Minnesota Dept. of Natural Resources, 2003 b.

Endangered, Threatened, and Special Concern Species of Minnesota

Bald Eagle

(*Haliaeetus leucocephalus*)

Minnesota Status:	Special Concern	State rank[1]:	S3
Federal Status:	Threatened	Global Rank[1]:	G4

HABITAT

During the breeding season, the Bald Eagle typically inhabits forests near lakes and rivers where large trees are available for nesting. The nest trees are usually within 1 mile of water, and are often closer. In northern Minnesota, red or white pines in the supercanopy (taller than the surrounding forest) are often selected as nest trees, whereas in the central and southern part of the state, eagles choose large hardwoods such as aspen or cottonwood. In winter, Bald Eagles can be found in upland areas where game or carrion is available. However, it is most common for them to congregate along major rivers where open water remains (such as near dams or power plants), as these areas provide opportunities for obtaining their major food items, fish and waterfowl.

LIFE HISTORY

For the purpose of assessing the impacts of human activity on Bald Eagles, the nesting period can be broken into four segments, as detailed in the following table. The "wintering" season for Bald Eagles varies by latitude, but can generally be considered to be October 15th through March 15th (a period which includes spring and fall migration).

Nesting Period Segment	Dates for	
	Northern Minnesota*	Southern Minnesota*
Critical - Eagles are involved with courtship, egg-laying, and incubation.	March 15th - May 15th	Feb. 10th - May 1st
Moderately critical - Eagles are becoming physiologically conditioned for breeding (February/March), or newly hatched chicks require frequent brooding and feeding (May/June).	Feb. 15th - March 15th *and* May 15th - June 15th	Jan. 10th - Feb. 10th *and* May 1st - June 1st
Less critical - Eagle chicks are one month old to 1 week post-fledging.	June 15th - Aug. 15th	June 1st - July 31st
Non-critical - Most eagles are not regularly present at the nest site.	Aug. 15th - Feb. 15th	July 31st - Jan. 10th

*The state is arbitrarily divided into north and south by State Highway 210.

IMPACTS / THREATS / CAUSES OF DECLINE

- habitat loss
- human disturbance
- farm runoff and industrial pollution
- leg-hold traps
- management activities such as timber harvest and burning
- power lines and transmission structures (collisions, electrocutions)
- roads and bridges (vehicle collisions)
- lead poisoning (e.g. by lead shot ingested by eagles during feeding)
- shooting (in violation of state and federal law)
- contaminants and poisons (particularly organochlorine, organophosphorus, mercury and other heavy metals)

PROTECTION

Bald Eagles are protected under the Migratory Bird Treaty Act, and under the Bald and Golden Eagle Protection Act of 1940 and the Endangered Species Act of 1973, as amended, which prohibit the possession or taking of Bald Eagles, or their nests, eggs, or young. "Taking" is defined by the Endangered Species Act as to harass (i.e., create the likelihood of injury), harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect, or to attempt to engage in any such conduct. Prohibited activities include, for example, cutting down nest trees (at any time of the year), and intense human activity that is demonstrated to have caused adult eagles to abandon eggs or young in the nest. Possession permits may be issued by the U.S. Fish & Wildlife Service for Indian religious purposes, or for scientific or exhibition purposes of public museums, public scientific societies, or public zoological parks.

In addition, the National and Minnesota Environmental Protection Acts prevent certain actions which would cause significant adverse impacts to the environment (including destruction of habitat for listed species) if there is a reasonable alternative to the proposed action.

If you are uncertain whether a proposed action may take Bald Eagles or their nests, or if you for any reason cannot follow the recommendations below, contact USFWS Ecological Services at (612) 725-3548.

RECOMMENDATIONS FOR AVOIDING AND MINIMIZING IMPACTS

These recommendations will be useful in avoiding or minimizing effects that may be caused by federal or non-federal actions, but ***all federal actions that may affect bald eagles must also complete consultation with U.S. Fish and Wildlife Service*** *under section 7 of the Endangered Species Act. A federal action is any action that a federal agency funds, authorizes, or carries out. Contact the U.S. Fish and Wildlife Service at (612) 725-3548 for further information regarding section 7 consultation.*

WINTERING AREAS[2]

Bald Eagle wintering area habitat contains three main components: foraging (feeding) areas, daytime perching areas, and night roosts. Within these areas, eagles need to be protected from human disturbance, physical alterations of their habitat, environmental contaminants, and loss of food resources.

Foraging and Daytime Perching Areas: In Minnesota, winter foraging areas where Bald Eagles congregate are located primarily along major rivers. Daytime perches tend to be near these foraging areas. While eagles are present, buffer zones (areas within which there is no human activity) of at least 1/4 mile (400m) should be maintained around foraging areas where possible. Where this is impractical, human use should be avoided between sunrise and 10am, when Bald Eagle feeding activity is greatest. Buffer zones around daytime perches should be 1/8 to 1/4 mile (250m-400m). At foraging areas along rivers, trees within 100 ft. of the shore seem to be preferred as perches. Therefore, no trees greater than 12 in. diameter should be removed within 100 ft. (33m) of river banks or other foraging areas. Activities which have the potential to kill trees (such as livestock grazing and dumping of dredge spoil) should be avoided within foraging and perching areas. New road and bridge construction should be at least 2 mile from major foraging areas.

Night Roosts: Bald Eagles are more sensitive to disturbance at night roosts than at foraging and daytime perching areas. No logging, development, or road building should occur at any time in critical roosts. Critical roosts are defined as those used more than 14 nights per season by eagles from local breeding territories *or* more than 14 nights per season by more than 15 eagles *or* roosts which have been documented as active for 5 years or longer. A buffer zone of at least 1/4 mile (400m) should be maintained around night roosts, within which both low and high impact activities, including recreation, are restricted while the roost is in use. New road or bridge construction should be at least 1/5 mile from critical roosts.

NESTING AREAS

Studies show that Bald Eagles are vulnerable to human intrusion. The vulnerability varies with the type of disturbance and the particular eagle, as some individuals have become accustomed to human activity near their nests. However, because some eagles are easily disturbed, human contact with Bald Eagles should be avoided whenever possible, particularly during the critical segment of the nesting period. The following table, adapted from the Minnesota Department of Natural Resources (DNR) Management Guidelines for Bald Eagle Breeding Areas, and the Northern States Bald Eagle Recovery Plan, summarizes recommendations for protecting individual occupied and active nest sites.

If a nest is not occupied during the year in which the activity will occur, the recommendations for the Non-critical Nesting Period Segment may be used year-round. If a nest is abandoned (unused for more than 5 years and not being maintained by eagles), activities are only restricted within the Primary Zone. Whether a nest is occupied, unoccupied, or abandoned must be determined in consultation with a DNR Nongame Specialist (see contact numbers below the table) and the U.S. Fish and Wildlife Service (612-725-3548). Because eagles often rebuild nests that have been blown out of trees, in this situation activities are restricted within the Primary Zone for 3 years after the event. If the nest is not rebuilt, zone restrictions are removed.

Activity	Nesting Period Segment			
	Critical	Moderately	Less Critical	Non-critical
Primary Zone: (within 330 feet of the nest)				
Landscape Alteration[a]	avoid	avoid	avoid	avoid[b]
Construction (structures, trails, etc.)[c]	avoid	avoid	avoid	avoid[b]
Burning[d]	avoid	avoid	avoid	restrict/minimize[b]
Minor Forest Maintenance[e]	avoid	avoid	avoid	restrict/minimize[b]
Motorized Access	avoid[f]	avoid[f]	restrict/minimize[b]	restrict/minimize[b]
Human Entry	avoid[f]	avoid[f]	restrict/minimize[b]	restrict/minimize[b]
Low Flying Aircraft	avoid	avoid	no restrictions	no restrictions
Secondary Zone: (330 to 660 feet from the nest)				
Landscape Alteration[a]	avoid	avoid	avoid	restrict/minimize[b]
Construction (structures, trails, etc.)	avoid	avoid	restrict/minimize[b]	restrict/minimize[b]
Burning[d]	avoid	avoid	avoid	restrict/minimize[b]
Minor Forest Maintenance	avoid	avoid	no restrictions[f]	no restrictions[g]
Motorized Access	avoid[f]	restrict/minimize[b]	restrict/minimize[b]	no restrictions[g]
Human Entry	avoid[f]	restrict/minimize[b]	restrict/minimize[b]	no restrictions
Low Flying Aircraft	avoid	restrict/minimize[b]	no restrictions	no restrictions
Tertiary Zone: (660 feet to 1/4 mile from the nest - May extend up to 2 mile from the nest, if topography or vegetation permit a direct line of sight to the disturbance area.)				
Landscape Alteration[a]	avoid	avoid	avoid	no restrictions[g]
Burning[d]	avoid	avoid	avoid	restrict/minimize[b]
Other Activities (as listed above)	avoid[f]	no restrictions[g]	no restrictions[g]	no restrictions[g]

[a] Landscape alteration includes activities such as clear cutting or land clearing, which result in significant changes in the landscape.
[b] Restrictions should be decided on a case by case basis, based on type, extent, and duration of proposed activity, and sensitivity of individual eagle pairs. For assistance, contact your nearest DNR Nongame Specialist: Bemidji (218-755-2976); Grand Rapids (218-327-4267); Brainerd (218-828-2228); New Ulm (507-359-6033); Rochester (507-280-5070); St. Paul (651-259-5110).
[c] For construction involving land clearing, see also recommendations for the "Landscape Alteration" activity.
[d] *If burning can not be done within the non-critical nesting period segment, please contact your nearest DNR Nongame Specialist* (see contact numbers above).
[e] Such as thinning of tree stands, pruning, and other like maintenance.
[f] Some eagles have become habituated to human activity and can be tolerant of these activities, particularly if they were occurring regularly at the time the eagles began nesting. In these cases, complete avoidance of the activity may not be necessary. If you believe this is the case in your particular situation, contact your nearest Nongame Specialist (see contact numbers above).
[g] However, the habitat should not be altered in ways that would make it unsuitable for future nesting.

REFERENCES

[1]Association for Biodiversity Information. "Heritage Status: Global, National, and Subnational Conservation Status Ranks." NatureServe. Version 1.3 (9 April 2001). http://www.natureserve.org/ranking.htm (15 April 2001).

Coffin, B., and L. Pfannmuller. 1988. Minnesota's Endangered Flora and Fauna. University of Minnesota Press, Minneapolis, 473 pp.

Grier, J. W., J. B. Elder, F. J. Gramlich, N. F. Green, J. V. Kussman, J. E. Mathisen, and J. P. Mattsson. 1983. Northern States Bald Eagle Recovery Plan. U. S. Fish and Wildlife Service. 76 pages +appendices.

[2]Martell, M. 1992. Bald Eagle Winter Management Guidelines. Unpublished brochure, The Raptor Center, University of Minnesota, St. Paul, unpaged. August.

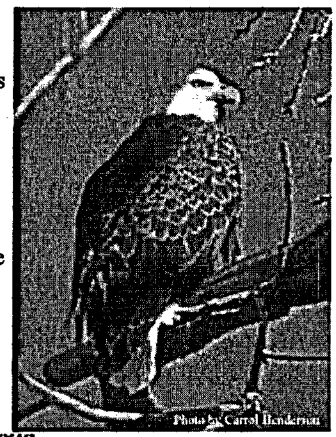
Minnesota Department of Natural Resources, 2004.

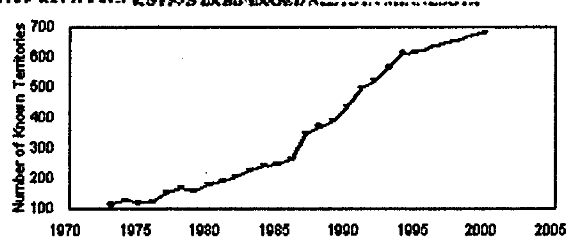
2000 Minnesota bald eagle survey

by Richard Baker, Joan Galli, and Sharron Nelson
Nongame Wildlife Program, Minnesota Dept. of Natural Resources
December 2000

Introduction

The Bald Eagle (*Haliaeetus leucocephalus*), our national symbol, has long been a valued component of Minnesota's wildlife. The state's first bald eagle survey (1973), conducted while the species was in the midst of a severe population decline due to the effects of environmental contaminants, found 115 active nests. Following the bald eagle's protection as a threatened species under the federal Endangered Species Act in 1978, a federal recovery team established a goal for Minnesota of 300 active breeding territories by 2000. This goal was reached in 1987. The Minnesota Department of Natural Resources (DNR) conducted statewide bald eagle surveys annually between 1973 and 1995. These surveys indicated that Minnesota's eagle population experienced a dramatic and ongoing recovery during that period.





In 1999, the U.S. Fish and Wildlife Service proposed to remove the bald eagle from protection under the federal Endangered Species Act. In preparation for this action, the DNR's Nongame Wildlife Program conducted a statewide bald eagle survey during the 2000 nesting season. The survey was designed to visit all known nests, provide a baseline for monitoring the state's bald eagle population in the future, and clarify current habitat needs of the species.

Methods and Results

The DNR began the 2000 bald eagle survey by soliciting reports of eagle nests from natural resource professionals and the public. These reports were combined with previously known nest locations to identify the areas to be searched during the 2000 survey. Surveys were conducted from small aircraft by Minnesota DNR, U.S. Forest Service, U.S. Fish and Wildlife Service, National Park Service, and tribal biologists. In late March and April, observers flew over known nesting areas to determine whether or not eagles were present. Over 1,300 known breeding areas were surveyed to evaluate activity, and 681 occupied breeding areas were identified. A second flight was conducted in June to count the number of nestlings in active nests. In 2000, the DNR chose to reduce costs by assessing reproduction at a portion of occupied breeding areas,

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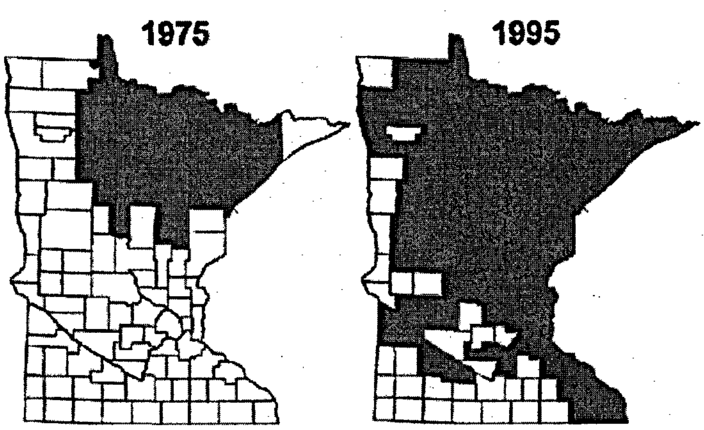
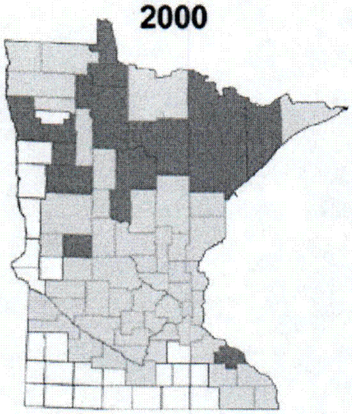
representing a range of ownerships and land uses. In all, surveyors obtained counts of young at 413 nests. The number of young per nest averaged 1.22 for all nests visited during the June flights, but this figure ranged widely for different areas of the state. For example, while 8 nests within the Minnesota portion of the Upper Mississippi National Wildlife & Fish Refuge produced an average of 0.87 young per nest, refuge-wide production from 84 active nests averaged 1.28 young per nest. The percent of active nests with any young was less variable, ranging from 69.9% to 100.0%, and averaging 76.5% statewide.

