers within their watersheds, such as youth groups, school classrooms, families, landowners, and other citizen groups who are interested in adopting, monitoring, and restoring their local river or stream.

It is envisioned that these watershed networks will be called Fox RiverWatch, West Branch RiverWatch, Rock RiverWatch, Illinois RiverWatch, Des Plaines RiverWatch, etc.

With the assistance of the steering committee, the RiverWatch Coordinator will be responsible for developing monitoring protocols and stewardship activity guides, recruiting citizen watershed organizations to join the network, and providing these organizations with training, program materials, and equipment.

The coordinator will also maintain a citizens' database, publish an Illinois RiverWatch Newsletter, and organize an annual awards program.

Facilitators

In areas without citizen watershed organizations, facilitators will be recruited from a variety of local agencies and organizations, such as conservation groups, Forest Preserve Districts, Soil and Water Conservation Districts, University of Illinois - Cooperative Extension Service, etc. to start up and manage small local or regional networks at the community, county or subwatershed levels.

Facilitators are expected to form local RiverWatch Committees of volunteer resource people who are interested in the program. And, as commitment in the area grows, it would be the goal of the local facilitator and committee, working with the state-coordinator, to facilitate the organization and success of new citizen watershed and subwatershed organizations to manage and expand these networks.

Training

In year one, the plan calls for the state-coordinator to recruit and train two volunteer facilitators from each of the state's 14 watersheds, including interstate watersheds, for a total of 28 facilitators. This figure may vary in each watershed depending upon a number of factors, including interest, need, and the population of each watershed.

In watersheds with operating watershed organizations, facilitators will be responsible to these organizations and assist them by conducting their semi-annual training workshops.

In year two, each facilitator will conduct two workshops to train and recruit 30 teachers and group leaders, for a state-wide total of 840 monitoring groups (60 per watershed). The program will increase the number of permanent ambient water quality monitoring stations in the state from 208 to 1,048.

Drs. Bob and Sonia Vogl, Associate Professors from Northern Illinois University's Department of Curriculum and Instruction, Outdoor Teacher Education graduate program, have been recruited to chair a curriculum development work group and train facilitators. Additionally, members of the Illinois Association of Regional Superintendents have committed $56,000 per year from teacher institute funds to fund training workshops, statewide.

RIVERWATCH PROGRAMS

Citizen Stream Monitoring Program

In this program, school and citizen groups (grades 4-adult) adopt a section of their river or local stream and are responsible for accurate monitoring of its water quality using easily learned biological water quality monitoring procedures.

Probably the best models for this program are the citizen stream monitoring programs sponsored by the Ohio Department of Natural Resources and Maryland Save Our Streams, Inc. In these programs, about 50 percent of the monitoring groups are school classrooms and the other half are citizen groups.

Citizens groups involved in this program also have the opportunity to select from one or more complementary adopt-a-stream activities to implement should they want to take action to help protect or restore the quality of their adopted waterway.

Participating science teachers also have the option to implement an adopt-a-stream activity or involve their students in a more comprehensive, multi-disciplinary river study called the "Interactive Water Quality Education Project."

The interactive project involves students in a series of complementary activities such as inventorying and mapping their adopted reaches and subwatersheds to identify potential pollution problems. Teachers can then select additional activities which are structured to empower students to become directly involved with their communities to help solve a problem they have identified.

Probably the best curriculum guide for the interactive project is the Global Rivers Environmental Education Network's "Investigating Streams and Rivers."

Illinois Clean Rivers Project

The purpose of this project is to engage Illinois' residents in an annual, state-wide, watershed cleanup day. It is envisioned that the project will be organized to facilitate annual "river rescues," on the same day, in each of the state's 14 major watersheds. An important objective is to demonstrate both local and regional support for maintaining clean, safe, healthy, and pollution free river systems.

It is anticipated that each volunteer group who agrees to adopt and clean up a local waterway will be given a sign to post at their adopted reach, with their group's name on it. This will provide recognition, and encourage them to keep their adopted river or stream clean throughout the year.

Probably the best models for this program are Minnesota's "Clean Rivers Project," and the annual "Rouge Rescue" organized by the Friends of the Rouge River in Michigan.

Adopt-A-Stream 2000 Program

The adopt-a-stream program not only provides activities for monitoring groups to select from, but it also provides a vehicle for citizen groups who are not part of a water monitoring program to help improve environmental quality. These groups can select an individual project or series of projects that serve their particular interests.

Activities guides to be developed include: (1) Watershed Surveys, (2) Stream Surveys, (3) Stream Cleanups, (4) Streambank and Habitat Restoration, (5) Construction Site Monitoring, (6) Storm Drain Stenciling, (7) WetlandWatch, (8) SkyWatch, (9) NPDES Permit Monitoring, and (10) Monitoring the Local Planning Process.

Projected Volunteer Program Cost-Effectiveness Analysis, Year 2

Program Costs

Direct (coordinator, assistant, etc.)		$ 108,288
Indirect (equipment, materials, etc.)		$ 89,053
Total Costs	(A)	$ 197,341

Outputs

Volunteer Hours		314,500
Average hourly rate for similar services		x $ 6
Total Output	(B)	$1,887,000

Cost-effectiveness analysis = (B)/(A) = 1:9.56 ratio

For every $1.00 spent on the volunteer program, approximately $ 9.56 in volunteer services are provided to the community.

Cost Per Service Hour = (A)/# of hours volunteered = $ .63

In year three, without expansion, it is estimated that the program would generate $17.00 in volunteer services for every $1.00 in expenses, and cost $ .40 per volunteer service hour.

CONCLUSION

The organizational structure of the Illinois RiverWatch Network will unify and focus volunteer efforts and the public towards protecting and restoring the quality of Illinois' river systems by offering citizen watershed organizations a uniform set of volunteer protocols and activity guides, and by assisting them with the development and expansion of their watershed networks.

Second, the program will help assure the success of new citizen watershed and subwatershed organizations in areas of the state where they do not currently exist.

Third, the program will provide valuable scientific data to assist state and local governments in their efforts to monitor and restore the quality of Illinois' surface waters, and help build the constituencies needed to implement environmental change.

Fourth, the program will support the efforts of the US Environmental Protection Agency to establish uniform volunteer environmental monitoring programs nationwide, and serve to support the goals of the emerging National Volunteer Monitoring Society.

Finally, the program will complement the goals of the Committee for River and Stream Protection in its work to assist watershed organizations in their organizational development, and the Illinois Environmental Council in its work on public policy issues of state and national importance.

ACKNOWLEDGEMENTS

The vision and plan presented in this paper reflect the work of many environmental leaders and volunteers nationwide. A special thanks goes to those who helped develop this plan, including: Brook McDonald (Conservation Foundation of Dupage County), Bob and Sonia Vogl (Friends of the Rock River), Laurene von Klan (Friends of the Chicago River), Elaine Hyland (Friends of the Des Plaines River), Mark Nickel (Friends of the Fox River), Virginia Scott (Illinois Environmental Council), and Clark Bullard (Committee for River and Stream Protection).

And a very special thanks goes to Lt. Governor Bob Kustra and the Illinois RiverWatch Network Steering Committee for adopting our vision and for lending their leadership and support to establish a meaningful volunteer river stewardship program for Illinois.

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MUD, FLOOD AND THE ILLINOIS RIVER

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INTRODUCTION

The 1993 Conference on the Management of the Illinois River System comes on the heels of the record 1993 flood, truly a unique midwestern event. The great flood of 1993, rated as a 500-year event along the middle Mississippi River, raises several important questions for those who live and work in the Illinois River Valley, or for that matter, for anyone attempting to manage water in any midwestern river valley. The question of more mud, or even dust, is of paramount importance.

Some questions I hope to address herein include the following. What were the unique hydroclimatological aspects of the flood of 1993? Should one plan and manage for more floods of this magnitude? Is there a trend to more floods? Is there apt to more serious flooding in the next few months? Has flooding intensity shifted in the Illinois River Basin? What will future policies relating to floodplain management be like?

THE FLOOD OF 1993

What can be said in just a few pages about the flood of 1993? At St. Louis its flow and height are claimed to approximate the 500-year flood, with flood stages exceeding 100-year values along the Illinois River south of Beardstown, the Mississippi from the Quad Cities to Cairo, and the Missouri from Kansas City to St. Louis. The hydrometeorological characteristics set the flood apart from most major river floods of the past and explain its causes. The flood was physically unique for three reasons.

The first factor was its enormous areal dimension, extending across parts of nine states (Figure 1). New flood records were set on parts of the Missouri, Mississippi, Illinois, and several other tributaries. The second factor that helped set this flood apart was the record long duration. At many locations on both major river systems, flood stages were exceeded for 30 to 80 days. The flood began in mid-June in the upper Mississippi and in mid September, the flood still existed in parts of the Mississippi south of St. Louis (Figure 2).

The third factor was the timing. Most extreme floods on both rivers, and on the Illinois, are due to excessive winter precipitation and ensuing snowmelt resulting in spring floods. The flood of 1993 was a summer flood. Historical weather records suggest that only 1902-1903 had wet conditions similar to those experienced in 1992-1993.

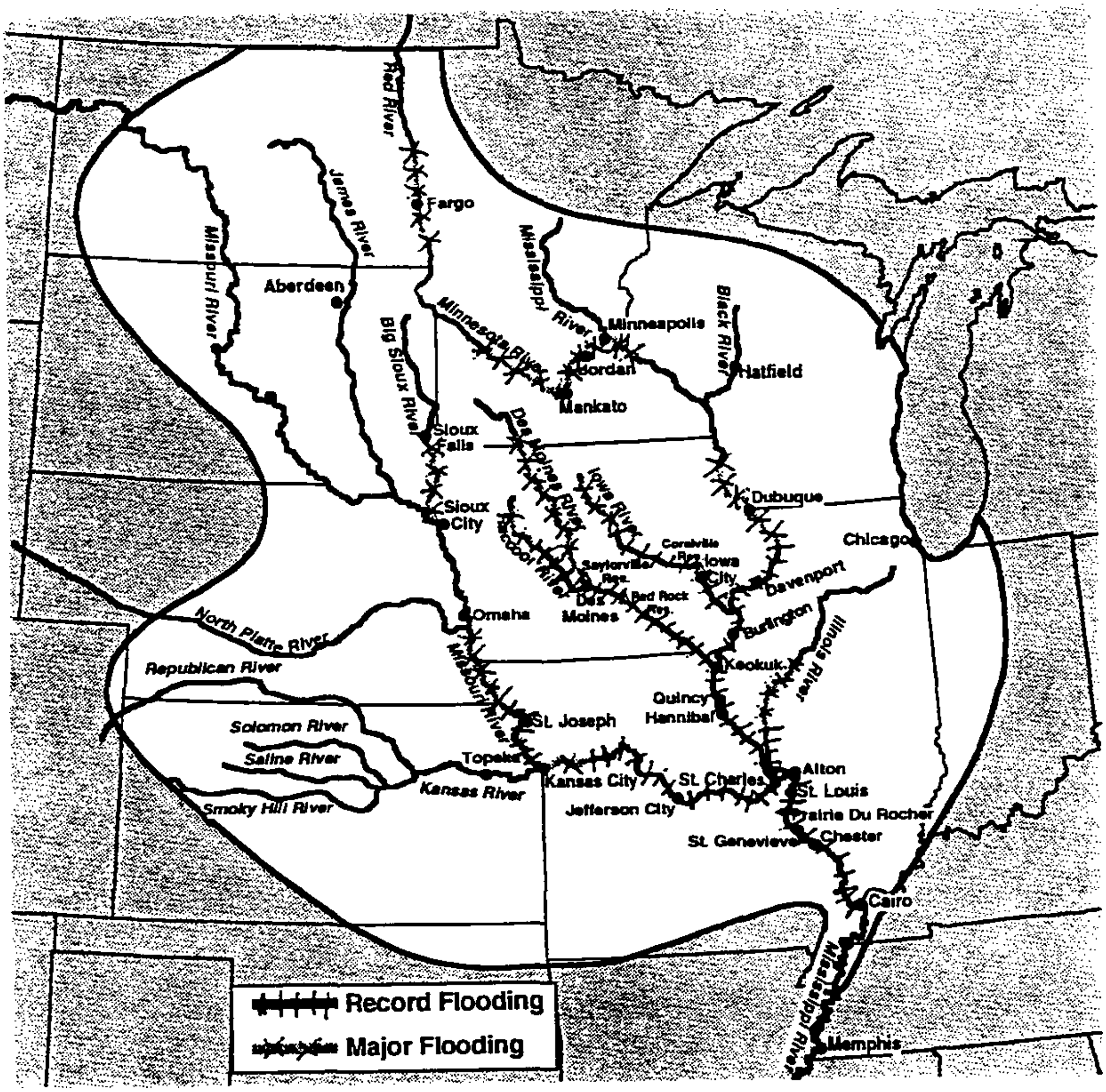


Figure 1. 1993 flood area with the river sections in major flood or with record flood levels.

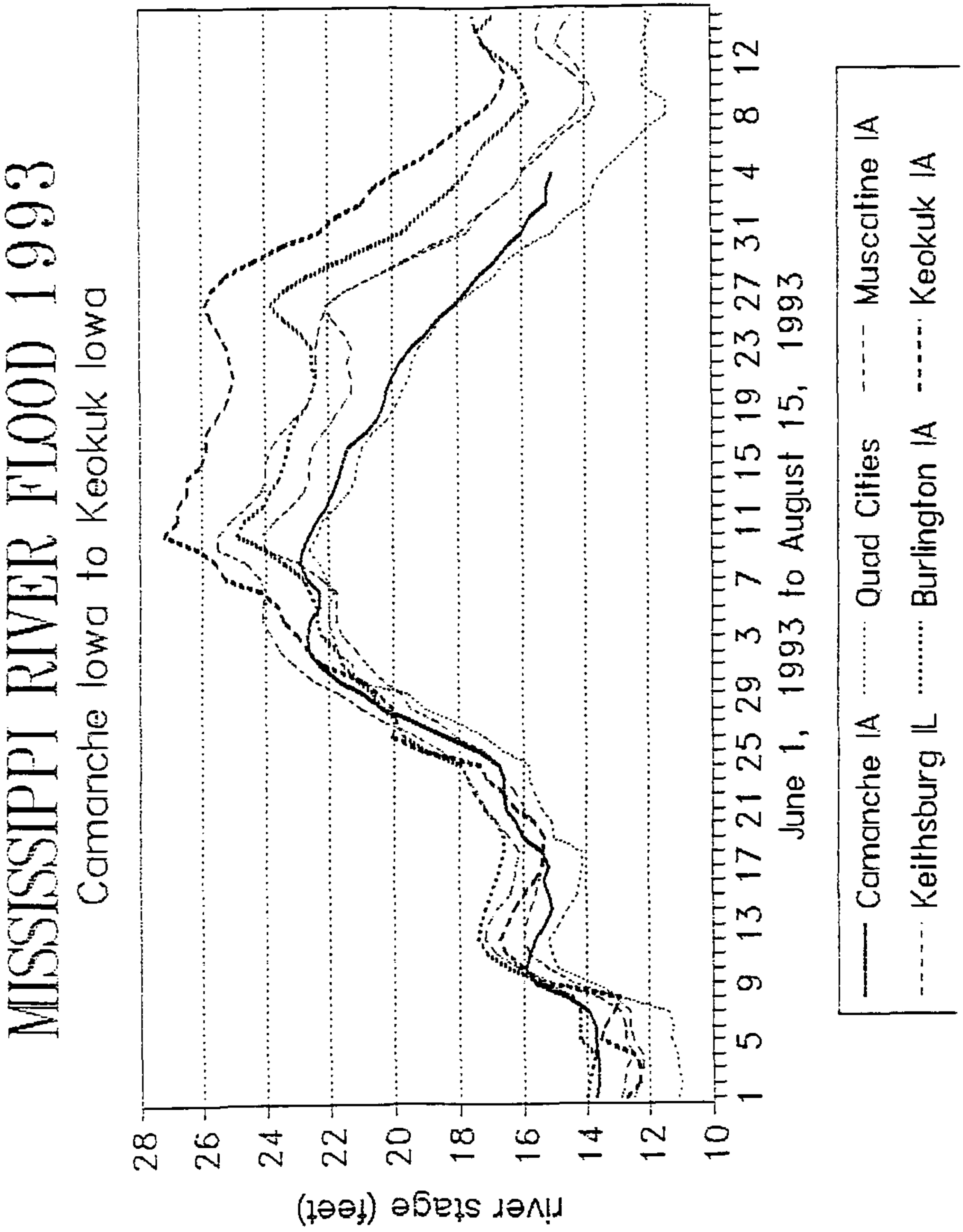


Figure 2. Series of hydrographs along the Mississippi River from June 1 to August 15, 1993.

Hydrometeorological Causes of the Unique Summer Flooding

The moisture conditions existing across the north central United States on May 1, 1993, can be best described as "saturated." The overly wet and cool spring of 1993, coupled with normal to above normal precipitation in the summer, fall and winter of 1992-93, had caused significant spring flooding in the upper Mississippi River basin. Soil moisture amounts, from the surface to a depth of six feet, across most of the 9-state (IL, IA, KS, MN, MO, NB, ND, SD, and WI) region were at field capacity by the end of May when values normally are less than capacity.

Maps of plant available moisture (expressed in percentages) at the 12-inch soil depth (Figure 3) illustrate the evolution of the wet soil conditions during the spring and summer of 1993. Values matching "field capacity" (90% to 100%) were region-wide on April 1, decreasing somewhat during April as evapotranspiration from new plants and growing crops began to be realized. Note, however that by June 1, most of the midwest had values of 100 percent or higher indicating widespread saturation of most soils due to the extremely heavy May rains.

As a result of the continuing rains and below normal temperatures of May, streams and rivers were well above seasonal average flows as June began. The genesis of a major summer flood had been established. All that was needed was prolonged heavy rainfall in the coming months.

Conditions Necessary for Major Summer Flooding

Extreme flooding of major river systems like the Mississippi and Missouri Rivers seldom occurs in the summer because of the highly variable, in space and time, nature of convective rainfall in the midwest, coupled with the high rates of evapotranspiration. Typical midwestern summers experience a few localized heavy rains of 6 to 12 inches in 1 to 2 days and which extend over a few thousand square miles. These are typically found randomly distributed in various locales in the 9-state region. These events produce localized flash floods on streams and tributaries but are not sufficient to produce major river flooding of any consequence.

Another common aspect of the precipitation climate of the midwestern summer involves atmospheric conditions capable of producing above average rainfall over sizable (state-scale) areas in random parts of the midwest during a typical summer. When these conditions do not occur, the midwest has summer droughts like that of 1988. These "wet periods" typically persist for 2 to 5 weeks and sometimes last up to 8 weeks creating the "wet summers" found in the climatic record. However, excessively heavy rain extending over wide multi-state areas and lasting more than eight weeks is a very rare event. These long-lasting and really extensive wet conditions become the second necessary atmospheric ingredient for producing massive summer flooding, along with exceptionally wet pre-summer hydrologic conditions. Conditions in 1993 met both of these summer flooding requisites.

Seasonal Rainfall in 1993

From a seasonal standpoint, above to much above average rainfall fell over the entire Upper Midwest in each of the four consecutive months from May through August. **The May-August 1993 rainfall amount is unmatched in the historical records of the central United**

States. June-July rainfall amounts and their return interval frequencies for selected midwestern states are listed in Table 1. The April-July amounts are exceptional in all states but Missouri, and the June-July values have return intervals of 75 years or more. The June-July amounts are exceptional values for each state and are further spectacular in having such widespread dimensions. Record wetness existed over 260,000 square miles. The Missouri July values were tempered by below normal rainfall in the extreme south, although some areas of northwestern Missouri had over 30 inches of rain in July alone. July values in Iowa and Missouri were more than 200 percent of normal. Seasonal rainfall records were shattered in all nine states.

Table 1. State Rainfall Amounts and their Frequencies

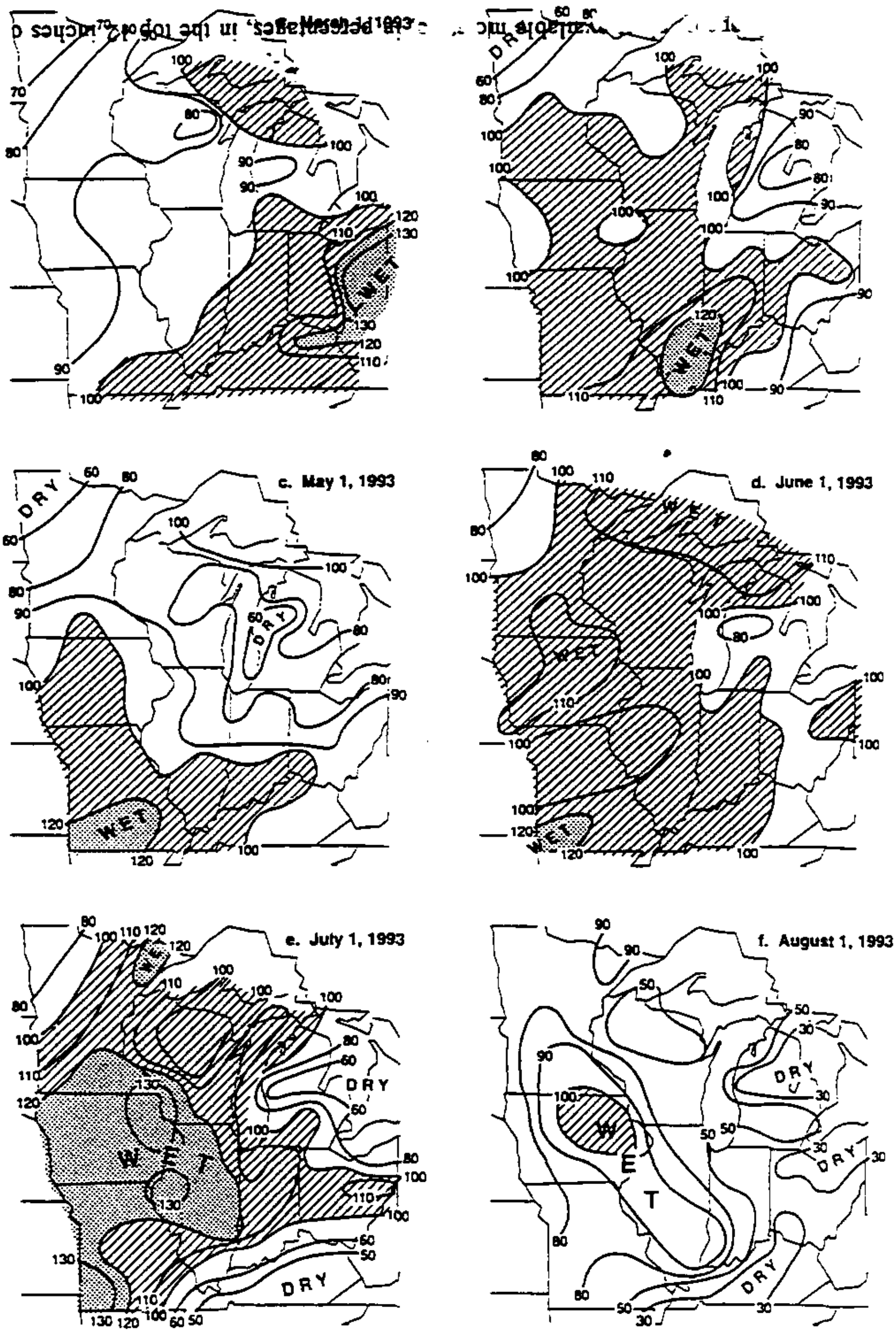
	April-July		June-July	
	amount, in.	frequency, years	amount, in.	frequency, years
Iowa	27.1	300	18.1	260
Illinois	22.9	45	14.7	85
Wisconsin	22.0	200	12.3	75
Minnesota	18.9	70	12.2	100
Missouri	22.7	19	16.2	80

The Mississippi River flood at St. Louis has been reported to be a 500-year event, and this exceeds the rainfall return intervals (Table 1) because the flood at St. Louis was the culmination, or combination of the heavy record rains on the lower Missouri basin being closely timed with those on the Upper Mississippi basin. The floods in each river 200 miles above St. Louis were sufficient to break historical records, but when they combined just above St. Louis, they created an exceptional monstrous flood of 500-year proportions.

Hydrometeorologic Conditions Causing the Summer Floods of 1993

The record-breaking heavy late spring-summer rainfall amounts and the ensuing record-breaking summer floods evolved from **six factors** during the 1993 summer. These factors combined in a unique fashion to cause record high flows on the lower Missouri and mid-Mississippi Rivers, as well as on many of their tributaries. Remember also that on June 1, all conditions in the hydrologic cycle favorable for flooding were present.

Persistence of Saturated or Near Saturated Soils. The saturated soils on June 1 (see Figure 3) became more saturated during June. By July 1 when typical midwestern values are 60 to 70 percent, the percent of plant available moisture values on July 1, 1993, were at total saturation, as reflected by the enormous area of 120 percent or higher values across Iowa, most of Missouri, central and northern Illinois, southwestern Wisconsin, and southern Minnesota. Values by August 1 were still abnormally high (50% to 60% are typical), indicating that near saturated soils prevailed in a large northwest-southeast oriented zone paralleling the Upper Mississippi River.



100% = field capacity

>100% = degrees of saturation (most soils peak at 130%)

Percent of Plant Available Moisture at 12-inch Depth

Figure 3. Maps of plant available moisture, in percentages, in the top 12 inches of soil for March - August 1993.

High Incidence of Rain Events. A critical factor affecting the record flooding was the near continuous nature of the rainfall. Point frequencies of rain in the nine-state area were between 16 and 22 days during July, compared to an average of 8 or 9 days with rain in July. The Upper Mississippi basin had measurable rains in parts of the basin on every day between late June and late July. The persistent rain-producing weather pattern in the upper midwest, often typical in the spring but not summer, sustained the almost daily development of rainfall during much of the summer.

Large-sized Rain Areas. The semi-stationary nature of the convectively unstable frontal conditions across the upper midwest from June through early August not only caused the near continuous occurrence of daily rains, but it also frequently created extensive areas of moderate to heavy rains. Frequently a day in June or July 1993 would have rain areas that were 100 to 200 miles wide and 400 miles long across parts of the nine-state area. Most of these rain areas included zones with 1 to 2 inches of rain over 5000 to 15,000 square miles. An excellent example of such rain areas is the isohyetal map of the July 7 rain area across central Missouri (Figure 4). A few such large sized areas of convective rainfall normally occur in most midwestern summers, but their high frequency in 1993 (at least 40 such cases) with quite large dimensions capable of affecting both the Missouri and Mississippi River basins were exceptional.

Orientation of Rain Areas. Several multi-day periods in June and July had large rain areas (see above) that were aligned with the orientation of the major rivers. In late June, several large rain areas were oriented northwest-southeast over the Mississippi River from northern Illinois into central Minnesota. Then in early July, similar systems became aligned southwest-northeast along the Mississippi's course from Quincy to southern Wisconsin and at the time the flooding was maximizing in this reach of the river. In early to mid July, several large rain areas were oriented west-east along the Missouri River and across Missouri, as illustrated in Figure 4. Such alignments deposited enormous amounts of water directly into the main stems of the rivers without any delay for runoff and in-stream storage in the tributaries.

Extremely Large Number of Localized Heavy Rains Capable of Producing Flash Floods. Intermixed with the frequent incidence of large areas of moderate to heavy rainfall, as described in B and C above, were many intense rainstorms having "flash flood" characteristics. These rainstorms are here defined as discrete areas, typically 1000 to 5000 square miles in size, where 6 up to 12 inches of rain falls in 24 hours or less. The isohyetal map of the large July 7 rain area (Fig. 4) contains three such intense 6-inch rain centers. Radar indicated over 9 inches in the rain core close to St. Louis. The early count of such storms indicates that at least 175 occurred in the 9-state area of excessive flooding from early May through August. This number of intense, short-lived rainstorms is likely a new record for the upper midwest.

Seasonal Evapotranspiration was Below Normal. The near continuous cloud cover of the June-August period (50 percent of the days were cloudy compared to a normal of 27 percent), coupled with temperatures 2 to 3 degrees below average and a very moist lower atmosphere, reduced actual evapotranspiration to below normal levels. This lessened the movement of moisture from the soil to the atmosphere and increased the flooding potential.

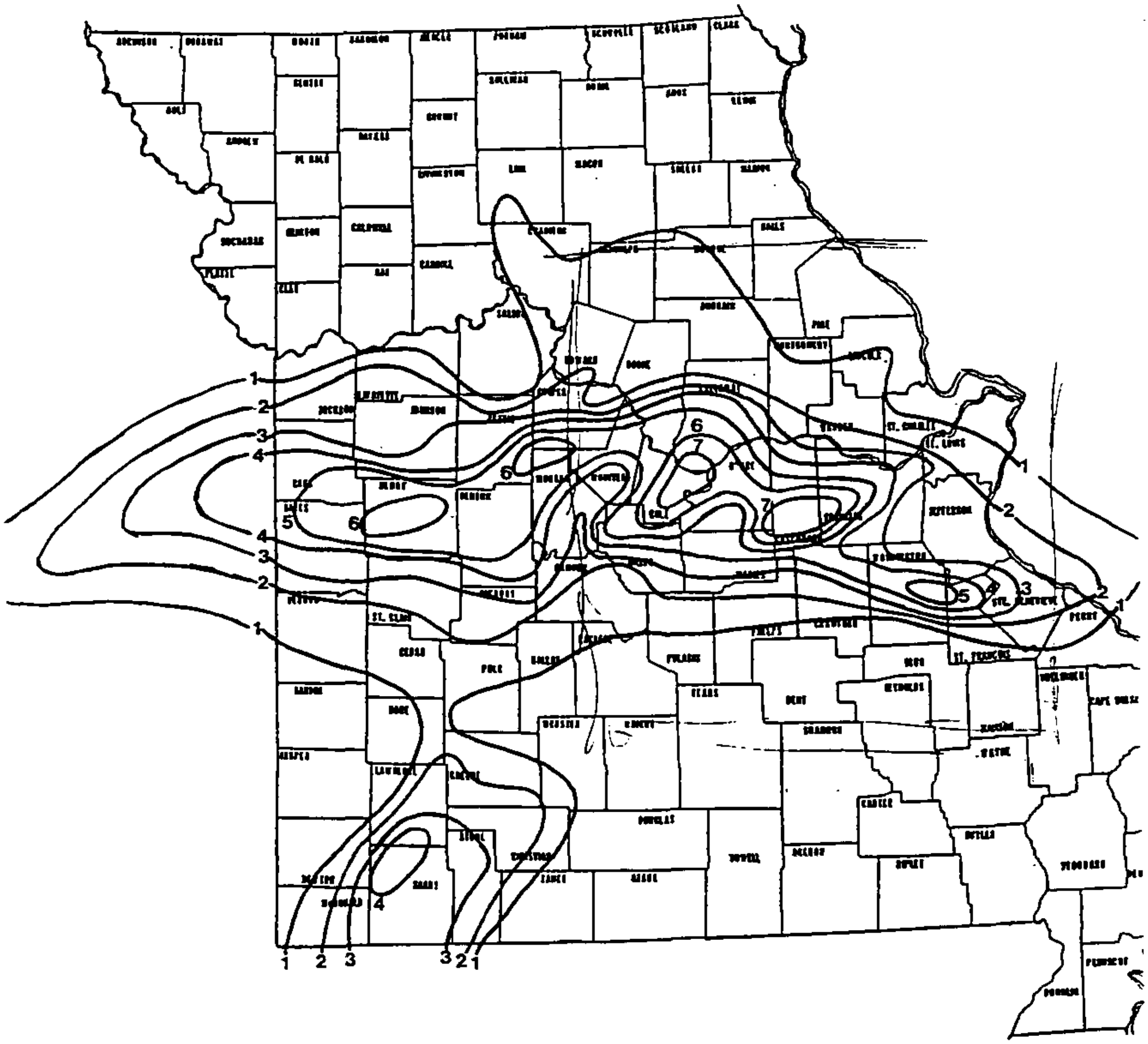


Figure 4. Isohyetal map for 24-hour rainfall amounts at 7 a.m. on July 7, 1993.

The Flood's Impacts

Books will be written about the impacts of the great flood. We can only begin to estimate the impacts at this time and many will develop and appear over the coming months and years. However, it is important to consider what we know now since they affect future recovery and policy development. The impacts of the 1993 flood fall into three broad classes: social disruption, economic impacts, and environmental effects. The social "costs" involving loss of life, persons evacuated, towns demolished, loss of income, and homes lost, already exceed those of Hurricane Andrew, considered to be the worst natural disaster on record.

The economic losses are staggering. Iowa estimates $11 billion and existing estimates push the 9-state flood losses above $20 billion. The losses to water management and treatment facilities, to all forms of transportation, to agriculture, and to business and manufacturing are each staggering. Levee failures were major with failure of 1043 of the 1345 non-federal levees and 39 of the 226 federal levees. As the flood recedes, we are finding more damage than estimated earlier, and I estimate that the final loss figure will exceed current estimates. There were also some "winners" such as the Illinois Central Railroad which was able to increase its north-south movement of commodities normally moving on the rivers and other railroads. The environmental effects remain speculative and many will take time to realize and measure definitively. Clearly the amount of erosion of uplands and floodplains was staggering, and as the water recedes we find mud and sand deposits beyond imagination.

Potential for Additional Flooding in the Immediate Future

A central issue for responding to and recovering from the massive summer floods of 1993 is the potential for future flooding in the flooded areas. Floods of almost any dimension would be detrimental to efforts to rebuild levees, highways, homes, and towns, and even to efforts to raise crops in 1994 in the floodplains of the Mississippi and Missouri Rivers and their major tributaries.

At the end of August 1993 soil moisture remained well above normal throughout most of nine-state flooded areas. It was the highest on record, matching typical spring levels. The slow-to-mature grain crops of 1993 will soon be harvested and much could be lost to untimely first freezes of fall. The season of evapotranspiration is drawing to a close across both large river basins.

The 90-day NWS outlook calls for normal to above normal fall precipitation in the central United States. This means that fall flooding could easily occur if heavy rain fell in parts of either basin. The onset of winter with frozen soils and soil moisture at field capacity or saturation, presents another situation very conducive to spring snowmelt floods.

Figure 5 shows the probability that soil moisture levels will be above normal on March 1, 1994, the beginning of spring. The probabilities are greater than 70 percent throughout the western Corn Belt, and probabilities exceed 90 percent in much of Illinois, Minnesota, and Iowa. Therefore, it is highly likely that spring runoff will be greater than normal. The soils will have a very limited capacity to absorb spring rains or snow melt. The size of the snow pack entering spring or amount of spring rainfall will be critical for determining the severity of spring flooding.

Figure 5. Probability (in percent) that soil moisture in the top five feet will be above the early March long-term average on March 1, 1994. These are climatological probabilities and we made no assumption about future weather conditions between now and March 1, 1994.

A soil moisture model was used to assess the potential for more flooding in the Mississippi. The model keeps track of "excess water," precipitation that either runs off into streams and rivers or percolates to become shallow groundwater. Excess water was calculated for the future period August 31, 1993 to April 30, 1994 using the 44 years of past weather scenarios. The area of this calculation was the Upper Mississippi River Basin.

Table 2 shows the distribution of potential excess water for these scenarios. Also shown is the climatological distribution of excess water based on calculations using the 44 historical years, 1949-1992. For several reasons, the actual runoff will be higher than the "excess water." For instance, the long-term average flow volume at Keokuk, Iowa for September-April is equivalent to a value of "excess water" of 4.5 inches higher than the median value of excess water of 1.9 inches shown in Table 2. Nevertheless, the model provides a tool to assess the flood potential in a relative fashion. There is a 50 percent probability that the excess water will exceed 6.2 inches, which is greater than the highest previous value of 5.3 inches in a single year. It is virtually certain that the average value of 1.9 inches will be exceeded. In the worst case scenario, the excess water across the basin could be as high as 12.9 inches, double that of any previous year since 1948. It is safe to say that the **potential** for flooding during the next eight months is at its highest level in at least 40 years because the capacity for soil absorption of precipitation is at its lowest late August value on record.

Table 2. Estimates of Excess Precipitation in Inches (i.e., Precipitation That Cannot Be Absorbed by the Soil) Over Upper Mississippi River Basin.

	Probability of Exceedence						
	100%	90%	70%	50%	30%	10%	0%
8/28/93 - 5/1/94	1.4	3.1	4.0	6.2	9.2	11.5	12.9
Average	0.2	0.4	1.4	1.9	2.7	4.3	5.3

FLOODING AND GREATER WEATHER VARIABILITY IS INCREASING

We have conducted two extensive studies of trends in flooding, one for Illinois, and one for the midwest. These show that both summer and cold season flooding is on the increase. This includes the frequency of flood events, their magnitude, and durations. These studies embraced parallel comparative studies of climate conditions showing that the flood increases are directly related to shifts towards wetter conditions with more heavy rain events. Figure 6 illustrates the upsurge of floods and heavy rain events in Illinois since 1920.

We have also addressed the question, is climate variability and weather extremes changing? We investigated severe storm "catastrophes," and extreme "climatic events" such as droughts and prolonged major large-area wet periods. Our analyses revealed that since the early 1980s, the United States has experienced an unusually large number of weather extremes. These occur in two types: those due to major storms lasting a few days, and those due to prolonged aberrations, defined as "climatic anomalies" lasting many months.

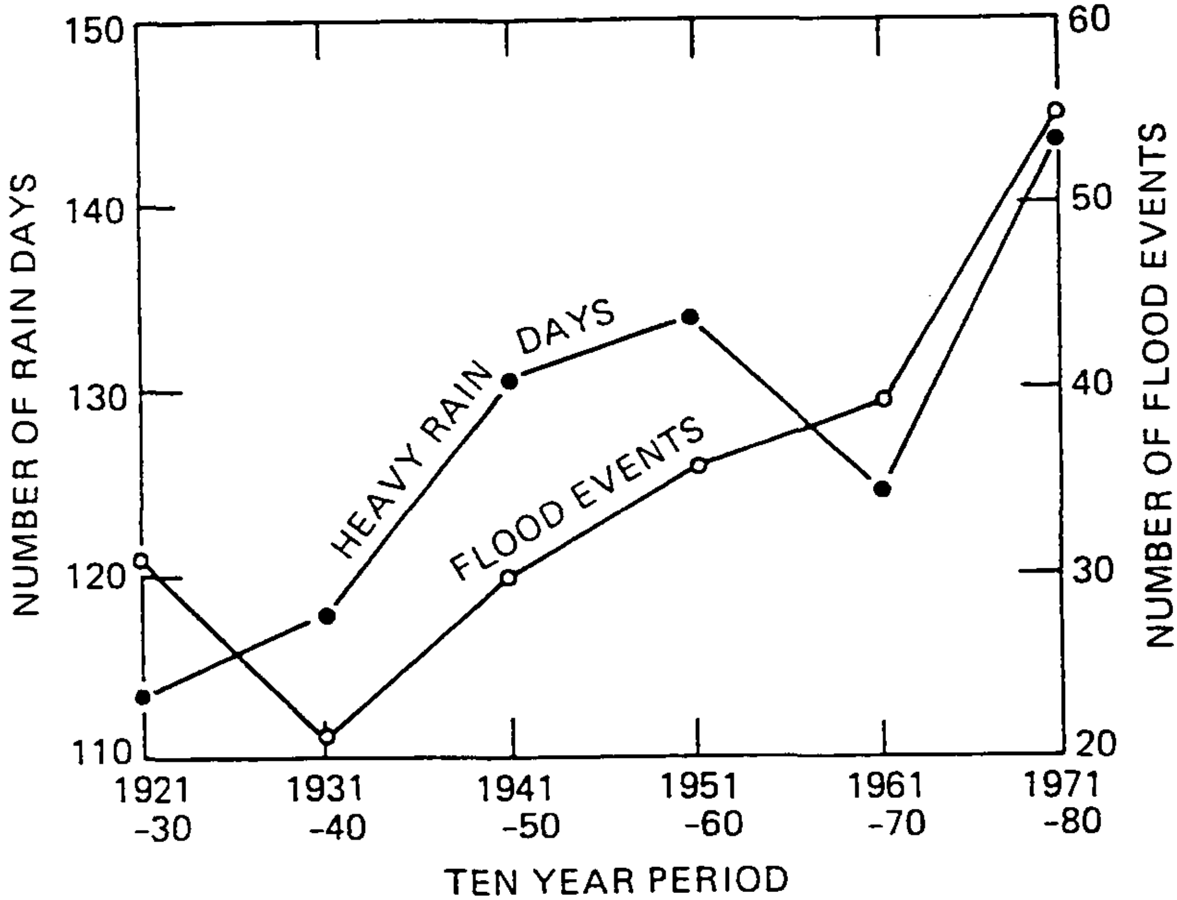


Figure 6. The decadal frequency of summer heavy rain days and flood events in Illinois, 1921-1980.

We investigated the incidence of "catastrophic storms," defined as those causing $100 million or more in losses, occurring since 1948. There have been 153 of these storms in the U.S. during the past 44 years. The highest 5-year period was 1988-1992 with 28 storms. The next highest 5-year total is 22 storms in 1950-1954. The magnitude and number of catastrophic events of the last three years are amazing. The number of tornadoes in 1991 was the third largest of record, and Hurricane Bob caused $1.5 billion in losses in New England and New York.

Major storm events in 1992 superseded those of 1991. On June 15-16 there were 123 tornadoes across the Midwest, the second greatest tornadic outbreak in history. The year ended with 1,293 tornadoes, a new record. The massive hailstorms of 1992 caused record highest crop losses in every state from North Dakota to Texas. Hurricane Andrew in August created $11 billion in losses and then Hurricane Iniki in September created $1.8 billion in losses in Hawaii. The year ended with a record "Northeaster" with winds, heavy rains and snow, and flooding across New York and New England. The current year began with the "Blizzard of 1993," a massive winter storm which began in Alabama and went to Maine causing $2 billion in losses.

Review of the non-storm "climatic anomalies" of the past reveals an amazing series of major shifts since 1980. First came a 5-year record wet period in the early 1980s leading to record high levels of the Great Lakes with major shoreline damages. This was followed by the droughts of 1986 through 1989. This drought peaked nationwide in 1988, but lasted for six years in the Far West. The spring of 1991 was a record wet and hot spring across the nation followed by record summer heat and a drought across the Corn Belt. The summer of 1992 was just the opposite, being the coldest summer since records began 100 years ago. Now, in late 1993, the nation is experiencing a record wet period in the upper Midwest, and a severe drought in the nation's southeast.

If the past is a prologue of the future, one thing seems likely. The current climatic regime with abnormally large extremes, both in storms and in climatic anomalies, may persist. Inspection of climatic and storm extremes during the past 100 years points to the 1930-1954 period as one quite similar to 1981-1993. That earlier 25-year period embraced major droughts, excessive wet periods, record flooding, and major hurricanes. This suggests that the current 13-year period of extremes with its huge cost to society and the environment could continue.

CONCLUSIONS

The genesis of the great summer floods of 1993 had been set by June 1 with saturated soils and filled streams across the upper midwest. The water from the ensuing persistent heavy rains of June, July and August had no place to go other than into the river courses. Record summer rainfalls with amounts achieving 75- to 300-year frequencies thus produced record flooding of the two major rivers, equalling or exceeding flood recurrence intervals to 100-to 500-years along major portions of the mid Mississippi and lower Missouri Rivers.

The 1993 flood reflects the fact that climate conditions have shifted over the past 10 to 20 years. They have brought generally wetter conditions to Illinois, with more extremes including floods and droughts. It seems prudent that those sensitive to the variations of precipitation should plan accordingly.

Another issue for the Illinois River basin, and those throughout the midwest, are the policy questions raised from the flood. Cries are being heard for a major changes in the nation's floodplain management program. One extreme view appears to be based on a theme that "we have failed in attempting to control the rivers, and it is time to return the rivers and their floodplains to their natural state." Another view is based on a theme that "the flood was such an extreme event it was bound to overwhelm most facilities and we should restore facilities as they were before the flood." The historical structural approach and more recent non structural, insurance-based approach are both being severely challenged. Changes seem likely. I suggest that those sensitive to the conditions along the Illinois River, and its use and management, should become involved in the national policy debate that has already begun.

LONG RANGE PLANNING ON THE UPPER MISSISSIPPI RIVER AND ILLINOIS WATERWAY NAVIGATION SYSTEM

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BACKGROUND

The Mississippi River is the third largest watershed in the world, gathering runoff from 31 states and flowing 2,500 miles to the Gulf of Mexico. The Mississippi and Illinois Rivers make up the Upper Mississippi River navigation system which has been in use for over half a century. This vital system provides a means for shipper to transport millions of tons of commodities; provides food and habitat for at least 485 species of birds, mammals, amphibian, reptiles, and fish (including many endangered or threatened); encompasses over 226,650 acres of national wildlife and fish refuge; is the source of water for hundreds of cities, communities, farmers, and industries; provides thousands of user days each year for recreation and boating enthusiasts; and is respository of significant cultural evidence of our Nation's past.

From the canoe of the early Indians, through the era of keel boats, steamboats, and ferries, to the hundreds of commercial shippers now using the system, this inland navigation route continues to provide a cost-effective means of transporting a variety of goods. The current system includes over 1,000 miles of navigable waterway, 37 lock sites and 385 terminals serving shippers of over $17 billion in commodities annually. Two-thirds of this country's grain is exported from the Mississippi River Valley, contributing significantly to our nations' balance of payments and overall economy.

According to the most recent statistics published by Waterborne Commerce of the United States, total commerce moved in 1990 on both rivers was 157 million tons , a far cry from the amount estimated by the engineers who designed the navigation system in the 1930's. Traffic has increased to a point where long delays are becoming commonplace. In 1992, tows at Upper Mississippi River Locks 20, 21, 22, 24, and 25 were delayed a total of 87,000 hours while waiting for lockage at a cost of $35 million. Performance monitoring statistics from the U.S. Army Corps of Engineers Navigation Systems Support Center indicate Lock 22, near Hannibal, Missouri, was the most congested lock in the study area. The average delay for the 3,306 tows that used the lock in 1992 was 7 hours. Delays are expensive to shippers. Assuming a cost of $400 per hour, this delay cost each tow processed at Lock 22 an average of $2,800. During the period 1988-1992, river traffic grew an estimated average of four percent per year. If this rate continues, delays at Lock 22 (and others) will increase to about 56 hours per tow by the year 2000, and lock capacity could be reached as early as 1998.