SURVEY RESULTS

		NESTS WITH KNOWN OUTCOMES			
	Total occupied breeding areas	Total active nests surveyed	Total young	Average young per active nest	% of nests with young
Major federal land units					
Chippewa National Forest	143	130	130	1.00	70.8%
Superior National Forest	78	73	89	1.22	69.8%
Tamarac National Wildlife Refuge	21	21	25	1.19	76.2%
Upper Miss. National Wild & Fish Refuge	15	8	7	0.87	75.0%
Voyageurs National Park	25	25	25	1.00	76.0%
Surveyed lands outside of major federal land units					
Northwest Minnesota	110	18	29	1.61	88.9%
Northeast Minnesota	56	35	49	1.40	91.4%
Central Minnesota	148	33	44	1.33	72.7%
Southwest Minnesota	30	30	46	1.53	80.0%
Southeast Minnesota	20	13	19	1.46	100.0%
Twin Cities Metro	35	27	41	1.52	85.2%
STATEWIDE TOTALS	681	410	504	1.23	76.5%

Counties with Active Bald Eagle Nests





Conclusions

The 2000 Minnesota Bald Eagle Survey documents the continuing recovery of the species within the state, and provides a baseline for population monitoring into the next millennium. Because the survey was largely limited to known nests, the results describe the minimum number of nests within the state. There are undoubtedly additional nests that have never been reported to the DNR, especially in the more remote and less visited regions of the state, and for eagles using 'atypical' habitat. The DNR will continue to record reports of bald eagle nests in preparation for future surveys.

As expected, growth of the state's bald eagle population appears to be slowing, but remains at a healthy level. As illustrated above, a comparison of 1995 and 2000 survey results indicates that bald eagles are slowly expanding into the southern and western portions of the state, where prime bald eagle habitat (large areas of forest near open water) is scarce, but critical habitat components (large trees for nesting; open water for foraging) are available. At the same time, the number of nests and reproductive success of eagles appears to be dropping in the forested region that provided a refuge for eagles in the 1970s. Due to the extraordinary efforts of Chippewa National Forest biologists over the years, data for that prime bald eagle habitat area provide a particularly complete example of this.

CHIPPEWA NATIONAL FOREST

	Total active nests	Ave. young per nest
1990	154	1.56
1994	188	1.57
2000	143	1.00

The observed decline in nest numbers and reproductive success in the forested region's prime habitat may indicate that available habitat in that region has reached its capacity to support eagles. Those eagles remaining in this densely populated region may need to expend more energy competing with other eagles, leaving less time for feeding young, and resulting in lower reproductive success. This observed decline may also be due, in part, to recent landscape-scale blow-downs of large trees in the region. This loss of nest trees may have displaced many eagles to locations that have yet to be found or are supporting less successful nests.

In cooperation with the U.S. Fish and Wildlife Service and Dr. James Grier, an eagle expert at North Dakota State University, the DNR will be using the 2000 Minnesota Bald Eagle Survey results to characterize bald eagle habitat in Minnesota, and to study the relationship of human disturbance to the reproductive success of eagles. These studies will provide information critical to the sustainable management of the state's bald eagle population.

CO1

Minnesota's bald eagle population appears large, healthy, and expanding as the new millennium begins. All indications are that more and more Minnesotans will be enjoying the awesome experience of watching an eagle soaring gracefully overhead. However, this prediction relies on the continued vigilance of every citizen in respecting bald eagles, protecting eagle habitat, and avoiding excessive disturbance to eagle nests. Only with this attention can Minnesotans insure that their children and grandchildren will have the pleasure of sharing their world with this magnificent bird.

The 2000 Minnesota Bald Eagle Survey was funded by Minnesotans who purchase Conservation License Plates for their automobiles, contributions to the Nongame Checkoff on state tax forms, and a grant from the U.S. Fish and Wildlife Service.

For more information on the 2000 Minnesota Bald Eagle Survey, where to see eagles in Minnesota, or to report sightings of nests, please contact the Minnesota Department of Natural Resources' Nongame Wildlife Program at: 888/646-6367 (toll-free) or 651/259-5122; 500 Lafayette Rd., Box 25, St. Paul, MN 55155-4025

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Archived Information

Below is information about the Eastern Distinct Population Segment which was established by the Final Rule to Reclassify and Delist the Gray Wolf in Portions of the United States that was published in the Federal Register on April 1, 2003. However, on January 31, 2005, a U.S. District Court in Portland, Oregon vacated and enjoined that Rule. Therefore, the Service currently considers the gray wolf to have reverted back to the ESA status that existed prior to the 2003 reclassification, and the information about the Eastern DPS is no longer valid.

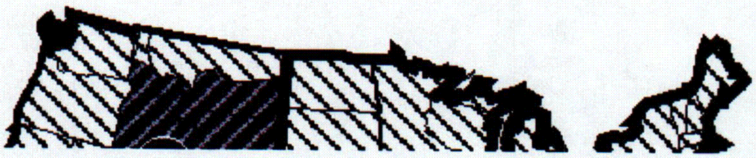
Gray Wolf Eastern Distinct Population Segment What It's All About

PDF Version

In 2003 the U.S. Fish and Wildlife Service changed the classification of the gray wolf (*Canis lupus*) under the Endangered Species Act (ESA). As a result of that change there are now three separate ESA listings for the species which correspond to three geographic areas in the lower 48 states where there are ongoing gray wolf recovery programs. In the eastern and western U.S., wolves were reclassified from endangered to threatened because wolf recovery programs are nearing their recovery goals. The definition of "threatened" is "likely to be on the brink of extinction in the foreseeable future," and is a more appropriate classification than "endangered" because those recovery programs have succeeded in reducing threats to gray wolves and increasing their numbers and range in the eastern and western U.S. This change to "threatened" status allowed Federal protections to be relaxed in those areas. In the Southwest, where gray wolf recovery is in the early stages, wolves remain classified as endangered. "Endangered" means they are on the brink of extinction.

To reclassify wolves in the eastern and western U.S. from endangered to threatened we listed the geographic areas where there are ongoing gray wolf recovery programs as Distinct Population Segments (DPS). The map below shows the areas included in the Eastern Gray Wolf DPS, the Western Gray Wolf DPS, and the Southwestern Gray Wolf DPS, where the gray wolf continues to be listed as endangered.

Status of the Gray Wolf in the Contiguous U.S.
April 2003



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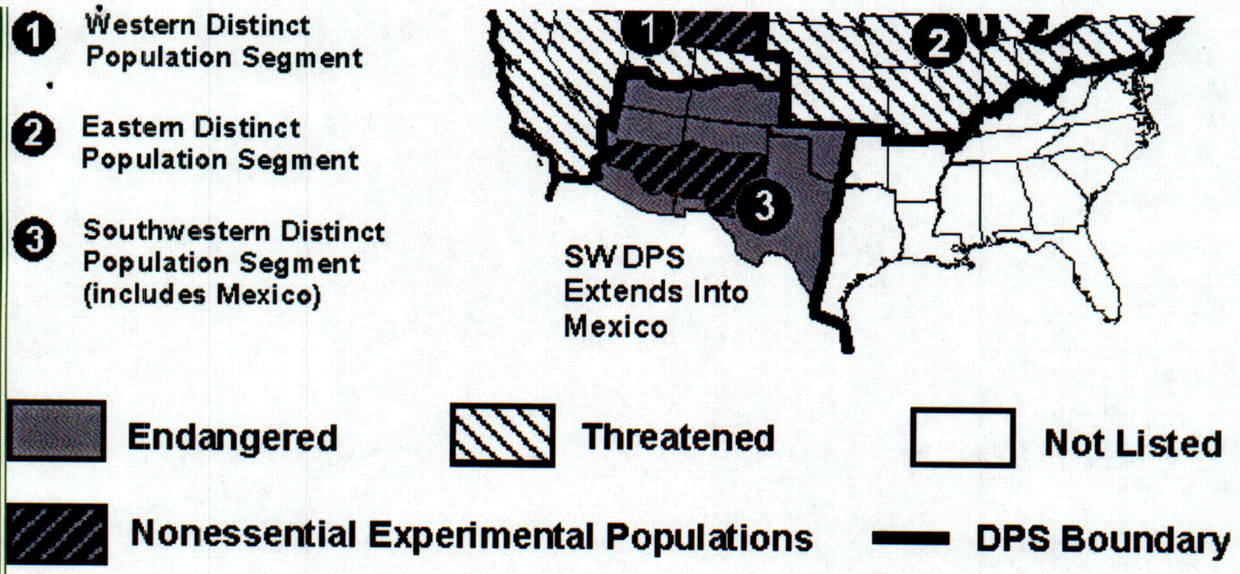

Eastern Distinct Population Segment

A Distinct Population Segment is one of several ways we can list animals as threatened or endangered. Under the ESA, the Eastern Gray Wolf DPS is treated like a species that is listed. A DPS listing differs from a species listing only in that it is usually described geographically rather than biologically. The Eastern DPS is made up of 21 states in the North Central and Northeastern U.S.

Recovery Actions in the Eastern Distinct Population Segment

A Distinct Population Segment is a listed entity, like a species or subspecies listing; it is not a recovery program. The recovery program for gray wolves in the eastern United States has been directed by the Recovery Plan for the Eastern Timber Wolf (Plan), which was prepared in 1978 and revised in 1992. The listing of the Eastern Gray Wolf DPS will not change the scope of that ongoing recovery program, and that Plan will continue to guide our wolf recovery efforts. Our recovery goal for restoring gray wolves in the eastern U.S. is being achieved by the expanding wolf populations in Minnesota, Wisconsin, and Michigan. At this time, we have no plans to restore gray wolves elsewhere in the Eastern United States. There is, however, a separate recovery program for the red wolf - another species of wolf - in the southeastern U.S. The red wolf recovery program is not within the area of the Eastern Gray Wolf DPS.

Because there is no firm evidence that a wolf population exists in the northeastern U.S., we cannot list that geographic area as a separate DPS. Instead, the Northeast is part of the Eastern DPS. Additionally, there is conflicting scientific evidence regarding the wolf species that historically lived in the northeastern states. Until we know which species of wolf occurred there, we cannot take any additional steps in planning wolf recovery in the Northeast. When the identity of the historical northeastern wolf has been determined, we will consider whether it warrants protection under the Endangered Species Act, and whether we should begin a Federal program to restore it.

Delisting the Gray Wolf in the Eastern DPS

Now that gray wolves in the Eastern DPS have been reclassified from endangered to threatened, we will consider whether they should be delisted, that is, totally removed from the protections of the ESA. The purpose of the ESA is to avoid the extinction of species; it is not intended to provide routine long-term management and protection to species that are not imperiled. The ESA provides emergency treatment; when the emergency is over the species no longer needs ESA protection and should be delisted so we can focus our efforts on other imperiled species. We believe that gray wolves in the Eastern DPS may no longer need ESA protection. Gray wolf numbers have already exceeded the numerical goals of the Recovery Plan for the Eastern Timber Wolf. We also need to evaluate the threats that will be faced by these gray wolves if Federal protection is removed. If we propose delisting the Eastern DPS, we will publicize the proposal, conduct public hearings, and open a lengthy public comment period before making a final decision. If the Eastern DPS is delisted, wolf protection and management would then be directed by State and Tribal wolf management plans and regulations.

Depending on the information that we have at that time about wolves in the Northeast, we will decide if those states should be included in a proposal to delist the gray wolf.

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Current Endangered Species Act Protections for Gray Wolves in the Eastern DPS

Gray wolves are now listed as "threatened" throughout the entire Eastern DPS. Threatened wolves are still protected by the Act. Federal penalties (fines and imprisonment) still apply to illegally killing or harming threatened wolves. Federal agencies must continue to consult with us on their actions that might affect wolves.

The Fish and Wildlife Service can grant permits for taking threatened wolves for a wider range of conservation-oriented purposes.

Gray wolves in Minnesota were reclassified from endangered to threatened in 1978; they retain that threatened classification.

Gray wolves in 11 states within the Eastern DPS are now subject to a special regulation under section 4(d) of the Act. These are the Eastern DPS states that are west of Pennsylvania, but excluding Minnesota. Under this special regulation:

> State and Tribal natural resource agencies can kill wolves that have killed or attacked domestic animals, if there is a likelihood of repeated depredations.
>
> Tribes can salvage dead wolves for traditional cultural use without a Federal permit.
>
> A very similar, pre-existing special regulation for depredation control remains in effect for Minnesota.

How the Reclassification from Endangered to Threatened Affects People in the Eastern DPS

The Endangered Species Act allows anyone to kill an endangered or threatened wolf in self-defense or to defend the life of another person. In addition, any State or Tribal wildlife management agency, or any Federal land management agency can kill a wolf that is a non-immediate threat to human safety. These provisions continue to apply now that wolves are listed as threatened.

A "section 4(d) Special Regulation" that allows State, Tribal, or Federal agents to kill or capture wolves that depredate on livestock and other domestic animals was enacted at the same time that the wolf was reclassified from endangered to threatened. (The 4(d) Special Regulation is described in the previous section). If you are having problems or expect problems, use the numbers below to contact U.S.D.A. APHIS/Wildlife Services, the State natural resources agency, or the U.S. Fish and Wildlife Service for help. If on Tribal land, the appropriate Tribal agency should be contacted. This previously was allowed only for wolves in most of Minnesota, but it now applies throughout most of the Eastern DPS. This provision does not apply to the northeastern corner of Minnesota, nor to the Northeastern states.

For more information on the Eastern Gray Wolf DPS, dealing with depredating wolves, state wolf management plans, or for links to information for other wolf recovery programs, go to:
http://midwest.fws.gov/wolf

To report wolves that are killing livestock or are behaving aggressively contact:
Michigan - Report All Poachers (RAP) line - 1-800-292-7800
Minnesota - USDA/APHIS/Wildlife Services 218-327-3350
U.S. Fish and Wildlife Service 612-725-3548
Wisconsin - Department of Natural Resources 715-762-4684 ext.107

April 2003

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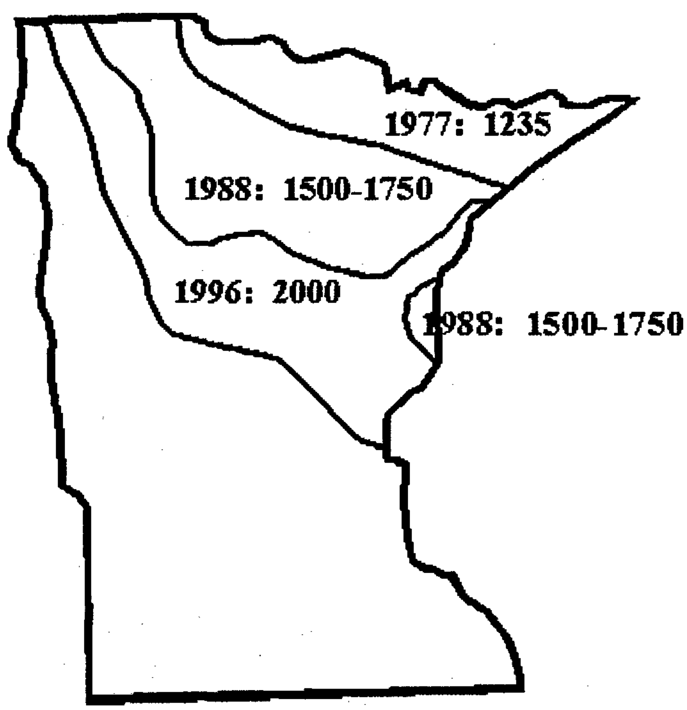
Gray Wolf Range Expansion in Minnesota



This map shows the expansion of gray wolf range in Minnesota over time. The first number is the year and the second number is the estimated gray wolf population at that time.