Most locks on the navigation system are 600 feet long with four exceptions: 1,200-foot locks on the Mississippi River at Lock 19, Melvin Price Lock and Dam, and Lock 27;

and a 1,000-foot lock at T.J. O' Brien on the Illinois Waterway. A majority of the tows currently using the system are 1,200 feet long which means a double lockage. This adds a minimum of one hour processing time and means higher shipping costs. Increased transportation costs are reflected in lower profits to shippers, the farmers and producers and higher costs to the consumer.

Economists estimate the present annual economic benefits of navigation as measured by savings in transportation costs at $500 million annually. That means that those who ship and receive goods would have to pay at least that much more if the Upper Mississippi River navigation system were not available. As a comparison, it costs about $18,000 to transport a barge load of grain from Burlington, Iowa, to New Orleans, Louisiana; by rail it would cost $32,000. The savings on shipping one bushel of corn via the waterway is 27 cents. One barge holds 52,500 bushels of corn. The savings per barge is $14,175 -- a direct benefit to producers and the Midwest economy.

U.S. ARMY CORPS OF ENGINEERS MANAGEMENT APPROACH

Operation and Maintenance

The U.S. Army Corps of Engineers uses a three-point management approach regarding its navigation responsibilities on the Upper Mississippi River system. The first point, Operation and Maintenance, assures that routine repairs and maintenance activities keep system components safe and operational. This includes dredging and long-term resource management programs.

Major Rehabilitation

Major Rehabilitation/Major Maintenance is the second point. The philosophy of the rehabilitation program is to maintain the reliability of the navigation system, performing rehabilitation when the components of the facility begin exhibiting unreliable performance. Rehabilitation began in 1975 on the Illinois Waterway and in 1986 on the Mississippi River. Most major rehabilitation projects include resurfacing deteriorated concrete areas on the lock walls and dam piers; repairing and replacing the lock and dam electrical and mechanical systems; overhauling lock miter gates, dam rollers gates, tainter gates, and emergency bulkheads; providing scour protections where needed; and rehabilitating lock central control stations.

Navigation Planning

The final point is Navigation Planning, which focuses on future capital investment planning. This third component is the basis for the Corps of Engineers' Upper Mississippi River and Illinois Waterway System Navigation Study which is in the second phase in a two-phase planning process.

Upper Mississippi River and Illinois Waterway System Navigation Feasibility Study

Authority for the navigation system study is Section 216 of the Flood Control Act of 1970 (Public Law 91-611). St. Paul, St. Louis , and Rock Island Districts of the U.S. Army

Corps of Engineers, with oversight provided by North Central and Lower Mississippi Valley Divisions, completed the reconnaissance phase study in December 1992. This was the first step in addressing capital investment planning for the system for the years 2000-2050. The multi-disciplined study team also prepared an Initial Project Management Plan (IPMP), which acts as a blueprint for conducting the feasibility phase of the study.

The purpose of the feasibility study is to determine the feasibility of navigation capacity improvements. This will be accomplished through a system-wide economic and environmental analysis. Through the system-wide analysis, the Corps will identify and prioritize needs, quantify costs and benefits, and recommend actions for the system. The study, estimated to cost nearly $40 million over six years, will result in a report to Congress recommending construction authorization of improvements which are justified within a 50-year planning horizon.

The feasibility study is being conducted by three Corps of Engineers Districts: St. Louis, St. Paul, and Rock Island. The study team is organized into five major work groups. Each work group has members from each of the three districts. The work groups include environmental, economic, engineering, public involvement, and study and project management.

Study Components

Environmental

The purpose of the environmental studies is to produce a system-wide environmental impact statement and preliminary investigations of specific sites recommended for navigation improvements with the conduct of scientific studies to evaluate system-wide physical and biological impacts of navigation traffic. Additional tasks include the development of data management methodologies and mathematical models to couple physical and biological study outputs to generate information on impacts to biological resources. In accomplishing its work, the environmental work group is utilizing several committees. These include a Navigation Environmental Coordinating Committee, a Technical Coordinating Committee, and Technical Work Groups. The Navigation Environmental Coordinating Committee is for the purposes of doing required coordination with state and federal resource agencies. The committee also provides input on the specific studies the environmental work group is conducting. The Technical Coordinating Committee, currently being formed, will assist in the design and development of scientific studies. The purpose of the technical work groups is to gather necessary expertise for a specific study and to assist in preparation of scopes of work for those studies.

Environmental Studies. The major studies being conducted by the environmental work group include the following:

Study 1	Data Management and Math Modeling
Study 2	Analysis of Illinois State Water Survey Data
Study 3	Physical Effects Model Study
Study 4	Sedimentation of Backwaters and Side Channels
Study 5	Bank Erosion Study
Study 6	Spatial Data Base Development

Study 7	Adult Fish
Study 8	Fish: Early Life Stages
Study 9	Fish: Drawdown Impacts
Study 10	Plant: Waves Impacts
Study 11	Backwater: Recreation
Study 13	Mussels: Assessment and Impact
Study 15	Fish: Specific
Study 16	Plant: Sediment

Historic Properties. The historic properties effort is an additional component of the environmental work group. The purpose of this component is compliance with the National Historic Preservation Act and the National Environmental Policy Act (NEPA). The major work efforts include consolidation of existing data, site-specific study of potential construction sites, and geomorphological landform modeling impact extrapolation. The total environmental effort, including historic properties is approximately $16 million.

Economics

The primary objective of the economics effort is to measure beneficial contributions to National Economic Development. Major work efforts include assessment of existing conditions and the future without project conditions Alternatives for the with-project condition will also be assessed. The work group is also providing support to the environmental work group with information needed for NEPA evaluation. The total economic investment is approximately $3.5 million.

Engineering

The engineering work group will perform analyses to evaluate the future without-project and the future with-project. The future without-project will include a projection of future operation and maintenance costs and future rehabilitation costs which will be required to keep the system operational. The future with-project analysis will include the feasibility and costs for small scale enhancements and large scale improvements. These costs will be used in the evaluation of alternatives. The total engineering work effort is approximately $14.6 million.

Public Involvement

The two main purposes of the public involvement program is to inform and educate the public and to include the public in the decision-making process. These purposes or objectives will be accomplished by public meetings, workshops and newsletters. The work group will summarize public opinion and input for use by the study team. The total public involvement effort is funded at approximately $850,000.

Study Management

The study and project management work group is responsible for coordination of the overall study team effort, financial management and funds control, to facilitate resolution of project issues, and actuate the plan formulation process. The study management team prepares and presents briefings and is involved in the federal budget process. The management team is also responsible for preparation of the final feasibility report. The study and project management effort is funded at approximately $4.7 million.

SUMMARY

The U.S. Army Corps of Engineers has initiated a six-year, $40 million feasibility study to determine the need for future navigation capacity expansion on the Upper Mississippi River and Illinois Waterway Navigation System. The study includes a system-wide Environmental Impact Statement. The study will result in a report to Congress recommending construction authorization of improvements which are justified within a 50-year planning horizon.

REFERENCES

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SEDIMENTATION AND IN-STREAM SEDIMENT MANAGEMENT

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ABSTRACT

Erosion and sedimentation are natural processes that cannot be stopped or eliminated entirely. Both processes have been accelerated by human intervention such as alteration of stream courses, construction of dams, changes in flow regime, constriction on and alterations of floodplains, and drastic changes in land use patterns. Consequently erosion and sedimentation have a significant impact on the Illinois River, including its backwater and bottomland lakes. According to the Illinois State Water Plan Task Force report published in 1984, erosion and sedimentation is the major critical issue in water resources facing the State of Illinois. The Illinois River basin, which drains about 44 percent of the State of Illinois, obviously contributes significantly to this water resources problem.

Recent research on erosion and sedimentation of the Illinois River has shown that about 13.8 million tons of sediment is delivered to the Illinois River valley annually. Out of this total sediment, 8.2 million tons are trapped in the valley, and the remainder is delivered to the Mississippi River. Most backwater lakes along the Illinois River have lost about 72 percent of their original capacity, and sediment has already filled in some of these lakes. This excessive rate of sedimentation has reduced the ecological and recreational value of most lakes along the river, making sedimentation the most difficult and still unmanaged problem facing the Illinois River valley.

Research recently conducted by the Illinois State Water Survey has also shown that the Peoria and LaGrange Pools are the two major pools in which most of the sediments are produced and deposited. These are also the major areas in which most of the backwater lakes are located. The river changes significantly to a flatter gradient within the Peoria and LaGrange Pools, forcing the deposition of sediments at a much higher rate. By 1985 Peoria Lake had lost about 68 percent of its original capacity. The U.S. Army Corps of Engineers has been dredging the Illinois River at several locations to maintain adequate navigation depth with the Alton Pool requiring the most dredging.

The management of soil erosion and sedimentation in the Illinois River basin will be one of the major environmental issues in Illinois for years to come. Consequently, a comprehensive management plan needs to include two major components: erosion control and sediment management. The erosion control component includes developing programs to control watershed erosion, streambank erosion, and bluff erosion. The sediment management component will have to deal with four major issues: backwater sedimentation, main channel sedimentation, sediment removal at selected reaches, and sediment quality.

INTRODUCTION

Many investigators have studied the sedimentation problem of the Illinois River. Some of them are: Forbes (1911), Forbes and Richardson (1913, 1919, 1920), Collinson and Shimp (1972), Bellrose et al. (1983), Havera (1983), Lee and Stall (1976), Nakato (1981), Bhowmik and Schicht (1980), Cahill and Steele (1985), Bhowmik et al. (1986), Demissie and Bhowmik (1986, 1987), Bhowmik and Demissie (1989), and many others. This paper will not summarize past research, data collection, and analyses but instead will concentrate on more recent studies and their relevance for the Illinois River.

The total drainage area of the Illinois River is 28,906 square miles of which all but about 4,000 square miles is located within the State of Illinois. The river drains about half of the state and the majority of the population lives within this basin. Not only does the river contain some of the main rivers of the state but also it is a major artery for commercial navigation. In fact, about 60 percent of the traffic moving on the Mississippi River in Alton, IL, is generated on the Illinois River, which is a vital link for commercial and recreational traffic, the natural lifeblood of the State of Illinois.

Erosion and sedimentation are neither new nor unfamiliar on this basin. Streams and rivers naturally transport and deposit sediment within slack water areas, and sometimes even scour the deposited sediment. Within a riverine environment or on its contributing watersheds, it is the excessive amount of erosion and sedimentation that causes problems. The Illinois River has encountered erosion and sedimentation problems for many years.

It is estimated that about 200 million tons of sediments are eroded from Illinois watersheds each year. With a delivery ratio of about 20 to 25 percent, at least 40 to 50 million tons of sediment are annually delivered to ditches, drainage channels, streams, rivers, lakes, impoundments, and major rivers such as the Illinois, Mississippi or the Ohio. There is no quick fix. It will require a long and concerted effort by private, local, state, and federal entities and agencies to make headway on this major environmental problem facing the water resources of the State of Illinois.

HISTORICAL PERSPECTIVES

The Illinois State Water Plan (1984) identified erosion and sediment control as the number one critical water resources issue in the state after a three-year review and public discussion of all water resources issues within Illinois. The Water Plan Task Force concluded that "excessive soil erosion on 9.6 million acres of Illinois farmland is threatening their productive capacity, degrading water quality, accelerating eutrophication of reservoirs, silting streams, and degrading fish and wildlife habitat." After the first Illinois River Conference in 1987, Governor Thompson directed the task force to develop an action plan for implementing the major recommendations necessary to solve the most significant problems of the Illinois River basin. This plan ranked sedimentation as the most significant problem requiring immediate attention. It stressed the immediate need for further data collection on sediment sources and distribution. It also stressed the need for a sediment management program for Peoria Lake as well as to implement economical bank stabilization techniques.

In 1993 the Governor's Water Resources and Land Use Priorities Task Force addressed the issues of siltation and sedimentation. This task force made numerous recommendations addressing the problems of eroding streambanks and shorelines. The task force stated that streambank and shoreline erosion are major sources of sediment deposition in Illinois lakes and streams and significantly impair the overall water resourcs. The task force clearly recognized that an expanded streamgaging network is required to properly identify high-priority problem areas.

SEDIMENT LOAD

Main Stem

The Illinois River watershed is shown in Figure 1. Originating at the confluence of the Kankakee and DesPlaines Rivers, the Illinois River flows in a southwesterly direction until it empties into the Mississippi River near Grafton, IL. Over the years, the Illinois River has been altered by the construction of locks and dams to improve navigation and building of levees to protect highly fertile farmland and some river communities.

The profile of the river with its locks and dams is shown in Figure 2. The river changes to a flatter gradient near river mile 230. This change in gradient naturally accelerates the deposition of sediment in Peoria Lake, LaGrange Pool, and Alton Pool.

Demissie et al. (1992) investigated the sediment inflow to the Illinois River from the local tributaries. Their analysis was based on available data, and all calculations were based on the suspended sediment load data from tributary streams. A ten-year representative period, 1981-1990, was selected for analysis. The tributary streams of the Spoon and LaMoine Rivers had the highest sediment yield areas followed by the main stems of the Spoon, LaMoine, and Vermilion Rivers. Other streams contributing significant sediment loads were the Sangamon, Iroquois, and DesPlaines Rivers, with the least contribution by the Kankakee River.

Demissie et al. also developed a sediment budget scenario (Figure 3) for the entire Illinois River for this selected ten-year period. This figure also shows the gradual increase in the water discharges, with the Kankakee and the Sangamon Rivers as the major contributors of this flow. However, the sediment budget portion of the illustration indicates that the Peoria and the LaGrange Pools have the highest sediment loads. The Spoon, LaMoine, and Sangamon Rivers are the major contributors of the sediment load to the LaGrange Pool. The Vermilion River is another major contributor of sediment load to the Peoria Pool. As this figure amply illustrates, the lower reaches of the river receive relatively larger quantities of sediment load compared with the upper reaches.

Demissie et al. (1992) also estimated the annual sediment delivery to the Illinois River valley from its watersheds. Based on this analysis, approximately 13.8 million tons of sediment are delivered to the Illinois River valley annually. Out of this total sediment load, 8.2 million tons are trapped in the valley and the remaining 5.6 million tons are delivered to the Mississippi River. Most of these sediments are essentially deposited within the backwater areas, sloughs, and channel borders. An estimate of the effects of the 1993 flood on sedimentation, especially within the lower reaches of the Illinois River where levees broke, is not yet available.

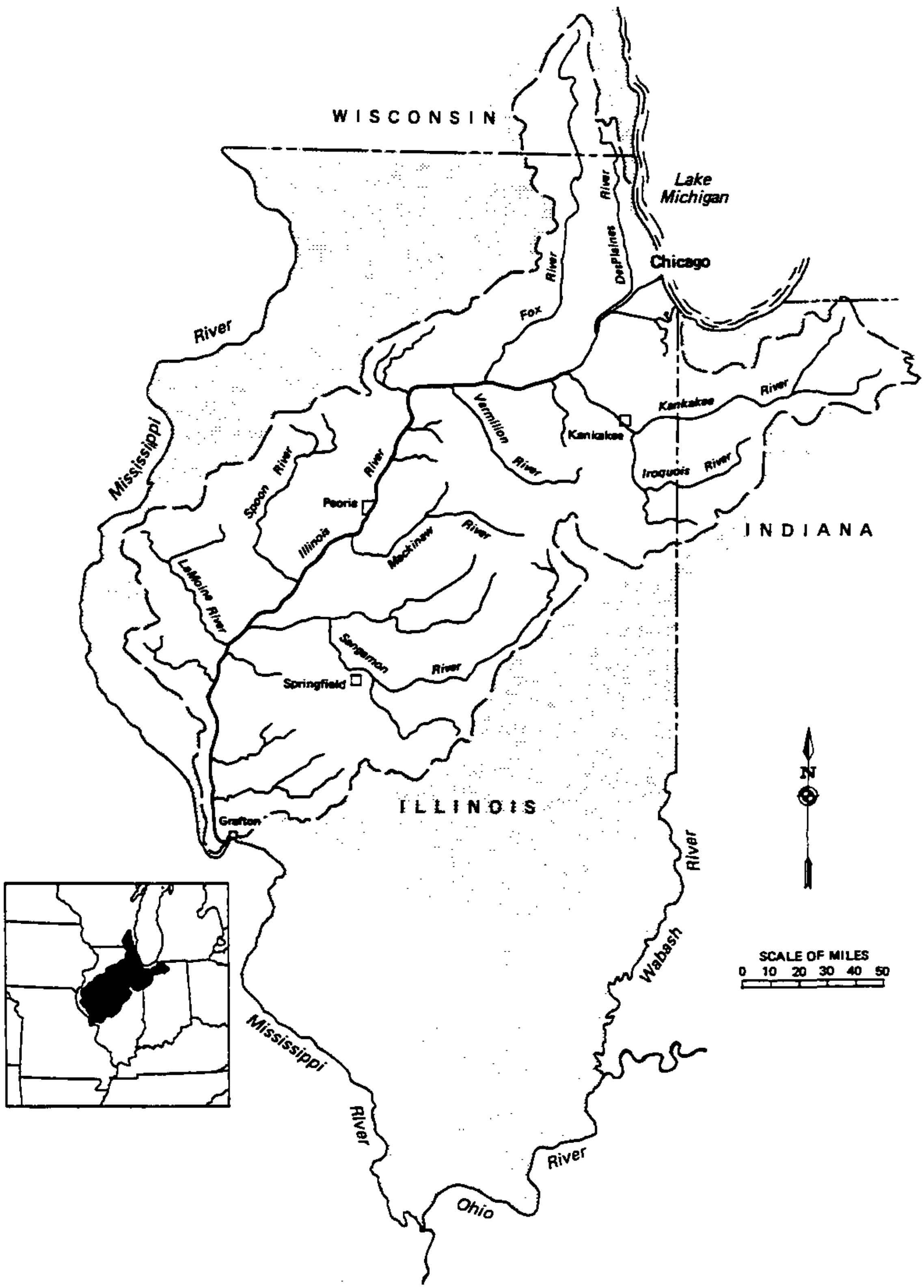

Figure 1. Watershed of the Illinois River.

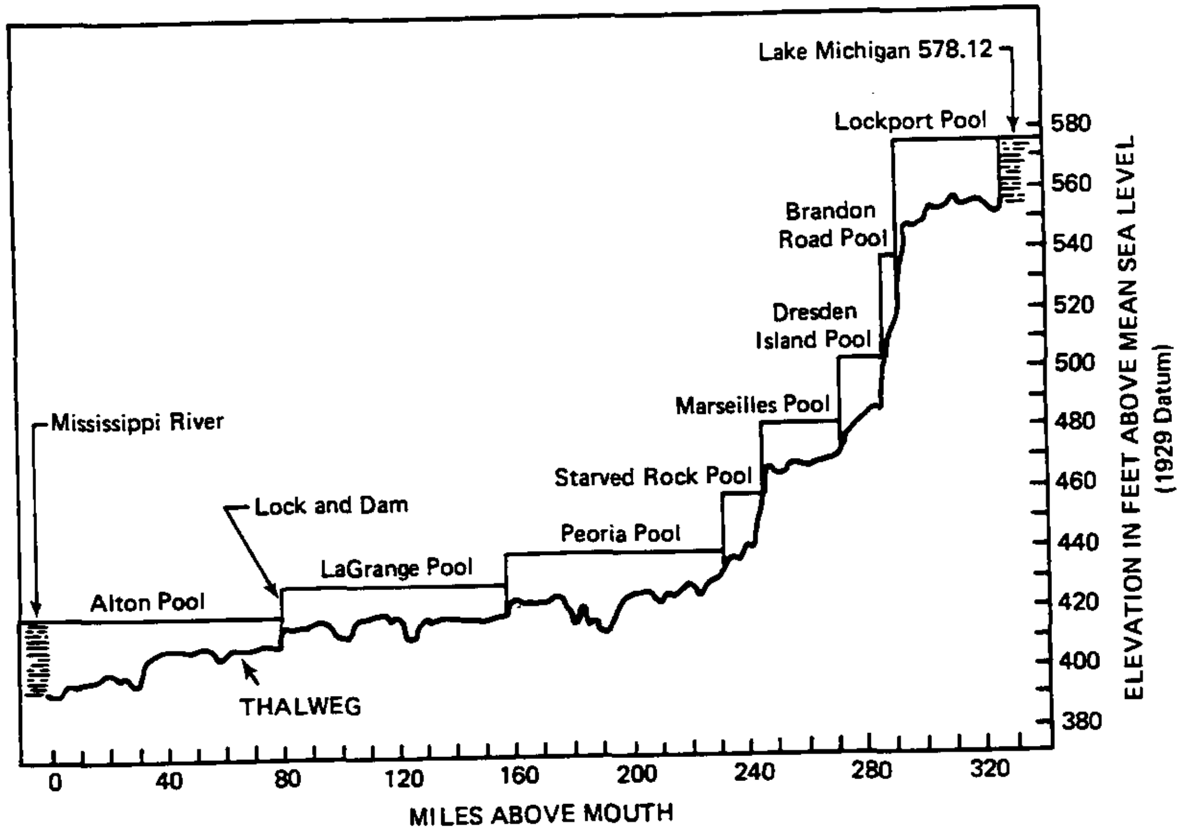

Figure 2. Profile of the Illinois Waterway.

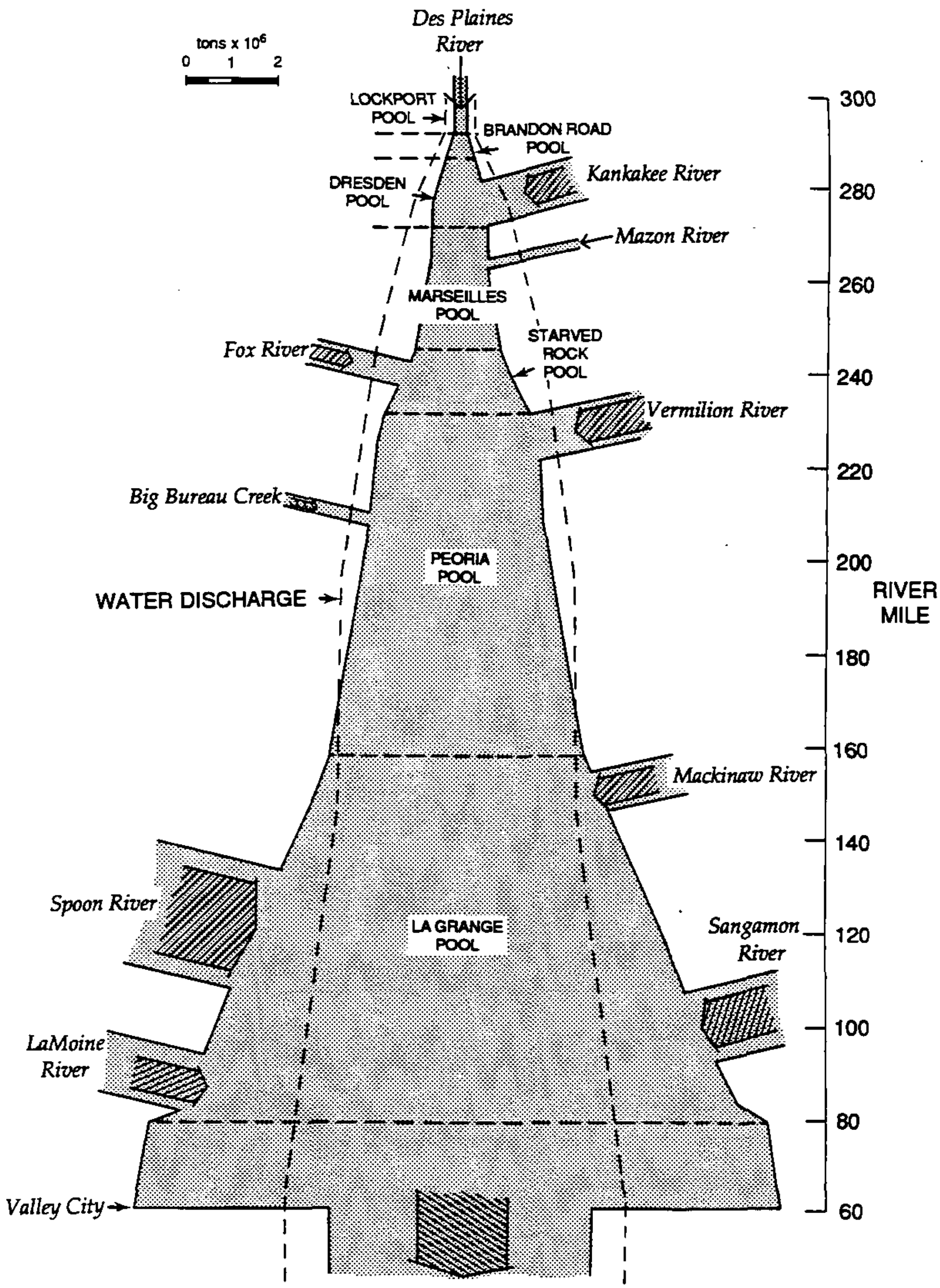

Figure 3. Sediment budget of the Illinois River (after Demissie et al., 1992).

Backwater Lakes

There are a large number of backwater lakes along the Illinois River (Figure 4). Most of them were created as a result of constructing locks and dams. Sediment deposition on selected backwater lakes was evaluated by Lee and Stall (1976), Bellrose et al. (1983), and Bhowmik and Demissie (1989). However, the last major set of data on sediment deposition within these backwater lakes was collected by Lee and Stall in 1975, and no new data have been collected except those for Peoria Lake (Demissie and Bhowmik, 1986).

Bhowmik and Demissie (1989) used Lee and Stall's data to estimate the present capacity of selected backwater lakes. In this calculation, the sedimentation rate for the 1975-1985 period was assumed to be the same as for the 1903-1975 period. Making this same assumption, Demissie et al. (1992) also computed the capacities of selected backwater lakes as of 1990 (Table 1). The percent capacity losses range from 22 to 100 percent, with an average of 72 percent. Obviously, some of the lakes are completely filled with sediments, and others no longer function as backwater lakes. Because these estimates were based on the data collected in 1975 by Lee and Stall (1976), a better quantification of the sedimentation rates within these backwater lakes is not possible without collecting new data.

Peoria Lake

Peoria Lake is the largest bottomland lake along the Illinois River. Even though it was known that Peoria Lake has been losing its capacity at a much higher rate than comparable lakes in Illinois, no definitive investigation of its sedimentation rate was done until the research completed by Demissie and Bhowmik (1986). Their study showed that by 1985 the lake has lost about 68 percent of its 1903 capacity. The estimated rate of sediment accumulation for Peoria Lake from 1976 to 1985 was 2 million tons per year compared to 1.7 million tons per year for the period 1965 through 1976. The local tributaries to Peoria Lake contributed about 2 million tons of sediment per year compared to a rate of 1.7 million tons per year for the period 1965 through 1976. Although the local tributaries of Peoria Lake contain about 4 percent of the drainage area, they may be contributing up to 50 percent of the sediments delivered to the lake.

The Illinois State Water Survey has completed a two-year study to determine the relative magnitude of the sediment loads contributed by the main stem of the Illinois and the local tributaries of Peoria Lake (Bhowmik et al., 1993). Ten local tributaries were monitored to determine the inflow of sediment and water from them. Long-term average coarse material deposition at the mouths of the tributaries as bed load was estimated based on the progression of the deltas at the base of these tributaries. Sediment inflow to Peoria Lake from the Illinois River was based on the estimated sediment load at the Henry gaging station. Table 2 shows the inflow of sediment to Peoria Lake from various sources during Water Year 1989 (WY89), essentially a dry year, and WY90, an average year. Present analyses show that about 1.2 million tons of sediment flowed into Peoria Lake in WY89 and about 2.7 million tons in WY90. No sediment budget for the lake was determined due to a lack of sedimentation surveys and nonavailability of sediment outflow data from the lake. However, this analysis did indicate that in WY89, the sedimentation rate in Peoria Lake was probably less than that determined on a long-term basis by a previous Water Survey study (Demissie and Bhowmik, 1985). Sedimentation in WY90 in Peoria Lake was probably the same or slightly less than that postulated in Demissie and Bhowmik, 1985.

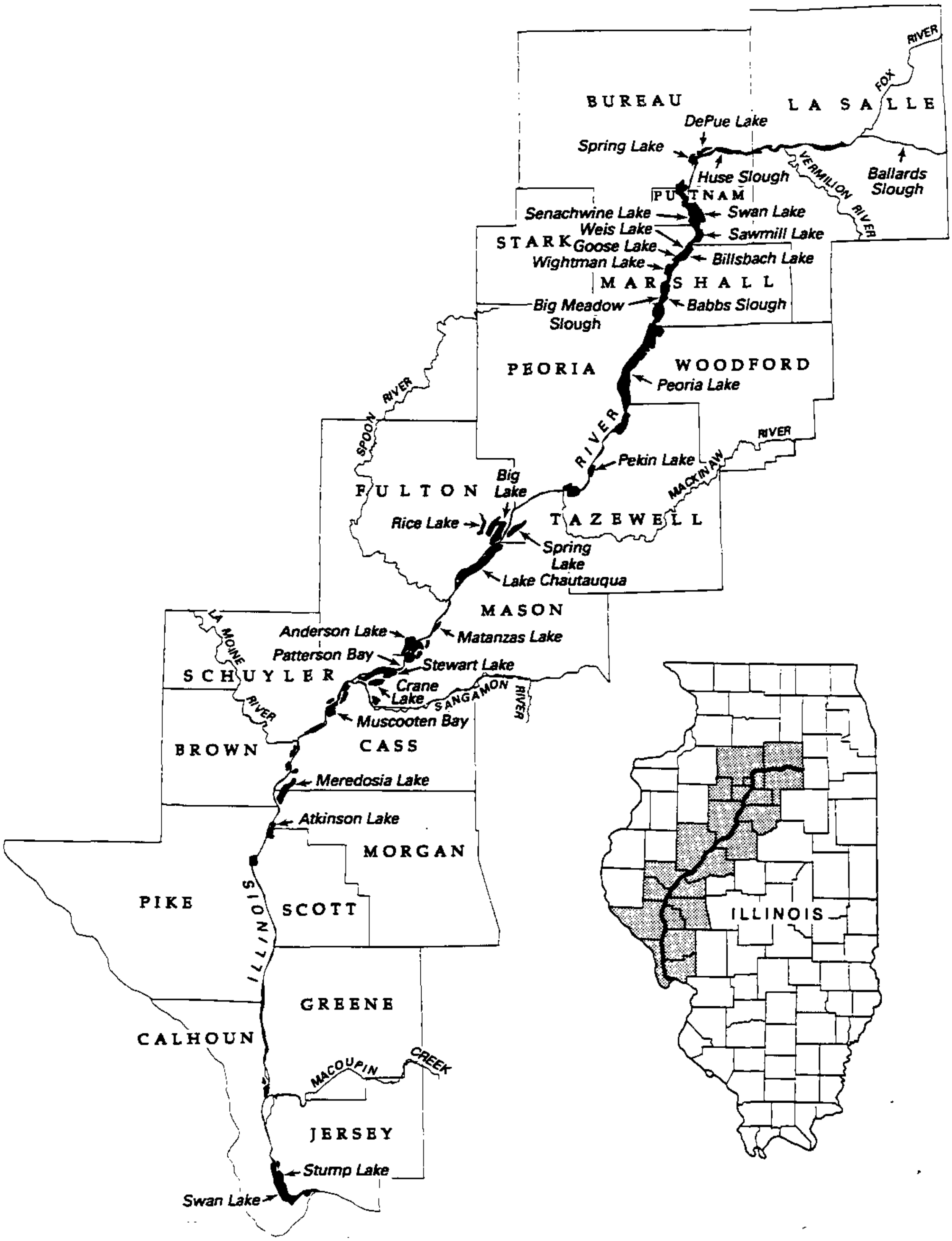

Figure 4. Location of backwater lakes along the Illinois River.

Table 1. Estimated Sedimentation and Capacities of Backwater Lakes in the Illinois River Valley as of 1990. After Demissie et al. (1992).

Pool	*Lake Name*	*River Mile*	*Capacity (acre-feet)* 1903	1975	1990*	*Sedimentation rate (in/yr)*	*Capacity loss (percent)*
Alton	Swan Lake	5	4,816	2,783	2,359	0.18	51
	Lake Meredosia	72	7,791	4,207	3,460	0.43	56
LaGrange	Muscooten Bay	89	1,459	184	0	3.12	100
	Patterson Bay	107	271	165	143	0.31	47
	Lake Chautauqua	125	14,293	11,679	11,134	0.33	22
	Rice Lake	133	3.064	1,119	714	0.32	77
	Pekin Lake	153	323	226	206	0.08	36
Peoria	Peoria Lake	162	120,000	56,600	29,150	0.79	76
	Babb's Slough	185	1,377	625	468	0.14	66
	Weis Lake	191	450	110	39	0.15	91
	Sawmill Lake	197	2,110	381	21	0.47	99
	Lake Senechwine	199	9,240	2,468	1,057	0.30	86
	Lake DePue	203	2,837	778	349	0.59	88
	Huse Slough	221	253	51	9	0.96	96
Marseilles	Ballard's Slough	248	142	36	14	0.91	90

Note: *The 1990 capacity was estimated based on the data available as of 1975.

Table 2. Sediment Inflows to Peoria Lake, in tons, after Bhowmik et al. (1993).

Component	*WY89*	*WY90*
Suspended load, Illinois River	800,600	1,218,000
Bed load, Illinois River	80,000	122,000
Suspended load, tributaries	100,541	613,334
Bed load, tributaries	219,000	730,000
Total	1,200,141	2,683,334

This analysis presented for Peoria Lake indicates that in developing any sediment management alternatives for the Illinois River, especially the backwater lakes, side channels, and sloughs, consideration must also be given to the management of sediments generated by local tributaries. In fact, it will probably be much more feasible to partially control sediment from a local but small tributary than from the entire Illinois River watershed.

Sediment Removal

The U.S. Army Corps of Engineers has been dredging portions of the Illinois River to maintain a 9-foot navigation channel. Because the dredging has been based on the navigational needs, it was not always done uniformly. Sometimes, especially in the earlier years, dredging was based on equipment availability and the area that was possible to be dredged in a single year. Dredging is done on a need basis requiring dredging operations to be done for several years in the same general area.

Data on dredging volumes were obtained from the Rock Island and St. Louis Districts of the U.S. Army Corps of Engineers (personal communication, Dick Baker and Mike Cox, 1993; Marge Robins, 1993). These data were arranged on a pool by pool basis and also on a yearly cycle. The cumulative dredging volume is plotted in Figure 5. Data on the Alton Pool are available from 1963 to the present. A quick glance at the figure indicates that all the dredging is confined to three pools, Alton, LaGrange, and Peoria. Thus these pools are the areas where sediment deposition is a problem requiring periodic dredging to maintain a 9-foot navigation channel.

Examination of Figure 5 will also show that the Alton Pool required the highest volume of dredging compared to the Peoria and LaGrange Pools. It also appears that sediment removal in Peoria Pool appears to have reached a steady state compared to the LaGrange and Alton Pools where it has been increasing steadily. This may also be an indication that the Peoria Pool may be approaching a dynamic equilibrium as far as the sediment transport and sedimentation are concerned compared to the LaGrange and Alton Pools. Quite possibly the LaGrange Pool will reach its dynamic equilibrium in the next two to three decades.

Management Strategies

The management of soil erosion and sedimentation in the Illinois River basin will be one of the major environmental issues in Illinois for many years. The problem cannot be solved easily or quickly. Unless a comprehensive, coordinated program is developed, proper management of the problem is unlikely. A comprehensive management plan for soil erosion and sedimentation needs to encompass erosion control and sediment management. The erosion control component includes developing programs to control watershed erosion, streambank erosion, and bluff erosion. The sediment management component will have to deal with three major issues: backwater sedimentation, main channel sedimentation, and sediment quality.

Sedimentation of Illinois waterways affects aquatic habitats, impedes the operation of commercial and recreational traffic, constricts the conveyance channel, and transforms these water bodies into shallows and wetlands. Various alternatives can be implemented to alleviate the chronic sedimentation of the Illinois River. A concerted effort by Illinois' natural resources agencies, in cooperation with local interest groups, is essential in evaluating, initiating, and implementing solutions for revitalizing selected backwater and bottomland lakes along the Illinois River.

Before a course of action is recommended, it must be understood that the Illinois River cannot be returned to its original condition. Moreover, some areas of the bottomlands and backwater lakes have undergone almost irreversible change and cannot be altered or revitalized without significant cost and effort. It is essential to thoroughly evaluate the backwater and bottomland lakes to identify which areas are of significant value to Illinois citizens. Once this determination has been made, efforts should concentrate on revitalizing only these high-value areas.

The last few Governor's Conferences on the Illinois River have identified siltation as the main problem facing the Illinois River. The following recommendations were developed after considering this as well as the other research reports evaluated for this paper. The recommended "courses of action" are divided into two broad categories: resource information and sediment management.

Resource Information

Basic information is essential in developing any management strategy intended to have a long-lasting impact. No recent data exists about sedimentation in backwater lakes, and there is only limited data about sediment loads carried by streams and rivers that drain directly into the Illinois River. Implementing the following recommendations will rectify this situation.

- Initiate and complete sedimentation surveys of selected backwater lakes to obtain information about the present state of these lakes. Establish a centralized data bank of physical, chemical, and biological data information, which is to be updated periodically. This will allow all the management agencies to initiate appropriate management alternatives. It will also enhance their ability to respond to critical issues during extreme events such as the Drought of 1989 and the Flood of 1993.

- Initiate and support a program to monitor instream sediment loads, including sediment quality at selected gaging stations on the tributaries and main stem of the Illinois River. Address and evaluate the effectiveness of various management alternatives for the Illinois River watersheds.

Sediment Monitoring

The "sediment management portion" is subdivided into three subheadings; Peoria Lake sediment management, in-lake management, and sediment input control. In-lake sediment management will have immediate impacts or benefits while sediment input control will probably start to show an impact on the receiving lakes within the next five to ten years. Intelligent meshing of "in-lake sediment management" and "sediment input control" is essential for long-lasting benefits for all the backwater lakes, including Peoria Lake. This management plan also includes demonstration projects that can be initiated easily by the State of Illinois' natural resources agencies.

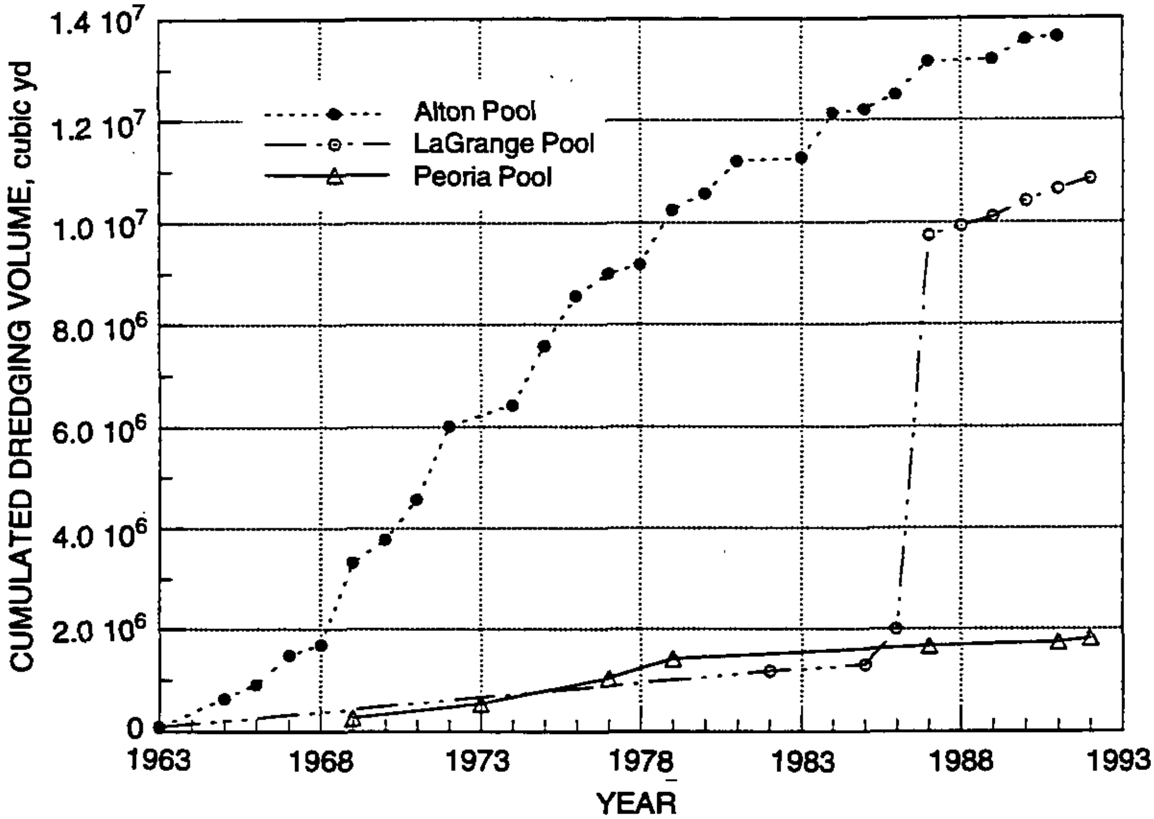

Figure 5. Dredging history on the Illinois River: Cumulative dredging volume since 1963.

Peoria Lake Sediment Management:

- Develop a comprehensive management program for Peoria Lake consistent with the recommendations made in various reports.
- Complete a comprehensive sedimentation survey of Peoria Lake. Without such a sedimentation survey, the present capacity of the lake and recent sediment deposition rate could not be determined.
- Continue to pursue the U.S. Army Corps of Engineers' FY89 environmental management program (EMP) funding for the island demonstration project in Peoria Lake. Prepare and submit other projects on Peoria Lake to the Corps of Engineers for consideration under their EMP.

In-Lake Management:

- Identify high-value areas beyond Peoria Lake and within the backwater and bottomland lakes. Develop a comprehensive management plan for these backwater and bottomland lakes.
- Develop and implement techniques for the removal of sediment by selective dredging. Conduct research to develop appropriate technology for this activity.
- Develop concepts and conduct feasibility studies for using dredged materials to create artificial islands, public parks, and playgrounds in the immediate vicinity of the dredging sites.
- Identify and develop techniques for controlling the sediment input to selected backwater lakes from the Illinois River by using methods such as gated control structures.
- Develop and implement management techniques for some or portions of the backwater lakes as shallow water wetlands and terrestrial habitats.

Sediment Input Control:

- Develop and implement economical bank stabilization techniques for streams located within the immediate vicinity of the river and backwater lakes.
- Implement best management practices on the highly erodible areas of the watershed.
- Notify the public that a state permit is required for stream channel modification or floodway construction.
- Modify Illinois Department of Transportation/Division of Water Resources permit requirements to include provisions to reduce erosion and preserve stream channel stability,
- Work with local units of government to encourage the incorporation of streamside vegetative buffers for all new and existing developments in both rural and urban areas.
- Review any state or federally funded projects on waterways, streams, rivers, lakes, or wetlands to determine their potential impact on the erosion and sedimentation of the concerned bodies of water.

CONCLUSIONS

Sedimentation of the Illinois River valley has been recognized as one of the major problems facing Illinois River. Out of the approximately 200 million tons of gross erosion occurring annually in Illinois, about one-half of it is generated within the watersheds of the Illinois River. It has been estimated that about 13.8 million tons of sediment are delivered annually to the main river, of which 8.2 million tons are deposited within the Illinois River valley and the river, and the remaining 5.6 million tons are discharged to the Mississippi River. Many backwater lakes along the river are now almost full of sediment and the average capacity loss is about 72 percent.

Peoria Lake, the largest bottomland lake along the Illinois River, has lost about 68 percent of its 1903 capacity by 1985. Recent inflow sediment data collected for Peoria Lake shows that in a drought year, the Illinois River contributes about 75 percent of the sediment and the remainder comes from the local tributaries. In an average year, however, the local watersheds and the Illinois River contribute approximately equal amounts of sediment load.

Sediment data analysis has also shown that the Peoria and LaGrange Pools are the two pools in which a major portion of the sediment load is generated. This is also verified by the amount of dredging that occurred in Peoria, LaGrange, and Alton Pools. From 1963 to 1992, a total of 1.2, 10.6 and 13.6 million cubic yards of sediments were removed from these three pools, respectively.

Management of sediment on the Illinois River will initially require the development of a comprehensive management plan, followed by the implementation and management of in-lake or in-stream sediment, and sediment input control. Sedimentation problems of the Illinois River must be addressed by controlling sediment inflows and by managing the sediment that is already present within the system. Without these two-pronged attacks, the sedimentation problems of the Illinois River valley cannot be solved.

ACKNOWLEDGMENTS

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AQUATIC BIODIVERSITY AND HABITATS OF ILLINOIS

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ABSTRACT

The diverse aquatic habitats of Illinois support over 3,000 species of freshwater animals, including protozoans, sponges, worms, water bears, beetles, midges, caddisflies, dragonflies, mayflies, stoneflies, mosquitoes, true bugs, snails, mussels, shrimps, crayfishes, copepods, amphipods, and fishes. For some of these groups (fishes, mollusks, crustaceans), the numbers of species historically found in Illinois are known and population trends well documented. For other groups, little if any information on their status, distribution, and life history is available, and data on population trends are lacking. Many groups such as fishes and mussels have experienced drastic declines in diversity (both in the number of species and of individuals). Some of the reasons for the declines are siltation, instream construction projects, navigation impacts, channelization, artificial impoundments, herbicides, pesticides, pollution, and competition from exotics. Through the cooperation of private industry, farmers, citizen groups, governmental agencies, schools, and the media, we may be able to reduce some of these impacts, designate streams for protection, and possibly slow the rapid loss of aquatic biodiversity in Illinois.