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Gray Wolf Recovery in Minnesota, Wisconsin, and Michigan

PDF Version

All of Minnesota, Wisconsin, and Michigan (as well as adjacent states) were once home to gray wolves. Killing by humans and declining numbers of prey - bison, elk, and white-tailed deer in the south and moose, deer, caribou, and beaver in the north - caused wolf declines early on. By 1838, wolves were eliminated from the southern portion of the lower peninsula of Michigan. Bounties paid for dead wolves began during the 1800s and by the early 1900s wolves were also gone from southern Minnesota and Wisconsin. By 1960 wolves were nearly eliminated from Wisconsin, Michigan (except Isle Royale), and most of Minnesota.

State laws in Wisconsin and Michigan protected wolves prior to 1973, the year the Endangered Species Act (ESA) was passed, but were too late to be effective. By the time Wisconsin gave the wolf protection in 1957, the species was extirpated from the State. Michigan followed suit in 1965 with endangered species protection for the gray wolf. At that time only a few lone wolves remained in the Upper Peninsula and an isolated population existed on Isle Royale.

In Minnesota, a bounty on wolves and all predators continued until 1965. Between 1965 and 1974, Minnesota had an open season on wolves and the State conducted a Directed Predator Control Program. With the control program and other kills, about 250 wolves were taken in Minnesota each year. During this time, the wolf population was estimated at 350 to 700 animals. The State's control program and open season continued until May 1974, when the gray wolf gained protection under the ESA.

Wolf Recovery

Perhaps the most important factor leading to wolf recovery in the Midwest was the ESA's legal protection against killing or harming wolves. Another factor was the ESA requirement that a Recovery Plan be prepared. That plan focused time, money, and energy on the most important conservation actions. Additionally, wolves rebounded because their primary prey, white-tailed deer, were doing well. Deer herds in Minnesota, Wisconsin, and Michigan increased through the 1980s and early 1990s because of mild winters and timber harvests that created prime habitat.

Recovery criteria for the wolf, as established in the Recovery Plan, includes the assured survival of the gray wolf in Minnesota and a population of 100 or more wolves in Wisconsin/Michigan for a minimum of five consecutive years. The Recovery Plan identified 1,250 to 1,400 as a population goal for Minnesota. The state's wolf population has been at or above that level since the late 1970s, thus achieving the numerical criteria for assuring survival of the wolf in Minnesota. The Wisconsin/Michigan wolf population has been above 100 since the winter of 1993-1994, achieving the latter numerical goal in the Recovery Plan.

With this consistent expansion in numbers and range, the gray wolf has been recovered in the eastern United States.

Minnesota
(Information from William Berg, formerly of the Minnesota Department of Natural Resources (DNR))
During the mid- to late 1970s, the Minnesota DNR estimated their wolf population at about 1,000 to 1,200. During the 1980s, researchers documented areas that wolves had recently colonized, which suggested that the numbers and range were increasing. Therefore, the Minnesota DNR conducted a 1988-89 winter survey that resulted in estimates of 1,500 to 1,750 wolves. A follow-up survey was conducted during 1997-1998 and, based on that survey, the DNR estimated the Minnesota wolf population at about 2,450.

During the last three decades, wolves increased their range in the northcentral and central parts of Minnesota. This successful range expansion was due to ESA protection from unregulated killing, high deer numbers, and dispersal of individuals from existing packs. Telemetry studies documented wolves dispersing from the major wolf range in northeastern Minnesota to recolonize new areas. Those studies also documented wolves dispersing from the few packs in northcentral Minnesota that were able to survive the "bounty era."

Today, wolves live in areas with higher road and human densities than previously believed to be suitable for wolf survival. Wolves continue to disperse to areas in west-central and east-central Minnesota (just north of Minneapolis/St. Paul), North and South Dakota, and Wisconsin.

The Minnesota Legislature passed legislation in May of 2000 that established a framework for wolf management. Using that guidance, the Minnesota DNR, in consultation with the Minnesota Department of Agriculture, completed the Minnesota Wolf Management Plan in early 2001 that would be implemented if wolves are federally delisted. That plan delineates two wolf management zones and provides different levels of protection to wolves in the two areas. The plan also establishes a minimum State population goal of 1,600 wolves, and it defers any action on allowing a general public taking of wolves for five years following Federal delisting.

Wisconsin
(Information from Adrian P. Wydeven, Wisconsin DNR)
From 1960 to 1975 there were no breeding wolves in Wisconsin. But soon after the wolf was listed as federally endangered, wolves began re-establishing themselves in Wisconsin, apparently dispersing from adjacent Minnesota. The Wisconsin DNR began monitoring wolves in 1979 using trapping and radio-collaring, winter track surveys, and summer howling surveys.

When monitoring began, 25 wolves were documented in the State. During the mid-1980s wolf numbers reached a low of only 15, probably due to an epidemic of canine parvovirus which apparently killed many wolf pups. Wild wolves seemed to develop some degree of natural resistance and wolf numbers increased after 1985.

Since that time, the Wisconsin wolf population has steadily increased. Wolf population estimates (late winter counts) between 1985 and 2004 increased from 83 wolves comprising 18 packs to 373 wolves comprising 109 packs, respectively.

Parvovirus seems to be declining, but is still present in Wisconsin wolves. Lyme disease and mange are also present in this population but the impact of these diseases, particularly on pup survival, is not well known. Wisconsin wolf researchers continue to monitor wolf movements in the Wisconsin-Minnesota border area, as well as the wolf range expansion southward into the central portion of the state.

The Wisconsin DNR held public meetings during 1996 to receive public input on development of a new State wolf management plan. A final plan was approved by the Wisconsin Natural Resources Board in October of 1999. That plan sets a management goal of 350 wolves in the State (outside of Indian Reservations). This goal was exceeded and Wisconsin is in the process of changing the wolf's status from "threatened" to "protected wild animal."

Michigan
(Information from James H. Hammill, formerly of the Michigan DNR)
As wolves began getting a foothold in Wisconsin during the late 1970s, biologists documented increasing numbers of single wolves in the Upper Peninsula of Michigan. Finally, in the late 1980s they documented a pair of wolves traveling together in the central Upper Peninsula. This pair had pups for the first time in the spring of 1991. The next year (summer of 1992), Wisconsin and Michigan DNR biologists radio-collared one of the wolves in the only known pack. By the end of 1992, Michigan biologists verified at least 20 wolves in the Upper Peninsula. Since then, except for 1996, numbers have steadily increased.

The end of the 1996-97 winter count found the number of wolves at 112, down from the 116 documented during the previous late winter count. That decline appears to have been due to two consecutive harsh winters and a high incidence of mange. In some areas of the Upper Peninsula, deer numbers were reduced by 80 percent due to record snow falls and low temperatures during the 1995-96 winter. This provided more prey for wolves during that winter but was followed by another severe winter with unusually deep snow in 1996-97. During that second winter there were few deer for wolves to prey upon and wolf deaths were high.

Since then, the Michigan Department of Natural Resources (DNR) completed several additional Upper Peninsula late winter wolf surveys. Trackers estimate that there were at least 174 wolves in 1998-99, increasing to 360 in 2003-2004. Thus, numbers have rebounded from the previous year's decline. Radio-collaring and monitoring Michigan's wolf population continues.

Michigan, through the DNR, established a Michigan wolf recovery team that completed a Wolf Recovery and Management Plan in December 1997. The Michigan plan recommends managing for a minimum of 200 wolves on the Upper Peninsula.

In addition to wolves on the Upper Peninsula, there have been wolves residing on Isle Royale, Michigan, near the Minnesota-Ontario shore of Lake Superior, since the winter of 1948-49. Their population has moved up and down with that of their prime prey -moose. Disease is also believed to be an important factor in population fluctuations. Following a peak of 50 wolves in 1979, the population plummeted to the low teens in the late 1980s and early 1990s. They have since rebounded to 29 wolves. Due to their low numbers and near total isolation from other wolves, these wolves are not considered to be contributing to meeting the Federal recovery goals for gray wolves.

Minnesota Wolf Population	
1973	500 to 1,000
1979	1,235
1989	1,500 to 1,750
1998	2,450

Wisconsin Wolf Population	
1973	0
1980	25
1995	83
2000	248
2004	373

Michigan Wolf Population	
1973	0
1980	0
1995	80
2000	216
2004	360

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Gray Wolf Biologue

PDF Version

Gray wolves have evoked a variety of responses from humans throughout history. Most Native Americans revered gray wolves, trying to emulate their cunning hunting abilities. However, wolves became nearly extinct in the lower 48 states in the early part of the 20th Century because settlers believed wolves caused widespread livestock losses. Constantly persecuted and targeted by predator eradication programs sponsored by the Federal government, wolves have been pursued with more passion and determination than any other animal in U.S. history. By the time wolves were finally protected by the Endangered Species Act of 1973, they had been exterminated from the lower 48 states except for a few hundred inhabiting extreme northeastern Minnesota and a small number on Isle Royale, Michigan.

Second only to humans in their adaptation to climate extremes, gray wolves were equally at home in the deserts of Israel, the deciduous forests of Wisconsin, and the frozen arctic of Siberia. Within the continental United States, gray wolves once ranged from coast to coast and from Canada to Mexico, but they were absent from areas of the Southeast and East that were occupied by red wolves (Canis rufus).

Wolf groups, or packs, usually consist of a set of parents (alpha pair), their offspring, and other non-breeding adults. Wolves begin mating when they are 2 to 3 years old, sometimes establishing lifelong mates. Wolves usually rear their pups in dens for the first 6 weeks. Dens are often used year after year, but wolves may also dig new dens or use some other type of shelter, such as a cave. An average of five pups are born in early spring and are cared for by the entire pack. They depend on their mother's milk for the first month, then they are gradually weaned and fed regurgitated meat brought by other pack members. By 7 to 8 months of age, when they are almost fully grown, the pups begin traveling with the adults. Often, after 1 or 2 years of age, a young wolf leaves and tries to find a mate and form its own pack. Lone dispersing wolves have traveled as far as 600 miles in search of a new home.

Wolf packs usually live within a specific territory. Territories range in size from 50 square miles to more than 1000 square miles depending on how much prey is available and seasonal prey movements. Packs use a traditional area and defend it from other wolves. Their ability to travel over large areas to seek out vulnerable prey makes wolves good hunters. Wolves may travel as far as 30 miles in a day. Although they usually trot along at 5 m.p.h., wolves can attain speed as high as 40 m.p.h. for short distances. Indirectly, wolves support a wide variety of other animals. Ravens, foxes, wolverines, vultures and even bears feed on the carcasses of animals killed by wolves. In some areas, bald eagles routinely feed on the carcasses of animals killed by wolves during the winter. Antelope are swift, elk are alert, and mountain goats are adept at climbing steep cliffs, in part, because of the long-term effects of wolf predation. Wolves also help regulate the balance between these ungulates (hoofed animals) and their food supply, making room for smaller plant-eaters such as beavers and small rodents.

Wolves are noted for their distinctive howl, which they use as a form of communication. Biologists have identified a few of the reasons wolves howl: before and after a hunt, to sound an alarm, and to locate other members of the pack when separated. Wolves howl more frequently in the evening and early morning, especially during winter breeding and pup-rearing. Howling is also one way that packs warn other wolves to stay out of their territory.

Early settlers moving westward severely depleted most populations of bison, deer, elk, and moose - animals that were important prey for wolves. With little alternative, wolves turned to sheep and cattle that had replaced their natural prey. To protect livestock, ranchers and government agencies began a campaign to eliminate wolves. Bounty programs initiated in the 19th Century continued as late as 1965, offering $20 to $50 per wolf. Wolves were trapped, shot from planes and snowmobiles, dug from their dens, and hunted with dogs. Animal carcasses salted with strychnine were left out for wolves to eat. This practice also indiscriminately killed eagles, ravens, foxes, bears and other animals that fed on the poisoned carrion.

Today about 2,450 wolves live in the wild in Minnesota, 29 on Lake Superior's Isle Royale, about 360 in Michigan's Upper Peninsula, 373 in Wisconsin, and about 761 in the northern Rocky Mountains of Montana, Idaho, and Wyoming. Wolves are being reintroduced to Arizona and New Mexico. An occasional wolf is seen in Washington State, North Dakota, or South Dakota. Populations fluctuate with food availability, strife within packs, and disease. In some areas, wolf populations also may change due to accidental and intentional killing by people.

Gray wolves are listed under the Endangered Species Act (ESA) as endangered in the southwest and as threatened elsewhere in the contiguous 48 states within their historical range. Endangered means a species is considered in danger of extinction throughout all or a significant portion of its range, and threatened means a species may become endangered in the foreseeable future. In Alaska wolf populations number 6,000 to 8,000 and are not considered endangered or threatened.

Wolf recovery under the Endangered Species Act (ESA) has been so successful that in 2003 the U.S. Fish and Wildlife Service reclassified wolves from endangered to threatened throughout a large portion of their historical range in the contiguous United States. And in 2004 a proposal was published to remove the gray wolves found in the Dakotas and eastward from the threatened and endangered species list. The wolf's comeback is due primarily to its listing under the ESA which resulted in increased scientific research, protection from unregulated human killing, reintroduction and management programs, and education efforts that helped increase public understanding of wolves.

Wolf recovery and management are polarized and controversial because of people's attitudes and perceptions about wolves. People interested in wolf management often have strong emotions (fear, love, and hate) regarding wolves, making wolf recovery one of the most difficult wildlife management program.

Some people oppose wolf recovery because of concern for human safety. However, wolf attacks on humans are extremely rare in North America, even in Canada and Alaska where there has been a consistently large wolf population. Most documented attacks have been in areas where wolves became habituated to people when they were hand-fed or attracted to garbage.

Ranchers and farmers fear that wolves will prey on their livestock. To address this concern, there are special rules in place throughout most of wolf range to allow removal of wolf packs that prey on livestock. In Minnesota, home of the largest wolf population in the lower 48 States, a State program provides compensation for livestock confirmed to be killed by wolves, and a Federal program conducts a trapping program to remove individual wolves that prey on domestic animals. Similar compensation and trapping programs exist in Wisconsin and Michigan. In the West and Southwest, a private compensation program run by the Defenders of Wildlife pays for livestock killed by wolves.

For the past 23 years, Yellowstone National Park has been at the center of debate over the wolf. By about 1930, wolves had been deliberately extirpated from the western United States, including Yellowstone. After years of comprehensive study and planning, the U.S. Fish and Wildlife Service reintroduced gray wolves into Yellowstone and U.S. Forest Service lands in central Idaho. In 1995 and 1996, 31 wolves from Canada were released in Yellowstone National Park. At the same time, 35 wolves were released on remote Forest Service lands in Idaho. All of the reintroduced wolves were fitted with radio collars and monitored by biologists from the Fish and Wildlife Service and other cooperating agencies. The reintroduction has been very successful and by December 2003 there were about 670 wolves in the Yellowstone area and Idaho.

The Yellowstone and Idaho wolves are designated as non-essential, experimental populations under the Endangered Species Act. This designation allows Federal, State, and Tribal agencies and private citizens more flexibility in managing those populations. Wolves that prey on livestock will be removed and, if necessary, destroyed. Ranchers may kill wolves they catch in the act of preying on their livestock on private lands. They may be issued a permit to do the same on public lands after certain conditions are met. A similar program is being used to restore Mexican wolves to their historical range in the southwestern United States.

Mexican gray wolves, which inhabited the Southwest, existed recently only in zoos until 1998 when 13 wolves were released in Arizona. To date, 80 wolves have been released in Arizona and New Mexico. In February 2004, at least 35 wolves remain in the wild with another 241 in zoos and other facilities. For the first time, four wolf packs produced pups in the wild in 2002. The goal is to establish a self-sustaining wild population of at least 100 wolves in the species' historical range.

Wolf recovery efforts have redressed past mistakes in wildlife management, restored a top predator to its ecosystem, and improved our understanding of the complex interactions among species in their natural environments.

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Fremling, C. and B. Drazkowski, 2000

Ecological, Institutional, and Economic History of the Upper Mississippi River

Dr. Calvin Fremling and Mr. Barry Drazkowski
Resource Studies Center
St. Mary's University of Minnesota
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Contents

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INTRODUCTION

The Mississippi is not just any river; it is the "Mighty Mississippi," a busy, vital, intracontinental water highway that connects North America's "breadbasket" with the rest of the world. The Mississippi River drainage basin includes the agricultural heartland of the United States, supermarket to the world. Its fertile soils, some of the world's richest, feeds one in every 12 of the world's people.

Today, most of the Mississippi River south of St. Paul, Minnesota, is a "working river," a water highway to the sea dominated by powerful, ponderous towboats. On their way downstream, the big ones may wrestle six acres of grain-laden barges toward the deep-water ports of Baton Rouge and New Orleans where the corn and soybeans will be transferred to ocean-going freighters for worldwide distribution. On their return trip, the towboats may push barges of fertilizer for the farmers that grew the grain, or fuel for cars, trucks, and farm machinery. Coal is shuttled upstream, as well as downstream, to supply power plants that furnish most of the electrical energy for cities, industries, and farms.

Commercially, the Mississippi is one of the world's most important and severely regulated rivers. "Regulated river" is a recent euphemism describing rivers that are dammed and constrained. By definition, the Upper Mississippi River is the reach from St. Anthony Falls in Minnesota to the mouth of the Ohio River at Cairo, Illinois. The Mississippi was modified to improve navigation as early as 1829 when snag removal was begun on the Lower Mississippi. Canals, cut through the Keokuk Rapids and Rock Islands Rapids, were completed in 1839 and 1854, and the river was intensively channelized with wing dams, closing dams, and shoreline protection during the 1878 - 1912 period. With minor exceptions (St. Anthony Falls, Rock Island Rapids, Keokuk Rapids, and Chain of Rocks at St. Louis), most rocks larger than volleyballs - from Minneapolis to Cairo - were placed there by the U.S. Army Corps of Engineers or the Corps' contractors as part of early channelization projects. In the past decade, additional rockwork has been done for habitat enhancement.

Broad, shallow impoundments were created on the Upper Mississippi when 29 navigation dams were constructed, mainly during the 1930's, to create a slack-water navigation channel 9 feet deep between St. Louis and Minneapolis. River travelers are usually surprised at the width of the Upper Mississippi in its impounded reaches where it is much wider (but much shallower) than it is at St. Louis or New Orleans where the river is undammed. The Upper Mississippi River contains some of the planet's most productive ecosystems, and most of the river above St. Louis supports intensive recreational use.

Because the impoundments alone are insufficient to maintain the 9-foot commercial channel, the river's main channel is routinely dredged in some reaches. Almost all sand islands along the main channel have been placed there as result of dredging. In recent years, attempts have been made to minimize the adverse environmental impacts of this practice.

Dams and levees, which aid navigation and floodplain agriculture, have reduced the river's natural ability to create habitat for fish and wildlife during periods of high flow. Yet, floods have increased in frequency and severity. Navigation impoundments, side channels, and sloughs are filling with sediment - and the rate of filling may be exacerbated by proposed increases in commercial traffic. Some river reaches are severely polluted. Exotic plants and animals are competing with native species, and whole ecosystems seem to be unraveling. Yet, we are exponentially increasing our demands on this diminishing resource. While the myriad manmade problems affecting the Mississippi are of recent origin, they have their foundation in the natural forces that shaped the river and its enormous watershed. A basic understanding of that geological history is necessary to appreciate today's river and its ills.

EARLY GEOLOGIC HISTORY OF THE UPPER MISSISSIPPI RIVER BASIN

Lakes are temporary features, but rivers are virtually immortal, and they are relentless shapers of the land. Mountains may rise up and detour them, but they continue to flow.

At the beginning of the Cambrian period, about 570 million years before present (B.P.), the North American continent was smaller than it is now and was mainly above sea level. At about that time, the earth's crust began to subside throughout much of the interior of the continent, causing oceans to advance over the low-lying, bleak, barren, land surface of the area now drained by the Mississippi River and its tributaries.

As the sea advanced, its pounding surf attacked the uplands and stripped off rock debris from the severely weathered land areas where a cover of protective plants had not yet evolved. Beach zones were high-energy environments where wave action and currents continued the disintegration of the rock debris, winnowing it, and depositing the coarsest particles in the surf areas as clean, well-sorted beds of sand that ultimately formed sandstones. Silt and clay were wafted out into quiet, deeper waters where they settled and were compressed to form shales. Abundant lime-secreting organisms produced deposits that formed limestones and dolomites in warm shallow water, with little input of sand, silt or clay. During the ensuing 500 million years the shallow Epicontinental Sea served as a collection basin for sediments that eroded and washed outward from primordial uplands and mountain ranges.

The oceans did not advance at a uniform rate. Forces deep within the earth caused mild subsidence or downwarping in some areas and uplifts in adjacent areas, causing shorelines to advance and retreat. This caused distinctive cyclic patterns in the sediment deposits, and ultimately in the sedimentary rocks that were formed from them. A sandstone stratum, for example, may be bounded above and below by shale or limestone. The layers of sedimentary rocks are now hundreds of feet thick in southern Minnesota and thousands of feet thick in the far west and deep south.

It is generally accepted that during this interval of inundation North America straddled the equator and subsequently became part of the supercontinent "Pangaea." Nearly all of the marine fossils found in central North America are of animals that flourished in warm, tropical seas.

Geologic forces during the westward drift of the North American plate caused the general uplifting of the North American continent from the Mississippi River to the Pacific Ocean. To the east of the Rocky Mountains, a great sedimentary rock plateau rose from the sea constructing a stable platform of sedimentary strata, bounded on the west by the youthful Rocky Mountains and on the east by the much older southern Appalachian Mountains.
The strata along the Upper Mississippi River are very stable. They were originally laid flat, and for the most part remain that way, but they do bulge upward, reaching their highest elevations near La Crosse, Wisconsin. They then tilt downward to the north, west and south, buried beneath younger strata.

It is within the easily erodible sedimentary platform that most of the Mississippi River and most of its tributaries now flow. Eastern tributaries drain heavily vegetated uplands. Their clear waters run through well-defined valleys. Western rivers drain the Rockies through semi-arid, sparsely vegetated, highly erodible areas. Although dams presently intercept much of their sediment load, western tributaries still provide the most silt to the Mississippi.

HOW PLEISTOCENE GLACIATION DETERMINED THE MODERN UPPER MISSISSIPPI RIVER DRAINAGE SYSTEM

Changing river courses

Soon after discovery of continental glaciation in the last century, geologists learned that there were at least four major glacial periods during the Pleistocene epoch that began about 1.8 million years B.P. The progressively younger Nebraskan, Kansan, Illinoian, and Wisconsin glaciations are each named for the state where their maximum development is evidenced. Most evidence for continental glaciation came from studies of the continents themselves, but oceanographers have recently amassed a detailed glacial chronology from cores of deep-sea sediments. Each glaciation was followed by an interglacial interval in which the climate became similar to today's.

During preglacial time (late Tertiary), the Central Lowlands of the northern United States had been drained principally by streams flowing northward into Canada. The northern tributaries of the Missouri River drained into the Arctic Ocean via Hudson Bay. The northern tributaries of the present Ohio River flowed northward across Pennsylvania, Ohio, and Indiana into the St. Lawrence River system that flows into the North Atlantic Ocean.

Nebraskan, Kansan, and Illinoian glaciers sequentially advanced as far south as the approximate present position of the Missouri and Ohio Rivers. The modern courses of these rivers were determined as vast quantities of meltwater collected along the leading edge of the glaciers. Because northward flow was restricted by ice, the rivers of meltwater flowed in a general southerly direction and became tributaries of the Mississippi River.

The "Wisconsin" glacial, that began about 100,000 years B.P. and ended about 10,000 years B.P., was the last major glaciation in North America, and is the best understood because its deposits are widely exposed and have not been disturbed by subsequent glaciers.

Worldwide, about 20 million square miles of the earth's surface were covered during Pleistocene glacial maximums. As much as 30 percent of Earth's land surface was ice-covered, compared with about 10 percent today. The average thickness of the ice sheets was about one mile, causing sea levels to be lowered about 450 feet. Expansive tracts of the continental shelves of North America were then dry land. Today, commercial fishermen trawling along the eastern seaboard often snag tree stumps from forests that grew there.

Continental glaciation and commensurate changes in ocean levels greatly accelerated erosional processes in the Northern Hemisphere. Worldwide, falling ocean levels caused river gradients to become steeper. Consequently, the rivers ran faster and were able to "degrade" or downcut through previously deposited sediments. Rising ocean levels, on the other hand, reduced the gradient of rivers, decreased their sediment carrying capacity, and caused valley floors to rise or "aggrade" as they became choked with sediment. This complex interplay of glaciation and fluctuating ocean levels alternately caused master valleys and tributary valleys to flush and to fill. In the case of the Mississippi River, the story is more complex because the rapid draining of glacial lakes, impounded by retreating glaciers late in the Wisconsin glacial, caused torrents of sediment-free water to entrench the Upper Mississippi valley while the Lower Mississippi valley was aggrading.

Evolution of the modern Upper Mississippi River downstream from Minneapolis is generally believed to have begun about 1,500,000 years ago when Nebraskan glacial ice, that had approached from the west and northwest, displaced the Mississippi River eastward from its northwest-southeast course through central Iowa to its present location. As it flowed along the eastern edge of the Nebraskan glacier as an "ice-border stream", it incised a new channel through sedimentary rock strata, and establishing the present general course of the Mississippi River from near the Twin Cities southward to the Mississippi Embayment. The general course of the Lower Mississippi is much older - probably as old as the Atlantic Ocean. It has probably flowed through the Mississippi Embayment - the sediment-filled troughlike structure that reaches north from the Gulf of Mexico to Cairo, Illinois - since the late Paleozoic Period over 250 million years ago.

As the Wisconsin ice sheet retreated northward, it stood across the valley of the Mississippi at St. Paul and discharged great quantities of water, gravel, sand, silt, and clay down the valley. As the valley floor of the main stem rose, the gradients of tributaries decreased commensurately, causing them to drop their sediment loads. This, in turn, additionally elevated the floors of tributary valleys, causing them to be flat and continuous with the valley floor of the mainstem.

The greatest of all Upper Mississippi floods began about 12,700 years ago when Glacial Lake Agassiz, North America's largest glacial lake, spilled over its southern rim, forming the torrential Glacial River Warren that carved the immense valley now occupied by the Minnesota River. Lake Agassiz served as the source of the Mississippi River for about the next 2,700 years, and was the hub of migration for cold-water fishes and many other species of aquatic life that now live in the interior of Canada, the northern United States, and much of Alaska.

With the Great Lakes' outlet to the North Atlantic Ocean via the St. Lawrence River blocked by ice during Wisconsin glaciation, the water level of Glacial Lake Superior rose until it was four or five hundred feet higher than today's Lake Superior. It spilled over its southern rim, forming the Glacial St. Croix River that supplemented the flows of the River Warren.

During the time when the St. Lawrence outlet of the Great Lakes was blocked by ice, the Mississippi River also received overflow of meltwater from Glacial Lake Michigan via the Illinois River, and from Glacial Lake Erie via the Ohio River. Flowing waters tend to transport as much sediment as they can carry. Sediment-poor water is called "hungry water" due to its great erosive capacity. Because Glacial Lake Agassiz and the Great Lakes served as settling basins for glacial sediments, their overflows ran comparatively clear, and their hungry waters greatly increased the erosive capacity of the Upper Mississippi River, enabling it to export sediments faster than they could be supplied by tributaries. This resulted in the entrenching of the Mississippi channel over 200 feet in some reaches.

As ice retreated northward, Glacial Lake Agassiz drained to the north and east, and the Great Lakes resumed their drainage via the St. Lawrence River into the Atlantic Ocean. Relieved of their massive burdens of ice, the glacial outlet channels of both Lake Agassiz and the Great Lakes began to rebound, completing the beheading of the River Warren, and the Glacial St. Croix, Illinois and Ohio Rivers. With the cessation of flows from its glacial tributaries, the Mississippi lost most of its ability to transport sediments from steep-sloped tributaries, causing its valley to fill to its present level as an overloaded braided stream.

Terraces

The Mississippi tended to entrench itself during the floods caused by the draining of glacial lakes, but between floods the valley floor aggraded as tributaries brought in more glacial drift than the Mississippi could carry away. The result was a succession of prominent, bench-like terraces (remnants of the former flood plain)
flanking the river from St. Anthony Falls to the mouth of the Ohio River.

The highest terraces are evidence that the valley had aggraded to over 50 feet above its present level prior to scouring by flows from the glacial rivers, which entrenched the Mississippi valley, and secondarily caused the entrenchment of flat tributary valley floors. Because the terraces are nearly level, and less subject to flooding, they have been used as locations for communities. They are also used for agriculture, roads, railroads, and as home building sites. Native Americans used them for summer encampments, especially if they occurred where a navigable tributary joined the Mississippi.

The remarkable Unglaciated Area

Near Red Wing, Minnesota, the Mississippi enters the distinctive "Unglaciated Area," a rugged landscape of stream-dissected rock strata of Paleozoic Age. It includes parts of northeastern Iowa, southeast Minnesota, northwest Illinois, and southwest Wisconsin. Glacier after glacier approached this remarkable area, but left it virtually unscathed. If the area had been recently scoured by ice, its topography would not be nearly so rugged. The beautiful cliffs would have been erased.

Most of the bluffland within the unglaciated area and along both sides of the river from the Twin Cities all the way downriver to Cairo, Illinois, are marked by karst landscape - characterized by sinkholes, caves, springs and disappearing streams. The groundwater of the karst region are extremely susceptible to pollution from farm fields, feedlot runoff, failed sewage lagoons, and residential development.

POSTGLACIAL CLIMATE AND ITS ECOLOGICAL IMPACTS

As glacial ice retreated northward, climatic zones and vegetation also shifted to the north. Deciduous forests, for example, replaced Iowa's coniferous forests,, and they, in turn, gave way to prairie grasslands.