AQUATIC BIODIVERSITY

If you ask someone to think of an aquatic animal, the first thing that probably comes to mind is a fish. Most people who fish are familiar with some of the more common game species, including channel catfish, smallmouth bass, and the Illinois state fish, the bluegill. But if you were to ask someone how many different species of fish are found in Illinois, he or she probably couldn't tell you. It is therefore no surprise that most people don't have the slightest idea how many species of freshwater sponges or dragonflies occur in our state, or why it's important to know such things. Thus, we need to continually educate the public about the importance of biodiversity. For example, we need to explain that one of the reasons dragonflies are important is that they consume vast numbers of the 60-plus species of mosquitoes found in Illinois. We need to enlighten the fishermen that there are 126 species of mayflies and approximately 1,000 other species of aquatic insects that serve as a food source for the catfish, bass, and walleye in our streams and lakes. In fact, there are thousands of aquatic animals found in Illinois, most of which the average citizen never sees, that play an indirect but extremely important role in our lives (Table 1).

Table 1. Numbers of species of aquatic animals found in Illinois. Data from Post (1991).

	Illinois	North America
Protozoans	1000's	
Sponges	14	
Hydra & Freshwater Jellyfish	11	
Flatworms	?	~200
Gastrotrichs	60	
Rotifers	150-175	
Nematodes	?	~500
Worms	126	
Bryozoans	?	23
Tardigrades (Water Bears)	13	
Water Mites	?	~1500
Insects	~1200	
Crustaceans	179	
Fishes	187	
Mollusks	176	

Unfortunately, many of the numbers in Table 1 are estimates. The state lacks the personnel with the necessary expertise to identify and conduct research on most of the organisms found in our waters. For groups that are economically important (i.e., fishes, mussels, crayfish), the biology and distribution are fairly well understood, but most other groups have not been studied in any detail and their diversity and distribution are virtually unknown.

AQUATIC HABITATS

Illinois, perhaps more than any other state, is defined by its waterways. You can easily pick out our state on a map or satellite photo of North America just by looking at the streams and lakes. Illinois is bounded on the northeast by Lake Michigan, on the west by the Mississippi River, on the south by the Ohio River, and on the east by the Wabash River. The Illinois River cuts across the state, running from Lake Michigan to the Mississippi River. Because of its location, its proximity to large rivers, and its relatively large latitudinal range, a wide variety of aquatic habitats are present in Illinois, including over 2,700 named streams that make up over 26,000 miles of inland waterways (IDOC, 1992). Illinois can be subdivided into five main physiographic provinces, each of which has unique habitats (Fenneman, 1938).

- The Great Lakes - Lake Michigan Basin
- The Wisconsin Driftless Section
- The Till Plains Section
- The Shawnee Hills-Ozark Plateaus Section
- The Coastal Plains Section

The geological history of each of these areas has influenced the distribution and diversity of aquatic animals found within the state, and many of these regions contain species found nowhere else in Illinois. For example, the Coastal Plains, south of the Shawnee Hills, contains the only Illinois populations of the crayfish, *Orconectes lancifer*, the taillight shiner, *Notropis maculatus*, and a freshwater mussel called the Texas lilliput, *Toxolasma texasensis*.

Protection of Streams and Riparian Habitat

The focus of habitat preservation since the turn of the century has been on terrestrial habitats, with little attention given to aquatic systems, particularly flowing waters. Although the general public has long been interested in clean water for drinking, swimming, and fishing, interest in the protection of aquatic ecosystems has largely been the concern of a few dedicated scientists, private citizens, and conservation organizations with little financial or political power to achieve their goals.

The importance of aquatic ecosystems is slowly being recognized by the general public, business, and government. Natural resource managers are beginning to shift their attention from terrestrial habitats, such as prairies and forests, to streams and their associated biodiversity. On the federal level, since the enactment of the Wild and Scenic Rivers Act of 1968, 15,000 km of streams and their associated flood plain habitats have been protected. Although this program has been a success, far more work needs to be done (fewer than 1,600 km occur east of the Mississippi River). Of the original 5.2 million km of rivers in the contiguous United States, only 42 free-flowing stream segments greater than 200 km remain (Benke, 1990). In 1982 the National Rivers Inventory was completed and identified streams of high quality with potential for protection. Only 2% of the 5.2 million km of streams qualified for inclusion in the inventory.

The biodiversity of streams is being degraded or destroyed at an alarming rate both nationally and within Illinois. In North America, roughly one-third of our native fish species and over 70% of the freshwater mussels are considered to be endangered, threatened, or of special concern (Williams, et al. 1989, 1993). In Illinois, many aquatic species have already been lost from our rivers, and many others are presently considered to be endangered. If we look at the groups for which we have the best data (fishes, mussels, and crayfish), we see an alarming reduction in the number of species since the turn of the century with an incredibly high percentage of those remaining on the threatened or endangered species list (Table 2). What is most troubling is that many aquatic species are still in decline, and at least five of the 12 species of fish extirpated from Illinois have been lost since 1950 (Burr, 1991). Some scientists claim that "water quality" is improving citing studies that show that fish and invertebrates are returning to streams which were devoid of life a few decades ago. But the fact of the matter is that we are still losing species at an alarming rate and that the primary reasons are siltation from poor land management (largely agricultural) and urbanization.

Table 2. Numbers of Illinois threatened, endangered, and extirpated fishes, mussels, and crayfish.

Group	Threatened	Endangered	Extirpated	Total (% of native fauna)
Fishes	9	21	12	42 (22%)
Mussels	4	20	15	39 (50%)
Crayfish	-	4	1	5 (22%)

The decline in aquatic organisms is far greater than that documented for terrestrial species and attests to the magnitude of the problem and the inadequacy of water protection measures in Illinois and other states. Over 30% of all threatened and endangered species in Illinois are associated with aquatic and wetland habitats, including more than 61% of all state-listed animal species (Figure 1).

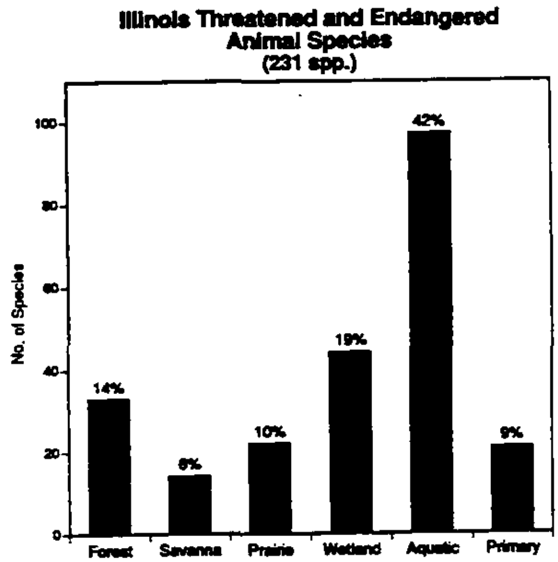

Figure 1. Number of threatened and endangered animal species and percent of the total by habitat type. Data from Jim Herkert, Illinois Dept. of Conservation, Division of Natural Heritage.

Causes of Stream Degradation and Loss of Biodiversity

Efforts at stream protection without a plan to eliminate the sources of degradation are ultimately going to fail. Smith (1971) identified factors responsible for the loss of fish diversity in Illinois: siltation, drainage of lakes, sloughs, and wetlands, drought, pollution, dams and impoundments, elimination of riparian habitat and subsequent temperature increase, and species interactions (native and exotics).

These factors are also responsible for the loss of species in other aquatic groups, including amphibians, mussels, crayfish, insects, and plants. One of the recent and potentially most damaging factors is the increase in exotic species found in Illinois waters (Table 3). For example, competition from the zebra mussel has had a devastating effect on native mussel populations and threatens to eliminate them from the Illinois River entirely. Recent attempts by misguided individuals to purposefully introduce yet another exotic, the black carp, *Mylopharyngodon piceus*, to act as biological control agent on zebra mussels is doomed to fail and will exacerbate the demise of our native mussels.

Table 3. Number of native and exotic species of aquatic fishes, mollusks, and crayfishes found in Illinois and the percentage of the total fauna represented by exotics.

Group	Native Species	Exotic Species	Total (% Exotic)
Fishes	187	22	209 (10%)
Mussels	78	2	80 (3%)
Crayfishes	23	1	24 (4%)

Efforts at Stream Classification and Protection in Illinois

The Illinois Natural Areas Inventory and Illinois Nature Preserves system have been highly successful in identifying and protecting representative examples of nearly all major terrestrial habitat types and communities in Illinois. As of August 1993, 230 sites totaling over 30,000 acres have been dedicated as Illinois Nature Preserves. These dedicated lands provide habitat for many rare terrestrial species: nearly 16% of all known locations for threatened or endangered animal species are found within dedicated Illinois Nature Preserves (Figure 2). However, at present only one stream segment has been designated as an Illinois Nature Preserve, and less than 6% of all known occurrences of threatened or endangered aquatic animals in Illinois occur within waters flowing through or encompassed by Illinois Nature Preserves (Figure 2).

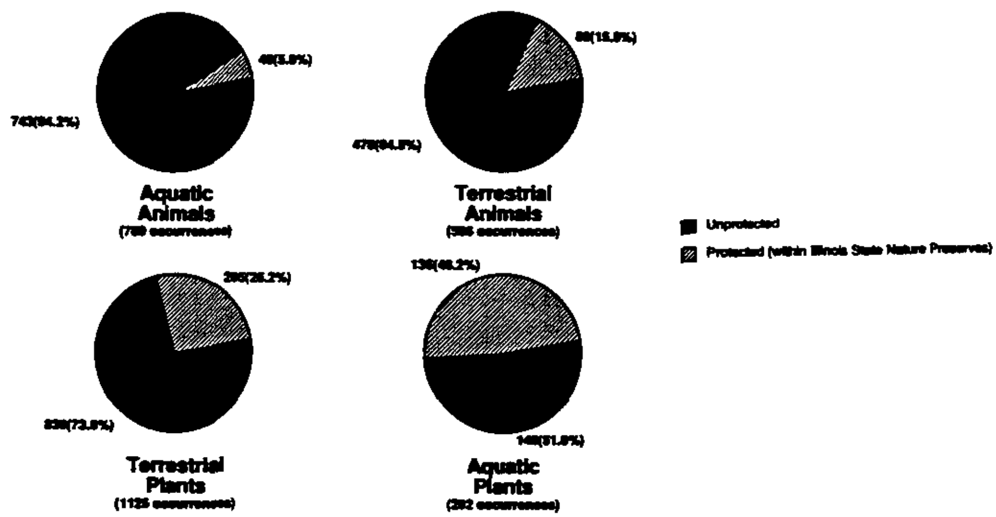

Figure 2. Percentage of known occurrences of threatened and endangered species found within Illinois Nature Preserves.

Protecting streams presents new challenges to resource managers and conservationists. When protecting a tract of land, it is relatively easy to identify the property owner and plan for the acquisition of the property in question. In trying to protect streams it is necessary not only to protect the water and underlying land but also the riparian habitat and the land within the entire watershed. Purchasing an entire drainage is both expensive and impractical. If the overall goal of stream conservation is to protect the biodiversity of the system, a multifaceted approach is needed. This approach needs to address the problems of water quality, loss of habitat, and reduction of harmful land use practices in the watershed. As was stated by Page (1991), it is far better and less expensive to protect existing high quality habitat than to try to restore an already degraded system. A few of the recent efforts at education and stream protection in Illinois include:

- Smith (1971) was the first to analyze, document, and identify the reasons for the disappearance of native fish species in Illinois from a statewide historical perspective.
- The Governor's Conferences on the Management of the Illinois River (1987, 1989, 1991, 1993). These conferences bring together people from various disciplines to discuss the use, management and conservation of the resources of the Illinois River drainage.
- Illinois Nature Preserves Commission's 25th anniversary symposium, "Preserving the Aquatic Biodiversity of Illinois: Inventory, Research, Regulation," held in Carbondale in 1989 (Phillippi & Anderson, 1989). This was the first meeting focusing specifically

on the aquatic environment in Illinois. A list of the top 13 outstanding streams of Illinois was first proposed at this meeting (Page et al., 1989).

- The Biological Streams Characterization or BSC (Hite & Bertrand, 1989). The BSC is a stream quality index developed by the Illinois Department of Conservation and the Illinois Environmental Protection Agency to categorize streams based largely on fish populations, water quality, and some data on aquatic macroinvertebrates. In the BSC system streams are categorized from "A" (highest quality) to "E" (lowest quality). Twenty-four streams or stream segments are currently considered to be in the "A" category, and 50 are in the "B" category.
- Illinois Natural History Survey symposium, "Our Living Heritage: The Biological Resources of Illinois" (Page & Jeffords 1991), held to commemorate the 20th anniversary of Earth Day. A session on streams and their biodiversity was held which focused on the loss of habitat and the plight of aquatic organisms in Illinois.

Other recent projects include: the Rivers Curriculum Project (a network of students at secondary schools around the Midwest gathering water quality data and learning about the importance of stream ecosystems started by Dr. Robert Williams, SIC - Edwardsville); the Illinois Riverwatch Network. (discussed earlier today by Pat Reese); and the Mackinaw River Project (educating high school students about the diversity of organisms found in streams - Mike Reuter, Illinois Nature Conservancy).

Biologically Significant Streams of Illinois

Society, through the formation of environmental protection agencies and endangered species lists, has mandated that maintaining biodiversity should be a high priority. Because of the large-scale modifications that have occurred in Illinois over the past 200 years, we are faced with protecting almost all native species. It should be our objective to preserve and protect 100% of the stream-dependent biodiversity. However, due to limited resources, we must concentrate on identifying and protecting those streams with the highest species diversity or those that contain rare or endangered species. We can identify these streams because Illinois has the best long-term data sets on aquatic organisms in the country. We have excellent data on fishes, mollusks, and crustaceans. We know more about the diversity of plant and animal species inhabiting our lakes and streams than any other state. By combining these data bases, we can identify those streams or stream segments that contain the highest diversity and are most in need of protection.

A recently completed study conducted by Illinois Natural History Survey (INHS) scientists with funding from the Illinois Department of Conservation (IDOC) and the Illinois Department of Energy and Natural Resources identified the Biologically Significant Streams of Illinois (Page et al., 1992). INHS biologists identified 108 streams or stream segments supporting populations of endangered, threatened, and watch list species or those supporting a high diversity of mussels. These streams plus the 24 streams designated as "A" streams in the BSC Classification bring to 132 the number of biologically significant streams currently recognized. These streams or stream segments are now being added to the Illinois Natural Areas Inventory.

AQUATIC BIODIVERSITY OF THE ILLINOIS RIVER DRAINAGE

The results of the study on the Biologically Significant Streams of Illinois showed that most of the streams with extant populations of threatened or endangered species or high mussel diversity are located in the Wabash/Ohio River drainages. Because of the geological history of the area, the streams in these drainages are home to many aquatic species not found in the rest of the state.

The Illinois River drainage is relatively diverse but contains no endemic species. In addition, the watersheds in the Illinois River drainage have been extensively cultivated and modified which has resulted in a severe reduction in species diversity. Still, there are many streams (e.g., the Mackinaw and upper Sangamon River) which still contain a diverse fauna and are worthy of protection. The number of native species of fishes, mussels, and crustaceans historically known to occur in each of the major drainages of the Illinois River Basin is given in Figure 3. Although many of the streams of the Illinois River drainage had a diverse aquatic fauna in the past, if we look at three of the drainages for which were have data since 1980 (Illinois, Sangamon, and Mackinaw), we see that the number of species of fishes and mussels has declined dramatically. In the case of the Illinois River proper, the reduction has been close to or above 50% (Table 4).

Figure 3. Number of fishes (F), mussels (M), crustaceans (C), and total species (T) found in each of the major drainages of the Illinois River (shown in map at right).
Data from Illinois Natural History Survey collections.

River/Drainage	F	M	C	T
1. Illinois River	125	47	10	(182)
2. Des Plaines River & Lake Michigan tribs.	86	34	16	(136)
3. Fox River system	91	31	12	(134)
4. Little Vermilion River, etc. system	71	7	10	(88)
5. Kankakee - Iroquois River system	86	35	13	(134)
6. Vermilion & Mazon River systems	72	29	13	(114)
7. Spoon River system	65	41	11	(117)
8. LaMoine River system	52	13	10	(75)
9. Mackinaw River system	79	28	9	(116)
10. Sangamon River system	88	47	18	(153)
11. Lower Illinois River tributaries	65	10	13	(88)

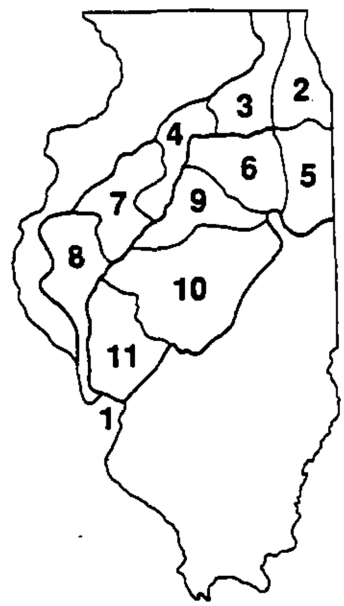

Table 4. Reduction of native fish and mussel species in the Illinois, Sangamon, and Mackinaw rivers, 1890s-1990s. Data from Illinois Natural History Survey Collections, Havana Field Station, and IDOC, Division of Fisheries.

	Illinois River	Sangamon River	Mackinaw River
No. of native fish species known	125	88	79
No. of native fish species today	69	65	60
Net Loss	**56 (45%)**	**23 (26%)**	**19 (24%)**
No. of mussel species known	47	47	28
No. of mussel species today	23	33	20
Net Loss	**24 (51%)**	**14 (30%)**	**8 (29%)**

CONCLUSION

The decline, extirpation and extinction of aquatic organisms is inextricably linked to habitat loss and degradation. Although the protection aquatic ecosystems has lagged considerably behind their terrestrial counterparts, recent efforts and programs within government, private organizations, and the public are encouraging. While it is too late for many species, large populations of rare and endangered plants and animals can still be found in Illinois' waters and protected. Water quality and the biological integrity of aquatic ecosystems are essential to the health and economic prosperity of the human race. Unless we begin to strike a balance between conservation and exploitation, and set aside certain areas that are strictly off-limits to development, the extinction of aquatic species will be the first in a series of declines in biodiversity that will forever diminish our quality of life.

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WATERSHED PROTECTION APPROACH
A STRATEGY FOR COMPREHENSIVE RESOURCE MANAGEMENT

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T.E. Davenport, U.S. EPA Region 5

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ABSTRACT

The goal of the watershed approach is to maintain and improve the health and integrity of aquatic ecosystems using comprehensive approaches that focus resources on the major problems facing these systems within the watershed context. To accomplish this, at a minimum, the following type of activities must occur: (1) align resource programs to support risk-based watershed planning and management based upon scientific data; (2) promote the development of partnerships between local, state, and federal agencies; (3) address the primary threats to ground and surface waters; (4) effectively measure progress towards restoring, maintaining, and protecting waterbodies and aquatic habitats; and (5) promote stewardship, and a broad understanding of, and participation by, the public.

INTRODUCTION

The increased awareness of the interdependance of natural systems among resource stewards has resulted in the development of holistic approaches to managing natural resources. Holistic approaches recognize the various media that comprise our surroundings, such as water, air, and land. A portion of this holistic approach is represented in the development of a comprehensive watershed protection approach, whereby water programs recognize all relevant media.

The mandate of the Clean Water Act is to restore the biological, chemical and physical integrity of our nation's waters. While progress has been made towards meeting this goal, we are finding that the optimization of our efforts has been hindered by a fragmented approach towards identifying environmental concerns,identifying critical pollutants and their sources,and implementing management solutions. In Region 5 we have learned a great deal from efforts such as 208 plans,lakewide management plans (LaMPs) and remedial action plans (RAPs),about the environmental benefits of managing resources in the context of natural watershed boundaries. This experience has given us a vision of how watershed management can work if key water program efforts are brought to bear upon environmental issues.

The Region 5 Water Division has many opportunities for promoting, supporting, and enhancing watershed management. The Region 5 Water Division Watershed Protection Approach lays out the strategy for how the Water Division will make the transition to conducting all Division activities in a way that fully supports holistic management on a watershed basis. This strategy has been developed in two parts. The first part includes our vision statement, along with goals and objectives, for which action plans will be developed.

The second part consists of a watershed management process, the elements of which are critical components of sound watershed management. It is our intention to utilize this strategy to develop EPA/State agreements to identify minimum State requirements in support of the watershed protection approach.

Under the Watershed Protection Approach the Water Division will make decisions on actions (e.g., grants, program review, permits, enforcement, etc.) by assessing that action's potential impacts on the watershed, and selecting among alternative actions based on natural resource goals in that watershed.

REGION 5 WATER DIVISION WATERSHED PROTECTION APPROACH VISION STATEMENT, GOALS AND OBJECTIVES

In Region 5, the watershed protection approach has been developed around a common vision statement and strategic approaches or goals. Both serve as guiding principles in the development of the specific objectives for the watershed protection approach.

Vision Statement

To ensure that our natural resources are preserved, protected, and restored through effective and efficient implementation of programs on a watershed basis.

STRATEGIC APPROACHES

The strategic approaches which support the vision statement and provide the framework for watershed protection objectives are defined within the context of institutional goals. Region 5 will work cooperatively with States and other agencies through technical,financial and management assistance to ensure the implementation of these approaches.

Institutional Goals

<u>Goal 1: Establish, in cooperation with each State, a process which utilizes ecological risk assessment and other factors to identify and select priority watersheds for appropriate action.</u>

To minimize risk to ecological health by using ecological assessment in the priority setting and decision making process. Ecological risk assessment outlines a process whereby ecological goals are established,impacts and stressors to the natural system identified,ecological endpoints established,and program management alternatives developed in accordance with the ecological endpoints.

<u>Goal 2: Establish a Regional process for effective coordination across institutional boundaries on cross media issues.</u>

To develop a process within EPA Region 5 Water Division which supports the watershed approach. This framework will allow provide a focus on opportunities for program flexibility,coordination and integration at the State and Regional level which will ultimately yield the desired ecological goals.

Goal 3: Enhance State capacity to effectively address environmental issues on a watershed basis.

To provide the states within the Region the technical, financial, and management support required to implement the watershed approach

Goal 4: Encourage partnerships among all stakeholders in priority watersheds through open and effective communications.

To encourage and facilitate the partnerships amongst Federal, State,and local agencies who have a commitment to preserving,protecting and restoring the watershed.

Goal 5: Assure that good science is used in all phases of watershed management.

Through the use of existing watershed tools and expertise,ensure that watershed approaches are developed and implemented in the best way possible. Where watershed science is lacking, ensure that necessary science is developed and supported through technical assistance and training.

Goal 6: Demonstrate the effectiveness of the watershed approach through program and project monitoring and assessment.

Through the use of existing state efforts, build upon ongoing watershed management approaches thereby demonstrating the effectiveness of the approach. The demonstration will provide additional value to the current activities and support other long-term programs such as LaMPS, and RAPs.

APPROACHES FOR WATERSHED PROTECTION

In developing the regional watershed protection approach, it was necessary to examine general operational approaches with the Division as well as specific approaches within varying programs to determine to what extent they supported the vision statement and strategic approaches. To fully support these, there has to be changes in the approaches that Federal, State and local agencies presently utilize. These changes are described and discussed below.

Program Integration

EPA's Role and Responsibility

Watershed management occurs in distinct phases: Assessment/Data Gathering, Planning, Implementation, and Evaluation. To a great extent, EPA's level of involvement will be dictated by the phase that the watershed is in and the authorities that can be exercised. It is also necessary to recognize that a team effort needs to be employed to provide for effective management.

Within the context of a team approach, there may be times when EPA must wear the "black hat." There are times when EPA can wear the "white hat" to provide a forum for facilitation of voluntary efforts. As such, the Region must be flexible to carry out the intent of the Clean Water Act along with its "watershed partners."

Prioritization

Threats versus Impairments

The disparity in priorities,and the ever increasing requests for additional priorities raises the question of who,in the end,will be making the final decision on where to implement a watershed protection approach? What should be the criteria for prioritization of watersheds,and should EPA even be involved in the process?

Traditional views towards designating areas for watershed protection have looked to areas where significant degradation has occurred. Generally, because of the degree of degradation, the cost of restoration is enormous. In some cases true restoration will be impossible to achieve in a meaningful time frame.

An alternative view looks towards identifying those areas where resources are threatened. In these areas, restoration efforts may be less costly and demonstrable results can be achieved. Yet another option is to identify high quality resource areas that, once protected, could remain close to their existing high quality state. In this approach,success depends upon maintaining existing resource quality.

The Region, along with the states, needs to identify what their resource capabilities and goals are for implementing all phases of the watershed protection approach. Once resources are agreed upon, there could be room to consider the "political realities" of priority watersheds, and then to allow for the states to select watersheds.

Watershed Management Cycles

Watershed Specificity

The watershed protection approach recognizes that watershed management strategies or plans are specifically designed for the watershed in question. No two watersheds will contain the same natural resources or stressors, nor require the same implementation to assure ecological integrity.

Watershed cycles

An important consideration in approaching watershed management is the length of time necessary to adequately research, assess, plan and implement the approach. It is also important to consider timing in watershed approaches. Good planning and assessment takes time. The schedule is likely to vary with the size of the study area and extent of background information already available. The factor of time and timing cannot be understated. An agreed upon approach which brings to bear resources at the right time, for the right amount of time will certainly have more success than one that does not. A proposed watershed schedule is below:

Historical research/Assessment	3 years
Developing Goals/Objectives	1 year
Implementation	3 years
Evaluation	1 year

Based upon this watershed schedule,an eight (8) year watershed cycle is proposed. This cycle should be the driving force for programming activities.

Watershed Processes

Risk Assessment

Traditional approaches to prioritizing and managing programs have been fragmented, relying heavily upon the concept of media transport (air, water, and land). Comprehensive natural resource management relies upon the integration of programs through the various media (multi-media approach). However, not only does a multi-media approach need to be employed, but a process which assesses ecological health and prioritizes activities based upon ecological health needs to be employed. This process is embodied within an ecological risk assessment.

The ecological risk assessment can be used throughout the watershed cycle and is instrumental during critical junctures of the cycle. Such steps as problem formulation, exposure analysis, and determination of ecological response are all fundamental elements of an effective watershed protection approach. In addition, it is important to consider which stressors impact the natural resource in ways that are most detrimental to overall natural resource quality. This consideration of all stressors and ecological effect is ecological risk assessment.

Monitoring Strategies

The use of quality environmental data is the cornerstone for the development of successful watershed protection strategies. The data itself and manipulations of it will give resource managers the information necessary to direct all further efforts.

Successful monitoring strategies consider, for example, type of resource data, (biological, chemical, physical) data collection location, purpose of data collection, (predictive modeling, diagnostic), trend analysis, load estimates, resource characterization, length of data collection and parameters. All too often, environmental data that is collected is disparate, and cannot be used to make decisions with an acceptable degree of scientific certainty.

Existing monitoring efforts conducted by Regional personnel as well as those efforts supported through various grants and contracts needs to be realigned to support the watershed protection approach.

Water Quality Management Planning

Section 303(e) of the Clean Water Act establishes a process whereby State water quality planning activities can be conducted on a basin or watershed level at timely intervals.

The planning activities include ecological assessment, evaluation of existing programs, and recommendations for future management.

States must place an emphasis on Section 303(e). The development of basin plans is a critical need to assure that adequate assessment, planning, and basin management strategies be developed, reviewed, and updated on a regular basis. The information contained within the basin plan can be used as the watershed management strategy itself, or as part of the historical research and data gathering portion of the watershed protection approach.

Ecological Endpoints

Ecological Indicators as Assessment Tools

A traditional approach to evaluating natural resource quality has been the use of chemical water quality analysis. The development of biological criteria and biological indices (IBI and TSI, for example) as indicators of quality has provided an additional evaluation tool. In addition to these assessment tools, are physical parameters such as areal extent of resources and streambank recession rates, which can be used to describe natural resource quality. The integration of chemical, biological, and physical parameters in a manner which can be used to direct watershed planning and implementation is a challenge which lies before us.

The watershed protection approach proposes the use of biological and physical data as ecological indicators of the quality of our natural resources, while water quality data serves to augment and support the biological and physical data, as water quality indicators of natural resource condition.

Ecological Targets in Determining Watershed Goals

Effective watershed management begins with setting attainable goals which reflect the quality of the resource as a natural system. This quality is best articulated through a combination of biological and physical data as ecological indicators, which can then be used to establish ecological targets. Achieving the ecological target then becomes the goal for the natural resource for which the watershed protection approach is being implemented.

The ecological targets can then be translated through approaches such as modeling to discrete numerical targets. The numerical targets should include water quality data (in-stream, end-of-pipe concentration, etc) or pollutant load reductions.

WATERSHED MANAGEMENT-A PROCESS

An effective watershed protection approach relies upon a cooperative process with the States for (1) describing the impairments and/or threats to the watershed (conceptual model), (2) gathering data to support the decision making process, (3) developing strategies for restoration and/or protection, (4) implementing solutions, and (5) evaluating success. This process is iterative and requires sufficient time to prove itself successful. Below is a process outline, with objectives for related activities. To fully develop the watershed protection approach, the Region will work with the States to develop action plans which support the objectives.

Historical Research and Data Gathering

Program Integration

To develop a framework which integrates programs contained within and external to agencies so that watershed management is facilitated.

Data Acquisition/Inventory Natural Resources:

To establish a mechanism for the collection and integration of natural resource information required to develop, implement, and evaluate the watershed management approach.

Assessment

Evaluation of Natural Resources/Characterization of Ecological Effects:

To ensure that existing natural resource assessment programs accurately reflects the existing resource quality. To provide for reporting mechanisms which transfer this information to the resource stewards. To develop mechanisms whereby public opinion of resource quality protection and restoration needs are expressed and incorporated into the decision making process.

Prioritization of watersheds within the state:

To establish a process whereby all watersheds within the state are prioritized for development and implementation of a watershed management strategy.

Identify Sources & Causes of Problems/Characterization of Exposure:

To establish a mechanism for the identification and integration of sources of pollutants for which watershed protection and restoration programs are being developed.

Developing Watershed Goals and Objectives/Planning

Developing objectives/Problem formulation and conceptual models:

To provide for the development of watershed objectives to be achieved through the implementation of the watershed management approach. Watershed objectives for the individual resource area shall be attainable. Watershed objectives shall be discrete, measurable targets.

Formulate alternatives:

To develop a comprehensive strategy which can be used by all contributing agencies and public representatives to guide implementation activities in the watershed. The strategy incorporates all pollutants of concern identified previously.

Make Decisions- Alternative selection and Prioritization:

To establish a process whereby all alternatives can be selected which best meet the needs of the watershed. The process shall allow for input from all affected parties and can be used consistently throughout the state.

Implementation

Implement Watershed Management Plan:

To implement a comprehensive strategy which can be used by all contributing agencies and public representatives to guide implementation activities in the watershed. The implementation plan incorporates all pollutants of concern identified previously. All programs shall continue to be implemented at a base level and accelerated as needed.

Data Management Framework:

To provide for the management of all information pertinent to the watershed so that it is readily available to all agencies and interested parties.

Evaluation of Success

Evaluate Effectiveness:

To ensure that a mechanism exists which evaluates the effectiveness of the watershed management approach. This mechanism needs to be established at the beginning of the watershed management process and utilized as needed throughout the process. To ensure that state remains committed to watershed implementation until watershed management objectives are attained.

LEGISLATIVE PANEL

Discussion summarized by Michael D. Platt

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Moderator:	Sharon Kennedy
Panel:	David R. Leitch, State Representative, 93rd District
	John Philip "Phil" Novak, State Representative, 85th District

Representative David Leitch and Representative Phil Novak each made brief remarks regarding the importance of the Illinois River, the resources of its basin, and the legislative process as it relates to natural resources concerns.

The audience engaged Representative Leitch and Representative Novak in a question and answer session. Topics of discussion included: legislation pertaining to double hull barges, funding for conservation programs, protection programs targeting the Illinois River, competing interests, riverboat gaming, and the funding limitations of the Illinois budget because of mandates.

Remarks made by the participants were accepted by the audience as useful in understanding a "legislative" perspective on river protection issues.

MAKING PREDICTIONS THAT CHANGE THE FUTURE: FORECASTS AND ALTERNATIVE VISIONS FOR THE ILLINOIS RIVER

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If we could first know *where* we are,
and *whither* we are tending,
we could then better judge *what* to do,
and *how* to do it.

A. Lincoln. Illinois Republican Convention, Springfield, June 16, 1858.

ABSTRACT

The Illinois River ranks among a world class of large river-floodplain ecosystems that includes the Mississippi, the Amazon, and the Nile. These rivers are characterized by seasonal floods that spread over large floodplains and enhance biological productivity in comparison to less dynamic ecosystems, such as lakes and reservoirs. Despite a century of alterations, the Illinois River retains approximately half its floodplain and a floodpulse, and therefore is one of only three large river-floodplain ecosystems in the United States recommended for restoration by the National Research Council Committee on Restoration of Aquatic Ecosystems (1992). It is part of the Upper Mississippi River System, which Congress recognized as a "nationally significant ecosystem" in the Water Resources Development Act of 1986. Although no restoration can ever be perfect, it is possible to restore processes that enable a disturbed ecosystem to maintain, repair, and rejuvenate itself to a much greater degree.

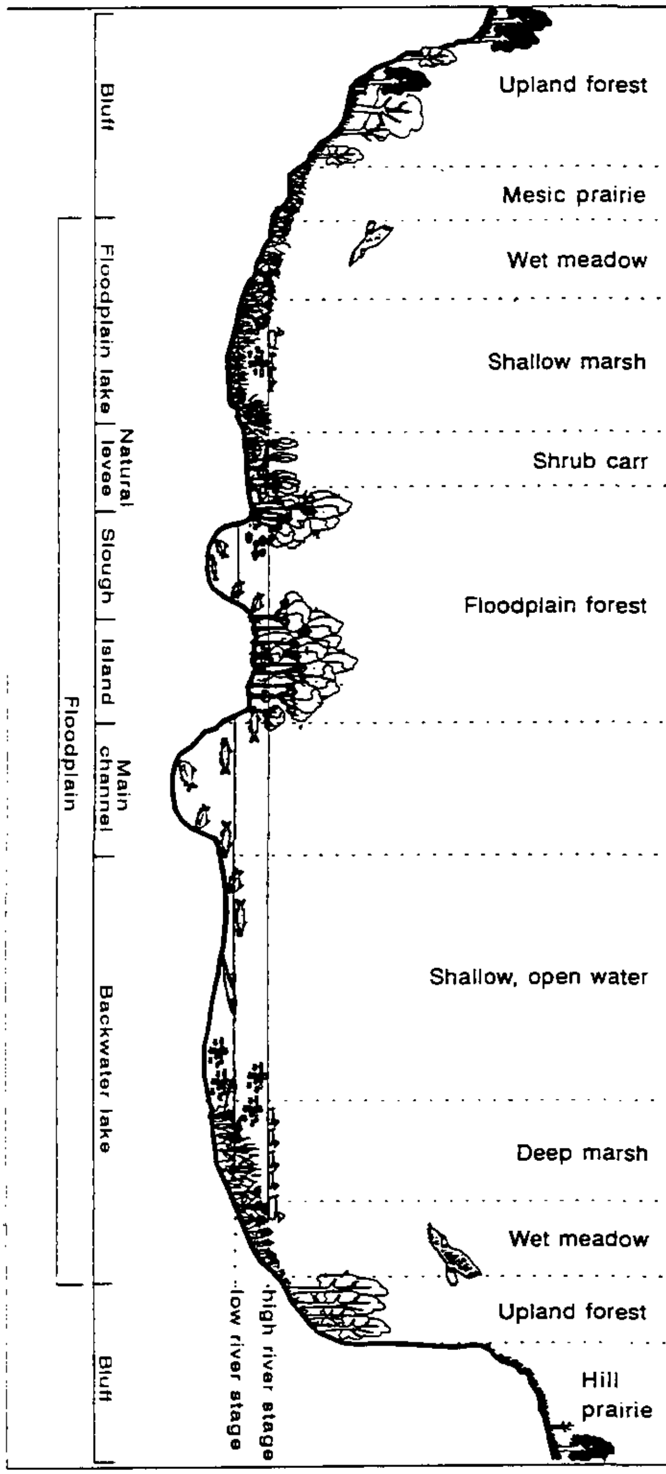
The predisturbance reference period for the Illinois should be the 19th century, when the river maintained itself in a dynamic equilibrium with no human intervention, rather than more recent periods when the river was disequilibrated by watershed alterations, Lake Michigan diversion, and navigation dams. Much can be learned from retrospective analysis of available data on predisturbance land forms, vegetation patterns, and hydrographs that could be applied to contemporary restoration of the river. Current efforts to rehabilitate and enhance portions of lakes or lands for a particular human use or highly valued species are expensive, interim measures that require continuing maintenance and may, in fact, worsen the excessive sedimentation and water level fluctuations they seek to mitigate. Ecosystem restoration saves money in the long run, because natural services (self-repair following natural or human disturbance, flood conveyance and storage, water purification, fish and wildlife production, preservation of biodiversity) are restored, instead of substituting human intervention at great cost and considerable risk of failure.

WHERE ARE WE?

Where in the World Are We? We are on the Illinois River, which ranks among a world class of large river-floodplain ecosystems that includes the Mississippi, the Amazon, the Nile, and the Mekong. River-floodplain ecosystems are characterized by seasonal floods that spread out over large floodplains and enhance biological productivity in comparison to less dynamic ecosystems, such as lakes or reservoirs (Figure 1; Bayley 1991). The annual floodpulses are so predictable and long lasting that plants, animals, and even human societies have adapted to take advantage of them. For example, wildflowers such as the endangered decurrent false aster germinate on fresh silt deposits left by the spring flood, where they are not shaded out by other plants. During the flood, fishes use the expanded floodplain lakes and the floodplains themselves for spawning areas and nurseries (Junk, Bayley and Sparks 1989). Every school child learns how the first civilizations developed in Egypt and Mesopotamia because large populations could be sustained in one place for millennia when the fertility of the soils was renewed each year by the annual overflow of the rivers. Outside the floodplains, the fertility was exhausted with a few years of steady cultivation, so people had to move on.

The Illinois River Floodplain. Although the undisturbed Illinois River was relatively small in terms of flow (approximately equal to the Rock River, prior to the largescale diversion of Lake Michigan water down the Illinois starting in 1900), it has an unusually large floodplain for its size. Large river-floodplain ecosystems have always been rare, because not every large river has a large floodplain: the Columbia, the Colorado, and the St. Lawrence are large North American rivers, in terms of water flow, but they are enclosed in narrow valleys or canyons, without large floodplains. The miles-wide (2 to 7 miles) floodplain of the middle and lower Illinois River is a gift of much larger ancestral rivers (Figure 2). *Intact* large river-floodplain ecosystems are *extremely rare,* and are becoming rarer still, because the developed countries of the world have altered entire watersheds and channelized and impounded virtually all their large rivers, and the developing countries are hurrying to catch up with them (Sparks 1992).

The Floodpulse. The undisturbed Illinois River had a protracted floodpulse that benefited flood-adapted vegetation, fish, and wildlife, not to mention loggers, trappers, clammers, fishermen, and hunters. The single flood generally rose slowly, starting in the fall, peaked during spring rains and snow melt, then declined gradually to a summer low, when plants could grow on newly-deposited mudflats and in the clear, shallow lakes and backwaters (Figure 3). The pulse usually was gradual and protracted because the hydraulic capacity of the floodplain was large in relation to the flow of the river, and the gradient was extraordinarily shallow: the rate of fall in the lower 223 miles was only 0.1 ft per mile (Mills et al. 1966; Talkington 1991). Also, the dense vegetation on the natural levees and surrounding the lakes slowed the water (and filtered out some of the sediment). Consequently, it took a relatively long time to fill and empty the floodplain, resulting in a gradual, smooth floodpulse in most years. In contrast, the Upper Mississippi River had two distinct floodpulses per year, and the lowest river stage occurred in midwinter, which may have reduced overwinter survival of fish, if they were trapped in shallow areas that froze solid (Figure 3). The gradient in the Mississippi was steeper, so the flood rose and fell more quickly than in the Illinois, increasing the risk of stranding young fish that had been spawned on the floodplain. Also, the major flood did not begin as soon in the spring as on the Illinois, where fishes had earlier access to floodplain spawning and feeding areas. These differences in the natural floodpulses between the two rivers may explain the greater fish yield in the Illinois around the turn of the century.



Upland forest	White oak, northern red oak, black oak, hickories, etc.
Mesic prairie	Big bluestem, indian grass, cord grass
Wet meadow	Big bluestem, cord grass, sedges
Shallow marsh	Catttails, bulrushes, water plantain, arrowheads, sedges
Shrub carr	Willows, silver maple, cottonwood
Floodplain forest	Silver maple, willows, cottonwood, elm, ash, hackberry, pin oak, bur oak, persimmon, pecan
	Illinois River
Shallow, open water	Pondweeds, coontail, wild celery, water milfoil, lotus, water primrose, duckweeds
Deep marsh	Cattails, bulrush, lotus, pondweeds, coontail, water milfoil, duckweeds
Wet meadow	Big bluestem, cord grass, sedges
Upland forest	White oak, northern red oak, black oak, hickories, etc.
Hill prairie	Little bluestem, sideoats grama, post oak, blackjack oak, eastern red cedar

Figure 1. Cross-section of the natural Illinois River-Floodplain Ecosystem. The floodplain is seasonally inundated and includes permanent and temporary lakes and ponds, but not the permanent deepwater channels. The land forms, such as the natural levees, sloughs, and islands are created by processes of erosion and deposition, primarily during floods. Each type of plant community has a certain moisture tolerance and consequently occupies a particular land form (and land elevation) depending on whether the community is adapted to permanent immersion or to seasonal flooding. Terrestrial animals such as deer and wild turkeys use portions of the floodplain during low river stages. During high river stages, they move to higher ground, and aquatic animals, including fishes, crustaceans, and aquatic insects use the floodplain and the expanded backwaters and lakes for spawning and nursery areas. The vertical scale and channel width on this diagram are greatly exaggerated: the floodplain can be 2-7 miles wide along the middle and lower Illinois River, the bluffs are approximately 100 feet high, and the main channel typically occupies only 3-6 percent of the total floodplain width.

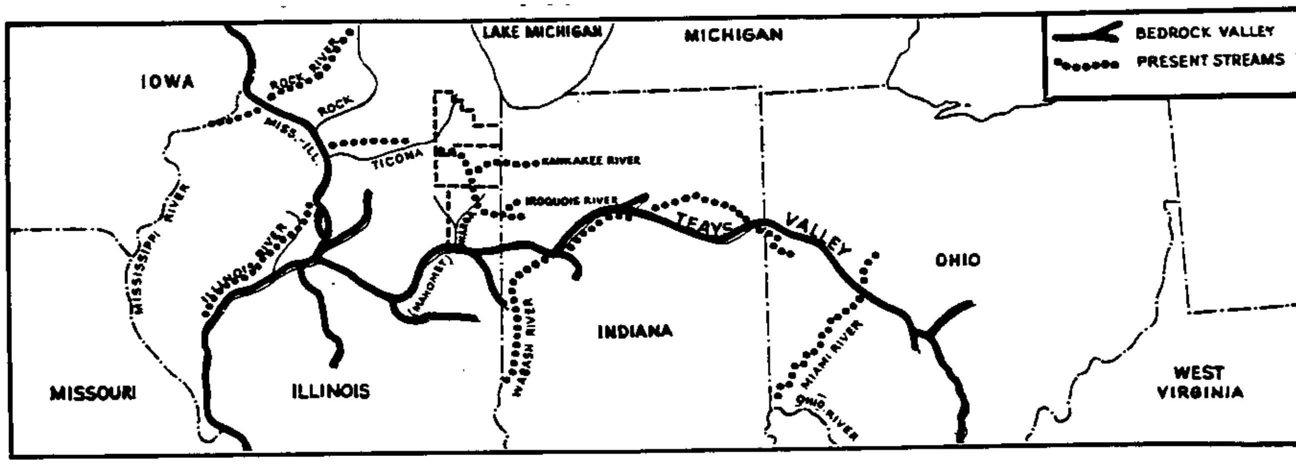


Figure 2. The Illinois River floodplain is disproportionately large in relation to the size and water flow of the contemporary river because it was created by much larger ancestral rivers. The ancestral Ohio River, known to geologists as the Teays River, drained much of the eastern U.S. as far as North Carolina. The ancestral Upper Mississippi River was a tributary to the Teays. The Wisconsinan glacier pushed the Ohio south and the Mississippi west and filled the east-west portion of the valley of the ancient Teays with sand and gravel outwash as it retreated. Surface water infiltrates the sand deposits and flows slowly along the old bedrock valley of the Teays into the Illinois River, forming the present-day Mahomet Aquifer. (Source: Barker et al. 1967)

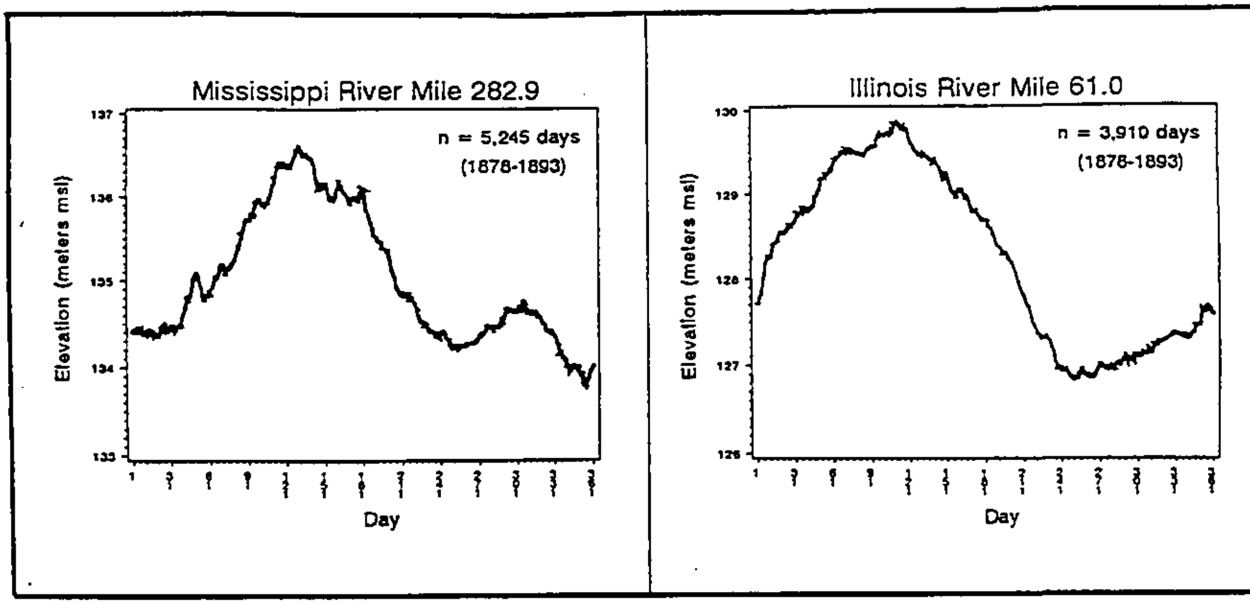


Figure 3. Comparison of the natural floodpulses of the Illinois River and Upper Mississippi River. The Mississippi had two peaks, a major one in the spring and a little one in the fall. Water levels in the Mississippi were lowest during the coldest part of the year. In contrast, the Illinois had just one peak--the fall flood kept rising through the winter to merge into the spring flood, perhaps enabling more fish to survive over winter (deeper backwaters are less likely to freeze solid than shallow ones) and contributing to the exceptional commercial fish yield of the Illinois River. Fish also had access to spawning and nursery areas much earlier in the Illinois, and the flood retreated more gradually, so young fish were less likely to be stranded. Water levels in the Illinois were lowest at just the right time for aquatic and moist soil plants: during the summer growing season. In both rivers, the fall flood made the summer production of seeds and tubers by the plants more accessible to migratory dabbling ducks, which like to feed in shallow water. The graphs show the average daily water elevations, in meters above mean sea level, starting 1 January (day 1 on the horizontal axis) and ending 31 December (day 365). Because of gaps in the data, the total number of days averaged does not equal the total number of days in the period of record (1878-1893), and differs between rivers. The gaging station on the Mississippi is 282.9 miles upstream from the mouth of the Ohio, in Pike County, Illinois, and the Illinois River station is 61.0 miles upstream from the confluence with the Mississippi, also in Pike County, near Valley City.

Biodiversity. So far I have described where we are among world rivers in terms of geological history, hydrology, and biological productivity. Now I turn to biodiversity, which has much to do with the geography of the Illinois and Mississippi. The north-to-south orientation of the mainstem Mississippi across 18 degrees of latitude (about 1300 miles) provided a southern escape route and refuge for aquatic species during the ice ages, when the Great Lakes and many northern tributaries were covered by ice sheets (Briggs 1986). When the glaciers melted, the species could recolonize the newly-opened northern drainages. In contrast, more species were lost during harsh climatic periods in Europe or the rest of North America where rivers ran east-west, northwards, or were simply too short to provide a southern refuge. The Mississippi and its major tributaries have been major incubators and conservators of freshwater species through the eons; one third of the 600 freshwater fishes in North America and most of the 297 species of freshwater mussels in the United States were found in the Mississippi drainage (Fremling et al. 1989; Turgeon et al. 1988; Neves 1993). In contrast, western Europe has only 15 species of freshwater mussels (Neves 1993), and there are only about 10 fishes that are endemic to the Great Lakes–the rest are mostly river residents or river migrants that have colonized the lakes on their own or been introduced by humans (Underhill 1986).

The Illinois as a Migration Corridor. In addition to conserving species during harsh climatic periods, the north-south orientation of the Mississippi and the lower 200 miles of the Illinois River made both rivers ideal migration corridors for waterbirds (ducks, geese, swans, herons, egrets), shorebirds (e.g., sandpipers), raptors (owls, hawks, eagles), and songbirds (warblers, finches, orioles, etc.) that move annually between their breeding grounds in the north and their wintering areas along the Gulf coast or in South America. Most fish undertake much shorter migrations within the river-floodplain ecosystem and its tributaries, but there is one long-distance aquatic migrant that rivals the birds. The American eel, *Anguilla rostrata*, spawns deep in the Sargasso Sea, northeast of Cuba. The baby eels drift and swim with the ocean currents toward the Gulf and east coasts of the United States. The males seek out river mouths, but the females swim as far upstream as the tributaries of the Illinois River and Upper Mississippi River, where they take 5 to 20 years to mature before starting their downstream migration (Pflieger 1975).

Connections. The Illinois is connected to the much larger Mississippi drainage and the Gulf of Mexico not only by animal migrations, but also by the transport of water, sediments, nutrients, and contaminants. What we do has downstream effects, and we in turn are affected by what happens upstream of us. Nutrients from the farmlands of Illinois contribute to plankton blooms in the Gulf of Mexico where the plume of freshwater from the Mississippi meets seawater. The blooms of algae senesce and sink, using up oxygen in the decay process and contributing to the spreading zones of oxygen depletion ("dead zones") on the bottom, which adversely affect commercially valuable fish and shrimp (Vorosmarty et al. 1986; Rabalais and Harper 1992; Rabalais 1993; Justic et al. 1993).

To summarize the answer to the question, "Where are we?": we are on a river that harbors an unusual number of species and belongs to an increasingly rare world class of large river-floodplain ecosystems. We are connected to the rest of the world: what we do in the Illinois Basin affects the Gulf of Mexico and the fate of species as far away as South America and the Sargasso Sea. We, in turn, are affected by what happens upstream, including upland watersheds.

Flood Pulse Comparisons
Prediversion and Postdam periods

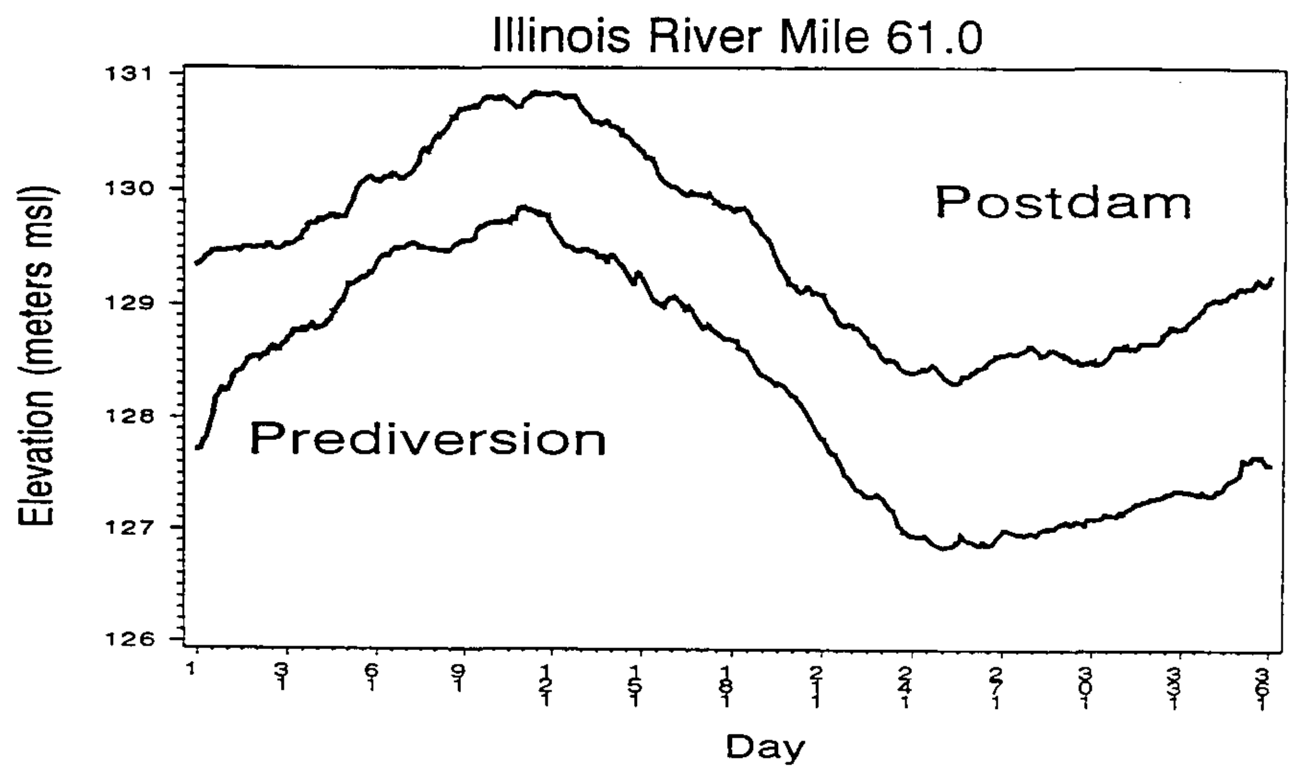


Figure 4. Fish populations have improved substantially in the Illinois River during the last 30 years, primarily in response to improved municipal and industrial waste treatment which improved water quality. In 1963 the poorest fish populations were in the upper river and Chicago waterways. The introduced carp and goldfish, which can tolerate low oxygen levels and other pollution-related stresses, comprised 60.7 percent of the catch obtained by an electrofishing survey. There were only a few other species and no gamefishes, such as bluegill and bass. By 1992 there were no goldfish, the percentage of carp declined to 5.3 percent, and gamefishes comprised 23 percent of the catch. The fish community in 1963 was better in the middle river, which includes the Peoria and La Grange reaches, than in the upper river, indicating better habitat and better water quality. Even here, however, carp comprised 22 percent of the catch and gamefishes only 9.9 percent. By 1992 carp declined to 13.1 percent and gamefishes increased to nearly half the catch.

WHITHER ARE WE TENDING?

Water Management and the Floodpulse. There is good news, some mixed reviews, and some bad news regarding trends in the Illinois River. One piece of good news is that despite a century of alteration, the Illinois River-Floodplain Ecosystem still retains a floodpulse and approximately half its floodplain (Figure 4). People are surprised by this, because they know the river has been dammed, and they assume the flow is controlled. Fortunately, the floodpulse still occurs in the Illinois River because navigation dams, in contrast to storage reservoirs, do not stop floods; rather, they maintain minimum water depths for navigation during the low flow season. In fact, during floods, the dams at Peoria and La Grange fold into the bottom of the river and boats go right over the top of them. The Illinois River is much less encumbered by navigation dams than the Upper Mississippi River because the dams on the lower 230 miles of the Illinois divide the river into three reaches, each approximately 80 miles in length, whereas the dams are only 10 to 46 miles apart on the Upper Mississippi River.

The down side is that the dams do not allow the river to get as low as it once did, so sediments delivered by the annual floods into areas influenced by the dams do not dry and compact during the summer, as they formerly did (Bayley 1991). The absence of this important compaction process went unnoticed during the first two decades of operation of the nine-foot navigation system, especially since fish and wildlife populations evidently increased to fill the lakes and backwaters that had expanded due to the higher water elevations maintained by the dams.

Other time bombs, besides loss of compaction, were ticking. The deeper waters were more efficient at trapping the sediments that were delivered to the river at increasing rates as agriculture intensified (with a shift to row crops, fall plowing, removal of streamside forests, and stream straightening) during the 1950s. As the bottom was raised by the accelerated deposition of watery, dispersed silt, the sediments were more easily and frequently resuspended by wind- and boat-generated waves, making the water cloudy. The waves were bigger on the greatly expanded lakes and backwaters because the wind fetch was greater, so aquatic plants were uprooted. The last of the floodplain trees that had been killed by permanent inundation rotted, or were carried away; with these natural wavebreaks gone, banks eroded at increasing rates, putting even more sediment into the lakes and removing even more windbreaks as whole islands eroded away. When the aquatic plants finally disappeared late in the 1950s, there were no roots left to anchor the bottom and no leaves or stems to dampen waves, so the waves churned the lakes into turbid, barren deserts. The aquatic plants probably disappeared because they could not get enough light to grow in the turbid water, nor enough roothold to anchor themselves in the watery sediments (Sparks et al. 1990; Bellrose et al. 1979; Bellrose et al. 1983). Another factor was increased fluctuation in water levels during the summer growing season, when aquatic plants need low, stable water levels. The fluctuations were probably caused by increased variability in the flow of tributaries resulting from upland drainage and channelization, and from reduction of the capacity to store and convey small floods on the floodplain due to sedimentation and levees. A moderate amount of water added to a small, constricted container will cause a greater rise than the same amount added to a very large, wide container. Levees not only reduce capacity directly, by constricting the floodplain, but also indirectly, by concentrating sedimentation in the remaining unleveed areas.

The end result was shocking to people who returned to the river in the 1960s after having last seen it in the early 1950s, such as the Korean War veterans. They remembered hunting for abundant canvasback ducks and bluebills over beds of wild celery and fingernail clams in Peoria Lake. With the plants and most of the bottom-dwelling invertebrates gone, the ducks no longer migrated down the Illinois (Mills et al. 1966). The demise of the clams and other invertebrates might have been linked to the collapse of the plants, because the plants remove ammonia from sediments as a nutrient, and ammonia is toxic to sediment-dwelling animals (Sparks and Dillon 1993; Sparks et al. 1992).

Biodiversity. Although the natural rivers of the Mississippi Basin conserved species during harsh times, the human-altered rivers have not done nearly so well. Aquatic species are disproportionately imperiled compared to terrestrial species, according to the Nature Conservancy (Master 1991), the Endangered Species Committee of the American Fisheries Society (Williams et al. 1989) and others (Blockstein 1992; Cairns and Lackey 1992; Hughes and Noss 1992; Titus 1992; Williams and Rinne 1992). One in ten species of freshwater mussels has gone extinct in this century, and almost three-quarters of the remaining freshwater mussels are either rare or imperiled (Neves 1993; Sawhill 1992; Stolzenberg 1992)! Twenty-seven percent of the extant North American fishes are endangered or in jeopardy, and the number is increasing (Williams et al. 1989). In the Illinois River, 10 percent of the fishes (13 of 131 species) and half the mussels (24 of 47 species) have probably been extirpated (Page et al. 1992; Cummings 1991). Declines are attributable to: (1) overloading with sewage and industrial waste, (2) habitat loss due excessive sedimentation and to leveeing and drainage of the floodplain, and (3) introductions of non-native species, such as the zebra mussel.

Water Quality and Fish Communities. Water quality has improved, after the expenditure of approximately $10 billion over the past 20 years (mostly on sewage and stormwater treatment in the Chicago area, but with substantial expenditures in the Peoria area as well), and the improvements are reflected in the return of gamefishes and cleanwater fishes. Near Chicago, stress-tolerant nonnative fishes, such as carp and goldfish, have declined markedly and gamefishes (bass and bluegill) have reappeared (Figure 5). In the middle reaches of the river near Peoria, gamefishes now comprise 43.6 percent of the total population (up from just 9.9 percent in 1963), and the river hosts nationally-ranked annual tournaments for walleye, sauger, and largemouth bass.

Although the gamefishes seem to be recovering from a century of degradation, the commercial fishery is still depressed, especially in comparison to its heyday in 1908, and in comparison with contemporary yields from the Upper Mississippi River (Table 1). In contrast to the gamefishes, most of which feed in the water column, most of the commercial fishes feed on clams, snails, worms, and aquatic insects that live on or in the bottom of the river and its backwaters. The quality of the sediments has not improved to the same extent as water quality, and the bottom-dwelling fishes appear to be affected both by direct contact with the sediment, and indirectly, through their food supply (Sparks and Lerczak 1993). The situation may be gradually improving, however, because fingernail clams have been reported in several places where they had died out, and we have seen some adult mayflies (*Hexagenia*) clinging to the walls of the Forbes Biological Station at Havana after they have emerged from nearby waters.

Chronic pollution from point sources has been greatly reduced, but problems remain from spills or episodes of toxicity caused by changes in pH (acidity), temperature, oxygen levels, or other environmental factors (Sparks et al. 1992; Sparks and Dillon 1993). A contaminant that is not harmful under average environmental conditions may become toxic under other conditions, even though the concentration remains the same. For example, fish are more sensitive to toxic

Table 1. Trends in Commercial Fish Yield (pounds/acre per year).

Years	Mississippi River	Illinois River
1908		178.4
1950s	26.3	38.1
1970s	29.2	3.7
1980s	24.9	10.0

In 1908, 200-mile reach of the Illinois River out-produced every other river in the U.S., except for the Columbia, where the salmon do most of their growing in the sea, getting caught when they return to the river to spawn. The per-acre yield was an astounding 178.4 pounds! More than 2,000 commercial fishermen were employed on the river (U.S. Department of Commerce and Labor 1911), and they caught 24 million pounds of fish--10 percent of the total U.S. catch of freshwater fish! As recently as the 1950s, the Illinois still yielded substantially more fish than the Upper Mississippi River. By the 1970s, however, the yield dropped to a low 3.7 lbs/acre--totaling only 0.32 percent of the U.S. freshwater harvest. The yield has increased somewhat, in response to improved water quality, but further increases will probably depend on improvements in habitat quality and in sediment quality. Most of the commercial fishes feed on clams, snails, aquatic worms, and aquatic insects, which have been affected by toxic ammonia concentrations in the sediments (Sparks and Dillon 1993; Sparks et al. 1992).

ammonia at winter temperatures than they are during the summer (Reinbold and Pescitelli 1990). Also, algal blooms in backwater lakes along the Illinois River can alter the chemistry of the lakes, thereby increasing the amount of ammonia which exists in the toxic, un-ionized form (Sparks et al. 1992).

Nonpoint Pollution and Habitat Quality. Conferences focusing on the Illinois River, including this one, certainly have made people more aware of the sedimentation problems in the Illinois River and how these problems are linked to erosion of upland soils and stream banks. More land is probably enrolled in various soil conservation programs than 20 years ago. In contrast to the water quality indicators, however, habitat indicators show little improvement. With only a few exceptions, submersed aquatic plants have not returned to areas where they were abundant in the 1950s (Sparks et al. 1990). The plants require clear water and low, stable water levels during the summer growing season, because the light they need to grow is attenuated by turbidity and deep water. The Illinois River remains turbid, indicating that attempts at upland erosion control may have been ineffective so far in reducing sediment delivery to the river; also, sediments are being recycled by currents and waves within the river.

The problem is aggravated by upland drainage and stream channelization that deliver runoff from summer storms to the mainstem river all at once, instead of slowing and absorbing it. Channelized streams also have more power to erode their beds and banks than natural, meandering streams. The effects of channelization can propagate in two directions: downstream, in the form of increased sediment delivery to the mainstem Illinois, and upstream, in the form of headcuts (severe channel erosion and downcutting that gradually move upstream through a drainage).

Social Values and Human Demands. So far, I have discussed trends in the river resources themselves: water quality, habitat quality, fish. It is equally important to consider trends in social values and demands placed on those resources. In the 19th century, wetlands and floodplains were commonly regarded as worthless areas that needed to be "reclaimed" for productive use by humans; water that flowed to the sea unharnessed for irrigation or industrial use was "wasted"; and the average citizen would have been baffled by the terms "ecosystem" or "biodiversity."

The social value of a resource may rise with its scarcity, like price in the market place. Concern about endangered species and the environment is highest where both are scarcest: in the most populous parts of the U.S. (Weiss 1994). Now that 85 percent of the wetlands in Illinois have been drained, and virtually all the rivers in the Midwest have been degraded by excessive erosion or sedimentation, there is increasing public demand to preserve what is left and restore at least some of what has been lost (National Research Council 1992). Riverfronts that had been decaying industrial areas have been turned into public parks and tourist attractions in cities such as Peoria and St. Louis. The number of freshwater fishermen, migratory bird hunters, and nonconsumptive outdoor recreationists (ecotourists, boaters, hikers, bird watchers, etc.) is projected to grow (Flather and Hoekstra 1989). Social values can translate into economic values as well: a single Bassmaster Superstars fishing tournament at Peoria brought $8 million into the local economy in 1993 (see article by Uphoff, this volume), and river-based recreation in a sample of just 76 counties along the Upper Mississippi River is conservatively estimated to generate 18,000 jobs and $1.2 billion annually in the U.S. economy (Carlson 1993).

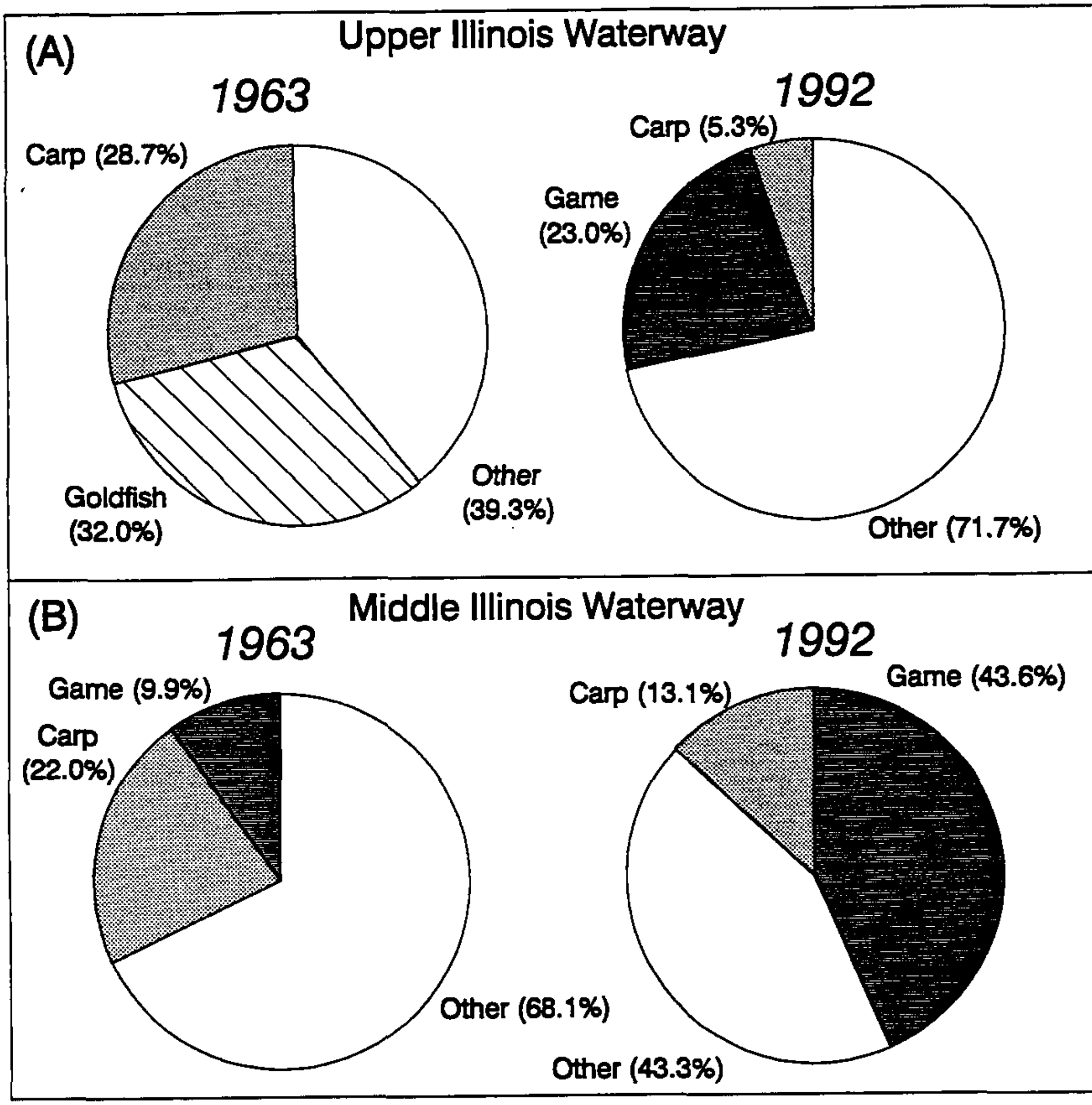


Figure 5. The Illinois River retains a floodpulse despite a century of alterations. The lower line shows the hydrograph prior to 1900 when the Chicago Sanitary and Ship Canal was opened and the diversion of wastewater from the Lake Michigan drainage into the Illinois River was substantially increased. There were no navigation dams and very little of the floodplain had been leveed and drained. The upper line is the hydrograph since the navigation dams for the 9-foot channel began operation in 1940. The low part of the floodpulse has been elevated because the navigation dams keep the river higher than it was naturally. The dams do not control the high part of the floodpulse, but it too has been elevated, because of constriction of the floodplain by levees (Mulvihill and Cornish 1930; Alvord and Burdick 1919), elevation and filling of the unleveed floodplain by excessive sedimentation, and increased rainfall (Singh and Ramarmurthy 1990).

In summary, people not only seem to value intact river-floodplain ecosystems more than in the past because they are scarce and getting scarcer, but also because they have a better understanding of the value of natural services such as production of fish and wildlife, cleansing of water and air, and conveyance and storage of floods (this important function was brought to everyone's attention during the flood of 1993). The questions of where we are and whither we are tending are not merely geographical questions, but also social ones. We have a new way of looking at natural systems that is quite different from the 19th century exploitative/extractive view. Now that we know where we are and where we are going, we are ready to think about what we should do and how to do it.

WHAT SHOULD WE DO?

I think most people at this Governor's Conference could agree on two things we should do. First, we should *preserve* those parts of the Illinois River ecosystem that are in relatively good shape. For example, it might surprise some people to know that deep within the Sanganois Conservation area near Beardstown there are floodplain ponds with clear water, abundant aquatic plants, and good fish populations, and canoe trails that follow sloughs bordered by stands of native pin oaks and pecans. There are some other areas similar to the Sanganois that should be protected from development by being purchased and managed as public lands.

However, most lakes and sloughs that are open to the Illinois River are degraded because of excessive sedimentation, and most people would agree that we need to *restore* these areas. *How* we go about preserving and restoring the Illinois River and its associated lakes and backwaters is an important question that is addressed in the next section.

HOW TO DO IT

The Preservation and Enhancement Perspective. Preserving, rehabilitating, or enhancing pieces of land are not the same as restoring functioning ecosystems. Preservation is the protection of something that is already in good shape, by purchasing and setting it aside, as a nature preserve, for example. Rehabilitation and enhancement imply fixing up or modifying a feature (levee district, lake, or backwater) for a particular purpose, such as a waterfowl feeding area, fishing area, or boat harbor.

An approach used by waterfowl managers is to wall off portions of the lakes and floodplains to keep silty river water out and control water levels. An "ideal" floodpulse (low water during the summer growing season) for moist soil plants (which dabbling ducks and geese eat) can be maintained within the levees by regulating water levels with pumps and gates. Deeper water levels for aquatic plants and the ducks that feed upon them can be maintained in other impoundments. In some cases, such as Lake Chautauqua and the Emiquon Refuge near Havana, the areas were originally drained and leveed for agriculture, and the preexisting levees are simply maintained. Another example is the Banner Marsh south of Peoria, which was leveed, drained, and mined for coal before being sold to the state for use as a hunting and fishing area.

There are several problems with this approach, including the cost of maintaining the levees, gates, and pumps. If high levees are constructed or maintained, the floodplain cannot fulfill its hydrologic function of conveying and storing major floods, and the flood heights and damages increase elsewhere. If low levees are constructed, the floodplain can convey major floods, and moist soil plants can still be protected from the little floods that occur more frequently now than at the turn of the century, but the impoundments will still receive sediment during major floods. Although these impoundments benefit the ducks that feed on the plants, the levees and gates may interfere with the migrations of fish to their spawning, feeding, and wintering areas. Fish can enter impoundments that have low levees during the spring flood, but the fish and their young may be trapped inside when the impoundments are drawn down to expose the mud flats. Different species have different requirements and human advocates, so the approach of compartmentalizing the floodplain to optimize management for a particular group of animals (and human advocates) can become quite controversial and contentious. Optimizing water regimes for one or a few species in complex river ecosystems such as the Illinois, which has thousands of species of plants and animals, including 118 kinds of fish, risks creating suboptimal conditions for others.

Creating an "ideal" water regime for certain species every year is probably unnecessary and even undesirable, as long as a mosaic of habitats exists, so that spawning, feeding, and overwintering can occur somewhere in the river-floodplain ecosystem within accessible range of local populations, even if the same area is not used for the same purpose every year. A floodplain depression that is ordinarily dry during moderate floods may become a spawning site during record floods, when traditional spawning sites are unusable because of excessive water velocities or sediment loads. Although the water regime might be suboptimal in a given year for fish, most warmwater fishes are adapted to a variable system by means of a high reproductive potential that enables them to quickly make up for lost year classes (Junk et al. 1989; Bayley 1991). Migrant waterbirds have a very plastic, opportunistic behavior. If they fail to find food or suitable resting places, they move on. In contrast to fish, birds are able to move over levees and over land to other drainages and to inland cooling lakes and reservoirs created by man. When the food supply for diving ducks failed in the Illinois River in the late 1950s, they shifted to the Upper Mississippi River (Mills et al. 1966). The problem is that state and federal fish and wildlife agencies want to satisfy constituents who may see reduced wildlife populations on a favorite area in a given year as a failure of the agency or local manager. Public education undertaken by these agencies should include concepts such as compensatory recruitment and opportunistic behavior and a longer term and larger scale view of biological productivity in river-floodplain ecosystems.

Some year-to-year variation in the flood pattern is probably necessary to maintain a full complement of species; for example, some plants may require an unusually long summer low-flow period to set seed and replenish soil seedbanks. Other plants, such as cottonwoods, may require a rare combination of extreme events: A major flood that provides fresh mud flats with no shading from competitors, followed by several years of low flow that enable the seedlings to grow large enough that they are not swept away or drowned out by the next flood. Extreme events may even have a rejuvenating function; for example, record floods may rejuvenate some long-abandoned side channels by scouring away accumulated sediment.

Rehabilitation and enhancement techniques should be regarded as interim measures, designed to treat symptoms (excessive sedimentation and water level fluctuations) until the causes (excessive sediment yields and excessively variable water yields from the drainage basin, water level variations due to diversion and dam operation, reduced hydraulic storage and conveyance capacity on the floodplain) can be brought under control by the watershed and ecosystem restoration approaches described below. The approach of partially or completely isolating portions of the floodplain and backwaters from the river may in fact be counter-productive, because the more the floodplain is leveed off, the less hydraulic capacity is left to absorb the little midsummer floods that are detrimental to moist soil and aquatic plants, and the more sediment is concentrated on the remaining unleveed areas.

The Watershed Perspective. Most people now recognize that the Illinois River is a product of its watershed, so to restore and preserve the river, we need to reexamine and improve the way we manage water and sediment in the uplands, streams, and major tributaries, as well as within the river-floodplain itself. A systems approach is needed, because just reducing sediment influx upstream may actually accelerate bed and bank erosion downstream, resulting in no net decrease in sediment delivery to the Illinois River. Upstream soil erosion control might need to be coupled with riparian revegetation, dechannelization of downstream tributaries, and reestablishment of natural tributary deltas to store sediment. Although funding will always be limiting, much could be done within current budgets by using the results of the systems analysis to retarget and increase the effectiveness of existing programs.

Just reducing sediment influx to the Illinois River will not solve all the problems, however, because sediments are recycled within the lakes and backwaters and excessive short-term fluctuations in water levels are also a problem.

The Restoration Perspective. Restoration, in its broadest and most comprehensive sense, is the return of a disturbed ecosystem to a close approximation of its condition prior to disturbance (National Research Council 1992). The word "approximation" is critical–no restoration can ever be perfect. No reasonable person would argue that we can or should restore the Illinois River to its condition prior to the time of European settlement. The natural system would have changed to some degree on its own since the 1500s, in response to changes in natural factors such as climate, and anyway, we could not return to the presettlement condition without drastically reducing the size of the human population in the drainage basin.

However, we can restore *processes* that will enable the river-floodplain ecosystem to maintain, repair, and rejuvenate itself to a much greater degree than it does now. It is far more cost-effective in the long run to give the ecosystem some scope to maintain itself than it is to attempt to control or replace all natural functions with human intervention. Like the ancient Egyptians, we first need to appreciate and understand the river-floodplain ecosystem and then adapt our management accordingly. They knew that the annual flood of the Nile renewed the fertility of their fields, and religious prohibitions against interfering with the flood were recorded in the Book of the Dead from the 21st dynasty, 1085-712 BC. They believed that everyone was summoned to judgment after dying, and anyone who could not truthfully swear that they had kept the commandments would not enter the afterlife. Among the commandments was this: "Do not hinder the waters of the inundation." The Egyptians lived in harmony with their river for 3,000 years, while we have degraded ours within a mere century; we would do well to take a lesson from them.

Use the Natural System as a Model. The restoration perspective implies that we look to the *predisturbance ecosystem* as the model for a restored system that can maintain a dynamic equilibrium, even under a moderate degree of natural or human disturbance. Although we can only approximate the predisturbance system, there is much to be gained by at least attempting to understand how it functioned and maintained itself, then applying this knowledge to restoration.

If we base our vision only on what we (or our older colleagues) can remember, our time perspective will be too short, because at best we will refer to a period from the 1930s to the 1950s. As mentioned earlier, this was a relatively good period, from the standpoint of fish, wildlife, and outdoor recreation, but unfortunately one that could not be sustained because of the forces and changes set in motion by raising the water levels (by diversion from Lake Michigan and by navigation dams) and by alterations of the watershed. The lakes and backwaters that were expanded and deepened by the diversion and the dams continue filling with sediment, although at a slower rate as they become shallower. We can reduce the rate of filling by reducing sediment delivery from the tributaries, but we cannot stop the process altogether, nor can we afford to do enough dredging to return the river and its lakes to a 1940s condition. Raising the dams to deepen and expand the lakes and backwaters will merely increase the sediment trapping efficiency and the wind fetch, so that we temporarily will have large muddy lakes until 20-30 years go by and they fill with sediment to about the same water depths as we have now.

Instead of this short-sighted perspective that looks only at the immediate post-disturbance period of the 1940s and 1950s, we should look at the structure and function of the river-floodplain ecosystem as it was *before* the diversions, dams, levees, and drastic alterations of the drainage. Turn-of-the-century charts show that there were a series of long islands in the Peoria Lakes, and the lakes were much smaller than they are today. The islands, with their trees, served as windbreaks and wavebreaks, and may have directed scouring flows through the much smaller and narrower lakes during floods.

Some natural channels, such as Bath Chute, have maintained themselves for over a century, while others have filled in half that time. It would be worth learning what features make a side channel self-maintaining, so that we could restore these important habitats for fish. Is there a way we could guide the sedimentation that is occurring now, perhaps by installing deflection dikes to keep some areas scoured out, while increasing the rate of sedimentation elsewhere, so that when the river finally attains sedimentary equilibrium, it will look something like it did in 1900? In contrast to structures that close off side channels and wing dams that confine the river flow to the 9-foot navigation channel and keep it scoured out, these new structures would divert some flow to create or maintain side channels. If we must dredge some areas, the embryonic natural levees and islands that form behind the deflection dikes would be logical places to put the dredge spoil.

In other parts of the river, low, broad natural levees once screened floodplain lakes and backwaters from winds and the silt loads of the river. In some places, river water not only had to cross the natural levees but also shallow wetlands before it could reach lakes that were farther away from the river. These lakes thus were doubly protected from sediment by a natural system that we could imitate.

Closing the Barn Door before All the Horses Are Out. Although sedimentation is a major problem in the Illinois River, the repeated introduction of nonnative species via the man-made connection to the Great Lakes is another. All the species of clams, mussels, and snails that remain in the river are threatened by the European zebra mussel, which invaded the river in 1991 and now carpets the bottom at densities approaching 100,000 per square yard in some places. The zebra mussels attach to the shells of the native mollusks, impeding their movements, interfering with their feeding and respiration, and eventually killing them. Some thought should be given to installing a thermal barrier in the locks in Chicago, to prevent introductions of several other potential pests that have arrived in the Great Lakes via the bilge water pumped out of ocean-going ships. Also, the laws requiring ships to pump out their bilge water at sea should be strengthened and strictly enforced. The thermal barriers might also reduce the populations of zebra mussels already in the Illinois River by cutting off the supply of planktonic larvae from Lake Michigan. Population declines might cascade downstream, because zebra mussels live only 4-5 years and are dependent on the downstream drift of larvae to maintain their populations. There should be stricter federal laws regarding importation of any nonnative species, such as the Asian grass carp, which was introduced to the Mississippi drainage by the state of Arkansas. The grass carp is apparently already reproducing in the Ohio River and in the Mississippi near St. Louis and could compete with plant-eating ducks and hinder efforts to reestablish aquatic vegetation in the Illinois River.

Continuous Biological Monitoring. Although water quality has generally improved, toxic episodes remain a problem, as mentioned earlier. Many years of pollution abatement and ecosystem recovery can be undone by a single episode. Some of the new continuous monitoring systems that use mussels or fish as sensors should be installed along the river to provide an early warning of developing toxicity, so that corrective action can be taken. Installation of just a few of these at public expense on the main river would have the beneficial effect of setting off a wave of defensive monitoring by industries and municipalities eager to prevent spills from reaching the river and anxious to prove that they are not responsible for any downstream toxicity that is detected.

A Nagging Problem. Regardless of whether we enhance or restore the Illinois River-Floodplain Ecosystem, the problem of private underwater landholdings will have to be addressed. When the nine-foot navigation project was constructed on the Upper Mississippi River, land that was to be flooded, or subject to increased flooding, was purchased by the federal government. This procedure apparently was not followed on the Illinois River, so that portions of the bottom of Peoria Lake, and perhaps many other areas, are privately owned. Federal or state habitat enhancement or restoration projects cannot be done on private lands, even those that may be surrounded by public lands.Lake important under

An Ecosystem Restoration Strategy for the Illinois River. The Illinois River was one of only three extant large river-floodplain ecosystems in the United States identified by the National Research Council (1992) as retaining enough of its natural features to merit restoration (the others were the Upper Mississippi River, and the Atchafalaya, a distributary of the lower Mississippi). We need to recognize that an ecosystem is much more than the sum of its parts, and that the approach of isolating portions of the floodplain and backwaters to enhance duck use or fish populations (building duck ponds and fish ponds) is at best an interim solution to the symptoms of excessive sedimentation and fluctuating water levels. The long term solutions require both a watershed perspective and an ecosystem perspective. Upland watersheds and tributary streams must be managed to reduce sediment yields and smooth out water delivery that is now excessively flashy (the water peaks higher and drops lower than in the past). Existing watershed programs should be refocused on these problems. Ecosystem restoration means that we restore, to the extent possible, the processes that enable the river-floodplain ecosystem to maintain, repair, and rejuvenate itself, while recognizing that we can only approximate the original system. We must also protect the ecosystem from invasions of non-native pests by better federal regulations and enforcement against accidental and intentional introductions and by barriers to inhibit interbasin dispersal of pests. Installation, at several locations along the river, of continuous biological monitoring systems, that use fish or mussels as sensors, would help identify and reduce the frequency and severity of toxic episodes that can undo many years of ecosystem recovery.

The realistic vision and model for restoration should be the predisturbance ecosystem at the turn of the century, which maintained a dynamic equilibrium, rather than the disturbed system of the 1940s, which was disequilibrated by watershed alterations, Lake Michigan diversion, and navigation dams, and is not sustainable, as we should have learned by now. There is much to be learned from retrospective analysis of 19th century land forms, vegetation patterns, and water elevation hydrographs that could be applied to contemporary restoration of the Illinois River.

Ecosystem management does not mean "hands off", but it is management from a different perspective than the traditional approach of optimizing conditions for a few highly valued species on isolated parcels of land. It does mean working with natural processes such as erosion, sedimentation, and seasonal floodpulses, attempting to manage and guide them, rather than completely thwarting them. Hunters, fishermen, and preservationists who are now at loggerheads over how much land, money, and management effort will be devoted to this or that species could find common ground in restoring the floodplain and the floodpulse that maintains all the species. Now is also a good time to join forces with Association of State Floodplain Managers and the Federal Interagency Floodplain Management Task Force, who are evaluating the flood of 1993 and recommending procedures for reducing future flood damages and flood management costs. Nonstructural approaches to flood management, such as not rebuilding damaged structures in floodprone areas and moving people out of harm's way, are congruent with restoration of floodplains and riparian zones. Ecosystem restoration actually saves money and increases economic efficiency in the long run, because natural services are restored (flood conveyance and storage, water purification, production of fish and wildlife, preservation of biodiversity) instead of maintained by human intervention at great cost and considerable risk of failure. I believe is cheaper and less problematic to let a phenomenally productive river floodplain ecosystem preserve species and produce fish and wildlife than it is to build and operate hatcheries and zoological parks.

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A HISTORICAL PERSPECTIVE ON WETLANDS AND WATERFOWL POPULATIONS AND THEIR IMPORTANCE IN THE ILLINOIS VALLEY

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ABSTRACT

Historically, the Illinois River valley was among the most productive riverine systems in North America with respect to fish and wildlife populations. The numerous and generally shallow bottomland lakes, which flanked the river, hosted veritable gardens of aquatic vegetation. The aquatic plants and associated invertebrate fauna were central to the biological productivity of the Illinois River system.

In the late 19th century the Illinois River valley became renowned for the waterfowl populations frequenting its luxuriant wetlands during fall and spring migrations. As a result, a strong waterfowl tradition, including the establishment of private duck clubs, the development and use of duck calls and wooden decoys, and the pioneering of many waterfowl management practices, emerged and prospered in the valley.

Principally as a result of anthropogenic effects, numbers of some waterfowl species began to decline in the valley during the 1950s. Aquatic vegetation disappeared from the lakes in the late 1950s and 1960s, mainly because of the effects of sedimentation and fluctuating water levels, and has not recovered. Attempts to reestablish aquatic vegetation have been largely unsuccessful.

Various recommendations for preserving and restoring wetlands in the Illinois Valley have been submitted for over 80 years. The most reasonable economic and ecological way to establish and maintain quality wetlands and their attendant animal populations, including waterfowl, is to restore selected drainage and levee districts, especially below Peoria.

HISTORY

The Illinois River occupies a valley much older than the river itself as a result of a series of unique geological events. This valley in essence is what was the Mississippi River valley before the Wisconsinan glaciation. Meltwaters from the receding glacier spread out into the large valley, forming bottomland lakes and a sluggish river. The bottomland lakes, ponds, and sloughs covered approximately 56,000 acres between the sites of present-day Utica and Grafton and were the heartbeat of the unique river system (Bellrose et al. 1983).

The Illinois River was once one of the most productive rivers in North America, its fish and wildlife populations virtually unequaled. The shallow and clear bottomland lakes were filled with aquatic vegetation, including pondweeds, coontail, and waterlilies (Kofoid 1903). Arrowhead, marsh smartweed, and river bulrush were abundant at the shorelines.

Wild rice grew in Senachwine Lake, Rice Pond, and Rice Lake. Although some lakes were 12 to 16 ft deep, most were 4 to 6 ft, allowing sunlight to penetrate to the rich, fertile soil of their basins.

Extensive forests of pin oaks and pecans, favorite foods of mallards and wood ducks, graced the magnificent bottomlands south of Peoria (Uhler 1933). The floodplain ranged from 1.5 to 3 miles wide above Peoria, 3 to 5 miles wide near Havana, and 6 to 7 miles wide near Beardstown (Mulvihill and Cornish 1929). Below Beardstown, the filling of the bottomlands by sediment had progressed further historically; therefore, the lakes were smaller, and large areas of prairie occupied the floodplain beyond the forests.

The Illinois Valley has a rich waterfowl tradition. Preceding the Wisconsinan glacier, legions of mallards and other species of ducks likely funneled down the ancient Mississippi River valley. For the past 12,000 years or so, the Illinois River has continued to host this traditional fall passage of waterfowl seeking the abundance of food present in the lakes, marshes, and bottomland forests.

Waterfowl were a staple in the diet of native Americans who frequented the valley. European explorers were overwhelmed by the seemingly inexhaustible supply of waterfowl. In December 1699, St. Cosme indicated the abundance of wildlife on the Illinois River by commenting that "no one need fast on that river, so great is the quantity of game of all kinds: swans, bustards, or duck" (Kellogg 1917:354). DeLiette, who lived with the Illinois Indians in the late 1600s, described waterfowl on the Illinois River and Peoria Lake as follows: "I am now going to tell something which will perhaps not be believed, although I am not the only one who has witnessed it. The waters are sometimes low in autumn so that all the sorts of birds that I have just mentioned [bustards, swans, French ducks, musk ducks, teals and cranes, both white and gray] leave the marshes which are dry, and there is such a vast number of them in the river, especially the lake [Peoria Lake], on account of the abundance of roots in it, when, if this game remained on the water, one could not get through in a canoe without pushing them aside with the paddle" (Pease and Werner 1934:349-350). Later Strode (1893:88-89) wrote about Thompson Lake near Havana: "The noise and fuss of the waterfowl we could plainly hear. Going out where we could have an unobstructed view we were surprised at the great numbers of waterfowl. There were simply square acres of the lake's surface, covered with ducks, geese and brant." A disturbance by Strode "caused thousands of ducks and geese to take to the wing; the air was black in every direction with great circling flocks."

AQUATIC VEGETATION

The historic Illinois River was indeed a "Garden of Eden" for waterfowl. The entire area of the lower Illinois Valley subject to overflow, from LaSalle to the mouth, was about 400,000 acres, including about 70,000 acres of river channel and lakes. During the 20th century, a series of events induced by humans has abused the Illinois River floodplain. In 1900, the diversion of water from Lake Michigan increased low-water levels at Peoria by 5-6 feet (Bellrose et al. 1979) and at Havana by 3.6 feet (Forbes and Richardson 1919). Although waterfowl benefitted as the surface areas of bottomland lakes, sloughs, and marshes doubled from about 54,000 acres to over 120,000 acres (Bellrose et al. 1979), the flooding of thousands of acres of bottomland forest during the growing season resulted in the loss of pin oaks and pecans, species sensitive to increased water levels.