The climate of immediately postglacial midwestern America has no modern analog. The present interglacial period, called the "Holocene or Recent", was triggered by a gradual increase in the earth's mean annual temperature for the first 4,000 or 5,000 years, culminating in a period of temperatures higher than today called the "Altithermal." The warmest time interval in our interglacial, called the hypsithermal interval, was warmer than now, and has no modern analog. It began about 8,500 years B.P., lasted until about 5,000 years B.P., and was followed by cooler temperatures that favored several episodes of advance and retreat of mountain glaciers. Cold returned about 1350 AD, causing the "Little Ice Age" that lasted until about 1870 AD. It caused the temporary expansions of glaciers and ice caps, and southward shifts of vegetative zones - and it must have severely impacted native Americans. It is interesting to note that much of the exploration and early exploitation of the Upper Mississippi River Basin took place during the last years of the Little Ice Age.

PREHISTORIC PEOPLES

The Mississippi River and its tributaries may have been utilized by prehistoric peoples for 11,000 years or more - first as hunter gatherers and more recently as agriculturists who supplemented their cultivated produce with fish, game, and wild plants from the river, its valley, and the uplands.

The Mississippi and its tributaries became transportation routes, facilitating the trading of copper from Michigan, lead ore from Illinois and Iowa, obsidian from the Yellowstone, and shells from the sea. There were extensive trade networks in place on the Mississippi River long before the American-European invasion. The rivers were also avenues for the diffusion of cultural influences long distances from their points of origin.

On the Illinois side of the Mississippi River within sight of the soaring Gateway Arch at St. Louis, lie the archaeological remains of the central section of an ancient Indian city that today is known as Cahokia. Cahokia was the center of the most sophisticated pre-historic Indian civilization north of the Rio Grande, and it acted as an intense cultural reactor that profoundly touched and influenced aboriginal groups throughout the Mississippi Basin. The city was first inhabited about 700 AD by prehistoric Indians of the Late Woodland culture. Between 800 AD to 1,000 the Mississippian culture emerged, and developed an extensive agricultural system with corn, squash, beans, and several other seed bearing plants as principal crops. This stable food base, supplemented by hunting, fishing, and gathering wild food plants, enabled Cahokians to develop a highly specialized social, political, and religious organization. At its peak, from AD 1100 to 1200, the city covered six square miles and had a population of about 20,000.

A gradual decline in Cahokia's population began sometime after AD 1200, and by the 1400s the site had been abandoned. Depletion of resources probably contributed to the city's decline. Climate change after AD 1200 may have adversely affected crops and wild plants and animals needed to sustain a large population. Agriculturists were probably more sensitive to minor climatic changes than were hunters. Other factors such as war, disease, social unrest, and declining political and economic power may have taken their toll.

By 1,000 AD, American Indians were cultivating localized portions of the Mississippi River valley below the Twin Cities for maize or corn, beans, squash, sunflowers, and tobacco. Timbered areas in the rich river bottoms were cleared for garden plots. Hunting and fishing remained important, however. Farther north, in the Headwaters area, wild rice was substituted for corn as the staple vegetative food.

During the past 1,000 years the climate has changed several times alternating from warm/moist (1000-1250 AD), to warm/dry (1250-1450 AD). Warm/moist conditions recurred for about 100 years, and were followed by the much cooler/moist conditions of the Little Ice Age that lasted from 1350 to 1870 AD.

THE MYTH OF THE ECOLOGICALLY BENIGN NATIVE AMERICAN

A popular misconception is that American Indians were ecologically invisible, living in perfect harmony with the environment. On the contrary, many Indians were farmers. By 1500 AD they had cleared large areas to produce corn, beans, squash, tobacco, and other crops. Today, 60 percent of the dollar value of U.S. crops comes from crops first cultivated by American Indians.

Vast areas of the Mississippi Basin were cultural landscapes where Indians regularly set fires to improve game habitat, facilitate travel, reduce insect pests, remove cover for potential enemies, enhance conditions for berries, and drive game. Frequent, low intensity fires shaped the famous oak savannas of the Midwest. They existed as components of the landscape prior to Indian intervention, but Indians' actions greatly expanded the extent of such habitats.

For native Americans, fire was a prime horticultural tool. It was easily and quickly employed, and it could be used to work large areas. Applied periodically for centuries, fire was a force as profound as weather in its ecological impact. Most Indian fires were set in spring and fall when soil moisture was high and conditions were favorable for low-intensity burning of the forest. This tended to create plant communities adapted to low-intensity fires and to reduce the number of high-intensity fires caused by lightning.

The European perception that indigenous people had small ecological impact was influenced by the devastating effect of Old World diseases on native populations. Smallpox, introduced in the early 1500s, was especially lethal. It has been estimated that North America's Indian population collapsed from perhaps 18 million in 1500 to less than 1 million by the late 1700s, when the first waves of American-European settlers poured westward over the Appalachians. Thus, many Indian agricultural lands had two to three centuries to reforest before the first permanent European-American settlers arrived. The landscape looked more "pristine" than it had in more than 1,000 years.

VEGETATION AND WILDLIFE AT THE TIME OF AMERICAN-EUROPEAN SETTLEMENT

The Headwaters pineries extended southward to about Brainerd, Minnesota. There the Mississippi River entered an area characterized by a mosaic of prairie, savanna (grassland interspersed with fire-resistant trees), and extensive stands of "big woods." Although the prairie was mainly a product of climate, much of it owed its existence to grazing and prairie fires that kept invading forests in check. Trees standing in prairies were prime targets for lightning that often ignited them and/or the dry grasslands. Fires also set by native Americans, either accidentally or purposely for a variety of reasons including making the grasslands more attractive to grazers like elk and bison.

Indian use of fire as a game management tool in the Winona, Minnesota, area was documented by Lafayette Bunnel (1897, p225). "After a very cold spell until late in the fall, that had closed Lake Pepin, there came several days of mild, dry weather, and then a sudden change and a strong westerly wind. In a few hours time it was almost as dark as night. All of the men folks were away but myself, and I had just returned, when Matilda told me that she did not know what to do with Mrs. Kennedy, for the coming darkness and smoke had led her to believe that the world was coming to an end sure enough. Just then an old squaw with some of her people came up to the house, and asked what was the matter, and Mrs. Kennedy told her. Indians do not swear, but they have strong expressions of contempt, and the Sioux woman withheld none of her language, and ended her harangue by saying: 'Thou foolish white woman, canst thou not smell the burning grass of our buffalo prairies? Thinkest thou that our people are fools not to prepare early food for them?'"

Along the river corridor south of St. Paul, easily burned areas tended to be grassland or savanna. These included bluff tops, broad terraces, broad valley floors, and large islands. Most steep southwest-facing slopes existed as "goat prairies." Hardwood forests were most prevalent in areas protected from fire. These included deep valleys, north-facing slopes, and smaller islands.

In mid-September, 1805, after journeying upstream through the Unglaciated Area below Lake Pepin, Zebulon Pike penned this vivid, concise description of karst topography, savanna, and a braided river. (Being braided is characteristic of rivers that are overloaded with sediment.) "In this division of the Mississippi the shores are more than three-fourths prairie on both sides, or, more properly speaking, bald hills which, instead of running parallel with the river, form a continual succession of high perpendicular cliffs and low valleys; they appear to head on the river, and traverse the country in an angular direction. Those hills and valleys give rise to some of the most sublime and romantic views I ever saw. But this irregular scenery is sometimes interrupted by a wide and extended plain which brings to mind the verdant lawn of civilized life, and would almost induce the traveler to imagine himself in the center of a highly cultivated plantation. The timber in this division is generally birch, elm, and cottonwood; all the cliffs being bordered by cedar. The navigation unto Iowa River [Upper Iowa River] is good, but thence to the Sauteaux River [Chippewa River] is very much obstructed by islands; in some places the Mississippi is uncommonly wide, and divided into many small channels which from the cliffs appear like so many distinct rivers, winding in a parallel course through the the same immense valley. But there are few sand-bars in those narrow channels; the soil being rich, the water cuts through it with facility" (Coues, 1965, p 306).

George Catlin also described the unspoiled Mississippi River blufflands in 1824. "The whole face of the country is covered with a luxuriant growth of grass, whether there is timber or not; and the magnificent bluffs, studding the sides of the river, and rising in the forms of immense cones, domes, and ramparts, give peculiar pleasure, from the deep and soft green in which they are clad up their broad sides, and to their extreme tops, with a carpet of grass, with spots and clusters of timber of a deeper green; and apparently in many places, arranged in orchards and pleasure-grounds by the hands of art."

Stephen Long, in his journals of 1817 and 1823, also described the prairies, savannas, and forests along the Mississippi River between St. Louis and the Falls of St. Anthony. His descriptions corroborate those of Pike and Catlin.

Today, the prairie heritage of the Upper Mississippi Basin is reflected in the names of its cities and towns - Mound Prairie, Long Prairie, Belle Prairie, Belle Plain, Plainview, Eden Prairie, Prairie de la Crosse (La Crosse), Prairie du Chien, and Blooming Prairie to name a few. If not named for the prairies, towns were often named for groves of trees that provided shelter, fuel, and building material for pioneers - Walnut Grove, Soldier's Grove, Maple Grove, Cedar Grove, Cherry Grove, Inver Grove, and Spring Grove.

SETTING THE STAGE FOR THE CAUCASIAN INVASION

Hernando De Soto, searching for riches with 600 Spanish conquistadors, is credited with the "discovery" of the Mississippi near Memphis in 1541. Most likely, the river came as no surprise to him because it had appeared on a Spanish map in 1513, probably as a result of intelligence gained from Indians. After De Soto, 132 years passed before Caucasians again visited the Mississippi.

By the seventeenth century, three "superpowers"- England, France, and Spain- were competing to establish colonies and control the New World. They also hoped to discover a river that flowed into the Pacific Ocean, so they could establish a lucrative trade route to the Orient. The French were first to penetrate the Upper Mississippi Valley, when, in 1673, the fur trader Louis Joliet and his party, which included Father James Marquette, canoed from the Green Bay of Lake Michigan up the Fox River, portaged over the low continental divide into the headwaters of the Wisconsin River, and continued downstream into the Mississippi. After floating southward to the mouth of the Arkansas River Joliet concluded that the Mississippi flowed into the Gulf of Mexico and not the Pacific Ocean. They returned by going up the Illinois River, over the low continental divide, and down the Chicago River into Lake Michigan.

Although they had not found a short cut to the Orient, the exploration of Joliet and Marquette helped establish France's claim to the interior of the continent. Soon France was sending colonists to populate the vast new territory it called "Louisiana." Other French explorers ascended the Mississippi from its mouth; some reached its headwaters by traveling overland from Lake Superior. A trade route became firmly established from Lake Superior up the St. Louis River, and then overland to the headwaters of the Mississippi. A route from the Mississippi to the far north was established by ascending the Minnesota River to its source on the western border of Minnesota, through Big Stone Lake and Lake Traverse into the headwaters of the Red River of the North, which flows northward toward Hudson Bay.

La Salle was the first European to travel the length of the Mississippi River from the Great Lakes to the Gulf of Mexico. He claimed the entire drainage area for France and named it Louisiana.

The French established trading posts at many locations along the Mississippi and demonstrated that it was navigable along its entire course. By the middle of the 18th century, France had established trading posts throughout the mid-continent, providing further support for ownership. St. Genevieve, Missouri, the first permanent settlement west of the Mississippi, was founded in 1735. St. Louis, located strategically at the confluence of the Mississippi and Missouri

Rivers, was founded in 1764. The names of other towns along the Upper Mississippi are further testament to the far-reaching influence of the French: Cape Girardeau, Prairie du Chien, La Crescent, La Crosse, Trempealeau, Lamoille, and Belle Prairie to name a few.

In 1763, following its defeat by the British in the French and Indian War, France ceded its holdings west of the Mississippi to Spain and its lands east of the river to England. At the end of the American Revolution, just 20 years later, Great Britain ceded all land from the Appalachian Mountains to the Mississippi River to her former colony - and American settlers poured over the Allegheny Mountains into the eastern part of the Mississippi basin.

Subsequently, the Spanish returned ownership of the territory of Louisiana to the French, who, in turn, sold it to the United States in 1803. Except for a very small portion of what is now southern Alberta and Saskatchewan, Americans now controlled all of the land drained by the Mississippi River and its tributaries.

Three centuries passed between the discovery of the mouth of the Mississippi in the Gulf of Mexico and the location of its source in the wilds of northern Minnesota. Many explorers searched for the river's source. Zebulon Pike made the first unsuccessful attempt in 1805. Henry Rowe Schoolcraft, guided by an Ojibwe Indian, finally "discovered" that Lake Itasca was the true source of the Mississippi in 1832.

With Lieutenant Zebulon Pike's exploratory voyage up the Mississippi from St. Louis in 1805, the U.S. Army Corps of Engineers began extensive surveys of the Upper Mississippi. From 1817 to 1823, Major Stephen H. Long explored the UMR, looking for ways to improve it for settlement and commerce. As a result of his report recommending, among other things, that canals be constructed around the rapids, Congress assigned responsibility to the Corps for managing the Mississippi and improving it for steamboats. The authority has rested there ever since (Madison 1985).

PRESETTLEMENT PLANT COMMUNITIES

An interesting mix of modern technologies has corroborated the vivid descriptions of presettlement landscapes by explorers Like Pike, Catlin, and Long. In 1785, the U. S. General Land Office (GLO) initiated the Rectangular Survey System to dispense land to settlers in western territories. It divided the landscape into townships containing 36 sections, each of which was one square mile in size. At each section corner and midway between section corners, GLO surveyors pounded a steel post into the ground. In timbered areas they referenced the post's location by selecting two nearby trees, and recording the direction and distance to them, the trees' common names, and their diameter breast high. If no trees were present, the post was set into an earthen mound and prairie was recorded in the field notes. After each surveyed mile, the surveyors recorded type of terrain, soil, plants composing the undergrowth, and tree species. Early surveyors and explorers often used the term "oak opening" for savanna.

As part of the U. S. Geological Survey's Upper Mississippi River Long Term Resource Monitoring Program, survey records of the GLO have been used to reconstruct the structure and distribution patterns of plant communities that existed over 150 years ago along the UMR. Using digitized GLO data, computer-generated maps plot the former forests, savannas, prairies, marshes, and areas of open water.

These reconstructions reveal that prairies once dominated the floodplain. Forests were generally restricted to islands, banks of the Mississippi and its tributaries, valley slopes and ravines. Flooding has long been considered the principal factor influencing plant community types on the floodplain, but it is now known that fire, either natural or human-caused, played an important role in maintaining floodplain prairies, savannas, and open woodlands.

In the Pool 4 area, for example, GLO surveyors reported that island forests were dominated by flood tolerant species like elm, silver maple, willow, bur oak, birch, and ash. Because the GLO surveyors did most of their work along the Mississippi during the winter when trees were leafless, they may not have always distinguished bur oak from swamp white oak. The barks of the two species are similar. Uplands were predominantly covered with savanna communities of fire-tolerant white oak, bur oak, and black oak. Some of the savannas had a park-like distribution of trees with a grassy understory. In others, oak groves were interspersed with open prairies and dense thickets of fire-stunted oak and hazel brush. Fire-sensitive sugar maple - basswood forests were restricted to steep mesic ravines and north facing slopes protected from fire. The floodplain had communities similar to both islands and the surrounding uplands. Bur oak, tolerant of both fires and floods, was the dominant tree species on both floodplains and uplands in 1848. Presently, silver maple is the dominant flood plain species in Pool 4.

Farther south, using GLO survey records from 1815-1817, reconstructions were made of the presettlement landscape at the confluence of the Illinois and Mississippi Rivers. About 56% of the floodplain consisted of forest and savanna dominated by hackberry, pecan, elm, willow, and cottonwood. Prairies covered about 41% of the presettlement

floodplain.
Between 1817 and 1903, all of the higher elevation mesic prairies were converted to agriculture. Species diversity has decreased in floodplain forest communities since impoundment in the 1930s, and silver maple is now the dominant species.

After 1830, steamboat traffic increased rapidly, creating an enormous demand for the fuelwood that lined the river banks. Woodyards became "big business" and many farmers supplemented their incomes by harvesting and selling cordwood from bottomland forests. Hardwoods with the highest fuel value were selectively harvested. These included oak, ash, maple, elm, pecan, and hackberry. Willow and cottonwood were less desirable, just as they are now for woodstoves and fireplaces.

EARLY EXPLOITATION OF WILDLIFE RESOURCES

By 1900, elk and bison had been eliminated from most of the Mississippi River Basin. Beaver seemed doomed to extinction because of over a century of exploitation by trappers, and a closed season was declared in 1910.

The extinction of the passenger pigeon was especially shocking to Americans, many of whom could remember flocks that darkened the sky hour after hour. In 1813, John James Audubon had mathematically calculated that a single flock in the Ohio River Valley contained more than 1,115,000,000 birds. A century later the world population of passenger pigeons had been reduced to a single captive bird in the Cincinnati Zoo. Named "Martha", she died on September 1, 1914, at age 29 (Department of the Interior 1976). Commemorating the passing of the passenger pigeon, Aldo Leopold wrote:

The pigeon was a biological storm. He was the lightning that played between two opposing potentials of intolerable intensity: the fat of the land and the oxygen of the air. Yearly the feathered tempest roared up, down, and across the continent, sucking up the laden fruits of forest and prairie, burning them in a traveling blast of life. Like any other chain reaction, the pigeon could survive no dimunition of his own furious intensity. When pigeoners subtracted from his numbers, and the pioneers chopped gaps in the continuity of his fuel, his flame guttered out with hardly a sputter or even a wisp of smoke.

The effects of man on the aquatic resources of the Mississippi River had been recognized as early as 1870, when it was observed that the fishery resources in the river system were rapidly declining. In 1871, the Congress established the Office of the United States Commissioner of Fish and Fisheries. Within four years, the states of Iowa, Minnesota, Wisconsin, and Missouri had established their own Fish Commissions. The activities of these groups basically fell into two categories, fish stocking and fish rescue.

Prior to the formation of the 9-foot channel impoundments in the 1930s, water levels fluctuated greatly throughout the year. Spring floods submerged lowland areas and as the floodwaters receded, pools and lakes cut off from the main channel of the river were formed. Conditions were favorable for the growth of newly hatched fish in such flood plain lakes, but the stranded fish usually died as water levels receded and the lakes dried up. Freeze outs usually killed those land locked fish, which survived the summer, during the winter.

The U.S. Fish Commission began rescue operations in 1889, and 35 fish rescue stations had been established on the Mississippi River in Minnesota, Wisconsin, Iowa, and Illinois by 1923. Fish rescue operations declined substantially after 1925, but were continued until the 1950s at a few locations.

MISMANAGEMENT OF THE LAND

Impacts of agriculture

The exploitation of the Upper Mississippi River drainage basin, beginning in the 1840s, by immigrants and their descendants profoundly affected landforms. Their farming and forestry practices bared the land, creating the equivalent of a great climatic change. Pioneer farmers cultivated the Mississippi Valley floor, terraces, and the top of the plateau. Erosion rates increased so much that the floor of the modern Upper Mississippi Valley was blanketed by soil that washed into the river and its valley as a result of steep-land agriculture. Hay and small grains such as wheat, oats, and barley were the main crops.

Below the Twin Cities, the bluffland is very rugged - especially in the Unglaciated Area; and most agricultural land in the area is not level. Early settlers usually cultivated every part of their land, which was not too steep for horse-drawn machinery. Conservation to the early farmers usually meant letting no portion of their land lie unproductive.

With horse-drawn machinery and the moldboard plow that had been introduced in 1837, they opened land that should not have been cultivated. Bluff tops were plowed to the extreme edges of the bluffs - and often over the edges. Sure-footed horses traversed areas that today's tractors cannot. Hillsides that were too steep to be plowed were logged, burned, and grazed. Bluffland fires were so common that steamboats could sometimes travel at night because their routes were fire lighted. White settlers carried on the Indian tradition of burning to discourage tree growth and to stimulate the production of additional grasses for grazing.

Dairy cattle and horses were the principal grazers, but sheep and goats also helped denude the hillsides. Soil conservation measures such as contour tillage, strip cropping and terracing were unheard of. Soil conservation practices improved after the 1930s, but wetland drainage and stream channelization increased. Adding insult to injury, the gullies that developed on steep land were often filled with topsoil so that cultivation could continue.

Because the land lost so much of its protective cover and its water retention capacity, floods in tributary valleys were common at all seasons of the year, and alluvium washing down from the uplands caused the aggradation of most valley floors. Entire valley communities were slowly inundated, in some instances, by sand and silt from the uplands. The lower reaches of tributaries and their deltas still store most of the eroded soil.

The settlers that migrated to the Upper Mississippi River Basin to farm the rich prairie soils also drained the wetlands that had filtered nutrients and helped regulate runoff rates. An estimated 34-85% of wetlands in Wisconsin and Minnesota have been lost, and 85 to 95% in Iowa, Illinois, and Missouri. Because of wetland destruction, stream channelization, agricultural drainage, and urbanization, floodwaters presently reach the river faster. Today, Mississippi River flood stages are higher and last longer, but low water stages are lower.

European settlers transformed the native tall-grass prairie into one of the most productive agricultural regions in history, first with horse-drawn machinery, and more recently with heavy machinery and an ever-expanding arsenal of fertilizers and insecticides. The Great Plains has become an inland ocean of corn and soybeans.

Contour farming and strip cropping were introduced in the area in the late 1930's. Row crop agriculture, mainly for corn and soybeans, was limited before World War II, but it expanded greatly after the war.

In Wisconsin, upland erosion and tributary sediment yields to the Mississippi were highest during the 1850s through the 1920s, with rates declining since then because of improved land management practices.

Tillage that does not use the moldboard plow and leaves at least 30% of the plant residue on the ground is considered conservation tillage. Moving away from the moldboard plow toward conservation tillage and no-tillage has reduced soil erosion while increasing soil fertility. Soybean acres rotated to corn lend itself to no-tillage because there are fewer weeds and a lighter blanket of crop residue. Conservation practices such as minimum till or no till provide more vegetative cover and reduce runoff; this increases base flow and reduces storm flow.

In the silt-loam soils of the rugged unglaciated areas of Winona County, Minnesota, for example, conservation tillage and no-tillage have been practiced by some farmers since the 1950s, but the practices have become very popular since about 1985. Conservation tillage is now practiced by at least 80% of area farmers.

Increasing numbers of farmers have discontinued grazing woodlands and steep slopes since the 1950s, recognizing that it is poor business and poor conservation. Large scale burning is no longer permitted, except as a prairie restoration tool in some state and federal preserves. The impact of no grazing or burning is most evident on steep, south-facing slopes that are characterized by dryness and temperature extremes. In these "goat prairies," prairie vegetation is rapidly being replaced by dense stands of red cedar (juniper). Most of the red cedar stands are virgin forests, having invaded areas that were treeless for thousands of years due to climate, grazing, and burning.

We cut the top off Minnesota and Wisconsin and sent it down the river

Removal of pine forests by clearcutting in the St. Croix, Chippewa, Black, and Wisconsin watersheds disrupted the stability of soils and sediments that had been held in place only by dense vegetative cover. As settlers poured into the treeless prairies of the mid-continent in the 1840s and 1850s, the need for lumber for houses, barns and sheds became acute. Fortuitously, the upper watersheds of the Mississippi Headwaters, St. Croix, Chippewa, Black, and Wisconsin Rivers were forested with mature stands of white pine and Norway pine. What's more, the immense forests were laced with big rivers that seemed to be designed for the sole purpose of floating logs. At the peak of the ensuing logging that peaked in the 1880s there were over 100,000 lumberjacks, armed with double-bitted axes and two-man crosscut saws, in the winter forests of Minnesota and Wisconsin. White pine, a light and strong wood, was exploited first. It took only 40 years to log off the world's finest stand of white pine.

With the depletion of the white pine, loggers turned to the less valuable Norway pine. Sixteen-foot logs were hauled by sleigh over iced roads or by railroad to riverside landings where they were stacked to wait for the spring floods that would transport them to saw mills or downstream to the Mississippi. Logs and rough-sawn lumber were made into rafts for their trip downstream to saw mills in Winona, Minnesota; La Crosse, Wisconsin; Clinton, Iowa; and Rock Island, Illinois, and other cities. During the peak of the lumbering period in the late 1800s, there were more than 80 sawmills located on the Upper Mississippi River and about 120 located on tributary streams.

The short-lived logging boom which began in 1875 hit its peak in 1892, and in 1915 the steamboat Ottumwa Belle snaked the last remnants of Wisconsin lumber down the Mississippi River. By early in the twentieth century most of the pine forests of Minnesota and Wisconsin had been cut, and the logging companies moved westward.

The pearl button industry

Commercial fishing for clams began on the Mississippi River in 1889, when the first button factory was started in Muscatine, Iowa. The fishery rapidly expanded northward and southward to supply pearl button factories at several cities along the river. The clam beds were depleted, however, in a few years in most areas. For example, beds near New Boston, Illinois, produced more than 10,000 tons of shells between 1894 and 1897, but were then abandoned. It became apparent that the mussel fishery was doomed unless methods of artificial propagation could be developed. Accordingly, the U.S. Bureau of Fisheries established the Fairport Biological Station in Iowa in 1908. Although artificial propagation was successfully employed on a large scale, depletion of the beds continued. Water pollution and siltation accelerated the process, and by 1950 the few remaining button factories were making buttons cut from shells collected from streams in Tennessee and Arkansas. The development of synthetic buttons in the early 1950s was responsible for the demise of the industry.

IMPROVING THE RIVER

Ockerson gave one of the most complete physical descriptions of the Upper Mississippi River while it could still be considered in a relatively natural state in his 1898 paper, "Dredges and Dredging on the Mississippi River". He noted that between St. Anthony Falls and the mouth of the Missouri the "banks are low, and the oscillation between high and low water rarely exceeds 25 ft. In the upper half of this reach the river is divided into a great many sloughs, which serve as high water channels, but are often nearly or quite dry at low water. The water carries but little sediment; bank erosion is comparatively slight; for 21 miles it flows through a lake of slack water 30 ft deep (Lake Pepin); the flow in two places is interrupted by rapids where the bed of the stream is solid rock (Rock Island and Keokuk); in the upper portion, the navigable depth at low water sometimes gets down to 2 1/2 ft, and navigation is usually suspended during the winter season for a period of four months or more in consequence of the river being frozen. The low-water slope averages about 0.5 ft per mile. The low water discharge is about 25,000 cu. ft per second. High water generally comes in May and June, and the low water season begins about the first of September and lasts until navigation is closed by ice. Sandbars are numerous and crossings are consequently frequent, and their locations are constantly shifting.

In 1823, the steamboat Virginia reached St. Paul, Minnesota, and marked the beginning of a new era for the Upper Mississippi. Steamboats made it possible for people to travel to the frontier without bearing the hardships that early explorers had experienced. The Corps of Engineers began to improve navigation on the river in 1829 by removing snags and sandbars, by excavating rock to eliminate rapids, and by closing off sloughs to confine flows to the main channel. These alterations enabled shallow-draft steamboats to use the river and its tributaries as water highways. Concurrently, erosional processes in the watershed were accelerated as settlers logged the forests, grazed and plowed the prairies, and practiced steepland agriculture.

Early canal construction, dredging, and snag clearing

The Upper Mississippi had long stretches of rocky rapids largely missing downstream from St. Louis. The lower rapids (Des Moines Rapids) stretched for about nine miles from Keokuk, Iowa, to Montrose, Iowa. The upper rapids were more extensive and dangerous; they ran for about 15 miles from Le Claire, Iowa, to Rock Island, Illinois. Rocks weren't the only threat to steamboats. For thousands of years sunken trees, logs, and stumps had accumulated in the river, lying in wait to tear out the hulls of keelboats and steamboats. Powerful, twin- hulled snag boats, known as "Uncle Sam's tooth pullers," began removing snags on the Lower Mississippi River in 1829.

The Upper River's rapids were an even greater problem than the snags. In 1837, surveys were made of the Rock Island rapids at Rock Island, Illinois, and the Des Moines rapids at Keokuk, Iowa. In 1838 and 1839, the USACE was authorized to blast a channel 5 feet deep and 200 feet wide through the Des Moines Rapids. In 1854 the Corps was further authorized to cut a channel through the Rock Island Rapids and to clear snags and other hazards from the Upper Mississippi River. The snag clearing was completed in 1867. Even though the larger rocks were removed from its channel, the Rock Island rapids remained a major obstacle until the Moline Lock, completed in 1907, enabled boats to bypass the worst of it. Six years later the Keokuk Lock was completed as part of a power dam built to generate electricity.

The 4 1/2-ft and 6-ft channel projects

The completion of the first transcontinental railway in 1869 was followed by a growing railway network that threatened river commerce. Not only did the railroads provide greater access to markets in the east and west, but they could run when the river was frozen or impassable due to extreme low flow. Railroads running westward needed bridges, and the first Mississippi bridge, completed in 1856 at Rock Island had already claimed 64 steamboats.

In1878, Congress authorized the creation and maintenance of a navigational channel 4-1/2 feet deep on the Upper Mississippi River between St. Paul, Minnesota, and the mouth of the Ohio River. Among the reasons for this authorization were the beliefs that effective waterways would force the railroads to charge competitive prices and that, if river routes did not improve soon, the railroads would become so dominant that future river improvement would be impossible. The 4-1/2-foot channel was to be obtained by the construction of wing dams, closing dams, and shore protection, and by dredging. Although it was funded yearly by Congress, the 4 1/2-foot channel project was not substantially finished until 30 years later, in 1907.

The purpose of wing dams and closing dams was to constrict the area through which the river flowed. Using closing dams to cut off alternate channels and wing dams to direct the river's flow down a single narrow channel, a swift current was created to prevent deposition of sediments in the main channel. The main areas of deposition were on the downstream side of the wing dams where the sand gradually filled in the area between the dams and the shore. When successful, the wing dams forced the current toward the opposite bank at a greatly increased velocity. As a result, that bank was in danger of eroding away and had to be protected. Rock and brush were again the materials used.

Wing dams were constructed of readily available materials - willows cut from the river bottoms and limestone and dolomite quarried from nearby bluffs. The willows, which were tied in bundles 20 feet long and 12 inches in diameter, and rocks were barged to dam site. There the bundles were loaded aboard a building barge and woven into mattresses. The mattresses were skidded into the river and held in place by ropes until sufficient rock could be loaded on the mattresses to sink them, layer after layer, into the depths. The dams were built in from 5 to 40 feet of water and were constructed so that they projected as much as 6 feet above the water. Usually, on the opposite side of the river from the wing dams, the shore was fortified with rock so that water, which rushed around the ends of the wing dams, did not erode away the opposite shore. Durable, erosion-resistant dolomite and limestone rock was quarried from the bluffs and brought down to the river by horsecart originally, but some quarrymen developed tram systems that brought rock to the river's edge much more efficiently.

Wing dams were usually constructed in the summer, but sometimes they were built during the winter, and the materials were hauled onto the ice on sleighs. Once the rock and brush had been laid, workers sawed through the ice around the dam and let the dam fall into place.