Many bottomland lakes were drained with the subsequent development of drainage and levee districts in the valley, principally from 1903 to 1926. The 38 organized drainage and levee districts and three private levees incorporated about 205,000 acres of bottomland (Mulvihill and Cornish 1929). Three drainage and levee districts–Partridge, Chautauqua, and Big Prairie, representing approximately 8,000 acres–were subsequently abandoned and reverted to a seminatural state (Bellrose et al. 1979). There are no levees in the 13 miles from Grafton north to Otter Creek. From Otter Creek to Beardstown about 130,000 acres, or 95 percent of the available land, was leveed; from Beardstown to Havana 19,000 acres, or 30 percent, was leveed; from Havana to Peoria 37,000 acres, or 73 percent, was leveed; and from Peoria to LaSalle only 2,600 acres, or 4 percent of the available land, was leveed (Mulvihill and Cornish 1929).

The species of wetland plants found in the bottomland lakes were affected principally by fluctuating water levels, turbidity, water depth, and competition by other plants (Bellrose et al. 1979). Bellrose (1941) documented the importance of stabilized water levels to submergent aquatic plants, such as pondweeds, in the Illinois Valley. He also noted that American lotus, river bulrush, marsh smartweed, and arrowhead were among the aquatic species most tolerant to variable environmental conditions. From 1938 to 1940, sago and longleaf pondweeds, coontail, and marsh smartweeds were abundant in those bottomland lakes, which had stable water levels and were generally protected from the river. In lakes separated from the river at low water stages and thus with semistable water levels, river bulrush, American lotus, and coontail were most abundant. In lakes connected to the river at all water stages and, correspondingly, with fluctuating water levels, river bulrush, American lotus and moist-soil plants were prevalent.

Vegetation was further monitored in selected lakes through 1959. For the lakes studied that were separated from the river at low water stages, the percentage of lake basin in vegetation (including moist-soil plants) was 46.8 for 1938-1942 and 58.4 for 1944-1959 (Bellrose et al. 1979). For lakes isolated from the river at levels below flood stage, and thus with somewhat stable water levels, the percentage of the lake basin in vegetation was 48.9 for 1938-1942 and 36.5 for 1944-1959. Until the 1950s, lakes isolated from the river, and thus sustaining less fluctuation in water levels, had more extensive acreages of aquatic plants.

Unfortunately, after the 1950s, aquatic plants virtually disappeared even in those lakes that were separated from the river and that had minimal fluctuation of water levels. Turbidity and softness of lake beds, which resulted from sedimentation and altered water levels, were responsible for the decline in vegetation (Bellrose et al. 1979). Turbidity readings taken in 1963 and 1964 at low-river stage were two to three times higher than benchmark values recorded in 1896 (Mills et al. 1966). By the 1970s, generally only beds of plants most tolerant to fluctuating water levels and turbidity–American lotus, river bulrush, and marsh smartweed, all poor duck foods–remained (Bellrose et al. 1979).

An inventory in the 1970s revealed that there were 183,120 acres of waterfowl habitat in the Illinois River floodplain and lower portions of the Des Plaines and Kankakee rivers (Havera 1992). Bottomland forest constituted the largest portion of habitat (34.9%). The major tree species in the bottomland forests were willow, elm, cottonwood, and silver maple.

Open water/lakes ranked second in total area (21.8%) and included the renowned bottomland lakes. Submergent and floating aquatic plants were the least common, representing only 958 acres, or 0.5 percent, of the waterfowl habitat. Submergent and floating aquatic plants were also rare in La Grange Pool in 1990 (Peitzmeier-Romano et al. 1992). A total of 5,041 acres (2.8%) of emergent plants were inventoried. Identified emergent plants, listed in order of descending abundance, were bulrushes, American lotus, marsh smartweed, cattail, and arrowhead. Moist-soil plants totaled 15,759 acres, or 8.6 percent of the habitat, and could conceivably colonize a large amount of the additional 15,262 acres of mud flats under suitable water conditions. Scrub-shrub habitat, dominated by willow, cottonwood, and buttonbush, occurred on 6,650 acres (3.6%). Intensive management for waterfowl food production occurred on at least 20,283 acres of public and private land in the Illinois River floodplain (Bellrose et al. 1979, Havera 1992).

Of the 183,120 acres of waterfowl habitat in the Illinois River valley, 73,002 acres (39.9%) occurred in La Grange Pool, and 56,271 acres (30.7%) occupied Peoria Pool (Havera 1992). Correspondingly, La Grange and Peoria pools are the most important waterfowl areas in the Illinois River valley. A substantial amount of habitat (39,253 acres) occurred in Alton Pool, mostly in the lower extremities. Starved Rock Pool contained the least amount of waterfowl habitat (3,508 acres).

With the loss of aquatic plants as a result of sedimentation and other factors, the integrity of the wetland systems and the quality of waterfowl habitat in the Illinois Valley were significantly diminished (Havera and Bellrose 1985). The abundance of certain species of waterfowl is directly related to the availability of native food resources (Bellrose et al. 1979). The Illinois River, however, remains an important migration area for waterfowl, but it is necessary to re-establish and maintain sufficient amounts of aquatic plant and moist-soil communities to satisfy the current and future nutritional requirements of migrant waterfowl.

PLANTING OF AQUATIC VEGETATION

The Illinois Natural History Survey made extensive experimental plantings of aquatic and moist-soil plants in various parts of the Illinois and Mississippi river valleys from 1939 to 1942 when the Illinois River still supported abundant aquatic vegetation. About 97 percent of the plantings failed to perpetuate the species planted, although the species planted were those that appeared most adapted for the particular habitat. The researchers found that if environmental conditions were suitable, plants were already growing there; and if nothing was growing on an area, it was quite evident that supplemental plantings would fail (Bellrose 1941, Anonymous 1945). Private duck clubs put much effort and expense into planting wetland species with only fair or temporary benefits (Bellrose 1941). Waterfowl food plantings made by 28 duck clubs in the Illinois Valley resulted in 34 planting failures and 22 plantings that were only partially successful at best. Bellrose (1941) concluded that with the exception of fluctuating water levels, turbidity was the most important factor affecting aquatic plant beds in the Illinois Valley. Many other factors, including soil character, sedimentation, and wave action, influenced the abundance of aquatic plants. Recent revegetation experiments conducted with arrowhead and sago pondweed in Peoria Lake from 1986 to 1989 (Roseboom et al. 1989) and with wild celery in 1990 in backwaters near Havana (Peitzmeier-Romano et al. 1991) were also largely unsuccessful in accomplishing long-term establishment.

WATERFOWL

The waterfowl populations of the Illinois Valley inspired some of the world's finest decoy carvers, call makers, and private club owners, caretakers, and members. The 100-mile stretch of the Illinois River between Beardstown and LaSalle probably had more call makers than any other place in the United States (Thomas 1988). The art of carving and painting lifelike wooden hunting decoys reached its height of perfection in Illinois, particularly in the Illinois Valley, between 1870 and 1940 (Parmalee and Loomis 1969).

Heilner (1943) remarked that the private duck club was an institution peculiar to North America. By the early 1800s, hunting and fishing clubs were organized and functioning in the East (Rahn 1983). Private duck clubs began to appear in the Illinois Valley in the late 1800s when the river and bottomland lakes were still in rather pristine condition. The duck clubs established their own mystique and personality. Hunters from distant locations arrived at these private clubs by rail, steamer, launch, or cabin boat before the 1920s when roads and motor vehicles became more commonplace (Thompson 1988).

The clubs contributed significantly to sport hunting and the waterfowl resource. Management practices developed over the years by the clubs and their caretakers formed a solid base for modern waterfowl management. For example, the private clubs in the Valley were among the first to initiate "rest areas" to hold ducks to improve hunter success (F.C. Bellrose, pers. commun.; Uhler 1933). F.C. Bellrose (pers. commun.) observed that almost all of the large private duck clubs (about 20) in the Illinois Valley in 1938 had refuges. Private clubs were also the first to set bag limits, ban automatic shotguns, stop spring shooting, and establish shooting laws (Heilner 1943).

In 1930, about 300 of the 440 private waterfowl hunting clubs licensed in the state were located in the 19 counties along the Illinois River (Bradford 1931). In 1963, Illinois had more private waterfowl hunting clubs than any other state in the Mississippi Flyway, and as much as 22 percent of the moderate- to high-value wetlands in the Mississippi Flyway was under private duck club control, thereby maintaining essential waterfowl habitat (Barclay and Bednarik 1968). During 1975-1981, there were 582 private duck hunting clubs registered in Illinois; most were clustered along the Illinois River. The private clubs continue to serve critical roles in providing rest areas and food for the fall and spring passage of waterfowl through the Valley and also habitat and associated benefits for many other species of wildlife.

The Illinois River valley historically has been one of the most important migration areas for mallards in the United States. Leopold (1931) reported that 3 million ducks were observed resting at both Crane Lake and Clear Lake during the late 1920s. From December 1 to 7, 1944, Bellrose documented a total of 3,855,000 mallards and American black ducks on just seven lakes in the Valley, including 1,500,000 at Lake Chautauqua. Frederick Lincoln, the first person to extensively band ducks in the United States, placed bands on mallards in 1922 in the Illinois Valley and noted that "when all the other ducks are gone, there will still be mallards on the Illinois" (Heilner 1943:88). However, because of human actions, the once-magnificent habitat of the Illinois River valley has become degraded, and along with the declining continental numbers of mallards, the number of mallards passing through the Valley each fall has steadily declined. A three-year moving average of the peak number of mallards during fall on the Illinois River from 1948 to 1992 revealed a significant ($\underline{P} < 0.05$) downward trend (Fig. 1). Nonetheless, for 1953-1991, the peak number of mallards inventoried in the Illinois Valley during fall migration represented an average of 22.7 percent of all the mallards found wintering in the Mississippi Flyway (Havera 1992).

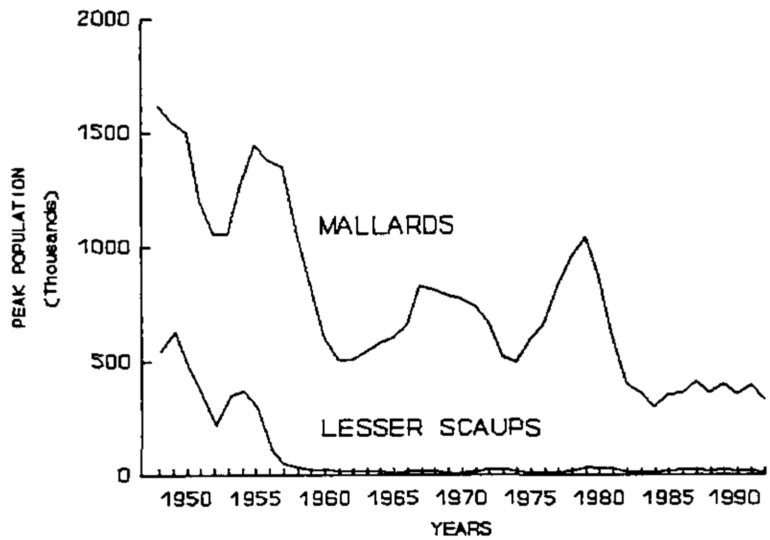

Figure 1. Three-year moving average of the peak numbers of mallards and lesser scaups aerially inventoried in the Illinois River valley during fall 1948-1992.

Food habit studies for mallards from the Illinois Valley during 1979-1981 (Havera 1992) were compared with those from 1938-1940 (Anderson 1959). The most notable finding was that during 1979-1981 Japanese millet, buckwheat, and grain sorghum--plants intensively managed for waterfowl--were major foods representing 10.6 percent of the diet. These foods were not found in the diet of mallards in 1938-1940. Additionally, during 1979-1981 the aquatic plants of coontail, longleaf pondweed, and common arrowhead no longer constituted an important part of the mallard diet as they had in 1938-1940 (10.4%). Thus, in recent years, food items from domestic plants cultivated by hunting clubs and public areas had replaced the seeds of aquatic plants, which were no longer available in the Illinois Valley.

The drastic declines of lesser scaups and canvasbacks in the Illinois Valley are particularly noteworthy. These species were abundant in the Illinois Valley before the mid-1950s. The plant and animal food resources used by lesser scaups and canvasbacks began to disappear from the upper Illinois River valley in the mid-1950s and have not recovered. The largest concentration of lesser scaups observed during aerial inventories in the Illinois Valley occurred on renowned, food-rich Upper Peoria Lake, where 700,000 were seen in 1949. The crash in the number of lesser scaups occurred in the 1950s (Fig. 1). The peak number of lesser scaups recorded in the Illinois River region north of Peoria was 585,100 in 1954, 73,650 in 1955, 34,250 in 1956, and 10,075 in 1957. The number of lesser scaups stopping in this region has never recovered.

The largest concentration of canvasbacks aerially inventoried in the Illinois River valley since 1948 occurred on Upper Peoria Lake, where 95,000 were present in November 1953. The peak number of canvasbacks recorded north of Peoria was 105,160 in 1952; in 1971, a maximum of 120 were observed there. As with the number of lesser scaups, the number of canvasbacks in the Illinois River region crashed in the mid-1950s and has not rebounded.

How much habitat will be necessary for waterfowl in the Illinois Valley in the future? The wetland and upland habitat restoration objective of the Upper Mississippi River and Great Lakes Region Joint Venture of the North American Waterfowl Management Plan identified a deficiency of 15,000 acres in Illinois (U.S. Fish and Wildlife Service 1993). The Illinois Division of Waterways (1969) concluded that to meet the potential waterfowl hunting demands in the Illinois Valley, it will be necessary to utilize all bottomlands not having a higher economic use. The Division (1969) recommended that at least 100,000 acres be under public management by 2020 and that at least 50,000 acres be under private management. Thus, satisfying these requirements would place about 35 percent of the Illinois River valley bottomlands under waterfowl management.

PAST RECOMMENDATIONS

Illinois River bottomlands encompass 425,837 acres (Illinois Division of Waterways 1969). The river and lakes occupy approximately 9 percent of this area. In 1969, 11 percent of the bottomlands were in government ownership, with the State of Illinois owning 7 percent (29,800 acres) and the United States 4 percent (17,000 acres). About 8 percent was under the ownership or jurisdiction of private sports clubs. The largest single use of the bottomlands was for agriculture, with about 187,400 acres, or 44 percent of the total, under the jurisdiction of various drainage and levee districts. The remaining 120,000 acres of the bottomlands included nonprotected farmland as well as urban, industrial, and miscellaneous uses.

The major pollutant of agricultural waterways today is sedimentation--an irreversible process. Erosion removes 201 million tons of soil each year in Illinois (Illinois Department of Agriculture 1992). The impact of sedimentation on the physical structure of the aquatic communities of the Illinois River valley has drastically altered the ecological functions of these fragile communities. However, there are encouraging indications. In 1990, Illinois led the nation in the amount of cropland planted with conservation tillage systems, which were used on 37.3 percent of the state's cropland. Illinois also led the country in no-till planting (11.6% of cropland) in 1990.

Early in the 20th century, visionary Stephen A. Forbes expressed his concern about the loss of the Illinois River floodplain to drainage and levee districts. Forbes (1919:13-14) stated that the reclamation and drainage of the floodplain "leaves the Illinois River much as Samson was left when shorn of his locks by the self-seeking Delilah." Forbes (1912:44) found that "the productivity of a stream is dependent upon the extent and condition of its back-waters and the period of its overflow, a fact which makes drainage district operations on the river bottoms a menace to its productiveness." Forbes (1919:10) also remarked that "by diking and drainage operations the Illinois River is being robbed of the haunts of its water birds, and corn will presently be growing every year on some 200,000 acres of forest, marsh, and lake over which its waters spread a few years ago in time of flood."

Several recommendations for preserving and restoring the wetlands in the Illinois Valley were made prior to the first Illinois River Governor's Conference in 1987.

1. Professor H.B. Wood, University of Illinois, offered in 1911 that State acquisition of swamp and overflowed land for preservation for future generations would be a solution to the decline in the Illinois River fisheries (Thompson 1993).
2. The General Assembly designated a Submerged and Shore Lands Legislative Investigating Committee in 1911; the committee intended that the fisheries and the remaining relatively undisturbed natural areas along the river be preserved as state parks (Thompson 1993).
3. Alvord and Burdick (1919:126) suggested that it would be possible to equip all levee districts with pumping plants, agricultural drainage, and flood gates, and to use a part of the districts each year for storing flood waters and fishing.
4. "The State should purchase bottomlands as necessary to augment the most favorable meandered lake holdings for studying, and, if possible, increasing the aquatic life of the river, and also for providing state parks or preserves" (Alvord and Burdick 1919:132).
5. Theodore Jessup suggested that the whole shoreline of the Illinois River, extending for nearly a hundred miles, from Peoria to the mouth of the Sangamon River, should be preserved either as a state park or included in a forest preserve system. Some parts of the Spoon River valley should also be considered (Friends of Our Native Landscape 1921:65-66).
6. In 1927 sportsmen promoted a "return to nature" proposal that the State issue bonds for $20 million for preservation and public recreation; the funds would have been used to purchase bottomlands including drainage and levee districts (Thompson 1993).
7. In 1929, Jacob A. Harman and others recommended using some drainage districts and all residual overflowed areas as permanent flood crest storage areas and game and fish preserves (Thompson 1993).
8. House Document No. 182-72-1, a navigation report on the Illinois River by the Chief of Engineers of the U. S. Army that was submitted to Congress on 16 December 1931, discussed the possibility of using seven selected drainage districts as flood control reservoirs (Jenkins et al. 1949).
9. In 1946, the Illinois Department of Conservation (IDOC) and Illinois Natural History Survey made a joint study and report upon the wildlife and flood control possibilities inherent in 17 selected drainage and levee districts located along the Illinois River (Jenkins et al. 1949).
10. In 1947, the U.S. Fish and Wildlife Service suggested conversion of five drainage and levee districts (Hennepin, East Liverpool, Thompson Lake, South Beardstown and Keach) covering 29,100 acres along the Illinois River into flood control reservoirs with wildlife benefits (Jenkins et al. 1950).
11. A thorough and detailed study conducted by consulting engineers for IDOC recommended eight drainage and levee districts encompassing 51,861 acres of the Illinois River floodplain for acquisition and development for outdoor recreation and flood control (Jenkins et al. 1950). These districts were Hennepin, Spring Lake/Clear Lake, Banner Special, East Liverpool, Thompson Lake, Big Prairie, Hartwell, and Keach. A secondary list of five districts totaling 34,400 acres for acquisition and development consisted of Big Lake, South Beardstown, Coal Creek, Crane Creek, and Big Swan.
12. In 1969, IDOC proposed, in the context of an Illinois River Corridor for Recreation, a program to preserve, protect, or restore the backwater lakes, sloughs, and bays,

and the acquisition of unspecified large tracts of land along the river for development into parks, refuges, and conservation areas (Illinois Division of Waterways 1969).

CONCLUSION

Previous studies have shown that drainage and levee districts along the Illinois River raise flood heights and decrease fish and wildlife habitat (Alvord and Burdick 1919, Jenkins et al. 1950). "If drainage and levee districts could be returned to their natural conditions they would once again become paradises for hunters, fishermen, and nature lovers" (Jenkins et al. 1950:58).

Following Forbes' (1910, 1919) remarkable philosophy, restoration of aquatic habitat in the Illinois Valley should focus on returning at least some portion of the leveed floodplain to the river so that it can indeed function as more of an unconstrained and productive natural system (Havera 1987). Selected drainage and levee districts in the floodplain should be acquired and allowed to revert to aquatic habitat with the levees retained to protect the wetlands from the sediment load and fluctuating levels of the river. Other drainage districts should be acquired and the levees modified or removed to allow access by the river to sustain and enhance its productivity and to provide for storage of floodwaters. These activities should be coordinated with land-use policies that are both economically and ecologically sound (Havera and Bellrose 1985, Havera 1987).

As summarized above, similar recommendations have been made several times since the early 1900s. Successful examples of the recommended strategy include Spring Lake, Tazewell County, in the Illinois Valley, and Louisa Refuge, Louisa County, Iowa, and the Ted Shanks Refuge, Pike County, Missouri, in the Mississippi River floodplain. In Europe, the Netherlands is restoring 60,000 acres of marsh, lakes, and forests on land reclaimed a century ago, almost one-tenth of their present farmland (Simons 1993). The Dutch government concluded that it makes economic sense to reduce farmland and livestock and return lowlands to nature. It is far past the time to take similar action in the Illinois Valley.

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COMMERCIAL FISHERIES AND SEWAGE TREATMENT: CONFLICTING USES OF THE ILLINOIS RIVER

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ABSTRACT

The Illinois River formerly supported one of the most economically successful commercial fisheries of all inland rivers. Competing demands to use the river for sewage treatment and removal altered the riverine habitat and greatly reduced the river's ability to support commercially viable fisheries by the 1920s. Scientific recognition of this fact, along with the development of sewage treatment technologies offered hope to restore the fisheries. Sewage treatment installations for domestic wastes and not for industrial effluent limited the benefits of the new technologies. The slow adoption of treatment technologies underscores the lack of social significance accorded the fishery.

INTRODUCTION

The once impressive fishing and musseling statistics of the Illinois River attest to its potential productivity. Commercial fishermen reported an estimated catch over 23 million pounds in 1908, but this dropped to near 7 million pounds in 1912 (Alvord and Burdick 1915) Likewise, mussel gathering reached a production peak in 1910. By 1914, however, both the upper and lower river (below Peoria) were without commercially exploitable mussel beds (Danglade 1914, 13-17). One critical element in the demise of the fisheries was a decision to use the Illinois River to carry Chicago's sewage.

Contemporary public health principles offered a justification for using the Illinois River to carry sewage. The cornerstone of sewage removal practices at the time was "natural purification"--or the belief that a stream possessed the ability to cleanse itself as it flowed seaward (Tarr, et al. 1984). This concept became the guiding principle behind Chicago's sanitation plan that went into effect in 1900. Essentially, the state's largest city used the Illinois River both as a sewage transport and treatment system. Set within the historical context of public health practice, the was a wholly acceptable plan, and one that won the approval of the state legislature and the public health agency (Rauch 1889). It did not enjoy such acceptance by the state fish commission, nor fishermen.

Nonetheless, it represents a typical historical conflict over natural resources -- the conflict between fisheries interests and those of an urban industrial society (Scarpino 1985). Public health in Chicago won out initially. As the century progressed, however, science and society re-evaluated the initial decision and took remedial measures to reduce the impact of sewage. Through the 1960s, however, sewage treatment was unable to keep pace with the wastes discharged to the river. Consequently, the commercial fishery was virtually eliminated as sanitation took precedence over natural resource protection.

EARLY POLLUTION CONTROL EFFORTS

Chicago undoubtedly faced a dire situation in the 1880s. To contend with disease outbreaks caused by contaminated Lake Michigan water, the city began pumping much of its sewage into the Illinois River drainage basin in 1871. This solution was only temporary and was unable to accommodate the growing population and its burgeoning sewage removal needs. A heavy storm in 1885 flushed the Chicago River's foul contents into the lake and introduced deadly bacteria to the drinking water supply, leading to a massive outbreak of cholera and typhoid (Cain 1978, 64). Subsequently, city leaders formed a sanitary district that devised a plan to create a gravity flow canal that would carry the city's effluent into the Illinois River. The plan was wholly justified by contemporary public health policy that viewed rivers as capable of purifying themselves. Thus, the introduction of Chicago sewage, along with substantial quantities of fresh water from Lake Michigan, into the Illinois River represented sewage treatment as well as removal. Since no cities along the Illinois drew their drinking water from the river, Chicago authorities did not perceive the plan as simply a diversion of Chicago's problem to another region. Furthermore, there had been years of experience with sewage diversion without adverse effects. The state board of health reported:

> In some recent dry-weather years, over half the low-water volume down as far as Peoria has come from Lake Michigan and with it the sewage of Chicago. While fish have not been disturbed at such times below the Kankakee, except in winter, yet below Peoria the organic wastes from the distilleries and cattle pens so pollute the water as to kill them. It is a question whether the present sanitary condition of the lower Illinois would not be worse if the flow of water from Lake Michigan were excluded (Illinois State Board of Health 1889, xvii).

Thus, Illinois sanitation authorities clearly saw the diversion as benefiting both Chicago and the lower river by diluting Peoria's contribution to the waterway.

This view was not shared by their counterparts in Missouri. St. Louis officials mounted a major campaign to stop Chicago's diversion of its sewage into the Mississippi River basin. Missouri's Attorney General instituted legal action that became the first interstate pollution case heard by the U.S. Supreme Court. Missouri sought an injunction against the opening of the canal, but last-minute subterfuge by the Chicago Sanitary District opened the canal before the court could rule. Nevertheless, the court ultimately heard arguments by Illinois and Missouri. Each side presented volumes of expert testimony to support their respective position. Missouri claimed that the Chicago sewage introduced typhoid to St. Louis' water supply. This, they argued, constituted a public nuisance and ran counter to prevailing riparian water rights. Illinois' attorneys countered that the river cleansed itself before it reached its mouth and if there was pollution, it more likely stemmed from industries in Peoria and Pekin, than Chicago. As evidence, the produced testimony from a Peoria distillery manager who reported that feedlot wastes "would accumulate along the bank for indefinite periods until high water washed it away, when it would flow down the stream in large islands, one of which was too large to pass between the piers of the Pekin Bridge" (Cosey in Leighton 1907, 144). Furthermore, they argued that any filth arriving at St. Louis came from the Mississippi River, above its junction with the Illinois. Justice Oliver Wendell Holmes offered the court's opinion in 1906. He ruled that Missouri failed to make its case and allowed Chicago to continue using the Illinois for sewage treatment and transport (Missouri v. Illinois 1905).

His ruling came before a series of biological investigations that followed the demise of the commercial fishery. Biologists arrived at a different verdict than the jurists, at least in terms of the pollution's impact on aquatic life. As early as 1900, the state fish commission criticized the use of rivers to transport sewage.

> We are frequently in receipt of complaints of fish being killed by the introduction of refuse from different manufacturing or other establishments, which is being turned into our rivers an streams . . . If no means of preventing the escape of such refuse into the waters can be found . . . it would be incumbent on the people interested to demand such protection as the law can give (Illinois State Board of Fish Commissioners 1900, 11).

Local officials offered mixed opinions on the impact of Chicago's sewage on water quality and the Illinois River fishery. At Ottawa there was no fishing due to the sewage. Further downstream, Henry residents reported fishing was satisfactory in summer months, but "fish taken in the winter were unfit for food on account of the gases of putrefaction in the river water which seemed to permeate the flesh of the fish" (Harman 1901, 100). In the face of obviously deteriorating conditions, the Fish Commissioners called for sewage treatment to replace dilution by 1904.

> If there were no other means than the use of the rivers to care for sewage and refuse, it would be a different proposition, but with septic devices that will care for it and do it well, there would seem to be no reason why proper legislation should not be had (Illinois State Board of Fish Commissioners 1904, 32).

Their call for adequate sewage treatment initiated a protracted process to reduce sewage's impact on the waterway.

THE ADVENT OF SEWAGE TREATMENT

The central problem remained: which cost was society willing to bear? Did the state see clean rivers and thriving fisheries as more important than protecting over 2,000,000 urban residents from tainted water supplies? In 1911 the Illinois Water Survey polled public officials to gauge their opinions on this issue. The general sentiment was that streams should continued to serve as sewage conduits, but they should be maintained so that they did not present a public health danger or nuisance. Also, the public health officials and scientists generally agreed that streams with an established fishery should be granted protection from polluting conditions. Ultimately, the survey compiler concluded that the consensus held that local conditions should dictate treatment options (Hansen 1911, 83-84).

Certainly by the 1920s, water quality in the Illinois called for sewage treatment. Even Chicago investigators sympathized with the situation along the Illinois.

> For over one hundred miles from Chicago, the inhabitants of the valley seem to have relinquished the most valuable rights of riparian owners. The water is not fit to drink, nor wash in, nor to water stock in, nor for the many domestic and industrial uses of a normal river. Fish die in it; the thought of swimming in it is repugnant to the senses; boating, far from being a pleasant and healthful diversion can be enjoyed

> by the hardy . . . the water is discolored, malodorous, poisonous. Fine black organic sewage mud covers the bottom and deposits the shores when the river overflows its banks (Soper et al. 1915, 95).

Scientists concurred with this somewhat dramatic observation. Forbes and Richardson of the Natural History Survey pointed out that sewage from Chicago delivered by the Sanitary and Ship Canal was one of the two principal reasons for the adverse changes in the Illinois River's biological environment (Forbes and Richardson 1919).

The U.S. Department of Public Health reported several years later:

> Practically none of the sewage reaching the Illinois or its tributaries is treated before discharge, so that dilution and natural purification alone have been depended upon to effect such improvements as occur. As a result, the upper Illinois is notoriously polluted by the overwhelming burden of sewage and wastes received from the main canal and from cities along its banks (Hoskins et al. 1927, 18).

Public Health Service researchers found that by the mid-1920s there were over 3.3 million people contributing sewage to the Illinois River. After adding the "population equivalent" of industrial wastes, they calculated that the Illinois river carried sewage equivalent to over 6.2 million people.

At this time, there were numerous sewage treatment options available and increasingly cities assumed their responsibilities to treat sewage before releasing it to public waterways. But professional judgement about whether the Illinois had reached its capacity remained mixed. The State Water Survey concluded in 1924 that tributaries of the Illinois were not overtaxed by the sewage released to them (Weinhold et al. 1924, 57). A few years later, the Water Survey found that eighteen of thirty-seven towns on the river provided at least partial treatment to their wastes. They reported that this represented an improvement over previous conditions (Bushwell 1927, 9). Furthermore, Chicago was making progress with treatment system installations. Experimental plants showed positive results with the activated sludge process and provided justification for opening two major plants in 1922 (Cain 1978,. 114). Overall this reduced the volume of untreated sewage, but such findings did not alleviate biological damage. W.C. Purdy, of the U.S. Public Health Service, reported in 1930 that "the valuable fishery interests of the lower river have been seriously harmed and threatened with extinction" (Purdy 1930, 2).

The late 1920s and early 1930s were important years in sewage treatment installation. Industrial production during the 1920s reached all-time peaks and consequently the volume of industrial effluent rose correspondingly. This prompted an increasing public reaction to the degradation of major waterways. Organizations such as the Izaak Walton League and other conservation groups initiated campaigns to clean up waterways for the sake of sport fishermen. Also, federal funds dedicated to Depression-era programs underwrote numerous sewage treatment plants and other infrastructure improvements. Along the Illinois River, this meant two things: (1) there was increasing public support for waterway clean up and (2) projects actually got underway.

Illinois congressman Henry Rainey spoke out on behalf of the Illinois Valley Protective Association during the early 1920s and told congress "The Illinois River with all of its romance and its beauty gone, has now become the greatest and the most offensive sewer to be found anywhere on the face of the earth" (In Waller 1972, 138). When Peoria began planning its sewage treatment system in 1926, to alleviate the principal source of sewage below Chicago, it outlined its mission this way:

> [The] problem at Peoria is to devise the necessary works for relieving the present over taxed sewers, for extending the sewers into nearby developing areas, and for sufficiently controlling pollution of the Illinois River by the industrial and human sewage of Peoria (Pearse, Greely & Hansen 1926, 1).

Construction proceeded and the treatment plant opened in 1931. Likewise many other treatment systems came on line during the late 1930s (Fig. 1).

Despite much hoopla, the impact of Peoria's modern treatment facility was lessened by the fact that it did not treat industrial wastes. Sanitary District officials reported that there were "practically no industrial wastes discharging to the sewer system." In fact, "care was taken to keep all the major industrial wastes out of the treatment works." In 1934, when congress repealed prohibition, many of the distilleries went back into operation and greatly exacerbated the problem. The pollution load from Peoria industries in the early 1930s was equivalent to that of about 1.4 million people (Peoria Sanitary District 1966, 21). Thus, the worst problem was barely addressed by the installation of municipal treatment facilities, which were the central thrust of 1930s-era sewage treatment projects. This reflected contemporary public health policy which held that industries were responsible for treating their own wastes and also the general municipal practice of excluding most industrial wastes due to their potentially harmful characteristics (acidic or toxic) and their excessive volume, which could overload municipal treatment works. By 1939, most industrial communities still allowed untreated trade wastes to flow into the Illinois River, while they offered some form of treatment for domestic sewage (Fig. 2).

Public health officials were quick to recognize this lingering problem and worked to encourage manufacturers to treat their own wastes. This became ever more critical in 1938 as a Supreme Court-imposed deadline for reducing the diversion of Lake Michigan water approached. Commercial Solvents of Peoria worked with engineering firms to develop waste recovery techniques and thereby reduce its pollution load. Metcalf and Eddy of Boston found a treatment system that would reduce the company's waste BOD (biochemical oxygen demand) by some 70 to 75 percent. As the outside consultants were working on treatment methods, research staff discovered that they could produce a commercial by-product from the fermentation wastes in 1937. The absence of market for the product (riboflavin) and subsequent war-time interruptions, diverted the company's attention to this problem. It was not until 1949 that the pollution control plans went into operation (Wheeler 1949, 178-79).

In Pekin, it took Standard Brands several years to install a treatment system. Initial planning began in 1934 and the company installed a treatment system that included several digestion tanks in 1940 (Greenleaf 1941). Despite some examples of responsible industrial waste treatment, state officials saw progress as unsatisfactory. A Sanitary Water Board survey on industrial wastes in Peoria shortly after the war found effluent with a population equivalent of nearly 700,000. It summarized the characteristics of industrial effluent and concluded that most industries should improve their treatment equipment (Illinois Sanitary Water Board 1945).

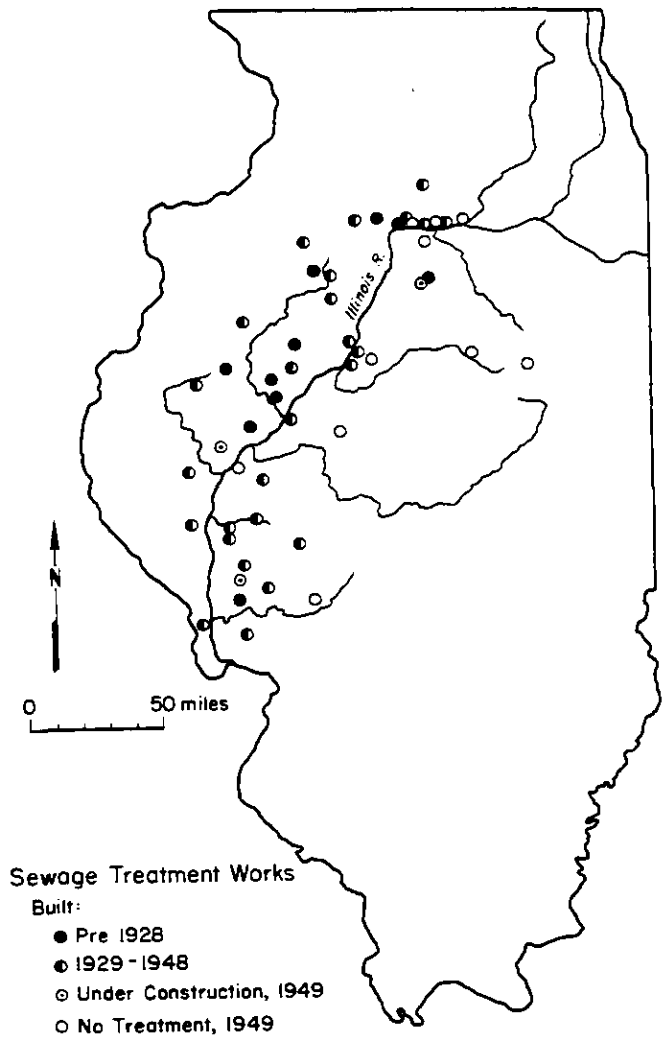

Figure 1. Sewage Treatment Works Built Along Illinois River, 1928-1949. After Illinois Sanitary Water Board 1949.

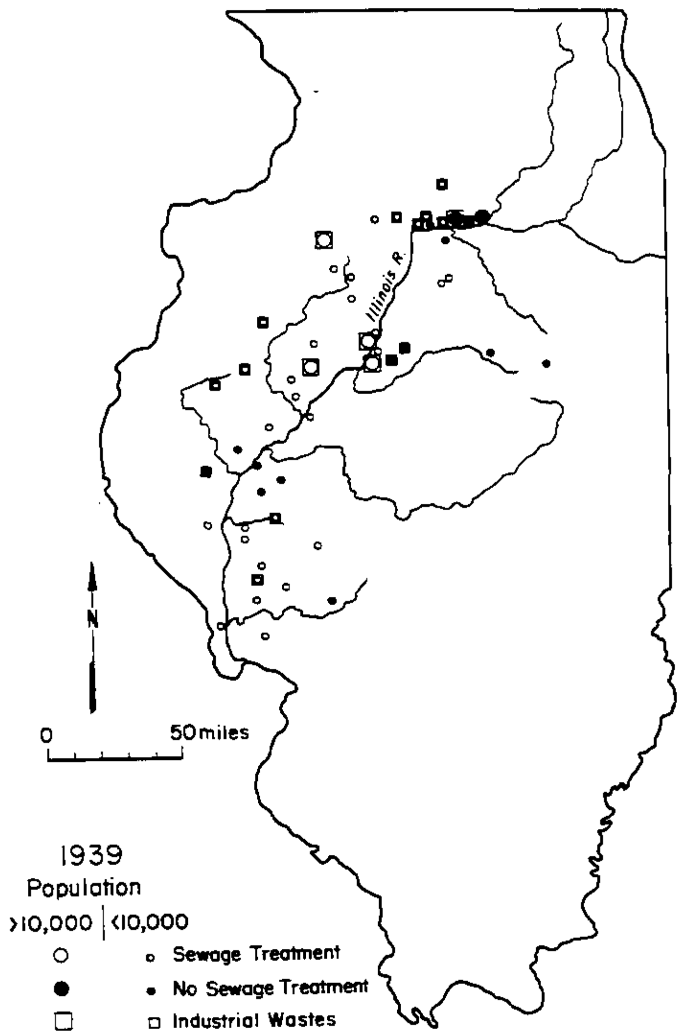

Figure 2. Sewage Treatment Facilities Along the Illinois River, 1939. After Illinois State Planning Commission 1939.

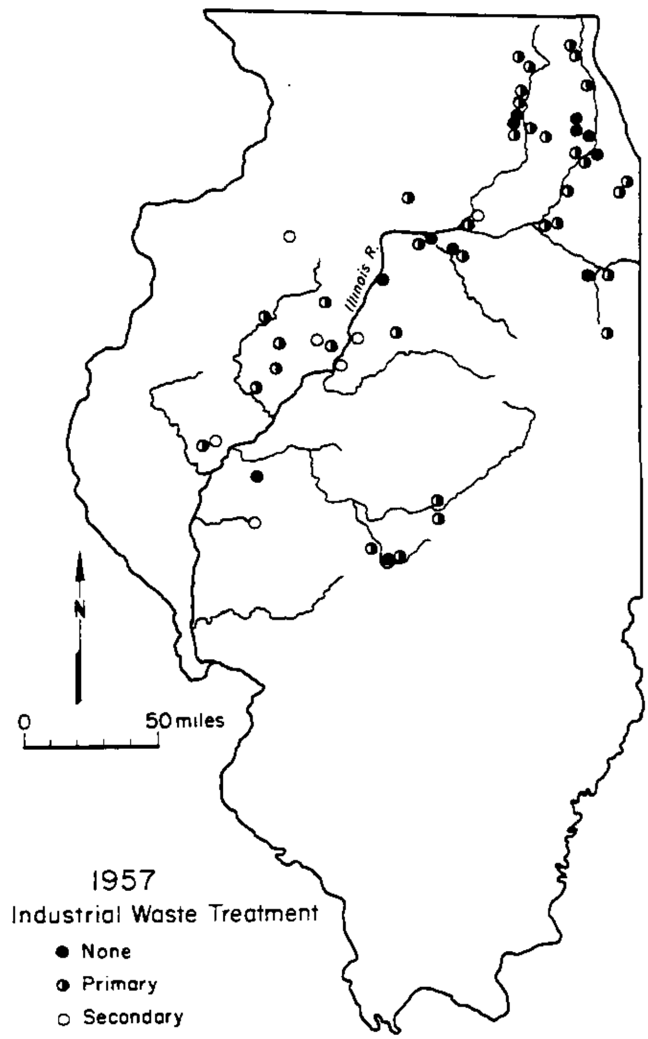

Figure 3. Industrial Waste Treatment Systems Along the Illinois River, 1957. After U.S. Department of Health, Education, and Welfare 1957.

During the post-war years, state public health officials realized that they would have to exert greater pressure on manufacturers. Before 1930, untreated domestic sewage was the greatest contributor to stream pollution. By 1949, the installation of municipal treatment systems greatly reduced the volume of general urban sewage. The 1950 Illinois River pollution study found that 97 percent of the population was served by sewage treatment (Illinois River Pollution Commission 1951, 10). In contrast, there had been negligible reduction in the volume of untreated industrial effluent. Estimates placed the total load of industrial wastes at a population equivalent of about 1.9 million in 1950, down only 0.1 million since 1937 (Illinois Sanitary Water Board 1950, 40). The industrial load now represented twice the volume of domestic sewage and drew increasing attention. Industrial treatment remained rudimentary along much of the Illinois River. Several manufacturers on the Fox and DesPlaines employed either primary treatment, which included only screening, or no treatment according the U.S. Department of Health, Education and Welfare 1957 inventory (Fig. 3). In Joliet, the survey showed extensive treatment for municipal wastes, but the Blockson Chemical Company used only lagoons while the Joliet Arsenal followed "good housekeeping" practices. Neither used a destructive treatment system. Companies generating large volumes of biological wastes generally had more complete treatment systems. The Morris Paper Company combined filtration and flotation and the National Biscuit Company at Marseilles used flotation, grit chambers, screens, settling tanks, and a digester – all aimed at removing high BOD wastes from the river (U.S. Department of Health, Education, and Welfare 1957). Further downstream at Peoria and Pekin, only the National Cylinder Gas Company employed a chemical treatment process. Given the removal of biological wastes by the late 1950s, one would expect the Illinois River's productivity to rebound by 1960.

This was not the case, however. Starrett's mussel survey during the 1960s indicated that twenty-five kinds of mussels were extirpated from the Illinois between 1900 and 1966. *Investigators found no living mussels in the upper Illinois River–the section most affected by* long-term pollution. In fact, as early as 1912, mussels had virtually disappeared from this stretch of the river. Starrett concluded that this indicated the upper river remained unsuitable for reestablishing mussel populations (Starrett 1971, 342-43). The Peoria pool appeared to be a more viable habitat, supporting thirty kinds of mussels. This reflected improving conditions since the early twentieth century (Starrett 1971, 349). The Peoria-Pekin pollution load had a noticeable effect on mussel populations and investigators found fewer than half the number of mussel types found early in the century (Starrett 1971, 354). Overall, despite dramatic improvements in the river's dissolved oxygen content, mussel diversity remained far below the turn-of-the-century numbers.

CONCLUSIONS

In 1900 when Chicago turned its sewage into the Illinois River, it was following basic scientific principles of the time. The concept of natural purification guided the development of the Sanitary and Ship Canal. It soon became apparent to natural scientists that the huge volume of sewage was overwhelming the ability of the Illinois River to biologically decompose the urban effluent. Efforts to provide sewage treatment for domestic waste improved the situation, but soon revealed that industrial wastes alone exceeded the stream's capacity. Through the 1950s and 1960s, the primary stream pollution abatement efforts centered on reducing industrial discharges. Although progress was reported, particularly with biological wastes, manufacturers continued to release toxic and other forms of non-biological wastes without adequate destructive treatment. Apparently, this limited the ability of mussel populations to re-propagate and repopulate the middle and upper stretches of the river. Although other factors also undermined the ability of Illinois River wildlife to repopulate the waterway, the historical management of sewage and industrial effluent was a major contributor to the fishery's demise.

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MODEL ENVIRONMENTAL STORMWATER MANAGEMENT STRATEGY FOR LAKE COUNTY

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ABSTRACT

A watershed-based, multi-objective approach that considers all the environmental values associated with surface water has been widely promoted as the ideal stormwater management strategy. Limited public funding, demand for a better environment and emerging stormwater quality regulations seem to make such an approach essential in the future. Though promoted as cost-effective, such a strategy is rarely implemented. Part of the problem lies in the complexity and up front costs of the approach as well as the lack of a suitable framework for implementation and best management practice decision-making. To help overcome these obstacles a model management strategy has been defined and is being applied to two drainage basins in Lake County. Preliminary findings and obstacles and advantages to the approach are discussed.

INTRODUCTION

In response to increased flooding, drainage problems, and watershed degradation associated with urbanization, the State legislature passed a bill in 1987 allowing Chicago area collar counties to establish comprehensive stormwater management programs (P.A. 85-905) (P.A. 85-1266). This paper describes the structure (that can serve as a model) of how Lake County has implemented that legislation to the watershed level. The first half describes the institutional framework enabled by the legislation followed by a planning and decision-making process for assessing a watershed's needs and selecting best management practices. In the context of this report a best management practice, or **BMP**, is the most cost-effective management activity or structure that can be applied to remediate or prevent a given stormwater problem regardless of its nature i.e. flooding, pollution, habitat disruption, etc. Through a grant from the Illinois Department of Conservation and Illinois Environmental Protection Agency and with assistance from the Northeastern Illinois Planning Commission, this model is being applied to the Flint Creek and Mutton Creek drainage basins.

ELEMENTS OF THE MODEL STRATEGY

Management Principles

In order to be cost-effective, avoid duplication and conflicts, a watershed approach must be **comprehensive** and include a complete **coordinated** system addressing program operations; planning, design and construction; finance, maintenance and regulation. Existing, municipal, state, federal, special district and road construction activities must be coordinated with the planning process. Where possible, management activities must strive to accomplish **multiple objectives**. It should go beyond drainage and flood control and work to improve water quality, wildlife habitat, recreation and community aesthetics.