Wing dams were usually built in a series with the shorter ones on the up-river end. The action of the current around the ends of the wing dams scoured a channel and deposited the sand in eddies behind the dams. The spaces between the wing dams rapidly filled with sand as high as the dams, and willows soon sprouted on these sandbars, creating new islands in a few years.

Meanwhile, larger, more powerful riverboats had evolved and they needed a deep channel to carry greater payloads. Congress appropriated additional funds in 1907 to deepen the navigable channel to 6 feet. This was to be accomplished by constructing additional wing dams and shore protection and by additional dredging. The project was only half completed in 1925 when the Corps determined that the 6-foot depth would not be possible the entire length of the river using present methods. In any case, the River and Harbors Act of 1927 abandoned the 6-foot proposal and authorized an eventual 9-foot channel.

The magnitude of the early channelization projects is mind boggling. In constructing the 4-1/2-foot and 6-foot channels, the Corps of Engineers built over 2,000 wing dams and closing dams between St. Louis and Minneapolis. In addition, many miles of shoreline were protected with riprap. Most limestone and dolomite bluffs that abut the river have quarries in them where rock was excavated for constructing the channelization structures. A typical quarry still has a pillbox-shaped mound of solid rock within it where the capstan of the derrick stood.

Riprap and wing dams prevented lateral movement of the river. In effect, they "hardened" the river or "fixed" it in position. They also had a dilatory effect on the river because they collected sewage and garbage.

Connecting the Mississippi with the Great Lakes

During the era of channelization of the Mississippi, a fateful connection was made linking the Mississippi with the Great Lakes. Completed in 1900, the Chicago Sanitary and Ship Canal connected Lake Michigan with the Illinois River. Lake Michigan had long been degraded by domestic and industrial sewage in the Chicago area, and the canal enabled the city to use Lake Michigan water to flush its wastes down the Illinois River into the Mississippi. In addition to being an ecological tragedy that caused severe degradation of the Illinois River, the canal also provided an avenue for exotic biota (e.g. the zebra mussel) to enter the rivers of the Mississippi watershed from the Great Lakes.

Headwaters reservoirs

Nine in-channel glacial lakes are found in the Mississippi Headwaters, including Lake Winnibigoshish and Lake Pokegama, both of which were dammed in the late 1800s as part of a U.S. Army Corps of Engineers navigation and flood-control system that includes four other lakes in the Headwaters watershed. The original purpose was to store spring runoff in order to augment low summer flows for commercial navigation between St. Paul and Prairie du Chien, but the nine-foot channel project made that function unnecessary. The reservoir dams are now mainly used for flood control, recreation, residential amenities, and conservation.

Taming the Des Moines Rapids

Although steamboats had operated on the Lower Mississippi River since 1811, it wasn't until 1820 that Major Stephen H. Long arrived at Keokuk on an exploratory trip for the U.S. Army in his strange sternwheeler the "Western Engineer." At Keokuk he encountered the first of two major obstacles to steam navigation of the Upper Mississippi River, the formidable Des Moines Rapids. They extended from Keokuk at the mouth of the Des Moines River 11 1/4 miles up the Mississippi to Montrose. The prevailing feature of the rapids was the flatness of the river bed, formed by almost horizontal ledges of limestone that followed the slope of the river. At low water the rapids were no more than 24 inches deep, a severe obstacle even for shallow draft steamboats. The rapids had limited traffic on the Mississippi as far back as the 18th century when fur traders had to have their boats unloaded and their cargo carried across the rapids in smaller craft called "lighters." Indian villages had sprung up at Keokuk and Montrose in response to the need for labor. Lieutenant Zebulon Pike used lighters in his exploratory voyage up the Mississippi in 1805.

In 1820 most rivermen assumed that no steamboat would ever conquer the rapids, although the small steamboat "Virginia" crossed them twice in 1823 on two trips to Fort Snelling, Minnesota. George Catlin, the famous artist, was a passenger on one of the trips. Few other steamboats dared go through the rapids.

In 1824 Congress passed the General Survey Act that gave the President authority to use officers of the U.S. Army Corps of Engineers to make surveys of navigation routes. This action has been of profound importance for the Mississippi River and the nation.

The first reconnaissance surveys of the Des Moines and Rock Island Rapids was made in 1829, and recommendations were made to excavate the Des Moines Rapids channel to a depth of 5 feet, but no further work was done until 1837 when Lieutenant Robert E. Lee resurveyed the rapids and endorsed excavating the channel. Work was done sporadically until1866 when it was apparent that excavation was not working. To improve the rapids the way suggested by Lee and others would have required an 11-mile cut, two hundred feet wide through solid rock, resulting in a narrow sluice with an extremely strong current, making navigation difficult and dangerous.

Keokuk was a busy place at the end of the Civil War, and there was a growing need for improving the rapids. Over 300 steamboats were engaged in commerce on the Upper Mississippi, yet they still had to transfer cargo to lighters or to the new railroad that ran between Keokuk and Montrose. The five state bordering the Mississippi north of the Des Moines Rapids were growing more than a third of the produce in the United States, and they wanted to ship it downriver. Most important, the young lumber industry was booming, with more than 400,000,000 board feet of lumber being rafted downriver to sawmills each year.

Anxious to heal the wounds of the Civil War and aware of the need to improve the Mississippi for trade between North and South, Congress authorized a four-foot channel north of St. Louis. As part of the River and Harbor Act, money was provided for improvement of the Des Moines Rapids and the Rock Island Rapids.

About a thousand men were employed at the peak of construction of the Des Moines Rapids Canal that opened to traffic in 1877. The lateral canal ran along the Iowa shore and was 7.6 miles long, 300 feet wide, and five feet deep. Its three locks provided a total lift of 18.75 feet. The locks were constructed of limestone quarried from the adjacent bluff.

The Hydroelectric Facility and Lock and Dam 19, Keokuk, IA

The Des Moines Rapids Canal performed well for many years, but it had limitations. During high water about 15% of downbound steamers chose to bypass the canal, thus saving over an hour of travel time. Almost all boats going up river used the canal rather than fight the current. The massive log rafts that floated downstream wouldn't fit in the canal and had to be broken up and reassembled, a procedure that could take 40 to 50 hours.

The beginning of the end for the Des Moines Rapids Canal came when the River and Harbor Act of 1902 authorized a survey at Keokuk to determine if a dam constructed at the foot of the rapids would benefit navigation. The report was favorable for a dam that would flood the entire rapids. A single lock would cut travel time and operating expense. Raft traffic would suffer, but it was already dying. Only one sawmill remained on the Mississippi south of Keokuk.

In 1905, the Keokuk and Hamilton Water Power Company (now the Union Electric Power Company) was authorized to construct a dam with a hydroelectric plant, a lock, and a dry-dock at Keokuk. These structures, with the exception of the dam and powerhouse, were turned over to the United States upon their completion in 1913. At the time of construction, the hydroelectric plant was one of the world's largest. Because it generated more electricity than could be sold, drainage districts were formed. They de-watered the floodplain land for agriculture using electric pumps, thus eliminating large expanses of floodplain forest. In 1913, the Keokuk dam was the only dam on the Mississippi below the Falls of St. Anthony. It profoundly impacted the ecology of the Mississippi River. Water that does not go through the dam's turbines, goes over the top of the 40-foot high dam which is consequently a barrier to migrating fish. The impoundment is an effective sediment trap.

The original 358-foot lock was an impediment to river traffic in the 9-foot channel project. It was replaced by lock 1,200 feet long and 110 feet wide, completed in 1957. Filling time for the lock is about 10 minutes and emptying time is about 9 minutes. A 15-barge tow can pass through the lock in one-half hour if the lockage goes smoothly.

The 9-ft channel

Channelization projects prior to 1930 had employed wing and closing dams, shore protection, and auxiliary dredging over other methods of maintaining the navigation channel. These methods were not only less costly, but they also permitted open-channel navigation, which was preferred by those who ran log rafts and packet boats. The short-lived logging boom began in 1878, hit its peak in 1892, and was over in 1915, when the last remnants of Wisconsin lumber were rafted down the Mississippi. Traffic by 6-foot draft steamboats also decreased rapidly because these obsolete craft could not compete with the rapidly expanding railroads. For these reasons and to provide work for the unemployed during the great economic depression of the 1930s, the Rivers and Harbors Act of July 3, 1930, authorized a 9-foot navigation channel with a minimum width of 400 feet to accommodate long-haul, multiple-barge tows. This was to be achieved by the construction of a system of locks and dams, supplemented by dredging.

In 1930, when it was first authorized, there were early concerns about the biological impacts of the 9-foot channel project. In numerous pronouncements, the Isaac Walton League condemned the 9-foot channel plan as detrimental to the environment. The league was especially concerned that soil erosion and pollution be controlled before the project began.

Writers of outdoor columns in newspapers were also vocal in condemning the 9-foot channel project. For example, the Voice of the Outdoors (Winona Republican Herald, July 26, 1930) stated,

> ".......we are still against the alleged nine-foot channel under the dam form of construction. We are now more convinced than ever that it will be a gigantic commercial failure and will be impossible to maintain without spending millions of dollars each year in dredging operations. It will completely destroy bass fishing on the river and will look like a lot of link sausages on a map and smell worse than said sausage if they were left exposed to the present heat for a week. The scenic attraction of the river will be completely wiped out."

Many observers expressed concern that soil erosion would constitute a severe problem in the proposed navigation pools. C. G. Bates, a forestry engineer, was quoted by the Voice of the Outdoors (Winona Republican Herald, July 23, 1930) as predicting that the proposed pools would be completely filled with sand in a period of 20 years.

The U. S. Bureau of Fisheries viewed the 9-foot channel project with serious misgivings. The following are direct quotes from the Bureau's written testimony presented at a hearing in Wabasha (Culler, 1931).

> "The Bureau of Fisheries views with much concern the establishment of a series of slack water pools along the Upper Mississippi River until the problem of pollution and erosion as they affect this upper section of the Mississippi River are solved. If the lake formed by the Keokuk Dam may be taken as a criterion, the creation of similar pools may mean the eventual elimination of all fish life inasmuch as the production of fish in Lake Cooper, which is formed by the Keokuk Dam, has declined according to the official statistics of the Bureau of Fisheries from 701,181 pounds in 1922 to 350,750 pounds in 1929.
>
> The construction of slack water pools such as the one that is contemplated at this time and in this particular section north of Winona, will mean the eventual elimination of the smallmouth black bass for which this section is so widely known."

The U.S. Bureau of Biological Survey (Henderson, 1931) reported on the other hand, that the 9-foot channel project could be beneficial to waterfowl and muskrats if water levels were stabilized. The Bureau's conclusions were based on a comprehensive study of the biological effects of Lock and Dam 19 on the Mississippi River. The following is a direct quote from Henderson's report:

It is very probable that considerable portions of the Upper Mississippi River Wildlife and Fish Refuge would be benefited by the construction level above a maximum of five feet in depth over the newly flooded bottomlands, provided that stable water levels are maintained throughout the year. The construction of these dams will undoubtedly make an entirely different type of Refuge, for most of the bottomland timber will be destroyed and the percentage of land unaffected by the flooding will be relatively small. Immediately following the construction of any system of dams flooding the lowlands, an adverse period must be anticipated, but following the re-adjustment and re-establishment of the aquatic and marsh vegetation, the Refuge should be an improved place for waterfowl and probably also for muskrats.

Although authorization for the project came in 1930, it received minimal funding during the early years of the Great Depression and the last years of the Hoover administration. With the Roosevelt administration in 1933 and its New Deal, the 9-foot channel project was resurrected to put people back to work. It authorized the Corps to build and operate one of the largest public works projects in the history of the U.S., and ultimately led to the construction of 29 locks and dams on the Upper Mississippi River. The system enabled modern towboats to traverse the 400-foot elevation gradient and 670 miles of river between St. Louis and Minneapolis.

By the end of the 1930's, the 9-foot channel and the lock and dam system had formed a series of lake-like river pools. This inundation altered the function of the rock channel-training structures. Their ability to direct flow to a narrow channel and their sediment-holding function were greatly reduced. In fact, rather than holding large volumes of sediment, some wing dams developed large scour areas. If not for the 9-foot channel, accretion behind the emergent wing dams would probably have created a river like much of the Missouri River, with a narrower, faster channel.

The establishment of the 9-foot channel project facilities raised water levels in most reaches of the river, but was not sufficient to provide the depth needed throughout its length. Thus, in areas where there is less depth than programmed for, it is necessary to dredge. Most channel deepening is accomplished by using a hydraulic suction dredge and discharging to channel-side higher ground through pipes floated on pontoons. The Corps of Engineers' dredge "William A. Thompson" performs most of this function on the Upper Mississippi.

Most of the resultant 29 locks and dams were constructed during the 1930s. An exception is Lock and Dam 19 at Keokuk, Iowa, which was constructed as part of of a hydroelectric facility in 1914. An 1100-foot lock was added at Keokuk in 1958. The southernmost lock on the Mississippi is the Chain-of-Rocks facility at St. Louis, Missouri.

The movable section of the dams consists of tainter gates, roller gates or a combination of both. Earth dikes and overflow spillways, where required, complete the dams. The dams are designed for navigation purposes only, except for some power generation at Upper St. Anthony Falls and Dam No. 1. The dams serve no flood control function.
The river reach between two dams is called a "pool," but the pools are not stagnant, they remain riverine in form and function. Water flows have been slowed, but remain strong in in the main channel and less so in labyrinths of side channels in upper pools. The effects of impoundment are increasingly less apparent in downstream pools where the main channel is fairly straight, less of the floodplain is impounded, and there are fewer side channel and backwaters.

CONVERSION OF THE FLOODPLAIN TO AGRICULTURE

Owners of flood plain land between LaCrosse and Prairie du Chien, Wisconsin, proposed during the early 1920's, that their land be drained so that it would be suitable for agriculture. The proposed reclamation project was to include timber clearing, construction of dikes to protect the land from high water and the digging of internal ditches to drain the land toward pumping stations where the drainage water would be pumped over the dike. The land owners proposed that drainage districts be created under state law and that drainage costs be charged against the land to be benefited. Opponents of such reclamation insisted that the flood plain areas should be preserved for recreation and for the conservation of plant and animal life. The Izaak Walton League of America, which strongly supported the parties opposing drainage, requested the Department of Agriculture to investigate the practicability of reclaiming floodplain land between St. Paul, Minnesota and Rock Island, Illinois. As a result, a reconnaissance survey was made to determine the use and potential value of the flood plain land.

The survey revealed that there were about 343,000 acres of flood plain land between St. Paul and Rock Island and that the principal agricultural use of the land was for pasturage for cattle in dry seasons. Less than a fourth of the land was mowed for hay and only a very small part was cultivated. Reclamation of about 10,000 acres of the land had already been accomplished by 1924. Most of this early land reclamation was done in Wisconsin where 6,600 acres of bottom land in Buffalo and Trempealeau counties had been drained by 1912. Because of a break in a dike in 1913, most of the area was flooded and no pumping was done between 1913 and 1924. The land reclamation program was abandoned and most of this land ultimately became the Delta Fish and Fur Farm (now part of the Trempealeau National Wildlife Refuge). A second drainage district of 3,600 acres was completed just below Savanna, Illinois in 1925. The survey reported that another 86,000 acres could be reclaimed at an average ditching and diking cost of $45 to $75 per acre. Operation and maintenance of the drainage pumping plants were to be provided by an additional annual assessment. Farm land thus created was to be utilized for growing corn, the report continued, because dairy farmers on the hills bordering the Mississippi were reported to have insufficient land suited to the growing of corn and were forced therefore, to import cattle feed from other states.