Watersheds and not political boundaries should serve as the management unit and the management strategy should address **prevention, remediation** and **maintenance**. Preventing problems from being created or aggravating existing problems will reduce the need for future remedial projects and protects investments made in solving existing solutions.
Once a preventative program is in place to stabilize the watershed, programs must be created that address existing problems and needs. Finally, consistent system-wide programs are needed to ensure that the current and future system will work as planned.

Dedicated and **equitable funding** ensures a successful program. The drainage system is public works infrastructure and needs consistent attention; not just after flood events. Everyone in the watershed uses and therefore benefits from the system. Although some benefit more than others, everyone is responsible for some level of financial support. The most cost-effective means are sought on a watershed-wide basis and not on a site-specific scale.

Finally, by emphasizing **nonstructural** approaches such as the preservation and use of the natural system, high construction, maintenance and environmental costs are avoided and there are greater opportunities to achieve multiple objectives.

Institutional Framework

Organization

A central organization is needed to coordinate and involve all public and private entities in the planning, decision-making and implementation process. In recognition of the existing fragmented management (in Lake County over 90 jurisdictions and agencies were found to have some role in stormwater management), the enabling legislation includes a purpose to, "Consolidate the existing stormwater management framework into a united countywide structure". It requires that a countywide stormwater management planning committee be established that includes equal municipal and county representation. In Lake County, this is called the Stormwater Management Commission.

Under the Lake County approach, the organizational structure includes additional entities to allow a "bottom-up" flow of information and decision-making. This begins at the watershed and basin level and allows input from public and non-governmental "stake-holders."

Basin Steering Committees. Informal steering committees are established for sub-watershed drainage basins that attempt to include all the major public and private interests. Specific issues and needs are discussed and plans or policies formulated which then move up the chain for adoption and implementation.

Watershed Management Boards. Each major watershed (four in Lake County) has a board consisting of a representative from each municipality, township and drainage district in the watershed. Their role is to advise the Commission on the unique needs of the watershed, integrate the basin plans into watershed priorities, request a budget and recommend to the Commission how and when the allocation should be spent. The Boards have no role in regulation.

Technical Advisory Committee. This committee advises the Commission on appropriate technical standards and policy with particular focus on regulations for new development as well as help integrate the watershed plans into countywide priorities. It is appointed by the Commission Chairman based of recommendations from the Watershed Boards and staff. It consists of a mix of public and private engineers and environmental scientists.

Stormwater Management Commission. The Commission sets policy, develops procedure, and approves plans and regulations for recommendation to the County Board for adoption. It requests a budget from the County, which is funded by the special stormwater management levy.

Authority

The central organizational entity must have the means by which plans, policies and regulations can be implemented and enforced. Otherwise, one entity could easily undermine a watershed management strategy. The enabling legislation allows for:

> "Setting minimum countywide standards for stormwater and floodplain management and; preparing a countywide plan for the management of stormwater runoff including the management of natural and man-made drainageways. Such countywide plan may incorporate watershed plans." and; ".... prescribe by ordinance reasonable rules and regulations for floodplain management and for governing the location, width, course and release rate of all stormwater runoff channels, streams, and basins in the county...."

Furthermore there are provisions for dissolving drainage districts and entering private lands with 10 days notice for inspecting facilities and removing obstructions.

Lake County has adopted a countywide Watershed Development Ordinance that includes standards for runoff rates and detention; floodplain and wetland conservation; and soil erosion and sediment control. These minimum regulations will apply to all significant future development in communities as well as unincorporated areas. The elements of the regulatory approach include the Ordinance, a Technical Reference Manual and Basin Management Plans working in tandem.

Funding

To provide a dedicated source of revenue a property tax up to 0.20 percent of assessed valuation can be levied to support the plan and bonds can be issued. Additionally, fees can be assessed to new development in lieu of on-site detention and for recapturing the costs of stormwater management infrastructure put in place to serve future development. Currently, Lake County only levies at a rate of 0.005 percent and charges fees for permits.

Watershed Management

Given the overall principles and institutional framework, the next step is to establish basin management plans. The model employs a simple assessment approach with a conceptual rather than design oriented outcome. In the absence of existing basin-wide studies, it is an important and low cost first step. Once the problems and needs of the entire basin are understood, a conceptual approach to management can be agreed upon by various "stake-holders." Then an Action Plan is developed that sets the schedule for further analysis and design, which can take place in a more cost-effective and focused manner.

Watershed Assessment

The first step is a watershed assessment to determine existing conditions and management needs. The basin steering committee is used to help determine the **goals** and **objectives** for the watershed as well as potential needs and expectations. A nominal group technique is employed to first generate a universe of issues and then focus and consolidate them into management objectives.

Next, an **inventory** of the basin is conducted. Using a standard questionnaire format, communities and various groups are polled on problem sites; previous studies and existing plans; land use and development; available mapping; and maintenance and related programs. The drainage system is divided up into reaches and sub-basins and inspected for hydrologic, hydraulic, biological, and environmental conditions. A standard form is filled out for each reach and entered into a PC database. Examples of data collected include severe erosion and sedimentation sites, outfall locations, substrate composition, riparian vegetation, and land use.

Overlays that match current aerial photography of the basin are **analyzed.** Themes may vary depending upon the information available and the study's objectives. Data generally available include transportation, surface water, wetlands, floodplains, soils, and land use. Special studies available in Lake County include presettlement vegetation mapping and a Wetland Advanced Identification Study that identifies the highest quality wetlands. Problem sites and information from other studies are also incorporated. A simple GIS-based method for mapping pollutant load intensity by land use has been developed and quick methods for calculating runoff are being developed to add to the detail of the analysis.

The overlays and data are compared and reviewed by a team of engineers, planners, and natural resource professionals to analyze potential sources of identified problems and then identify opportunities and constraints to potential BMPs. A list of potential BMPs are prepared for each sub-area.

BMP Selection Methodology

Once the compendium of problems and potential management options are identified, a series of matrices are used to select the preferred combination of BMPs. BMP selection is dependent on the type of watershed, the type of development, the effectiveness of the various BMPs, and the cost of the various BMP. The following outlines the selection process.

1. Determine watershed type and BMP objectives. The type of watershed or the resource that is being protected in the watershed will determine the objectives of a watershed

management and protection strategy. For example, smaller headwater streams are particularly sensitive to streambank erosion caused by hydrologic destabilization. However, lakes are most sensitive to nutrient loadings which lead to eutrophication.

2. Determine BMPs that are appropriate for the development type. Not all BMPs are appropriate for all development types. For example, swales may not be appropriate for less than quarter-acre lot, single family residential developments and detention basins may not be appropriate for small in-fill developments.

3. Select BMPs appropriate to the development type that are capable of achieving the objectives for the watershed. Different BMPs achieve different objectives. For example, dry detention basins provide very good rate control and reasonable sediment control but very little nutrient control and no runoff volume control. However, swales provide some runoff volume control but very little rate control.

4. Select a system of BMPs to cost-effectively achieve objectives. From the BMPs or combinations of BMPs that are appropriate for the development type and capable of meeting the watershed objectives, the most cost effective system can be determined. The selection should consider both short-term capital costs and long-term maintenance costs.

Action Plan

After performing the above steps, a series of policy and action statements are developed for review and adoption by the Basin Committee, Watershed Board and Stormwater Management Commission. Each jurisdiction and organization in the basin is also asked to adopt the recommendations. For easy reference and specificity, the Action Plan can be organized along functional lines such as recommendations for new development and developed areas; basin-wide, sub-basin and site specific needs; nonstructural and structural solutions and; federal, state, county, municipal, parcel owner (or private and public sector) actions.

ISSUES & DISCUSSION

Although this model is still being applied in the demonstration watersheds, there is sufficient experience administering the ordinance and discussing the management options with the steering committees to identify issues.

1. The primary issue revolves around "is it worth the cost?" This is an extremely complicated question that involves benefits that are difficult to quantify and who should pay.

Flood control has been the primary concern in the past and the result has been the construction of single-purpose reservoirs and detention ponds. The benefits of the other objectives (water quality, habitat, and community aesthetics) with the exception of recreation, are difficult to quantify in terms of dollars and cents. As a result, a pure benefit-cost analysis can not be performed. When specific questions about the costs and benefits can not answered, justification for the environmental approach is weakened. To address this need marginal and avoided cost analysis methods should be developed. Such methods are needed to justify regulations and to reformulate how public water resource projects are funded.

Avoided unit cost analysis may be used to justify certain management strategies. For example, the additional per acre costs of housing due to required erosion control measures can be compared to the eventual per acre costs of dredging a downstream lake. Thus, unit costs for preventative measures incorporated into new development should be compared to the unit costs of remedial measures. Production functions, comparing the pollutant removal efficiency of a BMP versus its total cost can be used to select the most cost effective BMP. Factoring in wildlife and habitat and community aesthetics will be more difficult and will rely on assessing community values and willingness to pay. Here, the additional or marginal costs of the comprehensive approach could be quantified on a per acre or per capita basis and value judgements made regarding whether the additional benefits are worth the cost.

2. The link between degraded natural systems and urban development needs to be recognized by all stakeholders. Community officials and developers need to recognize the link to gain acceptance for comprehensive approaches and regulations. Consumers need to recognize the link to gain acceptance and preference for stormwater and development practices which may be different than they are accustomed. For example, tolerance of alternative vegetation or standing water after storm events.

3. The ability to manage, regulate and enforce the ordinance, management plans and maintenance is information intensive and systems for reporting are lacking and resisted by local communities. Included under this issue is the current inconsistency with some community ordinances. For example, curb and gutter may be required where swales and natural systems are encouraged under the model or, riparian buffers of native vegetation may be prohibited under a "weed" or lawn ordinance.

4. There is a fear that more comprehensive stormwater management will increase development costs and cause loss of development to less restrictive communities. This requires the documentation of realistic costs and the cost of negative impacts and underscores the need for region-wide or watershed-wide consistency in standards.

5. Funding for comprehensive watershed stormwater management is severely constrained by the state-imposed tax cap in the Chicago metropolitan area. The lack of funding prevents the development of specific watershed controls and implementation of remedial projects that could reduce overall stormwater management costs. Greater burden is put on development to solve problems. One solution is the development of funding alternatives such as stormwater utilities.

CONCLUSION

In general, the approach employed in this model requires changes in the way development occurs; government programs are funded and operated and; community's view of what is "aesthetic." In Lake County, these changes are underway. A countywide watershed development ordinance has been adopted that addresses many of the model's principles. There is good support for the Lake County program (36 of 51 municipalities have chosen to enforce the ordinance themselves) and good participation on the basin steering committees. Through the completion of this project, the cost-effectiveness of comprehensive environmental stormwater management will be demonstrated.

CONSTRUCTION SITE EROSION CONTROL PROGRAMS IN NORTHEASTERN ILLINOIS

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ABSTRACT

Soil erosion from construction sites causes serious problems in Illinois. Eroded sediment degrades water quality and aquatic habitat, worsens flooding and drainage problems, and causes traffic hazards.

In response to local concerns and complaints, many municipalities in northeastern Illinois have implemented ordinances or other regulations for erosion and sediment control. However, in a recent evaluation of the effectiveness of erosion control programs, the Northeastern Illinois Planning Commission (NIPC) and its advisors concluded that most construction sites are not adequately controlled, resulting in serious offsite impacts.

Several specific inadequacies were documented. Control practices are not properly installed and are commonly used in inappropriate applications. Maintenance of control practices is rarely performed. Inspection and enforcement of ordinance requirements by local governments is seriously inadequate.

A principal recommendation of the study was to improve education, training, and technical assistance opportunities in the state. In response, NIPC requested and received funding to produce a video entitled *Erosion and Sediment Control: Procedures and Practices for Construction Sites*. NIPC also recently updated its *Model Soil Erosion and Sediment Control Ordinance*. Both the model ordinance and video have been widely distributed in northeastern Illinois.

INTRODUCTION

Soil erosion and offsite sediment runoff from construction sites causes serious environmental, economic, and public safety problems. Locally, sediment washes onto sidewalks and streets causing nuisances and traffic hazards. Sediment runoff also interferes with stormwater drainage by accumulating in storm sewers and ditches. By accumulating in stream channels, floodplains, and wetlands, sediment reduces stormwater conveyance and storage capacity thereby increasing the potential and severity of downstream flooding.

Sediment pollution also is a serious problem for Illinois streams and lakes. Statewide, siltation has been identified as the major cause of pollution resulting in less than full use support for streams and lakes (IEPA, 1992). Siltation impairs essential bottom habitat in waterbodies and may damage or destroy fish spawning areas. Suspended solids, resulting in water turbidity, also cause use impairment by adversely affecting aesthetics and degrading fish habitat. Further, elevated suspended solids levels can increase water supply treatment costs.

Uncontrolled urban construction sites, with estimated erosion rates of 20-200 tons per acre per year (Besadny, 1987), are major contributors of sediment. In comparison, agricultural areas in northeastern Illinois generally contribute from one to 20 tons per acre per year. Another significant, but often overlooked, contributor of sediment is stream bank erosion which is particularly severe during channel construction activities. Measurements of sediment yields in streams have indicated that developing watersheds contribute from 5 to 200 times as much sediment as stable, urbanized watersheds (IEPA, 1987).

The *Illinois Water Quality Management Plan* recommends that local governments and agencies adopt ordinances as well as standards and specifications for soil erosion and sediment control (IEPA, 1991). The Illinois Environmental Protection Agency (IEPA), as of October 1992, requires stormwater permits for construction activities disturbing 5 or more acres and specifically calls for the identification and implementation of soil erosion and sediment control measures.

Soil erosion and sediment control measures currently are required for many construction activities in northeastern Illinois. Many municipalities and counties regulate private development activities via local erosion control ordinances. Various public construction activities, such as highway projects, also implement erosion and sediment control as required by internal agency guidelines or by Federal permitting agencies. However, there is a growing realization that existing programs intended to control soil erosion and offsite sediment runoff often are ineffective in meeting intended program objectives, particularly the protection of downstream water quality.

EVALUATION OF LOCAL GOVERNMENT ORDINANCES/REGULATIONS

In 1991 NIPC evaluated the effectiveness of erosion and sediment control programs in the six-county northeastern Illinois region (Dreher and Mertz-Erwin, 1991). The first task of that study was to prepare an updated inventory of local government ordinances with the assistance of local Soil and Water Conservation Districts (SWCDs).

The inventory indicated that approximately two-thirds of the region's 268 county and municipal governments had an ordinance or other regulations requiring control of soil erosion and sediment runoff from construction sites. With the subsequent implementation of county-wide ordinances in DuPage and Lake counties, it is now believed that nearly three-fourths of all communities require erosion and sediment control. Generally speaking, the municipalities least likely to have regulations are older, mostly developed communities and smaller, outlying communities. Fortunately, most moderate to high growth municipalities have regulations.

In order to understand the scope of typical local regulations, the ordinances (or other relevant regulations) from 24 representative municipalities and counties were reviewed in detail. This review focused on several specific ordinance components, including: comprehensiveness, statement of purpose and findings, general principles, permit applicability and exceptions, technical standards, and inspection and enforcement provisions. Two observations are notable from this review. First, nearly half of the ordinances included little or no reference to water quality protection in their purpose statements. Second, the ordinances contained almost no specific criteria and standards. Instead, most ordinances adopted technical standards by reference. Several referenced the "Green Book" (*Illinois Procedures and Standards for Urban Soil Erosion and Sedimentation Control*, 1988) and only one referenced IEPA's "Yellow Book" (*Standards and Specifications for Soil Erosion and Sediment Control*, 1987).

To provide additional insights into the effectiveness of local erosion and sediment control programs, a questionnaire was prepared to assess ordinance implementation efforts. The questionnaire asked communities about the qualifications of their plan review staff, the frequency of construction site inspections, and their use of ordinance enforcement provisions. One notable finding was that in over half of the communities plan review and site inspection staff had no formal training in erosion and sediment control.

A final task of the evaluation of erosion and sediment control programs was to assess the actual effectiveness of installed control practices on the basis of field inspections. To assist in this evaluation, NIPC assembled a team of expert advisors which included representatives from county and municipal government, a county highway department, an SWCD, the U.S. Department of Agriculture, Soil Conservation Service (SCS), an environmental group, an engineering consulting firm, a landscape architecture firm, and the Illinois Homebuilders Association. There was a general consensus among the members of this group that there are significant deficiencies in many existing erosion and sediment control programs, particularly regarding the protection of water quality.

Several members of this group, particularly the representatives of SCS and the SWCD, concurred that practices often were not implemented and maintained in the field as called for in erosion control plans or in guidance documents such as the Green Book. Discussions of the problem, based on extensive field experience, focused on several key weaknesses in existing practices.

- Existing soil erosion and sediment control practices are often utilized in circumstances which are inappropriate. In general, there is an over-reliance on silt fences and straw bales in areas of concentrated flow instead of sediment traps and basins.

- Control measures often are installed improperly. For example, sediment basins are often constructed without adequate storage volume or proper outlet devices so that settling times are inadequate to achieve effective removal of suspended sediments.

- Perhaps the most common fault noted with existing practice was the failure to adequately maintain installed practices such as sediment basins and straw bales, thus greatly reducing their effectiveness.

- There often is a lack of understanding, particularly by some grading contractors, of the objectives of erosion and sediment control. This often results in the failure to adequately implement an otherwise well-prepared erosion and sediment control plan.

- Another problem observed in the field is the difficulty in controlling sites which involve construction in sensitive areas, such as streams, wetlands, or steep slopes. These types of sites often are inadequately addressed in the erosion control plan due, in part, to the lack of specific standards and procedures in reference materials such as the Green Book.

• Finally, it was noted that some sites suffer from the lack of proper sequencing of construction activities and the installation of erosion and sediment control measures. For example, while sediment control measures, such as sediment basins, should be installed prior to site clearing and grading this often does not occur because of perceived inconveniences relative to the site grading schedule.

SUMMARY OF FINDINGS FROM EXISTING PROGRAMS

Based on the evaluation cited above, it is apparent that the topic of erosion and sediment control has received a lot of attention from governmental units in northeastern Illinois. It also is obvious among erosion and sediment control professionals that most construction sites are not being well controlled. Some key observations from existing programs follow.

1. Erosion and sediment control is receiving increased attention from local governments. Nearly three-fourths of the municipalities and counties in northeastern Illinois have adopted regulations to control construction site activities. However, many of these programs have serious shortcomings in areas of staff training, inspection, and enforcement.

2. Installed soil erosion and sediment control practices often do not conform to approved erosion control plans or to accepted technical guidance such as the Green Book. Common problems observed on construction sites include failure to implement all measures of the control plan, inappropriate selection of control measures, improper sequencing of control measures, improper installation of measures, and inadequate maintenance. As a result, urban construction activities continue to cause significant, avoidable adverse impacts to water quality, aquatic habitat, and channel conveyance.

3. Most local ordinances do not include specific requirements for erosion and sediment control measures but instead refer to technical references such as the Green Book. Because many practitioners do not possess copies of the referenced technical manuals, there is considerable uncertainty about expected control practices.

4. The most widely referenced technical guidance documents are the Green Book and the Yellow Book, but both have notable deficiencies as the sole technical reference adopted by ordinance. The Green Book is an excellent reference for site planning and design standards but it is not adequate as the primary technical reference manual adopted by ordinance. In particular, it is sometimes unclear in defining the conditions under which specific practices apply and does not contain adequate guidance for the design, installation, and maintenance of some practices. The Yellow Book is seldom referenced by local governments, but it provides detailed standards and specifications for the design and implementation of erosion and sediment control practices and essential guidance on the conditions where different practices apply. A weakness of the Yellow Book is that some of its criteria, such as for sediment basin sizing, may not be appropriate to northeastern Illinois. Neither reference includes specific guidance

on the control of construction activities in sensitive areas such as streams and wetlands.

5. Local government staff, design engineers, and contractors could benefit greatly from additional training in the design, installation, and maintenance of erosion and sediment control practices. Only about half of the municipalities surveyed indicated that their staffs had received any specialized training in erosion and sediment control. Indications are that an even lower percentage of construction and grading contractors have received any formal training in installing and maintaining practices.

6. Inspection and enforcement of ordinance requirements by local government officials is most commonly oriented to the prevention of nuisance conditions and responding to complaints. Prevention of water quality impacts, which are often difficult to assess, is a much lower priority. The effectiveness of site inspection could benefit from the wider distribution and use by local governments of the *Illinois Field Manual for the Implementation and Inspection of Erosion and Sediment Control Plans* (Urban Committee AISWCD, 1990).

7. The adequacy of control of soil erosion and offsite sediment runoff from construction activities conducted by local and state public agencies (e.g., state and county highway departments) varies greatly among agencies and among project sites. The strengths and weaknesses of public agency programs are generally similar to those of municipal and county programs which regulate private development. One notable exception is that many local agencies have no written requirements for soil erosion and sediment control and are likely to implement controls only in response to the requirements of higher agencies, such as the Corps of Engineers, or in response to local citizens' complaints.

NEW TECHNICAL ASSISTANCE MATERIALS

The preceding evaluation pointed to the need for better tools to assist local government officials as well as the development community in preparing and implementing effective plans for soil erosion and sediment control. NIPC, with financial assistance from IEPA, USEPA Region 5, and several county stormwater committees and SWCDs, recently developed two such tools.

The first is an updated *Model Soil Erosion and Sediment Control Ordinance* (NIPC, 1991). This updated model includes additions and revisions based on experience gained in northeastern Illinois and in other parts of the country, including programs in DuPage, Kane, and Lake counties, Illinois; Dane County, Wisconsin; Loudoun County, Virginia; St. Charles County, Missouri; and the states of Georgia, Maryland, Ohio, and Wisconsin.

One of the significant improvements to the new model ordinance is a section which specifies minimum site design requirements for sediment control measures, stormwater conveyance devices, and soil stabilization measures, rather than simply adopting technical standards (e.g., the Green Book) by reference. The ordinance also emphasizes the special needs of construction in sensitive areas such as steep slopes and stream channels. Finally, the updated ordinance spells out important provisions for maintenance, site inspection, and enforcement.

Another new tool is an 18-minute video describing procedures and practices for construction site controls (NIPC, 1993). The video depicts the basic concepts and procedures for minimizing the effects of erosion, specifically addressing construction site planning and design, soil stabilization, sediment and runoff controls, and site inspection and maintenance. It also provides guidance on the implementation of specific control practices, focusing on those which are generally most appropriate in northeastern Illinois.

NIPC provides guidance to local governments in establishing local erosion and sediment control programs, including ordinances. Additional assistance is available from county Soil and Water Conservation Districts. SWCD's in northeastern Illinois are becoming more attuned to urban issues, such as construction site erosion control, and can offer advice on ordinance implementation and site inspection.

RECOMMENDATIONS

1. All local governments should adopt and enforce comprehensive soil erosion and sediment control ordinances. These ordinances should include the protection of water quality and aquatic habitat among their objectives. The ordinances also should include minimum operation and design standards, such as contained in the revised NIPC model, to supplement the guidance of the Green Book and the Yellow Book.

2. To achieve conformance with new construction site requirements for erosion and sediment control under the NPDES stormwater permitting program, the IEPA should consider delegating permit oversight responsibilities to local governments. Delegation would be contingent on the adoption and demonstrated enforcement of a comprehensive local ordinance.

3. A standard, statewide technical reference manual for soil erosion and sediment control should be developed with the input of relevant entities such as IEPA, USEPA, SWCD's, SCS, NIPC, representative municipalities and counties, the Illinois Home Builders Association, and IDOT. The ongoing update of the SCS's Urban Conservation Manual, in combination with the Green Book, could serve as the base for such a manual.

4. Training programs, including courses, workshops, seminars, and videos should be developed jointly by SCS, IEPA, NIPC, and the Association of Illinois Soil and Water Conservation Districts to improve the education level of local government staff, design engineers, and contractors. Training programs should include guidance on the design, implementation, and maintenance of soil erosion and sediment control measures, as well as information on the benefits of proper control programs. Such training programs should be offered at appropriate times and locations to ensure ready access by interested practitioners. Eventually, these approved training programs should serve as the basis for mandatory statewide certification of site design engineers and contractors.

5. The Illinois Field Manual should be widely circulated to, and utilized by, local government staffs, construction engineers, and contractors. This manual should be updated as field experience warrants.

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WATERSHED EROSION AND MANAGEMENT

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Pick up just about any newspaper or magazine these days, and you will see feature articles pertaining to erosion, sedimentation, water quality, residue management and no-till. Soil erosion is not a new problem and it is also not a problem just characteristic of the Illinois River Watershed. Instead it is one of worldwide proportions. Mr. Dwayne Andreas, noted U.S. industrialist and close personal friend of Mikhail Gorbachev of the past Soviet Union, recently gave this perspective to the soil erosion crisis: "The rapid loss of life-giving topsoil is a ticking time bomb more dangerous than even the nuclear threat. Nuclear warfare has become increasingly remote with the end of the Cold War. But worldwide hunger has become increasingly likely." He went on to state that "Globally, every tick of the second hand means that 175 tons of topsoil are lost! While it's taken over a billion years to build the topsoil cover that feeds the world, we've destroyed one-fifth of it in only 50 years!" The Population Crisis Committee issued the following assessment in their 1990 report by stating that "Each year the world's farmers are trying to feed 90 million more people on 24 billion fewer tpms of topsoil."

Here in Illinois, the average annual erosion on Illinois farmland has been approximately 160 million tons which is equivalent to over 57 Sears Towers in Chicago being filled with soil. Stated another way, for each bushel of corn being produced in Illinois, we have been losing two bushels of soil to erosion. This destruction cannot be allowed to continue.

The primary culprit responsible for this damage is the lowly raindrop. Soil erosion is a natural process and occurs when the soil particles are detached and transported by falling raindrops. Soil erosion not only causes damages to immediate landowners, but also is responsible for off-site effects that are very costly to society.

Landowners and farmers are concerned about controlling soil erosion because they realize that when soil erosion occurs, the very best parts of the soil are lost - the topsoil, organic matter, and nutrients. Research continues to document that soil erosion is responsible for long-term reduction in both productivity and profitability. Landowners also recognize that as soil erosion occurs, it will dramatically reduce the value of the land as a capital asset.

When the soil moves off the land during a rainstorm, it may be deposited in a nearby roadside ditch, or move into a creek and then downstream to contribute to sedimentation in a river or lake. Once the soil leaves the field, society begins experiencing the off-site effects of soil erosion. The Illinois River, with its many backwater lakes, has become a target for off-site damages associated with soil erosion. Reduced water-storage capacity of these backwater lakes is becoming increasingly evident. As sand deltas form at the mouths of many of the tributaries entering the Illinois River, the U.S. Army Corps of Engineers is experiencing increased difficulty with blocked navigation channels. The Flood of '93 adds credence to the increased risk and severity of flooding that is associated with off-site damages from soil erosion. Soil erosion can also alter the aquatic vegetation, reduce recreational opportunities, and affect both the quantity and quality of the drinking water supplies. The bottom line, is that soil erosion is costly. It is costly for the landowner in terms of lost soil and costly for society in terms of repair of off-site damages. It is in the best interests of both the landowner and society to control soil erosion. Research from watersheds throughout the United States continues to document that the easiest and most cost-effective way to address soil erosion and sedimentation problems is through proper soil and water management being implemented throughout the watershed.

Because of the growing public concern toward soil erosion and associated off-site damages, both the Illinois State Legislature and the U.S. Congress received the mandate to develop legislation to address these problems during the 1970s and 1980s. The Illinois General Assembly adopted the State Erosion and Sediment Control Guidelines on April 18, 1980. The Illinois Department of Agriculture was given the responsibility of implementing a voluntary program to reduce soil losses on agricultural land to the "T" or tolerable level of no more than five tons per acre per year, by the year 2000. When erosion exceeds the "T" value, soil is being lost so fast that its natural productivity is being diminished. The soil erosion issue garnered national exposure and consequently was foremost in the minds of Congress as it passed the Food Security Act of 1985, more commonly known as the 1985 Farm Bill. Conservation Compliance is a provision of the Food Security Act of 1985 and the Food, Agriculture, Conservation, and Trade Act of 1990. The Conservation Compliance provision targets farmers who produce crops on Highly Erodible Land (HEL). Highly Erodible Land, by definition has the potential to erode at the rate of eight times the "T" rate, or greater than 40 tons of soil per acre per year for most Illinois soils. Thus, Conservation Compliance addresses some of our nations most severely eroding soils, but does not impact soils with slight to moderate erosion losses. Farmers with Highly Erodible Land were required to develop conservation plans before 1990. They also must apply the plans before 1995 to remain eligible for price supports, crop insurance, and other benefits from U.S. Department of Agriculture programs.

Research has shown that there are three main ways, or a combination of these ways, for farmers to achieve Conservation Compliance. The first is through installation of conservation practices and structures such as terraces, waterways, and diversions. This is what I often refer to as the "cadillac" method of erosion control, because although it is very effective in controlling erosion, it is also the most expensive. The second method for achieving is through changing the crop rotation from continuous rowcrops to include more cereal grains, hay, or permanent pasture. Again, crop rotations are very effective in controlling erosion, but the main drawback is that most of these alternate crops are considerably less profitable that planting the rowcrops of corn and soybeans. The third method of achieving Conservation Compliance is by implementing the residue management programs of mulch-till and no-till. Research and practical experience has shown that residue management offers farmers the easiest and most cost-effective way to meet Conservation Compliance and control soil erosion. The Illinois Soil Conservation Service reports that over 75 percent of the conservation farm plans are utilizing mulch-till and no-till to meet

Conservation Compliance. On some of the more steeply sloping land, a combination of the above conservation methods may be necessary to address the erosion problem.

Has the T by 2000 Illinois Erosion Control Program and Conservation Compliance had an impact on the soil and water resources of our state over the past decade? According to the National Resources Inventory taken in 1982, see Table 1., Illinois had approximately 9.9 million acres of cropland that exceeded the "T" value out of a total of 22 million cropland acres. By the end of 1991 Illinois had reduced the number of acres exceeding "T" to approximately 5.2 million acres. This is truly significant progress in a relatively short time.

How has this been accomplished? The Illinois Soil Conservation Service has been collecting soil erosion data to monitor the adoption of conservation practices. From 1982 through 1992, 199,937 Illinois landowners began applying conservation measures on land that had previously not been treated for erosion problems (see Table 2). Through the adoption of a variety of conservation practices, 4,983,911 acres are now protected to "T" that had not been treated in 1982 (see Table 3). The result is that from 1982 through 1992, 66,689,172 tons of soil were not eroded from Illinois' fields (see Table 4). A major beneficiary of this soil savings and subsequent reduction in sedimentation has been the Illinois River System.

Although Illinois farmers are making significant progress in reducing the rate of soil erosion, as evidenced by the above data, we are not keeping pace with the "T" by 2000 Goals projected under the Illinois Erosion and Sediment Control Guidelines (see Table 5). According to the Illinois Department of Agriculture, by the year 2000 the tolerable "T" soil loss for all Illinois farmland should be 66.2 million tons per year. The current level of average annual soil loss for Illinois is 139.1 million tons. This means agriculture still has a lot of work to do, if the "T" by 2000 voluntary guidelines are to be met.

However, Illinois is making excellent progress in meeting the Federal Conservation Compliance Guidelines for the state's most Highly Erodible Land (see Table 6). By 1992, Illinois had 40 percent of the required conservation farm plans completely implemented, 31 percent partially applied, 26 percent either not affected or not needing any 1992 practices installed, and only 3 percent were out of compliance.

What has been the single, most important factor enabling farmers to make significant progress in meeting these state and federal erosion control guidelines? Without a doubt, it is the adoption of no-till farming practices. According to data from the Conservation Technology Information Center (see Table 7), in 1983 only approximately 34 percent of Illinois cropland was being farmed and protected by using conservation-till or no-till farming practices. In 1983 only 5 percent of the state's cropland was being farmed with no-till. By 1992, no-till acreage had expanded to 20 percent of Illinois' cropland acreage. Collectively, 48 percent of the state's cropland was being farmed and protected through conservation-till and no-till practices. Throughout this time period, the amount of conservation-till acreage remained relatively constant with only the no-till acreage expanding.

What do I see as the vision for Illinois' Conservation Efforts as it relates to soil erosion and the management of the Illinois River System? Based on Illinois SCS data, today only approximately 20 to 25 percent of the total cropland acres are still exceeding "T," and need conservation practices applied to them. The Illinois SCS data is based on calculations utilizing the Universal Soil Loss Equation (USLE). However, the USLE only measures sheet and rill erosion losses. Consequently, site-specific problems of ephemeral gully, gully, bluff, and streambank erosion still need to be addressed. Although Illinois is making significant progress in meeting the "T" by 2000 goals, in many cases the "most difficult" acres with soil erosion still remain to be treated. The ultimate objective is for all soils to meet the "T" or tolerable level of soil loss. As issues of profitability, water quality, and soil improvement become increasingly more important to landowners and society, I expect even greater adoption and use of no-till to occur.

What is no-till and what makes this system so valuable for erosion control and watershed management? No-till is a tillage system that leaves the soil undisturbed from harvest to planting except for fertilizer injection. Planting or drilling is accomplished in a narrow seedbed or slot created by coulters, row cleaners, or disc openers. Weed control is accomplished primarily with herbicides. With a no-till system, this year's crop is planted directly into the old crop residue remaining from last season. There is no plowing or tillage of the soil with no-till.

No-till was introduced into Illinois during the 1960s and was slowly tried by innovative farmers on a few acres at a time. In many counties, a summer field day would be held at one of these no-till demonstration fields and would be co-sponsored by the county Cooperative Extension Service, Soil Conservation Service, and Soil and Water Conservation District. Farmers attending these field days would typically look at the "trash" lying on the soil surface of the no-till field, gaze at the farmer, scratch their heads, and in astonishment ask the host farmer "Why are you no-tilling?" Today, with the rapid adoption of no-till taking place, the question that needs to be asked of farmers is "Why aren't you no-tilling?"

Today, the adoption of no-till farming throughout the United States is snowballing! Data from the Conservation Technology Information Center reports that in 1992 there were over 28 million acres of no-till in the United States, a dramatic 36 percent increase from 1991 (see Table 8). No-till corn acreage in the U.S. increased 44 percent and no-till full season soybean acreage increased 76 percent from 1991.

For the past several years, Illinois has been the leading state in the nation for no-till acreage. In 1992, Illinois had over 20 percent of the cropland acreage planted utilizing a no-till farming system (see Table 9). Seventeen percent of the corn acreage and twenty percent of the full season soybeans in 1992 were planted with no-till. Since its introduction into Illinois in the 1960s, no-till has continued to grow: 1983--1,038,710 acres; 1989--1,958,332 acres; 1991--3,074,354 acres; and in 1992--4,666,400 acres.

According to a recent survey, one out of three Illinois farmers is doing some no-tilling as a part of their farming operation. Illinois no-till acreage has expanded from 2 percent of the acreage in 1979 to 20 percent in 1992. This new interest in no-till is being fueled by the following factors: improved planters and drills; better herbicides; lower production costs; lower capital investment; and the need to meet Conservation Compliance. Other significant benefits of no-till include: better erosion control, comparable yields on most soil types, improved soil quality, moisture conservation, reduced surface water runoff, fuel savings, time and labor savings, reduced equipment inventory, and the opportunity for increased profits. The bottom line is that no-till makes "cents," both in terms of common sense--to protect our state's soil and water resources, and in terms of dollars and cents--to increase the profitability of agriculture.

During the past 20 minutes that I have been speaking, over 200,000 tons of soil have eroded throughout the world. I feel that no-till is not only a practical solution to Conservation Compliance, but it is one of the best means available to effectively control soil erosion. Without a doubt, the future of our Illinois River System, our State, our Nation, and even our World depends upon protecting our valuable topsoil. By adopting no-till farming systems, I feel we will not only control soil erosion, but we will also be able to protect and enhance the quality of our water resources, including the Illinois River, for the enjoyment and use by future generations.

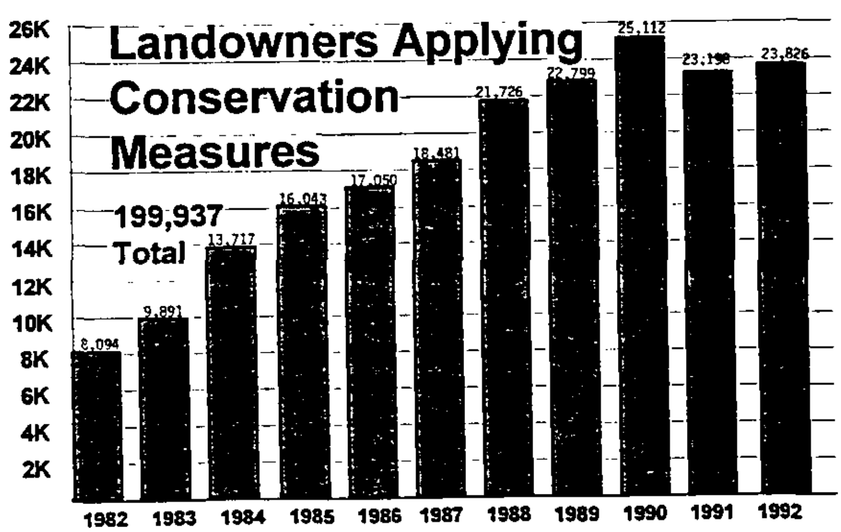
Table 1

ILLINOIS
Acres Exceeding T

Year	Total (million)	Cropland (million)
1982	10.8	9.9
1987	8.4	7.7
1991	5.9 (est.)	5.2 (est.)

–NRI, Illinois SCS

Table 2



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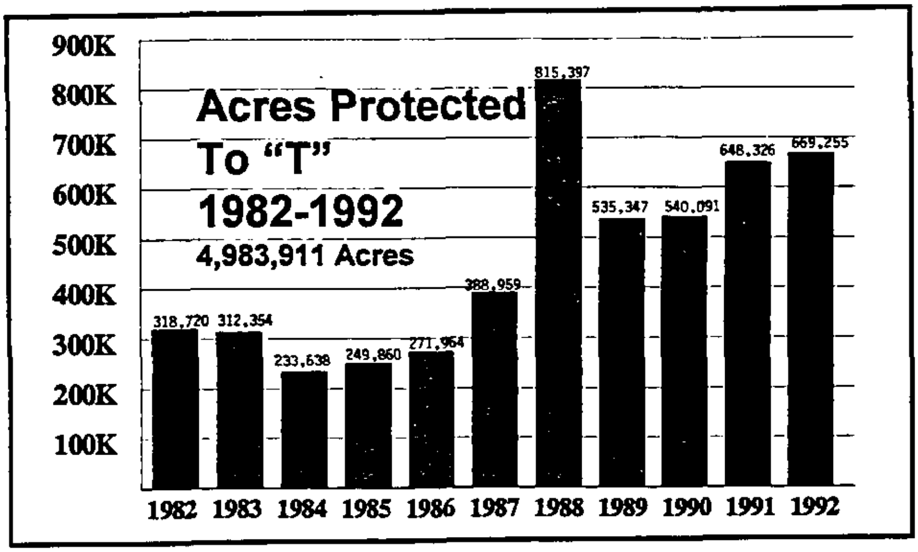

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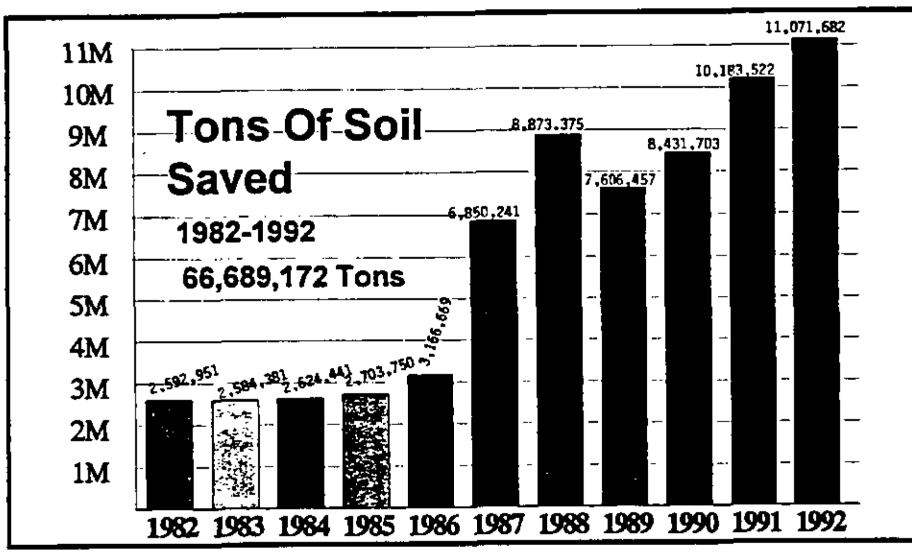

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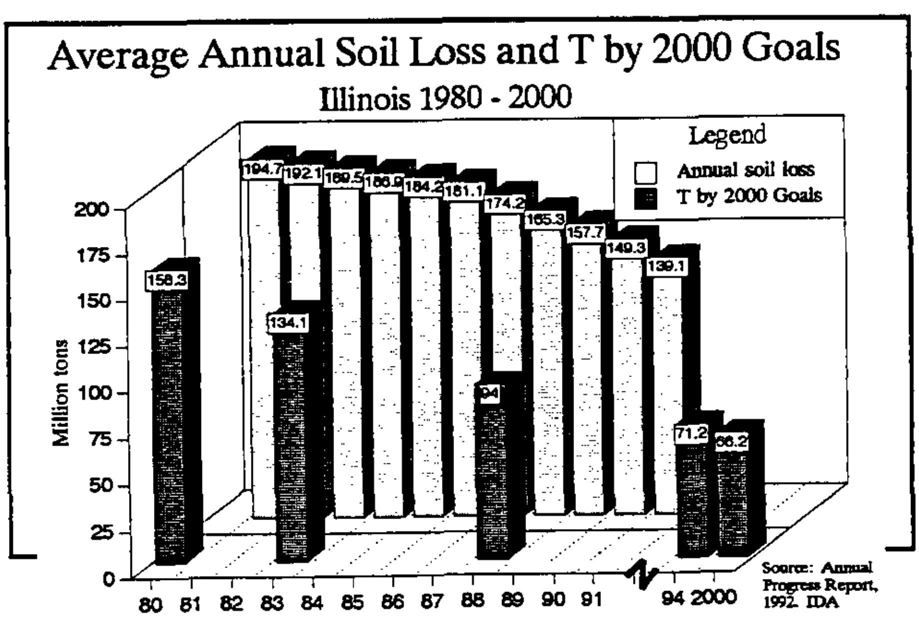

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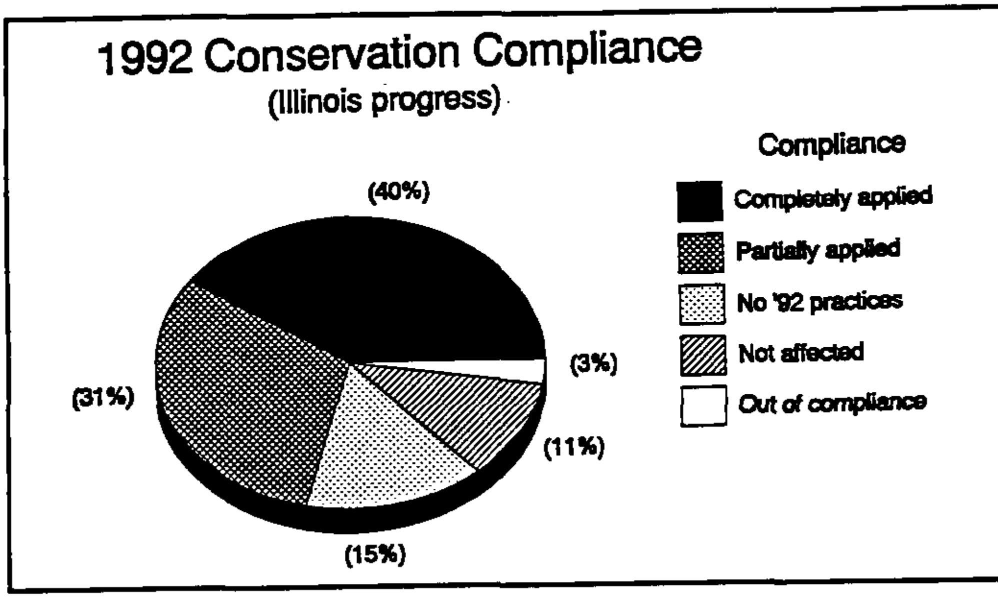

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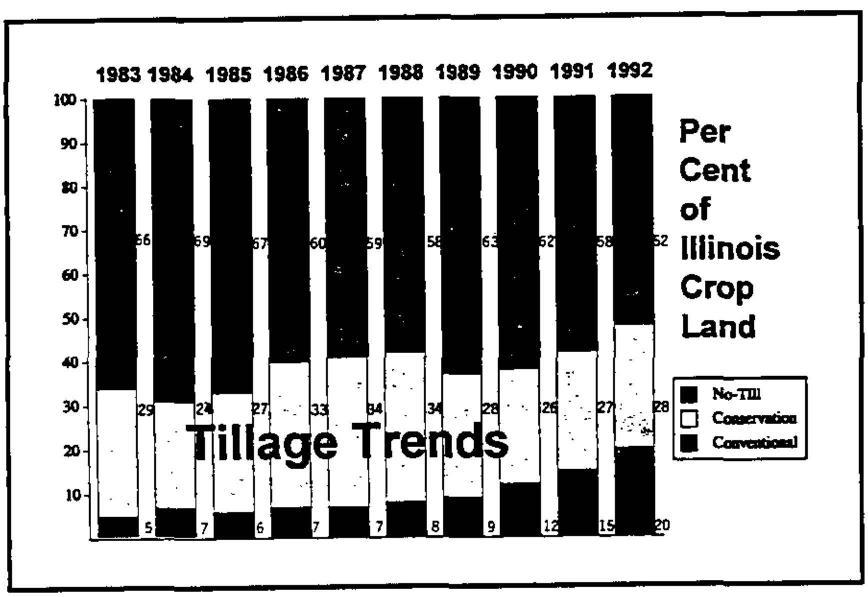

Table 8

NO-TILL IN U.S. IS *SNOWBALLING!*

Crop	1992 Acres	91-92 Change
Corn	10,568,103	+44%
Soybeans	8,222,034	+76%
Soybeans(dc)	3,084,833	-5%
Wheat	2,411,260	+10%
Oats	1,239,157	+17%
Gr. Sorghum	715,457	+31%
Forages	682,593	+18%
TOTAL	*28,078,484*	*+36%*

-Conservation Technology Information Center (CTIC)

Table 9

NO-TILL ACREAGE
IN ILLINOIS - 1992

Crop	Acres	Per Cent of Total Acres
Corn	1,942,077	17%
Soybeans	1,860,003	20%
Soybeans(dc)	474,908	83%
Wheat	250,120	17%
Oats	22,522	9%
Forage Crops	53,314	20%
Gr. Sorghum(dc)	52,539	88%
TOTAL	4,704,544	20%

—Conservation Technology Information Center (CTIC)

SURFACE WATER QUALITY AND PESTICIDES IN ILLINOIS

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ABSTRACT

Ambient water quality monitoring conducted in watersheds throughout Illinois between 1985 and 1992 has evidenced pesticide runoff from crop production areas. Detections of the prominent agricultural herbicides have been reported for all 30 sampling stations in the monitoring network. The most frequently detected chemicals were atrazine, metolachlor, alachlor, and cyanazine which were present in 73 percent, 50 percent, 47 percent, and 45 percent of the 1,171 samples analyzed, respectively.

Public water supplies have also been affected. Multiple pesticide residues were detected in 53 percent of the State's 129 surface water supplies tested in 1991 and the spring of 1992. Atrazine concentrations exceeded the 3 ug/l drinking water standard in 27 of the supplies. Compliance monitoring was initiated in July 1992. As of July 1, 1993, ten community supplies were found to be in violation of the atrazine standard.

AMBIENT WATER QUALITY MONITORING

Pesticide monitoring programs developed in Illinois during the 1970's focused upon the chlorinated hydrocarbon insecticides (e.g. Aldrin, DDT, Methoxychlor, etc.) and chlorophenoxy herbicides (i.e. 2,4,-D and 2,4,5,-TP). Due to their low solubility and other properties, detections of these chemicals in water quality samples were rare. Migration of the insecticides into aquatic ecosystems was evidenced, however, from the analyses of sediment and fish tissue samples.

In the mid-1980's, with newer pesticide products dominating the market, the Illinois Environmental Protection Agency (IEPA) modified its ambient surface water monitoring program to include a pesticide subnetwork that would provide for the detection of the more commonly used agricultural herbicides and insecticides. The pesticide subnetwork consisted of 30 sampling stations located in streams predominantly influenced by agricultural drainage (Moyer 1990).

Beginning in October 1985 six samples per year were collected from each of the 30 stations. In April 1991 the sampling frequency was reduced to three times per year. In order to represent ambient stream conditions sampling was carried-out according to a set schedule nd was not intentionally planned to coincide with precipitation/runoff events.

The data accrued through October 1992 indicated four of the most extensively used agricultural herbicides were being detected on a regular basis. Atrazine, metolachlor, alachlor, and cyanazine were found in all 30 sampling locations. Atrazine was detected in greater than 70 percent of the samples, while metolachlor, alachlor, and cyanazine were detected in 50 percent, 47 percent, and 45 percent of the samples, respectively. Metribuzin, trifluralin, and butylate were also detected in less than 10 percent of the samples. Analyses were also run for seven organophosphate insecticides and one fungicide. Fonofos and chlorpyrifos were detected in less than 1 percent of the samples. Diazinon, malathion, phorate, terbufos, methyl parathion, and captan were not found at concentrations above detection limits in any of the samples.

Table 1 summarizes information generated by the 1,171 samples collected between October 1985 and October 1992. The data are presented in two segments, 1985-1988 and 1988-1992, to illustrate the consistency of herbicide detections during the seven year period.

With the exception of atrazine, the mean concentrations of the reported herbicide detections were less than 1.0 ppb. The mean value for atrazine was 1.17 ppb. The maximum concentrations were significantly higher. For atrazine the highest concentration in a single sample was 65 ppb. The highest levels for metolachlor, alachlor, and cyanazine were 17 ppb, 18 ppb, and 38 ppb, respectively. The concentrations tended to be greater in the spring and early summer samples as compared to those collected during other times of the year.

The extensive presence of these contaminants in Illinois streams appears to be attributable to runoff of field applied agricultural chemicals. If the findings were related to releases from point source activities such as mixing/loading, catastrophic spills, or disposal the detections would occur less frequently, and the chemical concentrations reported would be considerably higher.

Table 1. Summary of pesticide detections at 30 stream monitoring stations in Illinois 1985-1992.

Pesticide	#/% Stations	% Samples
	Oct. 1985 - Oct. 1988	
Atrazine	30 (100%)	77%
Metolachlor	30 (100%)	46%
Alachlor	29 (97%)	46%
Cyanazine	29 (97%)	38%
Metribuzin	25 (83%)	10%
Trifluralin	13 (43%)	3%
	Nov. 1988 - Oct. 1992	
Atrazine	30 (100%)	68%
Metolachlor	30 (100%)	54%
Alachlor	30 (100%)	48%
Cyanazine	30 (100%)	51%
Metribuzin	19 (63%)	8%
Trifluralin	26 (87%)	8%

The stream monitoring data generate a concern regarding the potential effects of chronic exposure to sublethal concentrations of the herbicides on the stream biota. This is an area that needs further assessment. Another concern is the potential impact on drinking water supplies.

PUBLIC WATER SUPPLY SAMPLING

The 1986 amendments to the Federal Safe Drinking Water Act directed the United States Environmental Protection Agency (USEPA) to set additional national standards for drinking water contaminants. In 1991, USEPA promulgated new drinking water standards for 18 synthetic organic chemicals which included several pesticides used for weed and insect control in Illinois agriculture (USEPA 1991). These new regulations also established monitoring requirements which are applicable to all public water supplies.

In preparation for implementation of the Phase II Federal Drinking Water Standards the IEPA began analyzing finished water samples in 1991, and the spring of 1992, for a selected group of pesticides subject to regulation as well as several unregulated pesticides (Taylor 1993). The samples analyzed were submitted by the 129 supplies which utilize surface water as their primary source. All samples were collected at the public water supply treatment plant at a point in the system after treatment was administered.

The results of this testing indicated a significant number of detections of atrazine, alachlor, and other commonly used herbicides. A total of 27 water supplies had concentrations of atrazine that equalled or exceeded the 3 ug/l drinking water standard in one or more samples. It was also noted that three or more pesticides were detected in 53 percent of the contaminated samples analyzed during the two year period. The number and percentage of water supplies having multiple pesticide detections are shown in Table 2.

Illinois' compliance monitoring program for the surface water supplies was initiated in July 1992. Each supply was required to collect quarterly samples through June of 1993. The analytical results for this period were comparable to the pesticide analyses reported for the pre-compliance date testing. Atrazine was detected in 114, or 88 percent, of the water supplies sampled. Thirty-four of those supplies had one or more samples with concentrations of atrazine equal to or exceeding 3 ug/l. Metolachlor, cyanazine, and simazine were also detected in a significant number of samples.

Table 2. Surface water supplies in Illinois with multiple pesticide residues in finished water samples collected in 1991 and the spring of 1992.

# Pesticides Detected	# Supplies	% Supplies
5	9	7
4	27	21
3	32	25
2	24	19

Table 3. Average and maximum concentrations of atrazine detected in finished water samples from ten surface water supplies in Illinois, July 92 - June 93.

Supply	Four Qtr. Average	Maximum Concentration
	ug/l	ug/l
Highland	4.50	8.50
Sorento	3.75	7.20
Farina	5.00	9.00
White Hall	6.50	8.60
Shipman	8.00	17.00
Palmyra-Modesto	6.25	9.60
ADGPTV Wtr. Comm.	5.00	12.00
Kinmundy	4.00	7.30
Coulterville	4.00	8.40
Save Site	6.50	19.00

Compliance with the drinking water standards is based upon the average concentration of the four quarterly samples. Ten community water supplies were in violation of the atrazine standard by July 1, 1993. The four-quarter average and maximum concentration of the atrazine detections for each of these supplies is given in Table 3.

PREVENTIVE PRACTICE IMPLEMENTATION

Mitigation measures have been initiated in an effort to minimize the public's exposure to the pesticides in their drinking water. With concurrence from USEPA, Ciba, the principal manufacturer of atrazine, voluntarily amended its product label to require buffer strips between areas of application and points of entry into streams and impoundments. Application rates were also reduced. These changes first took effect during the 1993 crop production season. At least one other chemical manufacturer has considered the same course of action.

Locally, strategic planning committees have been formed in several of the watersheds affected by the pesticide runoff. The committees have involved public officials as well as agricultural interests. Each group has been charged to assess the current agricultural practices in their respective watersheds and to determine the appropriate alternatives for protecting their water resources against further occurrences of chemical contamination.

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RIPARIAN BUFFER STRIPS AS SYSTEMS FOR REDUCING NITRATE POLLUTION

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ABSTRACT

It is recognized that Federal water quality goals are not being met in agricultural regions of Illinois, where it is common to find nitrate concentrations in surface waters above the EPA drinking water standard of 10 parts per million. Agricultural land use is a principal cause of nonpoint source pollution. Under conventional agriculture 30-50% of the applied nitrogen fertilizer is leached to subsurface water and eventually enters streams and lakes in the form of nitrate. Literature on buffer strips conducted on the Atlantic Coastal Plain and in England indicate that forested and grass buffer strips may be effective in reducing subsurface nitrate pollution. Research findings in an Illinois agricultural watershed showed dramatic reductions of nitrate-N in both forested buffer and grass buffer strips. Nitrate concentrations in soil water at three subsurface depths (60 cm, 120 cm, and > 120 cm) from a perennial grass buffer composed of Reed Canary Grass (Phalaris arundinacea) and a forested buffer dominated by mature Cottonwoods (Populus deltoides) were compared to a cropped treatment with no buffer. Nutrient concentrations were also measured in surface flow and tile drainage. Reductions of nitrate-N occurred in both the forested buffer and grass buffer. In the forest treatment the reduction of nitrate-N at the 60 cm, 20 cm and >120 cm depth after passing through an 18 m wide riparian forest was 95-85%. Similar but less efficient nitrate-N reductions were found for the grass treatment buffer. After passing 67 m through the perennial grass buffer strip nitrate-N reduction at the 60, 120, and >120 cm depths ranged from 69-85%.

Although results indicate that buffer strips can effectively remove nitrate from subsurface ground water, tile systems (which drain 50% of all agricultural land in central Illinois) by-pass buffer strips thus limiting their effectiveness and shunting nitrate directly to streams. Tile drainage and nitrogen fertilizer are no doubt essential to sustain current production levels in central Illinois, however these practices have created a conflicting problem of reduced water quality.

An alternative technique is proposed that should be effective in tile drained lands. This technique involves constructing a streamside wetland that intercepts and processes agricultural runoff. The constructed wetland, located between the row crop and the stream channel, would be designed such that a majority of the agricultural drainage would slowly seep through the wetland soil, thus maximizing filtration, sedimentation, and denitrification

(biological conversion of nitrate to nitrogen gas). The wetland would be constructed by re-routing tile drainage to the ground surface above the floodplain and creating an earthen berm to hold back drainage waters. This wetland design is now being constructed and tested at the University of Illinois.

Riparian buffer strips and constructed wetlands are two techniques that should help meet the needs of both the farmer and the Federal government by: 1. Supporting existing tile drainage systems; 2. Improving water quality through the natural biological processing of nitrate; 3. Reestablishing wetlands in areas where they once existed.

INTRODUCTION

Major water quality improvements over the last 20 years are attributed to the treatment of point source (PS) pollution (Smith *et al.*, 1987; Herricks and Osborne, 1985); and it is now recognized that nonpoint source pollution (NPS) is largely responsible for the nation's failure to meet present federal water quality goals. Agriculture has been implicated as the major land use contributing to NPS degradation of surface waters in the United States (Humenik, 1987; Odum, 1989). Agricultural lands are highly modified ecosystems (Conway, 1987) that characteristically "leak" nutrients (Loucks, 1979). In Illinois it is common to find nitrate concentrations of streams, lakes and reservoirs in excess of 10 ppm (the EPA standard for drinking water). The correlation between agriculture and water quality degradation is a function of the industry's reliance on nitrogen fertilizer (Omernik, 1976; Farnworth *et al.*, 1979; National Research Council, 1982), the insufficient uptake by mono-culture crops (Dilz, 1988; Simonis, 1988; Nielsen *et al.*, 1988; Keeney, 1982; Blackmer, 1986; 1987) and poor nutrient retention by soils.

NPS control strategies are not as dependent upon technological remedies as are NP strategies, but rather rely on modifications of cultural and land use practices. Several authors have recommended the use, maintenance, and restoration of vegetative riparian buffer strips in agricultural regions for water quality mitigation. The fundamental objective behind this practice is to reduce nutrient export to surface waters by increasing nutrient cycling, retention time, and the rate of denitrification in the watershed. Stream-side vegetation has been shown to be important in maintaining stream water quality (Moring, 1975; Borman and Likens, 1979; Cooper *et al.*, 1986; Osborne and Wiley, 1988). Research in the eastern United States indicated that riparian vegetation acted as an effective filter for NO_3^--N (Lowrance *et al.*, 1984; Peterjohn and Correll, 1984) and that filter-strips of 18 m in width could effectively reduce NO_3^--N inputs to surface waters (Cooper *et al.*, 1986). In a riparian buffer wetland, on the Atlantic Coastal Plain, where shallow ground water reached the surface before entering the stream, denitrification reportedly removed 84% of the total NO_3^--N leaving the field in drainage water (Gilliam and Skaggs, 1987; Jacobs and Gilliam, 1985).

Riparian ecosystems link streams with their upland terrestrial catchments. They influence hydrological conditions by modifying storage capacity and aquifer recharge; in-channel primary and secondary productivity and organic-matter quality and quantity; biodiversity and migratory patterns; and, biogeochemical cycling (Sharitz *et al.*, 1992). In this paper we will focus on biogeochemical processes, specifically nitrate removal. Vegetated riparian buffer strips (RBS) can modify, incorporate, dilute, or concentrate substances before they enter surface water systems. It is for this reason that they have been adopted as tools to reduce input of nitrate from terrestrial uplands to aquatic ecosystems. RBS have become an accepted management practice under the Conservation Reserve

Program (Prato and Shi, 1990); however, several important questions must still be answered regarding their efficiency, vegetative composition, width and structure.

Recognizing the need to develop effective methods to reduce NPS pollutants from agricultural lands, we have provided a brief summary of the RBS literature pertaining to nitrate removal. We also present results of a forest and grass riparian buffer strip study conducted in central Illinois to determine the role of riparian vegetation in mitigating nutrient losses from a Midwestern upland terrestrial agroecosystem dominated by row crop agriculture. Preliminary results of an ongoing study that uses wetlands to remove nitrate from agricultural drainage water is also presented. We focus on nitrate in this paper because nitrate is highly mobile and it enters ground water and surface water rapidly through soil leaching; and N fertilizers are one of the key components to maize production.

Riparian buffer strips and nitrate removal

A review of the literature on the effectiveness of forested and grass buffer strips reported reductions in subsurface nitrate of 40 -100% in forested buffers and 10-84% in grassed buffers (Petersen *et al.*, 1992) . Surface runoff nitrate reductions of 79-98% in forest buffer strips 30-50 m wide and 54-84% in grass buffers 4.6-27 m wide (Table 1). Recent work by Jordan *et al.* (1993) reported 95-100% reductions in subsurface nitrate after transiting 35 m of a 55 m forest buffer. Haycock and Pinay (1993) have shown poplar forest buffer strips remove 100% of the subsurface nitrate within the first 5 m of flow through the RBS. While grass buffer strips reduced nitrate by 84% after 17 m of flow.

Table 1 gives an updated literature review of subsurface and surface nitrate removal efficiencies in forest and grass RBS. Results show that relatively narrow forested RBS can effectively reduce nitrate from both surface runoff and subsurface water. The amount of reduction is dependent on initial concentrations of nitrate, the width of the zone, the soil type (nitrification and denitrification rates), sedimentation rates, surface and subsurface drainage, temperature, successional rates and the surface vegetation (Petersen *et al.*, 1992; Richardson and Nichols, 1985; James *et al.*, in press). Generally, the greater the buffer width, the greater the uptake of nitrate. Although Haycock and Pinay (1993) found greater efficiency of nitrate removal in forested buffer strips, it is still not possible to determine whether forest buffer strips are generally more efficient than grass buffer strips in reduction of nitrate because of the differences in most study designs.

Before effective prescriptions can be developed for the use of RBS in reducing nitrate losses to surface waters, many questions must be answered. What types of RBS are most efficient in removing nitrate from surface waters? Will they saturate with time and become ineffective? What is the best species composition? What is the most efficient width of a RBS? Other factors that must be determined are the economic costs, social acceptance, potential benefits to society and potential incentives for agriculturalists who implement such strategies.

The next section presents results of a study conducted to determine whether forest and grass RBS could serve as viable systems to prevent the movement of subsurface nitrate to surface waters in the cornbelt of Central Illinois.

Description of Study Site

The study site on the East Branch of the Embarras River in southeastern Champaign County, Illinois, is located within the Central Corn Belt Plains Ecoregion, a low relief glacial till plain overlain with loess. The dominant soil association is Drummer-Kendall-St. Charles which overlies a dense basal till. Immediately adjacent to the river the dominant soil is Colo silty clay loam. Proctor silt loam (1 to 5% slopes) and Martinsville loam (5 to 10% slopes) are also found on the site. The soil structure facilitates downward water penetration on the cropped uplands through the surface soil and subsoil to the basal till where the flow is directed laterally toward the Embarras River. Much of the area is tile drained with exceptions being the two riparian buffers utilized in this study. The predominant land use is row crop agriculture with numerous constructed ditches and channelized natural waterways to assist land drainage.

The study site was divided into an upland zone planted in a corn/soybean rotation (1988 and 1989, respectively) and a riparian zone divided into the three following treatments paralleled the west bank of the Embarras River: 1) rowcrops planted down to the stream bank; 2) a riparian forest (approximately 18 meters wide) dominated by 70 year-old cottonwood trees (Populus deltoides; mean diameter at breast height (dbh) = 63.5 cm, basal area = 44 m^3 ha^{-1}) and silver maple (Acer saccharinum; mean dbh = 20.5 cm, basal area = 13.99 m^3 ha^{-1}); and 3) a 67 meter wide strip of Reed Canarygrass (Phalaris arundinacea) between the stream and rowcrops.

Research Design and Methods

Within each riparian treatment (rowcrop, forest, and perennial grass) three lysimeter transects, 15 meters apart, were installed perpendicular to the stream channel to follow the sub-surface lateral movement from the upland site toward the stream. Lysimeter transects on each treatment consisted of a center row of five paired lysimeters placed at 60 cm (shallow lysimeters) and 120 cm (deep lysimeters) below the soil surface. The paired lysimeters were located at the land-water interface, at the crop-buffer margin, and well within the cropped area. Marginal transects consisted of three shallow lysimeters placed at 60 cm below the soil surface and located in the same positions as the first three rows of samplers in the center transect. Piezometers were also installed (>120 cm, see below) in the center transect of the first, third, and fifth row in close proximity to the paired lysimeters. This design allowed the monitoring of the downward and lateral movement of nutrients in sub-surface flow from the cropped upland to the stream through the different riparian zones. Water samples were collected from deep and shallow lysimeters, and piezometers in an effort to track subsurface nutrient movement following precipitation events of sufficient magnitude and duration to allow soil percolation and subsurface NO_3^--N runoff.

Lysimeters were constructed to allow soil solution sampling at 60 cm and 120 cm below the soil surface yet permit complete burial of the sampler below the plow zone (25 cm below the soil surface). Osborne and Kovacic (1992) give a detailed description of the sampler construction, placement and sampling design. Lysimeters were installed at 60 cm or 120 cm below the soil surface. Piezometers were also placed into hand augured holes at a depth necessary to reach the water table.

Water samples were analyzed for NO_3^--N. One to two days prior to sample collection lysimeters and piezometers were cleared of all water and each lysimeter sampler evacuated to approximately -50 centibars. A peristaltic hand pump was used to obtain groundwater samples from piezometers. Following collection, samples were transported to the Illinois Natural History Survey (INHS) laboratory and analyses performed following standard methods (APHA, 1985). Nitrogen analyses were performed on a Technicon GTpc Auto Analyzer II. A tracer (NaBR) was also used to determine direction of groundwater flow. Transformed (natural logarithm) nitrate-N concentrations in solution at each sampling depth were analyzed for the effects of zone (upland crop v riparian) and buffer type (crop, grass, and forest) using analysis of variance.

Results and Discussion

Significant interactions occurred when the effects of buffer type (crop, grass, forest) and zone (upland and riparian) on shallow (60 cm) subsurface concentrations of nitrate-N were examined suggesting a non-linear response of buffer types within zones. No significant differences were found in the concentrations of nitrate-N ($F_{2,95} = 0.811$; $P = 0.448$) in the upland zone reflecting the homogeneous environmental and land-use conditions (e.g., fertilizer application rates, soil types, and crop cover) in this zone.

There was no significant difference in nitrate-N concentrations among shallow lysimeters in the upland and riparian crop sites. In the two other cases (i.e., the forest and the grass sites) the concentrations of nitrate-N in ground water in the upland crop areas were significantly higher than were mean concentrations at comparable sampling depths in the riparian zone (Fig. 1). The significant reductions in nitrate-N concentrations from the upland crop zone to the RBS suggest that nitrates were being removed from the system. Denitrification in RBS has been suggested as the primary mechanism for the reduction of nitrate concentrations in solution (Cooper *et al.*, 1986; Jacobs and Gilliam, 1985; Peterjohn and Correll, 1984; Pinay and DeCamps, 1988; Pinay et al., 1993). Others have also provided evidence that denitrification is an important mechanism contributing to the loss of nitrate-N. Bromide used as a tracer verified that subsurface groundwater moved laterally from the crop land through the forest and grass buffer strips to the stream.

In the riparian zone, concentrations of nitrate-N in shallow lysimeters were significantly greater in the grass RBS (2.43 ± 0.43 mg L^{-1}) than in the forested RBS (0.87 ± 0.23 mg L^{-1}, Fig. 1). There were no significant differences in nitrate-N concentrations in solution between the forest and grass RBS at 120 cm and >120 cm (Fig. 1). It is noteworthy that between the 60- and 120-cm depths the greatest proportional decrease in nitrate-N concentration (77.5%) occurred in the riparian crop site (i.e., from 16.86 ± 2.29 mg L^{-1} at 60 cm to 3.79 ± 1.22 mg L^{-1} at 120 cm, Fig. 1)The proportional decreases between the 60- and 120-cm depths in the forest and grass RBS (34.0 and 51.0%, respectively) were substantially lower than in the riparian crop site (Fig. 1). In the riparian crop sites the greater loss of nutrients in solution between the 60- and 120-cm depths is attributable to subsurface transport in drainage tiles directly to the stream channel, rather than to denitrification and plant uptake.

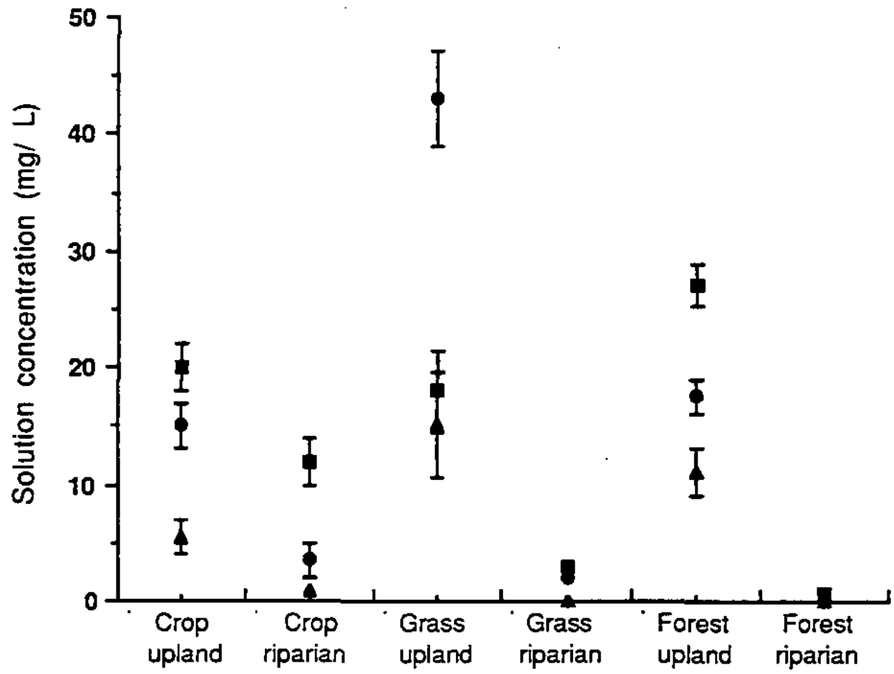

Fig. 5 Mean concentrations of nitrate-N in solution from shallow (square) and deep (circle) lysimeters and piezometers (triangle) in each upland region planted in row crops and each riparian (crop, grass and forest) zone duirng the study.

The evidence suggests that RBS can reduce N inputs to streams in Midwest agricultural systems. Osborne and Wiley (1988) concluded that the mitigating benefits of RBS will be maximized if they are sited in the smaller headwater streams whose lengths dominate any drainage network. In much of the Midwest, most lands in the headwaters of the catchment are privately owned. Undoubtedly, government support incentives will be required for large scale adoption of RBS in many regions of the U.S.

In areas that are tile drained the effectiveness of riparian buffer strips in removing nitrate-N will be reduced. One solution to this problem is to remove the tiles; however, this is not a viable solution because it would render the land unfarmable. Another more viable solution would be the creation of small wetlands fed by agricultural drainage and designed to optimize nitrate-N removal through plant uptake and denitrification. We are now studying the efficiency of artificial constructed wetlands for removing nitrate-N in lowland areas that are tile drained. To create such wetlands, tile drains are surfaced upland (sunlighted) rather than laid directly to the stream (Fig. 2). A berm is created adjacent to the stream (width of berm and distance form stream depend on the size of the drainage basin) to cause water to pool and thus increase retention time. It is anticipated that nutrient removal will occur in a fashion similar to that of RBS and natural wetlands (Lee *et al.*, 1975). Preliminary investigations indicated that constructed wetland buffers with a 1:20 wetland to drainage area ratio could effectively treat 65% of the water entering them for 5 days and 55% for 15 days.

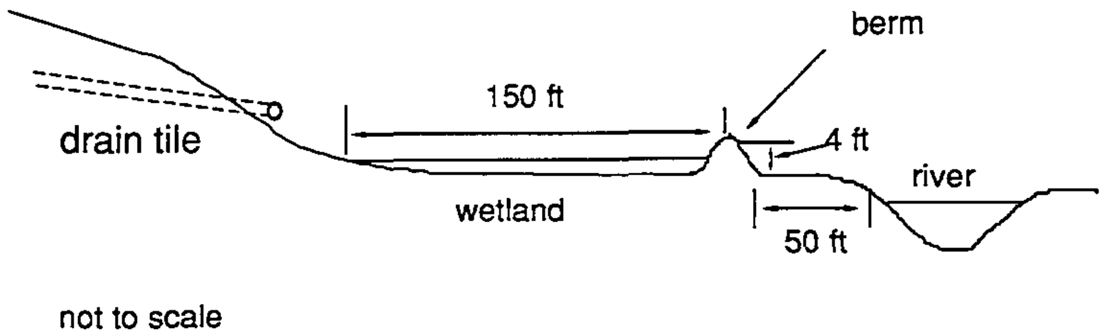

Fig. 2 Conceptual design of a constructed wetland buffer for facilitating the removal of nitrate-N from agricultural drainage water.

We believe that instituting RBS and constructed wetlands can be effective in removing considerable amounts of nitrate-N in agricultural surface waters. Riparian buffer strips and constructed wetlands are two techniques that should help meet the needs of both the farmer and the Federal government by: 1. Supporting non-tiled farmland and existing tile drainage systems; 2. Improving water quality through the natural biological processing of nitrate; 3. Reestablishing wetlands and riparian corridors in areas where they once existed. However, it should be recognized that no single method or technique will eliminate all nitrate-N input into surface waters, nor will it be universally applicable in every water quality mitigation program. A combination of options must be considered for any comprehensive water quality program, these options should include RBS, constructed wetlands, changes in farming practices such as no-till agriculture and fertilizer input management.

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LAKE BLOOMINGTON WATERSHED PROJECT

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In November 1985 an application for federal assistance through the PL-566 Small Watershed Program was filed with the Illinois Department of Agriculture, Division of Natural Resources by the McLean County Soil and Water Conservation District. The area under application encompassed both Lake Bloomington and Evergreen Lake Watersheds. The application was reviewed by the State Watershed Priorities Committee and recommended for approval to initiate inventories and evaluations for a PL-566 watershed project. Acceptance was acknowledged by the State Conservationist and appropriate agencies and sponsors were notified. In 1987 it was determined that the watersheds should be evaluated separately.

After the evaluation it was decided that all efforts would be concentrated on Evergreen Lake, one of the main reasons being it has a higher sheet and rill erosion rate. Then came the drought of 1988, which took a toll on both lakes. As a result of the drought the City of Bloomington decided to install the Mackinaw River pumping station which become their third source of water.

In 1989 the city made the decision to raise the spillway of Evergreen Lake five feet; consequently, the Evergreen Lake watershed project was put on hold. In August 1989 the Lake Bloomington Watershed Planning Committee was established by the sponsors who would represent various interests in the watershed including the City of Bloomington. Many of the same representatives who served on Lake Bloomington-Evergreen Lake Planning Committee served on this committee. The committee consisted of members of Regional Planning, City Council, County Board, Lake Bloomington Homeowners Association, farmers and a city engineer. The planning committee identified the following resource concerns: water supply and quality, shoreline erosion, recreation, wildlife habitat, watershed protection, and waste disposal.

The Lake Bloomington Watershed Plan and Environmental Assessment addresses the water supply, water quality and recreation concerns in detail and was combined into a single document. It includes the appropriate data needed to provide an understanding of the plan and its environmental impacts.

The Soil Conservation Service along with other agencies developed the Lake Bloomington Watershed Plan. The watershed agreement was signed on January 30, 1992, by the following agencies: McLean County Soil and Water Conservation District; City of Bloomington; IDOA, Division of Natural Resources; and USDA, Soil Conservation Service.

Both lakes are located north of Bloomington-Normal about 8 miles. Lake Bloomington being four miles east and Evergreen Lake being two miles west of I-39. Lake Bloomington was built in 1929 and its spillway was raised five feet in 1957 due to the drought of 1955 and Evergreen Lake was built in 1970, they are connected by a pipeline and serve as the primary and secondary water supplies for the City of Bloomington. Evergreen Lake has a park with no residential, Lake Bloomington has residential along with a church, Easter Seals and Girl Scout camp. Evergreen Lake has 686 acres of surface area and Lake Bloomington consists of 572 acres. The City of Bloomington has been experiencing a problem with high nitrate levels at different times of the year. However, they are fortunate in being able to blend the water from the two lakes. Evergreen Lake is normally lower in nitrate levels than Lake Bloomington. The size of the watershed is the major difference between the two lakes. Evergreen Lake has a 26,500 acre drainage area with Lake Bloomington having a 43,100-acre drainage area.

The watershed plan recommends the installation of two sediment basins: one on Money Creek and one on Hickory Creek. Originally the PL-566 program was going to pickup 100 percent of the cost but due to the demand of cost share they reduced that figure to 50 percent. Estimated cost of the project is $1.9 million. The City of Bloomington has allocated their 50 percent and is ready to proceed as soon as Soil Conservation Service completes the design process.

The basins are going to be located in the pool of Lake Bloomington. The lake will need to be lowered 5 feet at the time of construction. Normally the lake would be at that level during July and August with normal water usage. Soil Conservation Service completed surveying the structure sites and is in the process of designing the structures. In December 1992, Soil Conservation Service contracted Terracon Consultants to take soil borings to determine the soil stability at the structures sites. Silt depth at the sites average 8.5 feet with a water depth 2.5 feet. Originally the plan called for the structures to be built out of rock. The results from the soil boring allowed the design to be changed to an earthen fill with 24" to 30" layer of rockfill. The surface will be grouted to keep the rock in place and allow for better flow conditions when water is flowing over them.

The Money Creek and Hickory Creek structures will be approximately 500 feet long, 11 feet in height and 7 to 9 feet above the normal pool elevation of Lake Bloomington. The structures will have a 20 foot top width and 3 to 1 upstream slope and 6 to 1 downstream slope. The Money Creek pool will be 192 acres in size and the Hickory Creek pool will be 56 acres in size when water is flowing over the structure. Soil Conservation Service estimates that water will flow over the structures 15 days a year. The principal spillway for both structures will be a 42 inch reinforced concrete pipe and riser with the capacity to draw down the water level above the structures. Both sites will have a drain tile installed in the basin sediment deposition areas, allowing the areas to be drained so the sediment can consolidate. The structural measures are planned to hold a 50 year capacity of sediment from their respective watershed drainage areas. The Hickory Creek sediment basin will have an 80 percent trap efficiency while the Money Creek sediment basin will have a 73 percent trap efficiency. The structures are designed to help improve water quality and will be able to be drained during the summer months so that vegetation can be grown, which will absorb nutrients and chemicals. During the fall and winter months the area can be flooded to create wetlands which will enhance wildlife.

With the installations of the structures an additional 90 acres of wetlands will be created along with 42 acres of cropland which will be converted to woodland. The Soil Conservation Service has kept the City of Bloomington informed on any changes they feel would be beneficial to the project. The City of Bloomington has strived to keep good repore with all the people in the watershed. They strive to keep the public informed on the progress of the project.

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USING THE SWAN LAKE HABITAT REHABILITATION AND ENHANCEMENT PROJECT TO RESTORE ILLINOIS RIVER RESOURCES

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ABSTRACT

The Swan Lake Habitat Rehabilitation and Enhancement Project (HREP) lies along the Illinois River just above its confluence with the Mississippi. Constructed from funds provided under the Environmental Management Program, the Swan Lake HREP seeks to address the degrading effects of sedimentation and loss of valuable wetlands critically important to migratory waterfowl and fish. Most of the 2,900 ac Swan Lake wetland complex is managed by the Brussels District of Mark Twain National Wildlife Refuge, established primarily to benefit migratory birds. The northernmost 300 ac of Swan Lake, and adjacent Fuller Lake are cooperatively managed by the Illinois Department of Conservation. In addition to providing valuable waterfowl feeding and resting habitat, Swan Lake includes a significant proportion of Illinois River backwaters in Pool 26 and thus supplies important spawning, rearing, and wintering fisheries habitat.

The Swan Lake wetland complex is threatened by sedimentation from Illinois River floods, adjacent upland erosion, water level fluctuations, and wind-generated waves. The three goals of the Swan Lake HREP are (1) to restore aquatic macrophyte beds and associated invertebrate communities for the benefit of migratory waterfowl, (2) to provide habitat for overwintering fish survival, and (3) to provide spawning and rearing fisheries habitat.

Project features include an 8.5-mile perimeter sediment-deflection levee to reduce sediment deposition from river floodwaters, potential for an upland sediment treatment program, an interior closure to subdivide the lake into independently managed compartments, two island groups to reduce turbidity by acting as barriers to wind-generated waves, pumps to recharge and dewater individual units, boat access areas, and an innovative fish passage structure. The Swan Lake Habitat Rehabilitation and Enhancement Project (HREP), has been developed through the Environmental Management Program (EMP). The EMP, a $288 million program, was enacted by Congress in 1986 to develop a balanced ecosystem approach to management on the Upper Mississippi River System. Approximately two-thirds of EMP dollars are dedicated to the design and construction of habitat rehabilitation projects on the Upper Mississippi River System, of which Swan Lake is one such project. Construction is scheduled to begin later this year, with completion scheduled for fall 1996 (UMRBA 1993).

INTRODUCTION

The Swan Lake habitat project is located in Pool 26 adjacent to the west bank of the Illinois River, just above its confluence with the Mississippi River. The immediate project area includes 2,900 ac Swan Lake, 200 ac Fuller Lake, 950 ac of bottomland forest, and 550 ac of surrounding cropland, thus encompassing a total project acreage of approximately 4,600 ac (COE 1991a). Swan Lake is actively managed by the Brussels District of Mark Twain National Wildlife Refuge (NWR), U.S. Fish and Wildlife Service, with the exception of the uppermost 300 ac of Swan Lake, and adjacent Fuller Lake, which is managed under a cooperative management agreement with the Illinois Department of Conservation (IDOC).

The following information illustrates the importance of Swan Lake to wildlife and fisheries resources. From a wildlife perspective, Swan Lake lies in the middle of the Mississippi Flyway, a natural waterfowl migration corridor. The importance of this wetland complex to waterfowl can be seen by the fact that in 1955 some 20 million waterfowl use days were ascribed to Swan Lake, primarily to mallard, scaup, and canvasback. Just thirty years later, largely due to the highly degrading effects of excessive sedimentation, that number fell by almost 700 percent, to only 3 million waterfowl use days in 1985 (Havera 1985). Important waterfowl foods, including aquatic vegetation and fingernail clams, which formerly were abundant, are now extremely scarce, thus resulting in severely depleted waterfowl food resources (Mills et al. 1966, Bellrose et al. 1979, Sparks 1984). The importance of the area as a backwater fishery resource is demonstrated by the fact that Swan Lake, as an Illinois River-connected backwater, provides 40 percent of all backwater habitat in Pool 26, and 10 percent of all backwater habitat along the entire Illinois River (COE 1991a). It serves both as a spawning and nursery area, as well as overwintering habitat, to an array of fish species, including bluegill, white and black crappie, brown bullhead, white bass, sauger, drum, smallmouth buffalo, and paddlefish (Sheehan et al. 1988, 1989). Given the importance of this degrading backwater to wildlife and fisheries, it was selected as a primary site for habitat rehabilitation.

The major threat to the Swan Lake wetland complex, as in so many other locations throughout the Upper Mississippi River System, is sedimentation (GREAT II 1980e, COE 1991a). As a result of sedimentation in the Illinois River valley, there has been a continuing growth of terrestrial habitat and a loss of off-channel water habitat (Lee and Stall 1982). In 1976, Lee and Stall reported Swan Lake had lost over 42 percent of its capacity since 1903. In the case of Swan Lake, however, sediment deposition is intensified, as it is delivered into the wetlands from two sources. Approximately two-thirds of the sediment arrives from Illinois River flood events. The additional one-third comes from the immediately adjacent 30-sq. mi. watershed (COE 1991a). To give meaning to the amount of incoming sediment, it has been estimated by the Corps of Engineers (COE), St. Louis District (1991a) the overall sediment deposition rate into the lake totals approximately one-half inch per year. At the current rate, within 50 years the COE has estimated approximately one third of Swan Lake will become terrestrial habitat, with the remainder of the lake so shallow and turbid it is estimated there will be only a 7-inch average depth.

The greatest adverse impacts from sedimentation are direct loss of aquatic habitat; flocculent bottoms not conducive to plant anchorage; reduced light in the water column which further reduces aquatic plant production; and increased turbidities caused by wind-generated waves which sweep across the broad expanse of unbroken open water which Swan Lake contains (Ellis 1936, GREAT II 1980e, Jahn and Anderson 1986, COE 1991a). The greatly reduced or lost plant production results in adverse food supply impacts to both waterfowl and fish. Fish are additionally impacted by increased physiological stress caused when an influx of wintertime cold flowing Illinois River water enters a very shallow Swan Lake, now too shallow to mediate the extremely cold temperatures on the lake's fish populations (Sheehan et al. 1988, 1989).

As a result of identifying these serious adverse effects on the Swan Lake wetland complex, refuge staff and staff of the IDOC, together with Ecological Services personnel and staff of the COE conducted many planning meetings and public meetings before deciding on the final design for the Swan Lake HREP. The goals of the Swan Lake habitat project are fourfold: first, to restore aquatic macrophyte and associated invertebrate communities for the benefit of migratory waterfowl; second, to provide overwintering fisheries habitat; third, to provide fisheries spawning and rearing habitat; and fourth, to increase the overall habitat value of Swan Lake for waterfowl and fish (COE 1991a).

PLAN FEATURES

The consensus reached through the plan formulation process included several features. First, to retard the deposition of sediment into the project area by Illinois River flood events, approximately 8.5 mi. of perimeter sediment deflection levees are to be constructed. As a result of these levees, the COE (1991a) estimates there will be an 85 percent reduction in river-borne sediment input. Flood event intrusions are predicted to be eliminated in seven of eight growing seasons, and in one of two years during winter and spring. In addition, the material which is used to construct the perimeter levee will be excavated from the adjacent Swan Lake wetlands, and will thereby create additional deepwater fisheries habitat.

Second, to further address sediment inputs, a highly innovative and unique upland treatment program has been proposed in the adjacent watershed. This program is designed to reduce incoming hillside sediment by 30 percent (COE 1991a), and it has evolved to encompass a broad interagency and private landowner partnership involving cooperative efforts with the COE, Soil Conservation Service, the local Soil and Water Conservation District, and private landowners. The upland treatment program, as proposed, would involve the construction of 95 water and sediment control basins, 55 ponds, and 40 terraces. However, this element has been highly controversial, and at this time it lacks approval by the COE's Assistant Secretary of Army, primarily because it is the first HREP to address sediment at its source in the uplands, an area the COE feels is outside of its' jurisdiction.

The third feature of the Swan Lake HREP involves a new lake closure to subdivide the lake into smaller, independently managed compartments, which will significantly increase management effectiveness (COE 1991a). A water management plan has been developed which identifies a three compartment strategy designed to maximize resource benefits for the broadest array of wildlife and fisheries resources. The upper compartment, which includes Fuller Lake, will be managed as a moist soil unit, utilizing a maximum summer drawdown. The middle compartment, involving the upper two-thirds of Swan Lake, will primarily target diving ducks, with a partial drawdown annually exposing about 10 percent of the lake bottom. This management is intended to create submergent aquatics on the lake's interior and a small zone of emergent vegetation along the lake's border. The lower lake compartment will be managed at a nearly constant normal pool elevation, thus providing year-around fisheries access, as well as some additional benefits to resting and feeding waterfowl. To facilitate precise water-level management, each compartment will have a reversible 20,000 gpm Couch pump, along with gated water control structures, which collectively will provide the ability to carefully regulate water levels to produce desired submergent and emergent vegetation.

A fourth feature involves construction of two island groups in both lower and middle Swan Lake (COE 1991a). The island groups will be placed perpendicular to prevailing winds, for the purpose of reducing wind fetch over the unbroken expanse of Swan Lake, thus reducing lake turbidity levels. The islands will be created by excavated dredge material, which will create additional deepwater fisheries habitat. Plans include constructing the islands with varying widths between 60 and 100 feet, with 1 on 6 side slopes for wave protection, as well as shoreline willow plantings to further stabilize the islands. The islands will also be vegetated with grass cover to provide additional waterfowl nesting benefits.

At the present time, EMP habitat projects are not permitted to enhance recreational opportunities (COE 1991b), but they are allowed to compensate for reduced recreation as a result of project impacts. Consequently, as a result of reduced boat access, there will be a two boat ramps provided for access within Swan Lake (COE 1991a).

The final feature involves addressing what has been a controversial planning issue at Swan Lake, namely how to resolve fisheries access. When Mark Twain NWR was established by Congress, it was specifically enabled with its' primary purpose designated for management of migratory birds (USFWS 1979). Hence, all management actions must be compatible with that primary mandate. In the specific case of Swan Lake, it was recognized by planners and engineers that to effectively reduce sedimentation from Illinois River flood events, construction of a perimeter levee would necessitate a lake closure at the current opening at the mouth of Swan Lake where it meets the Illinois River. This closure was a significant concern to fisheries biologists, since it will reduce fisheries backwater access. As a result of extensive discussion, it was agreed an innovative fish passage structure would be constructed at the mouth of Swan Lake (COE 1991a). This structure consists of two principal portions: one, a 20-foot wide segment of open-topped concrete channel over four spans of 5-foot wide stoplog bays; and two, a directly adjacent unit that includes a 10-foot wide segment of open-topped concrete channel over a 6-foot wide sliding gate lakeside, and a 6-foot wide sluice gate riverside, along with a pump station. By closely monitoring fish passage over the stop-log structures and sluice and slide-gates, it can better be determined which fish species, guilds, and age-classes will use or not use this type of design. This type of information is critical to our understanding and developing the best design technology for future projects.

SUMMARY

To recap, the Swan Lake HREP involves the construction of several specific features designed to address resource problems at this important wetland complex. To deal with the primary resource problem of sedimentation, an 8.5 mi. perimeter sediment-deflection levee parallel to the Illinois River will be constructed. To address incoming upland sediments, a unique interagency and private landowner partnership has been proposed which would involve construction of 190 upland sediment control measures. An interior lake closure will further subdivide Swan Lake and adjacent Fuller Lake into three independently managed compartments complete with individual water level management capabilities, thus allowing precise management for dabbling ducks, diving ducks, and fisheries. Island groups will be constructed in the middle and lower portions of the lake to reduce wind fetch and the production of wind-generated waves and related high lake turbidity levels. Boating access will also be provided. An innovative fish passage structure, with intensive biological response monitoring, will be constructed at the mouth of Swan Lake where it meets the Illinois River.

In conclusion, with these specific measures, we hope to rehabilitate the formerly highly valuable Swan Lake wildlife and fisheries resources to a level comparable to its' historically tremendous value as both critical migratory bird habitat in the center of the Mississippi Flyway, and invaluable fisheries habitat as an Illinois River backwater fishery.

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URBAN STREAM RESTORATION

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ABSTRACT

Under Section 319 of the Clean Water Act, Region V of the USEPA has provided funds to the Illinois EPA to develop and monitor innovative nonpoint pollution control strategies. The Illinois EPA has formed partnerships with local governments to test biotechnical methods of stream bank stabilization and habitat enhancement on urban streams.

The Nonpoint Pollution Control Program of the Illinois State Water Survey was chosen by DuPage County's Department of Environmental Concerns and the City of Waukegan to design and implement such innovative approaches to urban stream enhancement.

INTRODUCTION

In the upper reaches of the Illinois River basin, degradation of urban streams is a common problem in the rapidly developing collar counties surrounding Chicago. Urban streams, like rural streams, suffer severe channel erosion when the energy generated by torrential floodwaters exceeds the sheer strength of the natural bank soils. Since development in urban areas will greatly increase runoff rates by increasing the areas of impervious surface, management of urban streams has emphasized construction of stormwater detention basins to reduce the runoff rates or armoring the stream channel with rock or concrete materials.

Just as the design of stormwater basins has been altered to include environmentally sound wetland functions, biotechnical methods have increased the stability of stream channels while retaining stream habitat features necessary for aquatic life. With 319 Nonpoint Pollution Control funding from Region V of the USEPA, the Illinois EPA has funded restoration and evaluation surveys of city parks along the Waukegan River and on a fully developed residential stream in DuPage County. These projects were administered by local government bodies as the Waukegan Park District and the DuPage County Department of Environmental Concerns.

GLENCREST CREEK

In Glencrest Creek, the restoration portion of the project was fully funded by the DuPage Department of Environmental Concerns. The environmental study of the restoration was funded by the 319 program of the EPA. The 2 square mile watershed is 85 percent residential and 5 percent commercial. The remaining 10 percent is open space - being a golf course and park. The demonstration segment occurs in the highly affluent Village of Glen Ellyn, where damage to the landscaping surrounding the homes had to be minimized. The purpose of the restoration was to test biotechnical methods, which would enhance riparian habitat, would stabilize stream banks, and could be installed by the landowner or a small contractor.

The stream channel has a schizophrenic nature with the upstream portion being underground stormwater sewers and an open concrete channel. As a consequence, high floodwater velocities have scoured a rocky streambed with substantial bank erosion in the demonstration area. Concrete box culverts for city streets and driveways had prevented extensive degradation of the streambed but bed slopes were more severe just downstream of the box culverts.

Restoration efforts were concentrated in stream reaches where landowner's lawns and homes were threatened by the largest bank erosion sites. Where homes were near the bank erosion sites, the Water Survey adapted the "lunker" technique (figure 1) utilized in Illinois state parks for the Illinois Department of Conservation. Since Glencrest is a very small urban headwater stream with extensive periods of low flow, the urban lunkers were made of recycled plastic lumber. This "Ecowood" structure would not dryrot because of alternate wetting and exposure to air.

Where nonnative understory plants had overrun native vegetation, buckthorn, multiflora rose, and amur honeysuckle were removed to allow sunlight to reach the eroded bank. Where root systems of large trees had been undercut by channel erosion, the trees were removed. Willows and dogwood were planted along the stream border to provide the dense root system required to bind bank soils.

In less critical areas, a new material was tested - A-jacks (figure 2). The A-jacks were chosen because vegetation can be densely planted within the installed structure. The A-jacks were the 2 ft diameter version of the massive 10 ft diameter structures utilized for ocean breakwaters. A fibrous geofabric, fibredam, was molded into crevices between A-jacks to prevent loss of bank soils before the root systems of willow and dogwood could expand throughout the soil and structures.

Because of the extensive and expensive landscaping surrounding the stream, all material had to transported by ATV with low pressure marsh tires. Traditional excavators with tracks or large tires were avoided for the same reasons. While embedding the lunkers and A-jacks in the streambank and bed was possible with hand labor, a walking excavator was utilized to speed entrenchment. The excavator could move along the banks with minimal damage to lawns and landscaping.

These sites are now 18 months old (figure 3). After a shortage of rainfall in the spring and summer of 1992, regrowth of tree cuttings and grasses has been rapid. The EPA evaluation found landowners are very satisfied with the project. Even with dry streambed occurring on portions of the demonstration reach of this small headwater stream, the post project fishery survey found an increase in species richness and density.

WAUKEGAN RIVER

The Waukegan River Restoration was jointly funded by the EPA 319 Nonpoint Pollution Program, the Waukegan Park District, and the City of Waukegan. The Waukegan watershed is 8,000 acres in an older developed community. As a consequence of its longer history, fewer stormwater detention basins exist. The volume and velocity of stormwater runoff has greatly increased.

Lunker Structures

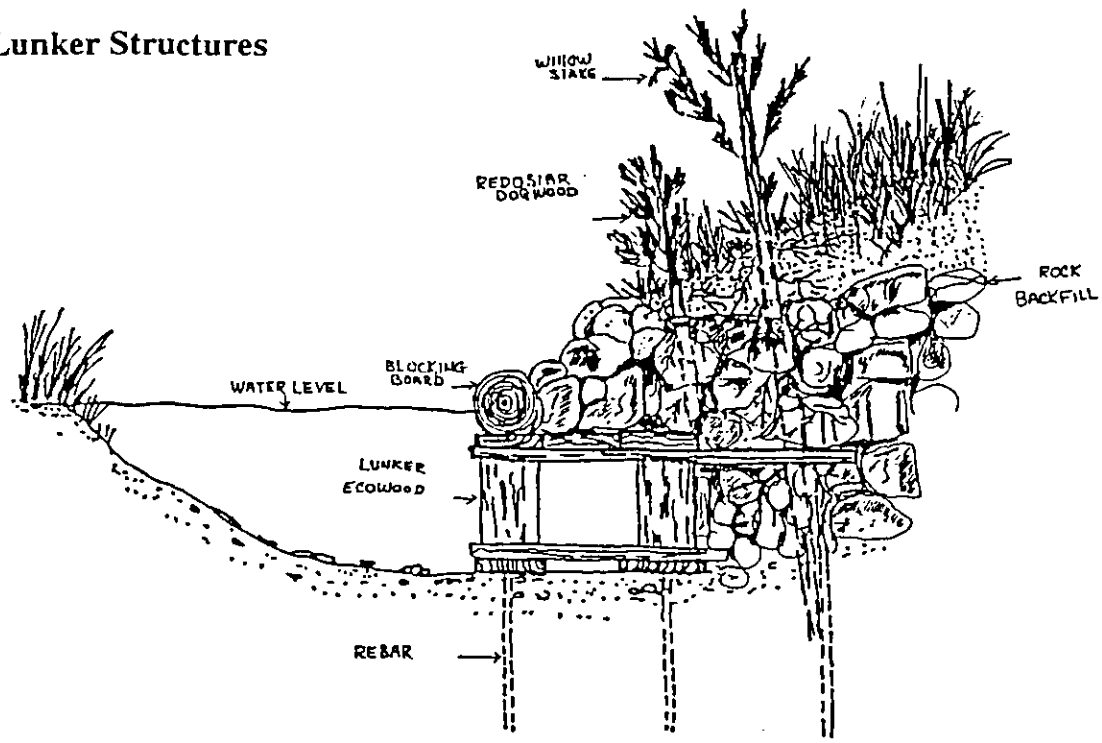

Figure 1

A-Jack Structures

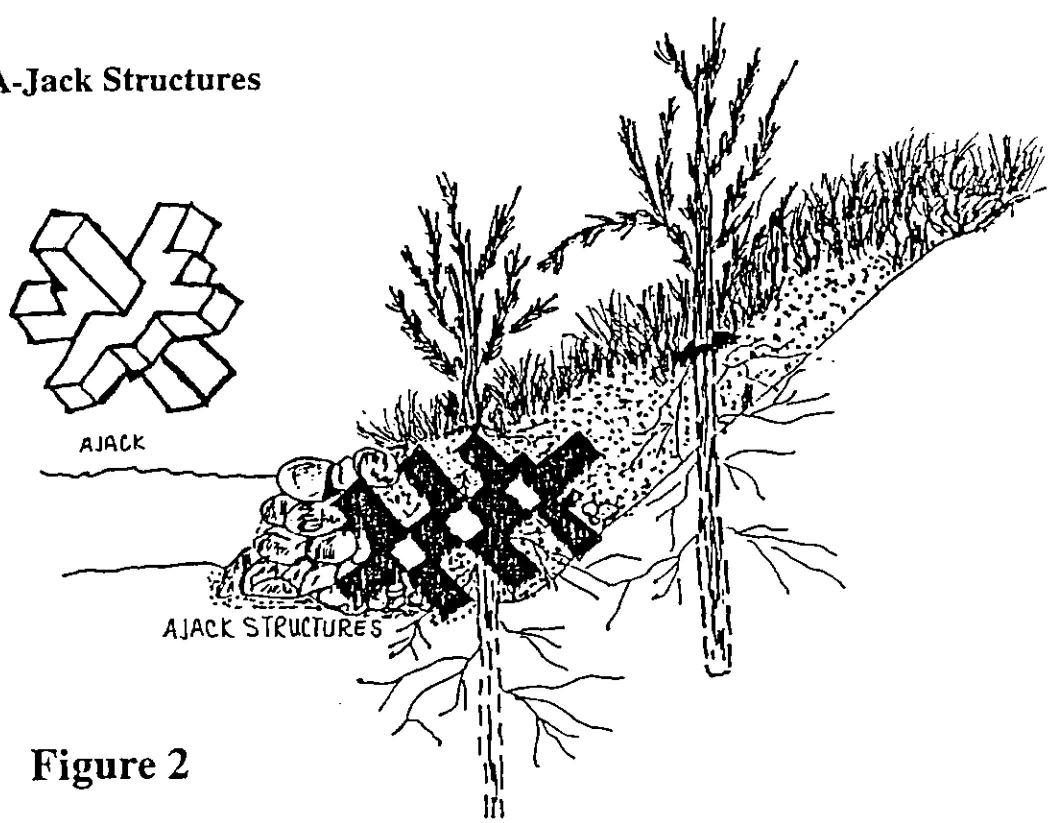

Figure 2

Glencrest Creek

Bank erosion on transect 180 where channel scour undercut trees opposite home.

Channel erosion undermined storm sewer and concrete footings of home

After 1 year, channel erosion has been effectively controlled by vegetative growth in both lunker and A-Jack structures

Figure 3

Manholes on the sanitary sewers were raised 2.5 ft to prevent the Waukegan River from overflowing into them during flood. The structural soundness of the sanitary sewers was threatened by continued channel erosion. Bank erosion was also destroying public access and public lands in Powell Park and Washington Park.

The City of Waukegan needed to protect the sanitary sewers but maintain the esthetic settings necessary for public enjoyment of the Waukegan Park District. With higher population densities and urban sprawl expanding across northeastern Illinois, the utilization of Waukegan Parks has intensified. The Waukegan River not only supports native populations of bass and channel catfish, but migratory Coho salmon and trout are caught by urban fisherman in its parks.

In downstream Washington Park, larger wooden lunkers were the basis of bank stabilization in these deeper waters. The city was concerned bank erosion cutting into the main sanitary sewer line away from the armored stream crossing. Therefore large cut stone was combined with vegetative plantings in a biotechnical technique called joint planting (figure 4). This prevented the stream channel from cutting behind the large cottonwood tree and exposing the main sewerline. This technique has maintained aquatic habitat while stabilizing the bank - even during a torrential July flood when over 4 inches of rain fell in one hour.

Powell Park is located further upstream where bank erosion had destroyed a stormwater outlet and endangered public access to downstream park areas. The Powell Park site was treated with A-jacks and recycled plastic lunkers. Figure 5 shows the Powell Park bank erosion site before restoration in 1992 and one year later in August of 1993.

The Illinois EPA is monitoring the effects of the biotechnical bank stabilization on instream habitat in both Powell Park and Washington Park. The Illinois Department of Conservation's Stream Program is determining the response of stream fish populations to this stream enhancement strategy.

For expanding populations to utilize the existing landbase in both rural and urban areas of Illinois, modern runoff rates will exceed the presettlement runoff rates when most of landscape was wetlands and prairie. The EPA's 319 Program of Nonpoint Pollution Control provides the means to test innovative techniques which protect Illinois urban resources and enhance the aquatic habitat of urban streams.

Waukegan Washington Park

Before Construction

Installation of Lunkers

2 Months After Installation

Figure 4

Waukegan Powell Park

Before Construction

Installation of A-jacks

1 year after installation

Figure 5

LARGE VISIONS AND SMALL VICTORIES: LESSONS LEARNED FROM THE MISSISSIPPI RIVER

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As many researchers and scientists have observed, the ecological collapse of the Illinois River may be a harbinger of things to come for the Upper Mississippi River. In that respect, we on the Mississippi River have much to learn from your experience on the Illinois River. There are striking similarities between the two river systems and indeed, they are related as both a single hydrologic drainage basin and an integrated navigation system. Just as we can draw parallels in the physical and ecological processes, we can also draw parallels in the management processes. It is that management and public policy perspective which I want to explore this afternoon.

MISSISSIPPI RIVER BACKGROUND

To set the stage for my observations on "lessons learned," let me provide just a thumbnail sketch of recent history in the Upper Mississippi River. We have been both blessed and cursed with a series of multi-year, multi-agency, multi-million dollar studies, all of which were, at the time, viewed as the definitive comprehensive opportunity to fashion a new approach to river management. In the early 1970s it was the GREAT (Great River Environmental Action Team) study, which used the problem of channel maintenance as a springboard to address issues ranging from water quality to recreation to floodplain management. In the late 1970s and early 1980s we had what is called the Comprehensive Master Plan for the Management of the Upper Mississippi River System, which was based on the results of a Congressionally authorized study designed in response to the controversy over construction of a second lock at Locks and Dam 26 near Alton, Illinois. And in the late 1980s, the Environmental Management Program was born from the recommendations of the Master Plan. With the Environmental Management Program we have what again sounds like a comprehensive approach to river management, which its most ardent supporters are beginning to recognize has substantial limitations.

Peppered throughout this history of supposedly comprehensive ventures are a variety of more modest, less expansive efforts. There is a Mississippi Interstate Cooperative Resource Agreement (MICRA) that addresses river-wide fisheries management. There is a Heritage Corridor Commission that is looking at the question of whether there should be some comprehensive strategy for linking the cultural, aesthetic, recreational, historic, and tourism features of the river valley. There is a plan being developed under the auspices of the Oil Pollution Act to address response to oil spills in the hope of avoiding a disaster similar to the Exxon Valdez oil spill in 1989 in Alaska. And the litany of examples can go on and on.

I am confident that there is an equally rich mosaic of programs, studies, and plans surrounding the Illinois River. Indeed, a number of the enterprises on the Upper Mississippi River include the Illinois River because it is a component of the total Upper Mississippi River System. I mention these various plans and programs not to suggest that the Mississippi River is particularly unique or distinguished in its reputation for the sheer number and diversity of special programs. But it is against this backdrop, that appears to many like absolute chaos, that I would like to formulate some observations and lessons learned. In addition, I should note that those lessons do not all necessarily arise from success. Rather, our failures and missed opportunities on the Upper Mississippi River can teach us a great deal if we choose to learn.

LESSONS LEARNED

At the risk of over-simplifying the complexity of large river management or generalizing to the point of obscurity, I have identified five types of lessons we have learned:

1. Have a big vision to guide you
2. Recognize that this is a "federal" river
3. Exercise state and local leadership
4. Build partnerships
5. Be opportunistic

1. Have a big vision to guide you

It is particularly in vogue these days on the Mississippi River to lament the fact that there is no grand vision for the future of the river system. We often feel that if we only had a comprehensive vision, the road to success would become immediately apparent. I would contend, however, that a big vision *does* exist for the Upper Mississippi River and that it is frequently implicit in the choices we make, if not the words we have engraved on some stone tablet. That vision is of a multi-purpose river system that features a balance between navigation, recreation, and environmental resources. Some will argue that this type of vision is too big, too vague, or uninstructive for making choices about individual actions. It is certainly not a blue-print. But, on the other hand, a vision need not, and should not, be prescriptive. A vision of the river as a harmony of a working transportation network, a recreational playground, and a healthy and diverse aquatic ecosystem does not suggest how many acres of waterfowl nesting grounds we think is ideal or how many tons of commodities we need to accommodate. But it *does* set the general framework for our management actions.

Where we have failed on the Upper Mississippi River is not that we lack a comprehensive vision, but that we have not effectively translated the one we have into the way we do business. As an example, when we undertake a significant investment in the navigation infrastructure, as we are poised to do in the context of the Corps of Engineers' navigation study, our instinctive reaction to preserving our vision of a system in balance is to insist that an equal financial investment be made in environmental programs. This is exactly what was attempted in the FY 1985 Supplemental Appropriations bill which first started the Environmental Management Program. That bill included committee report language which stated that "initial planning and design of the navigation and environmental improvements are to be undertaken simultaneously on equal fiscal footing..." Our vision of balance, harmony, and multi-purpose use seems artificially contrived when expressed in that way. In contrast, we should be exploring opportunities to blend and integrate our management actions for maximum multiple benefits. For instance, one of the options being explored on the Upper Mississippi River is to move the control point for the navigation pools from midpoint of the pool to the dam itself. During high flow periods, this would yield a broader inundation of the floodplain to take advantage of the ecological benefits that Dr. Sparks described as the flood pulse. In other words, use the dam system which was originally designed to make the river navigable, to control water level fluctuations for fish and wildlife habitat benefits.

2. Recognize that this is a "federal" river

Because the Mississippi and Illinois Rivers are part of this nation's waterway system, the federal government plays a major role in managing the rivers. The lock and dam system and channel maintenance activities of the Corps of Engineers are a powerful force in shaping the character of these river systems. On the Upper Mississippi River, the federal presence is even greater given the fact that over 500 miles are managed by the U.S. Fish and Wildlife Service as part of the national wildlife refuge system.

What this fact suggests is *not* that we are powerless to shape the river's destiny, but that we have very specific programs where we need to exercise our influence and where we have the potential to most dramatically affect river management. For better or for worse, those on the Upper Mississippi River have grown to accept the power of the federal influence and have aggressively positioned ourselves to work as closely with those federal agencies as we possibly can to ensure that federal programs are tailored to meet state and local needs as well. A few examples may be helpful in this regard.

The Corps of Engineers has just embarked on a major 6-year, $40 million study of the navigation needs on the Upper Mississippi and Illinois Rivers. No single action has had such a profound influence on these river systems as the construction of the lock and dam system by the federal government approximately 50 years ago.

As the federal government now studies what needs to be done to maintain the viability of this transportation network, the states are arguing that a full evaluation of the future environmental condition of the river system with the locks and dams in place, needs to be included as part of the study. If the states are successful in convincing the Corps of Engineers that the study must address this question, it will mark a departure from the original focus of the study, which was on the more limited question of the environmental impacts of barge traffic. It will also provide what many river resource managers believe is the necessary starting point for discussion of what actions are required to effectively halt or reverse the environmental degradation of the river system.

There is no doubt that the frustration level inherent in attempting to shape federal studies and programs can be quite high but it is in this arena that many of the decisions will be made that will have the most dramatic affect on the river system. At least on the Upper Mississippi River, the states, environmental interest groups, and the navigation industry all recognize that fact and have consistently pressed to involve themselves in these important ventures.

Another example of the federal influence of the river is the channel maintenance responsibilities of the Corps of Engineers. On the Upper Mississippi River, the Corps of Engineers dredges tons of sand and silt from the navigation channel each year. The disposal of that material can have a significant impact on the riverine ecosystem and has been an issue of some controversy for a number of years. Although state and local governments are not responsible for dredging, they have certainly grown to understand the advantages of involving themselves in those decisions. As a result of interagency discussions and negotiations on the Upper Mississippi River, dredged material is being used for such innovative projects as recreational beaches and islands to buffer large expanses of water from wave action.

3. Exercise State and Local Leadership

After just have described what a powerful force federal programs and actions exert on the river system, it may seem contradictory to suggest that the state and local communities need to exercise greater leadership in river resource management. After all, if the federal government holds the key, why bother? It seems to me that recognizing the influence of federal programs does not mean that we cannot have an affect on those programs nor that we should rely exclusively on the federal government to solve river problems.

First of all, from a very practical fiscal point-of-view, the trend in the federal government is clearly to reduce federal spending. While one could argue that shifts in political, or even broader cultural, priorities may yield greater spending in the future for natural resource and environmental programs, there is no doubt that the overall federal trend is downward. It is becoming increasingly more difficult to successfully argue that federal program should be expanded or that more federal funding is the answer. Consider if you will that the federal budget deficit plus interest is two and a half times greater than the budgets of all 50 states combined. In addition, only seven percent of the annual federal budget is available for "domestic discretionary spending." After eliminating entitlement programs, defense spending, and interest on the debt, this is the only small piece that is available for natural resource programs, and we compete against the vast array of other domestic programs in the federal system. This fact suggests that state and local governments must become more innovative and self reliant, taking on increasing leadership and responsibility for river resource management.

Secondly, despite the far-reaching impacts of federal actions on river resources, there are significant, and frequently legitimate, limitations on the federal scope of responsibility. Land use planning and management, water quality regulations, and recreational facility development are all examples of government responsibilities that have very direct impacts on the health and character of the river, but which for political or public policy reasons, we have vested with state or local, rather than federal government. There is much that state and local government can do if they choose to.

Third, state and local government can frequently be more innovative and creative than the federal government. Because of the need for national consistency or merely the inertia of larger bureaucracy, the federal government is frequently incapable of being sufficiently responsive to local needs and preferences. Regardless of whether Vice-President Al Gore's plans to reinvent and reinvigorate the federal system are successful, my guess is that state and local government will continue to be on the cutting edge, serving as laboratories for new and creative ways of doing business. In fact, the federal government frequently looks to the states for experimentation and innovation. In the field of health care, the national debate about federal health care reform did not receive prominence until states such as Hawaii, Oregon, and Minnesota and local communities like Rochester, New York led the way. Likewise, we find examples of state leadership in the field of water resources. The state of North Carolina has experimented with the integration of point source discharge permitting and nonpoint source pollution control at the watershed scale. This type of approach is now heralded as the wave of the future and has been used as the basis for designing a new federally supported watershed program in the Clean Water Act. Similarly, Wisconsin's nonpoint pollution program, based on priority watershed units, has been in existence since 1978, predating the federal nonpoint pollution program by nine years.

Despite all the reasons why state and local leadership is so critically important, in my view this has not been one of our strong suits on the Upper Mississippi River. While there is much that the states do on the Mississippi, we continue to struggle with uncertainty about what the appropriate state role should be. There are a variety of reasons for this, not the least of which is the fact that the river is heavily "federal" and that it is an interstate river. Shared problems and responsibilities often translate into "not my" problems or responsibilities. Further complicating this situation is the fact that the Mississippi River is a border between states. Rivers that are edges are usually not viewed with the same sense of stewardship as those that are wholly contained within state boundaries. It seems clear that in these two respects, the Illinois River is quite different from the Mississippi. Despite the fact that those of you who are concerned about the future of the Illinois River may frequently be frustrated by the variety of state agencies involved in river management, consider if you will, how lucky you really are in having a more limited political and institutional landscape with which to contend.

4. Building Partnerships

Having just observed that there are a tremendous variety of both federal and state programs and responsibilities that shape our river systems, it is clear that partnerships are the name of the game. The value of partnerships is two-fold. 1) It stretches your dollars. In tight budgetary times, making the most of every dollar is critical. 2) Partnerships offer an opportunity to meet multiple objectives. Individual agencies are often limited in their ability (either because of legal constraints or policies which they themselves set) to address all aspects of a given problem. Rather than throwing up our hands because we can't find that single "one-stop shopping" answer, we need to learn how to build better partnerships.

An example of this can be found right here on the Illinois River with the Swan Lake project. I know that this is a project than many of you may be familiar with and has a fairly high level of controversy surrounding it. In contrast to other habitat rehabilitation projects formulated under the auspices of the Environmental Management Program, the Swan Lake project includes sediment traps to address hillside erosion and protect against sedimentation of valuable habitat in the lake. Implementation of this feature of the project would require a rather innovative partnership with a local soil and water conservation district. However, the Corps of Engineers has indicated that the hillside treatment portion of the project, while valuable, is not within their authority to fund out of the Environmental Management Program. Regardless of your views on the Corps' judgement, it illustrates the challenge of partnership. Whether the Corps pays for the project with Environmental Management Program funds or some other source of funding is used, the collaboration of agencies at the local, state, and federal level is critical to the success of this project.

On the Upper Mississippi River we have both successes and failures of partnership and we have both used and abused the concept. The Environmental Management Program is often put on a pedestal as a national model of successful partnership. And indeed, it is a program in which all the states and participating federal agencies feel ownership and take pride. Yet we continue to struggle with ways in which that partnership can become more meaningful, satisfying, and effective. We have a strong history of partnership dating back to the era of river basin commissions and that legacy has bred lingering and high expectations about how we conduct business on that river, even though that commission no longer exists.

5. Be Opportunistic

In some circles, the term opportunism implies unprincipled or shady manipulation. This negative connotation, however, should not overshadow the fact that taking advantage of opportunities is simply the smart and, often time most effective, way of doing business. Those of us on the Upper Mississippi often fall into the trap of believing that what we really need is a special program for our unique river and that furthermore that program needs to comprehensively address the full array of problems that we face. Somehow, anything less than that seems to fall short. The fact of the matter is, that in our desire to achieve comprehensive perfection, we often miss tremendous opportunities. Two examples are worth noting:

(a) For nearly a year, the natural resource agencies on the Upper Mississippi River have argued that we need to think more holistically about managing the river ecosystem. Central to this concept is floodplain restoration and a return, at least in part, to the natural hydrologic regime of the river. In the midst of this discussion comes the flood of 1993. Suddenly national attention is focused on the midwest, the media is covering the story, the Clinton Administration is anxious to apply new ecosystem restoration concepts, and the Congress suddenly finds money to spend for flood recovery. At the risk of oversimplifying a very complex and politically charged issue, it seems that there is an opportunity here. Field biologist may not have originally conceived of ecosystem management in the context of flood damage reduction, but there is no question that they are intimately related and we need to seize the opportunity in the wake of this disastrous flood event to think more comprehensively about river system and ecosystem management.

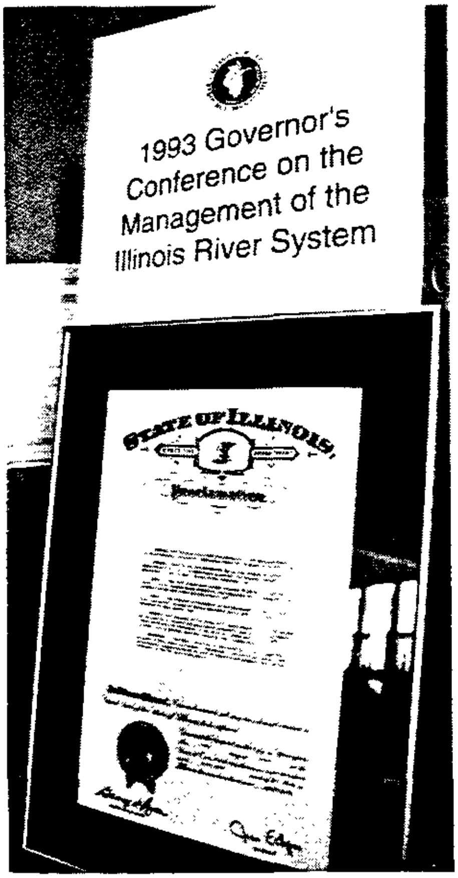
(b) The second example relates to the current debate over reauthorization of the federal Clean Water Act. The Clean Water Act is the highest priority on the environmental agenda of the 103rd Congress. The Senate Environment and Public Works Committee has already introduced its bill and the House Water Resources Subcommittee is expected to offer its own version within the next week. Current legislative proposals call for the establishment of new watershed planning and management bodies throughout the country. These watershed units will be responsible for undertaking new nonpoint source pollution programs and integrating those efforts with point source discharge permitting and wetlands regulation and protection. Because these new programs and approaches don't have Mississippi or Illinois River written all over them, we often fail to recognize what a powerful tool they could be in addressing our problems. Just because these initiative are designed on a national scale and our own Congressmen may not be an author of the bill, doesn't mean we shouldn't pay close attention and begin to evaluate how we can effectively apply these ideas and potential new funding sources to our own unique problems. And if we see limitations or opportunities to improve these proposals, it is to our advantage to engage ourselves in what will certainly be a lively debate in Washington. On the Upper Mississippi River we are intending to do just that, and I would suggest that you may want to consider doing so in the context of the Illinois River as well.

In closing, I want to return to the title of my remarks--large visions and small victories. I am particularly fond of a story that appeared in *Governing* Magazine last year entitled "The Virtue of Modest Accomplishments." The story is about Madeline Cartwright who took over as a principal of a north Philadelphia elementary school in 1979. When Cartwright showed up, she saw a fully dysfunctional institution--no order, no discipline, few resources, and very little education going on. Rather than announcing that she was going to turn that school into a world-class institution, she started small. She felt she had to accomplish something tangible right away. So she promised to get the building cleaned up. She recruited a handful of parents to come in on weekends and do something about the mess. It was a little thing, but it was within her power to accomplish. And once she did that, she had credibility and the makings of a powerful constituency that could help her take on other things.

The thing that Madeline Cartwright teaches us is that the value of a large vision is enormous. But it is in the small steps toward that vision that we can claim great success. I wish you all the best success.

Appendices

Photographs



The Executive Proclamation (left) reaffirms Governor Edgar's commitment to improving the Illinois River. About 75 conference participants toured Peoria-area farms during a pre-conference demonstration of nine different conservation practices that will reduce soil erosion and, hence, improve water quality. John Hubert (below left), SCS District Conservationist for Peoria, described soil conservation practices during a stop in the Senachwine Creek Watershed.

High school students examine water quality data they have collected throughout Illinois as part of the Illinois Rivers Project. Their data are incorporated into SOILNET, a multistate database on water quality. The students were among the two dozen groups that exhibited displays for the conference's poster sessions.

Lt. Governor Bob Kustra (above) announced a new Illinois River Basin Initiative. Joining him were Conservation Director Brent Manning and Agriculture Director Becky Doyle (top right). Lynn Uphoff (right), of the Peoria Convention and Visitors Bureau, described the substantial economic benefits Peoria reaps from hosting the BASSMASTERS Superstars Tournament.

The news media covered many sessions of the conference. Michael Platt, executive director of Heartland Water Resources Council, was interviewed by a reporter at Peoria's NBC-affiliated television station.

Roberta Parks (left), conference co-chair, introduced keynote speakers to the approximately 275 conference participants.

The historic flood of 1993 echoed through all three keynote speeches. Stanley Changnon (above left), a scientist from the Illinois State Water Survey who is serving on a national flood response committee, described the uniquenesses of the flood and its potential for reoccurring. Holly Stoerker, (above right) director of the Upper Mississippi River Basin Association of St. Paul, MN, considered the flood an opportunity to rethink flood policies. Richard Sparks, (left) who has been studying the Illinois River for 21 years at the River Research Laboratory of the Illinois Natural History Survey in Havanna, emphasized the importance of long -term, large-scale planning to restore the health of the river.

Appendix B

Poster Session Participants

The Nature Conservancy, Organizer

Friends of the Chicago River
Heartland Water Resources Council
Illinois-American Water Company
Illinois Department of Energy and Natural Resources
- Groundwater Education
- Illinois Natural History Survey
- Illinois State Water Survey

Illinois Environmental Protection Agency, Division of Water Pollution Control
Illinois' Rivers Project
Nature Conservancy, Illinois Field Office
Peoria Park District and Pleasure Driveway
Prairie Rivers Resource Conservation and Development
University of Illinois
- Cooperative Extension Service
- Illinois-Indiana Sea Grant Program
- Water Resources Center

Tri-County Regional Planning Commission
Tri-County Riverfront Action Forum
Upper Mississippi River Conservation Committee
U.S. Army Corps of Engineers, Rock Island District
U.S. Fish and Wildlife Service
U.S. Geological Survey, Water Resources Division
USDA Soil Conservation Service

Newspaper Clippings

C4 JOURNAL STAR, Peoria, Thursday, September 23, 1993

OUTDOORS

Flooding benefits bass

☐ Early results from annual river monitoring show fish fat, longer

Outdoors

Jack Ehresman

Life on the Mississippi River hasn't been ideal in recent months, but for some species of fish, the floods may have been beneficial. Others, however, may not have fared as well.

Dan Sallee, a department of conservation fisheries biologist involved with the state's stream program, said largemouth bass, sauger and walleye appea[r] ... cellent sp... findings of ... ing studies

"All our ... is done at ... said Sallee ... "We can't ... it's up in ... those area[s] ... for 90 day[s] ... get into o[ur] ... like in norm[al] ...

"It (the ... ping to the ... get some o... and I'm n[ot] ... to comple[te] ... temperatu[re] ... fast."

During 1... of the 1993 ... ence on th[e] ... Illinois Riv[er] ... plained hi... more detai[l] ...

"Everyt[hing] ... timing," h[e] ...

eggs, and the eggs take x-number of days to hatch. They drift in the current then eventually swim into quiet areas for the summer

oughta' be for this time of year. So far, it looks like we've got a good spawn on largemouth bass, but who knows what's gonna' happen this winter?"

Sallee said Butch Atwood, a fellow stream biologist who works the southern half of the state, was finding good spawns there, particularly on white bass and sauger.

"White bass really have me puzzled," Sallee said. "I think we should be seeing a lot of them, because the timing was about right for a good spawn

Floods will rise again next year

Expert: Questions are when? how much? and how bad?

By Tamara L. Aldus
Times staff writer

PEORIA — Stanley A. Changnon doesn't have good news for the flood-ravaged Midwest; he says more flooding is yet to come.

Changnon predicts flooding, most likely next spring, if the Upper Mississippi River Basin sees a week to 10 days of concentrated, heavy rain.

"You just can't get away from it," said Changnon, Illinois State Water Survey chief emeritus and the only Illi-

Floods

Continued from page A1

Changnon said, including the timing and the duration of the flooding where flood stages were exceeded for 30 to 80 days.

He said historical weather records show only 1902-03 had wet soil conditions similar to those seen in 1992-93.

"The May-August rainfall amount is unmatched in the historical records in the central United States," he said.

Illinois saw 22.9 inches of rain between April and June — something that is expected to happen every 45 years. From June to July, he said, the state got 14.7 inches, which occurs about 85 years.

The U.S. Weather Service says the 90-day outlook is normal to above normal rainfall for the central United States. The area already has seen above average rain for September, Changnon said.

He predicted the floods will become known as the worst weather disaster in this country's history; more homes were lost to flooding than to Hurricane Andrew in Florida.

Preserve river system: scientist

By ELAINE HOPKINS
of the Journal Star

If we want to save the Illinois River system for posterity, we should think like the Egyptians.

That's because both the Nile River in Egypt and the Illinois River are actually flood plain-river ecosystems, a river scientist said here Tuesday.

The Egyptians lived in harmony with their river system for 3,000 years, Richard Sparks told the Governors Conference on the Management of the Illinois River System.

tampered with the Illinois River system, one of the few flood plain-river systems in the U.S. As a result, the system is threatened with losing its biodiversity from habitat loss, Sparks said.

The river flood plain and lakes are one system, linked by flooding, he said. High water provides access to spawning areas for fish. Low water compresses fish, which can be consumed by other creatures such as migratory waterfowl. Thus both land and aquatic animals share the flood plain, making it highly productive. "Every point

means it must be preserved by setting aside prime areas, he said. Conservation of the system will require developing sustainable uses, and restoration as much as possible also is needed to reverse the losses.

The river system's biodiversity is its most important resource, Sparks said. In the future, biochemical prospecting from river resources could yield rich rewards, he said.

Even the much-maligned zebra mussel, considered a pest, possesses an amazing ability to glue itself, underwater, to boats, pipes and other animals. Then it can "unglue it-

Flood of '93 may spill into '94

☐ Meteorologist claims saturation this summer will pose some problems for farmers in the spring

By DAVID MOLL
of the Journal Star

The Great Flood of '93 isn't finished with the Midwest yet, a meteorologist serving on a national task force said Tuesday.

More flooding, though not in the same proportions, is almost

Students adopt town hit hard by floods

Students at Peoria High School have adopted the rain-drenched Henderson County community of Carman.

Student Activity Panel adviser Jan Furr said Tuesday that Peoria Charter Coach has agreed to transport at no charge a busload of Peoria High students to Carman on Oct. 4. The group will be bringing with them cleaning supplies, food and money they plan to collect next week. They also will tour the community and talk with flood victims.

According to Furr, the school plans additional fund-raising for Carman after their visit. The trip is aimed at helping students to understand who they are helping and what their efforts mean.

"The kids need that concrete connection," she said.

Balance sought in Illinois River projects

☐ 1993 floods focus new attention on improvement plans

By ELAINE HOPKINS
of the Journal Star

Whether we admit it or not, "we have a multipurpose river system," Holly Stoerker told the Governor's Conference on the Management of the Illinois River System on Wednesday.

Plans for the Illinois River, which is a part of the larger Mississippi River system, could strike a balance between navigation, recreation and environmental interests, said Stoerker, who gave the wrap-up speech at the three-day event. She is executive director of the Upper Mississippi River Basin Association of Saint Paul, Minn.

Funds invested in one aspect of the river, such as navigation, could also be used to promote a healthy, diverse ecosystem, Stoerker said.

The 1993 flood has focused attention on the river system and provided opportunities to improve it, she said. Federal legislation such as the reauthorization of the Clean Water Act could include funds for watershed management and wetlands protection. "Look at legislation and see how it applies to your area," she advised conference goers.

Other speakers discussed environmental problems in the Illinois River, from extinction of species to pesticide contamination. For years the river was treated as a residential and industrial sewer, said Craig Colten of the Illinois State Museum in a historical look at river problems. Progress in ending this pollution has been made, but more is needed.

Pesticides are showing up in surface water supplies throughout Illinois, said A. G. Taylor of the Illinois Environmental Protection Agency. Atrazine has been found in 88 percent of public water supplies, and in 10 supplies is over the federal standard.

Nitrogen from farm fertilizer also is a problem, said Dave Kovacic of the Illinois Natural History Survey.

Natural solutions to sediment and pesticide problems include raparian areas of forest and grassland alongside rivers and streams which catch sediment and filter pollutants, Kovacic said.

Wetland buffers should catch water from drain tiles in fields, he said. One acre of wetland is needed for every 20 to 40 acres of farmland.

On Tuesday, two members of the Illinois House expressed interest in river projects and suggested that taxing the "inevitable" Chicago gambling boats could provide funding. Otherwise, "user fees" instead of taxes might be the only source of money, they said.

"We need to identify a very specific program," said Rep. Dave Leitch, R-Peoria. He urged the audience to get to know members of the General Assembly. "We pay a whole lot more attention to what people we know in our districts say to us," he said.

"Lobbying makes democracy work," said Phil Novak, D-Kankakee, who chairs the House environmental committee. "Let us hear from you."

Appendix D

Participants

Adams, Audrey
Peoria Notre Dame High School

Adams, Pat
Champaign County Soil & Water Conservation District

Adams, Sam
Champaign County Soil & Water Conservation District

Alexander, Sue
Heartland Water Resources Council

Andrews, Allen H.
Illinois Valley Yacht & Canoe Club

Atherton, Sue
Illinoia-American Water Company

Austin, Tom
USDA-ASCS

Baldwin, Jim
Caterpillar Inc.

Ballowe, James
Bradley University

Ballowe, Ruth
The Nature Conservancy

Barbieur, Jeanne
The Nature Conservancy

Bean, George
TCI Cablevision

Bell, Peter G.
Environmental Science & Engineering, Inc.

Bennett, Nancy
Kane-DuPage Soil & Water Conservation District

Bersin, Stanley
Daily & Associates, Inc.

Bertrand, Bill
Illinois Department of Conservation

Bhowmik, Nani
Illinois State Water Survey

Bidlack, Cindy
Illinois Rivers Project

Blanchard, Steve
U.S. Geological Survey

Blodgett, Doug
Illinois Natural History Survey

Bogner, Bill
Illinois State Water Survey

Bolker, Michelle
Bradley University

Bornstein, Michael
U.S. Fish & Wildlife Service

Boruff, Chet
Illinois Department of Agriculture

Boyle, John
Tri County Regional Planning Commission

Britton, Ed
US Fish & Wildlife Service

Bromberg, Mel
University of Illinois Cooperative Extension Service

Brown, Judy
Washington High School

Bruyn, Rodger
Bureau County Farm Bureau

Burhans, Robert
Clark Engineers MW

Butts, Tom
Illinois State Water Survey

Byrns, Bill
Alliance to Restore the Kankakee River

Carey, Debra
Dixon Park District

Carlson, Bruce
St. Paul District of the U.S. Army Corps of Engineers

Carpenter, Jan
Illinois Environmental Protection Agency

Cender, Mark
Champaign County Soil & Water Conservation District

Changnon, Stanley
Illinois State Water Survey

Cima, John
Environmental Science & Engineering, Inc.

Clark, Gary
Illinois Department of Transportation Division of Water Resources

Coari, Marie
Colten, Craig
Illinois State Museum

Comerio, John
Illinois Department of Conservation

Condit, Don
Marshall-Putnam Soil & Water Conservation District

Cordero, Ramiro
USDA Soil Conservation Service

Crank, Chris
Mid County Varna High School

Crawford, Russ
Tri County Regional Planning Commission

Cummings, Kevin
Illinois Natural History Survey

Curtiss, Dana
ENR/RiverWatch Network

Delaney, Robert
U.S. Fish & Wildlife Service

Demissie, Misganaw
Illinois State Water Survey

Donels, Bill
Illinois Department of Conservation

Donohue, Terry
Illinois Department of Agriculture

Doyle, Becky
Illinois Department of Agriculture

Dreher, Dennis
Northeastern Illinois Planning Commission

Edwards, Randy
Marshall-Putnam Soil Conservation Service

Ehnle, Kurt
Soil & Water Conservation District

Ellestad, Jill
Environmental Science & Engineering, Inc.

Engelke, Russ
U.S. Fish & Wildlife Service

Eppley, Mike
Illinois Environmental Protection Agency

Erickson, Nancy
Illinois Farm Bureau

Everetts, Chris
Environmental Science & Engineering, Inc.

Fandel, Pete
University of Illinois Cooperative Extension Service

Fehr, Doug
Heartland Farm Bureau

Fennessy, Erin
Mid County Varna High School

Fillipini, Gena
Peoria Chamber of Commerce Intern

Frank, Steve
Illinois Department of Conservation

Frazee, Robert
University of Illinois Cooperative Extension Service

Fuller, Carol

Gates, Dave
St. Louis District U.S. Corps of Engineers

Gebbink, Ginnie
Elmwood High School

Gill, Cliff
Peoria County Soil & Water Conservation District

Girard, Tanner
Illinois Pollution Control

Goettel, Robin
Illinois/Indiana Sea Grant

Goff, Jerry
Daily & Associates, Inc.

Goodner, Dale
Peoria Park District/Pleasure Driveway

Greer, Mark
East Peoria High School

Grosboll, Allen
Office of the Governor

Haake, Ambra
Washington High School

Hamer, Steve
Illinois Department of Conservation

Hamilton, Tony
Illinois Department of Agriculture

Hammer, Ed
US Environmental Protection Agency Region 5

Hammond, Dave
Peoria Chamber of Commerce

Hart, Greg
Elmwood High School

Hart, Jim
Illinois Department of Conservation

Hendrickson, Harry
Illinois Department of Energy & Natural Resources

Herkert, Jim
Endangered Species Board

Hilsabeck, Rob
Illinois State Water Survey

Hirschi, Mike
University of IL Dept. of Agricultural Engineering

Hoben, Caroline
Knox County Soil & Water Conservation District

Hubbert, Jon
USDA Soil Conservation Service

Huggins, Jack
Pekin Energy Co.

Hullinger, David
Illinois State Water Survey

Jacobs, Bob
A.D.M.

Jeffords, Michael
Illinois Natural History Survey

Johnson, Chris
Peoria Notre Dame High School

Kammueller, Jim
Illinois Environmental Protection Agency

Illinois State Water Survey
Kendall, Chris
Stark County Farm Bureau

Kennedy, Sharon
Peoria County Board

Ketter, Jill
Marshall/Putnam Soil & Water Conservation District

Kietzman, Jane
Champaign County Soil & Water Conservation District

Kirkeeng-Kincaid, Teresa
Rock Island District US Corps of Engineers

Kirkland, Tom
Elan Engineering Co.

Kitchen-Maran, Kay
USDA Soil Conservation Service

Klein, Mike
Mid County Varna High School

Knapp, Vern
Illinois State Water Survey

Koehler, David
City of Peoria

Korab, Holly
University of Illinois Institute for Environmental Studies

Kovacic, David
University of Illinois Department of Landscape Architecture

Kraft, Jackie
McLean County Soil & Water Conservation District

Kramer, Gary L.
Caterpillar Inc.

Kraus, Al
Rock Island District U.S. Corps of Engineers

Kubillus, Sandy
Northeastern Illinois University

Kustra, Bob
Lieutenant Governor

LaFollett, Carrie
Elmwood High School

Lambie, Peter
Woodford County Board

Legaspi, Anthony
Peoria Notre Dame High School

Leitch, David
Representative 93rd District

Lerczak, Thomas

Leyland, John

Leyland, Marilyn
Caterpillar Inc.

Lutz, Richard W.
Illinois Department of Conservation

Mahnsmith, Roy

Manning, Brent
Illinois Department of Conservation

Martino, Maggie
City of Peoria

Massey, Jack
Illinois Rivers Project

Mathis, Bill
Bradley University

Matousek, David
Peoria Notre Dame High School

Mazur, Daniel
US Environmental Protection Agency Region 5

McCann, Shawn
Peoria Notre Dame High School

McQuilkin, Jane
Mid County Varna High School

Meinen, Don
City of Pekin

Meyer, Gary
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