Agricultural development of the UMR floodplain is heavily weighted to the river below Rock Island where the floodplain width averages 4-6 miles but may exceed 10 miles in some areas. Floodplain agriculture depends upon levees, and they too are unevenly distributed. From Minneapolis to Rock Island the floodplain is narrow, and about 3% has been leveed (about 15,000 acres). Between Rock Island and St. Louis, the floodplain is wider, and about 53% (about 530,000 acres) has been leveed. From St. Louis to Cairo, about 82% (about 543,000 acres) has been leveed.

POLLUTION

Early explorers were impressed with the quality of the Mississippi's waters. Both Pike and Long described the waters of the Mississippi below the St. Croix as reddish in color in the shallows. In deep water, Pike said it was as "black as ink." Long incorrectly interpreted the reddish color as being due to the color of sand on the bottom. Above the St. Croix, Long noted that Mississippi water was "entirely colorless and free from everything that would render it impure, either to the sight or taste." We now know that the waters of the St. Croix were naturally tannin-stained, reflecting their origin in northern bogs. They colored the waters of the Mississippi at their confluence. In its virgin state the Upper Mississippi was seldom muddy.

The first pollution complaints on the UMR concerned sawmill refuse, not because of aesthetics but because it constituted a navigation hazard. By the late 1870s, steamboat pilots reported that bars composed of sawdust were obstructing navigation above Lake Pepin and as far south as Winona. Also, river water permeated with sawdust retained resins that caused foaming in steamboat boilers.

By the late 1880s, Minneapolis was dumping about 500 ton of garbage into the Mississippi River below St. Anthony Falls each day in addition to raw domestic sewage and industrial wastes. St. Paul added an even greater amount of garbage and slaughterhouse wastes.

At the dawn of the 20th century, the River and Harbors Act of 1899 was the most broad and effective water pollution legislation in existence. It outlawed casting refuse into navigable waters and also stipulated that refuse could not be dumped on the banks of tributaries if it was liable to wash into navigable waters. The sawmill waste problem solved itself when the lumbering era petered out early in the century, but the problem of solid urban wastes continued to plague the river. Many citizens thought that treating these wastes was unnecessary, theorizing that the river would purify any material dumped into it. Many felt that rivers must forever be the common sewers and dumping grounds for everybody. By the end of the 19th century, the river was more important as a sewer than it was a navigation channel.

Today, the Upper Mississippi receives a complex mixture of agricultural chemicals, primarily herbicides and their degradation products, from the surrounding rich agricultural land that is intensively cultivated for corn and soybeans. The Minnesota and Des Moines Rivers, for example, are the primary contributors of alachlor, cyanazine, and metachlor.

To most observers, water quality in the Upper Mississippi River, has improved in recent decades. Gross pollution by domestic sewage has been reduced since passage of the Federal Water Pollution Control Act of 1972 that mandated secondary treatment of sewage effluent. But the river still receives an array of contaminants from agricultural, industrial, municipal, and residential sources. The impacts of these contaminants on river biota are still largely unknown.

Lake Pepin has been severely impacted by pollutants from the Twin Cities and from the Minnesota River. Lying in Pool 4, the lake begins about 75 kilometers below Minneapolis-St. Paul and extends 35 kilometers downstream. Ranging from 1.5 to 4 kilometers wide, Lake Pepin has a mean depth of about 5 meters and a mean water-retention time of 19 days. The hydrological effect of Lake Pepin has greatly enhanced the quality of the reach of river farther downstream. The lake traps sediment and associated contaminants, greatly reducing the transport of pollutants from the Minneapolis-St. Paul metropolitan area, the Minnesota River basin, and other sources to the riverine ecosystem downstream. Recent sedimentation rates in Lake Pepin range from 3 centimeters per year or greater in upstream reaches to about 0.5 centimeters per year in downstream reaches; 21 % of the lake's volume was lost between 1897 and 1986. The sediment-trapping ability of Lake Pepin substantially reduces contamination of burrowing mayflies and sediment downstream from toxic substances such as polychlorinated biphenyls (PCBs) and cadmium. The lake's sediment-trapping ability, however, will diminish as it fills with sediment and its volume declines.

The presence of PCBs in the river is attributed mainly to industrial sources. In sediments sampled during 1991-92 and in emergent Hexagenia mayflies sampled in 1988, concentrations were highest from the Twin Cities through Lake Pepin. Downstream from Lake Pepin, concentrations were much less. Greatest concentrations were in pools with cities, especially in the Quad Cities area (Rock Island, Moline, Davenport, and Bettendorf).

Improved waste treatment facilities in the Twin Cities area have caused marked improvement in general water quality during the past decade, resulting in recurrence of Hexagenia mayflies, increased fish diversity, and a more normalized comparative abundance of game and non game fishes.

The Mississippi changes character at St. Louis where the Missouri River enters the Mississippi, increasing the Mississippi's flow by nearly 50%. Historically, the Missouri contributed vast quantities of sand and silt from the Rocky Mountains and Great Plains. As evidenced by meander scars, flows of water and sediment, especially during floods, contributed to channel migration within the broad floodplain below St. Louis:

In the Upper Mississippi River Basin, more than 60% of the land area is devoted to cropland or pasture, and the major sources of nitrogen to most river waters are commercial fertilizers, manure, organic soils, and plant debris. The basin, excluding the Missouri River watershed, accounted for 31% of the total nitrogen delivered from the Mississippi River to the Gulf of Mexico between 1985 and 1988. Resulting high rates of nutrient loading downstream have contributed to the development of a 7,000 sqare-mile zone (about size of New Jersey) of reduced dissolved oxygen in the Gulf of Mexico.

INTRODUCTIONS OF EXOTICS

Fish stocking on the Upper Mississippi River began in 1872 with unsuccessful introductions of American shad and Atlantic salmon. Carp, deliberately imported from Europe, were caught in 1880 at Hannibal, Missouri; they were common as far north as Minneapolis by 1890.

Grass carp first appeared in the Upper Mississippi River commercial fishery in 1975. Natural reproduction in the Upper Mississippi has not been reported, but evidence of reproduction has been reported in the Lower Mississippi and some of its tributaries. Other exotics such as salmonids, rainbow smelt, and goldfish appear as strays in the Mississippi fishery, but none occur in significant numbers.

Purple loosestrife, a nonindigenous wetland plant introduced to North America from Europe in the early 1800's, was probably introduced into the Upper Mississippi River basin as an ornamental in the early 1900's. This beautiful, perennial plant forms dense monotypic stands in wetlands, replacing many native wetland plants. Purple loosestrife has no food value for wildlife, and its replacement of native emergent plants such as cattail makes wetlands less suitable as wildlife habitat. By 1985, purple loosestrife had become established throughout much of the Upper Mississippi River Basin. In the early 1980's, it had become notably abundant on the Upper Mississippi River National Wildlife and Fish Refuge, and it had infested wetlands of Pools 4 through 14 by the late 1980's.
Traditional control methods have met with little success, probably because the plant's seed reservoir is so extensive. Biological-control methods through the release of natural enemies such as root-boring and leaf-eating insects appear to be

succeeding. Eradication of purple loosestrife is probably not feasible, but it may be possible to achieve modest control.

Exotic submerged aquatic plants include Eurasian milfoil and curlyleafed, which have caused nuisance problems throughout the river system.

By 1991, the zebra mussel, a nonindigenous species from Eastern Europe, had entered the Upper Mississippi River via the tributary Illinois River. Zebra mussel populations expanded rapidly, and by mid-1993 zebra mussels were found throughout most of the Upper and Lower Mississippi River. By mid-August 1993, average densities of zebra mussels in the lower Illinois River had increased to more than 50,000 per square meter of river bottom. Subsequent high mortality reduced densities there to about 4,000 per square meter by August 1994.

Zebra mussels can directly harm certain native benthic invertebrates, particularly clams. Zebra mussels attach to hard surfaces, including the shells of clams, by means of byssal threads. Zebra mussel infestation on clams may interfere with the clams' feeding, reproduction, and movement.

Thus, the native clam fauna in the river could rapidly and severely decline unless methods for protecting clams from zebra mussels can be developed. Perhaps no other group of freshwater organisms is more seriously threatened with extinction than our native clams.

Zebra mussels could also alter the invertebrate communities inhabiting, the rock substrates of wing dams and other structures. Colonization by zebra mussels will probably affect some invertebrate species more than others. Zebra mussels do not prefer habitats with high water velocity. They are more likely, therefore, to displace Cheumatopsyche caddisfly larvae than Hydropsyche caddisfly larvae.

URBAN SPRAWL

The highest human population densities in the Upper Mississippi River watershed are in cities along its rivers. Urban development has increased the rate of water delivery to the river because of the conversion of permeable soils to concrete, asphalt, and rooftops. Storm runoff is contaminated with automobile wastes, industrial contaminants, residential fertilizers and pesticides, yard wastes, and trash. While municipal and industrial pollution have been controlled to a great extent in most municipalities, most urban runoff enters the river untreated.

IMPACTS OF RECREATIONAL USE

Recreation is a major use of the Upper Mississippi River. Activities include fishing, hunting, trapping, boating, camping, swimming, birding, and tourism. However, these activities are not evenly distributed along the river. Recreational use and expenditures are highest from Minneapolis to Rock Island where the river provides a rich mosaic of braided channel, islands, floodplain vegetation, and vegetated backwaters - mostly on public land. Recreational use and expenditures are low from Rock Island to Cairo where most of the broad, fertile floodplain has been separated from the river by levees and converted to agriculture, and where there are few backwaters and little public land.

In upper pools, especially from Lake Pepin to Prairie du Chien, recreational use is high. Swimmers and campers flock to the beautiful public sand beaches that flank the main channel, unmindful that virtually all of them are composed of dredge spoil that was pumped there by the Corps of Engineers as part of their routine channel maintenance practices prior to the 1973 ban on indiscriminant placement of spoil. Most of the islands are no longer being nourished by new spoil and they are being eroded by currents during floodtime, wind-driven waves, and especially by waves generated by boats. The effects of boat wakes are obvious along the main channel where the shores are subject not only to wakes of towboats, but also to the intense wakes of large, fast pleasure boats that far outnumber towboats on upper pools. The sediments that wash into the main channel are carried along by the current, inexorably moving downstream unless they are swept out into the backwaters where they will probably remain forever.

While impacts of boat-generated waves are obvious along the main channel, less obvious is the insidious damage done by hunters, fishermen, and trappers in the backwaters. Most of their impacts go unseen because their boating activity often occurs in early morning or late evening when observers are not usually active. Duck hunters who penetrate the most remote locations in pre-dawn darkness do the most serious damage. Competition for good hunting spots is fierce, and as hunters roar through narrow side channels with boats encumbered with bags of decoys and other heavy gear, their wakes wash sediment away from the shallow roots of the floodplain trees that line the channel banks. Because the trees are still anchored by their roots on the landside, the wind usually topples them inland, throwing up massive walls of roots about one foot thick. Thus, the shoreline retreats, islands become smaller, and the side channels becomes wider, usually shallower, and more monotonous.

ECOLOGICAL IMPACTS OF CHANNELIZATION

The Caucasian invasion of the Mississippi River Basin caused environmental changes that were analogous to a great climatic change. The pioneers came into a river environment where aggradation had been underway for over 10,000 years. By barring the land and increasing sediment input, they accelerated the rate of aggradation. Their engineering works also accelerated the aggradation. The free-flowing river was "hardened" with rock structures that collected sediment and prevented the river from meandering. Finally, the river was converted into a series of man-made lakes that serve as sediment traps and are subject to problems, such as eutrophication, that are typical of lakes receiving nutrient-rich effluent and runoff. It is important to remember that while rivers are virtually immortal, lakes are mortal. Lakes are born, and then pass through the stages of youth, middle age, old age, senescence and death as they inexorably fill with sediments or the products of enrichment. Lakes within agricultural and other fertile watersheds tend to age faster. This enhanced aging process is known as eutrophication.

Because the river has been channelized and dammed, it can no longer function as the large floodplain river that it once was - one that wandered within its floodplain, cutting new channels, creating new backwaters, and rejuvenating itself by alternately flooding and drying out. Presently, the river's productive wetlands are rapidly being transformed to relatively unproductive floodplain forest. Left unchecked, most of the transformation will apparently be completed in less than 50 years.

Impacts of nine-foot channel

Impacts resulting from the project are due to: 1) construction of wing dams, closing dams and shoreline protection associated with the 4 1/2-foot, 6-foot and 9-foot channel projects; 2) construction of locks, dams and earthen dikes; 3) impoundment of the river and the subsequent stabilization of water levels; 4) operation of the locks and dams; 5) construction and maintenance of navigation assistance structures such as channel markers; 6) dredging and the consequent creation of dredge spoil deposits; and 7) operation of commercial craft, pleasure boats and U.S. Coast Guard vessels.

Prior to the 1930's the river bottoms were primarily wooded islands separated by deep sloughs. Hundreds of lakes and ponds were scattered through the wooded bottoms. Bay meadows and small farming areas occupied some areas on larger islands. Marshes were limited to the shores of lakes and guts leading off the sloughs. Marsh flora was also limited, with river bulrush making up the dominant habitat. Most marshes, lakes and ponds generally dried up completely by the end of the summer. Thus, the uncontrolled river was subject to wide fluctuations of water levels, ranging from flooding in the spring to drying out of the river bottom land in the summer. Fluctuating water levels allowed marshes to dry prior to stabilization of water levels by the 9-foot channel project. During dry years the entire refuge throughout its 284 mile length became almost at once a virtual tinder box. Wild fire was a constant threat.

Early channelization projects, which were initiated in 1878, have been overshadowed by the 9-foot channel project of the 1930s. The navigation dams have transformed the Mississippi River, which was formerly a braided stream, into a series of large, well-fertilized, silted impoundments through which an appreciable current still flows. Navigation markers punctuate the main stream of the river and it is flanked in many areas by extensive deposits of dredge spoil. Railroad beds, highways, land fills and municipal flood dikes have constricted the flood plain in many areas and intercepted historic channels.

To accomplish the objectives of the project, the moveable section of the dams consists of tainter gates or roller gates or a combination of both, and earth dikes and fixed-elevation overflow spillways where required. The low dam elevations and small pool capacities relative to flood volume precludes operation of the dams for flood control. All the gates in each dam are removed from the water long before flood stage is reached so that natural open river conditions exist during the flood period.

Whenever flooding threatens in the Mississippi River valley because of high water content of the winter's accumulation of snow, some people believe that the navigation pools should be drawn down to provide storage capacity for the coming floodwaters. In earlier years, pools were drawn down in winter to increase capacity for spring floods; the result was devastating losses to fish and wildlife populations. However, there are two reasons why this drawdown cannot be performed, one legal and one technical. The legal reason is the 1934 "Anti Drawdown Law". It directs the Corps of Engineers to operate and maintain pool levels as though navigation was carried on throughout the year in recognition of the needs of fish and other wildlife resources and their habitats.

The technical reason for not drawing the pools down is the fact that the storage capacity of the navigation pools is so small in comparison with the magnitude of the flood flows that a drawdown would be refilled in a matter of hours and would not appreciably lower the stages reached by the flood.

The navigation dams of the Upper Mississippi have transformed the river into a series of impoundments, which occupy most of the floodplain of the river. Consequently, the river is much wider, and much shallower, above most dams than it is at New Orleans where the river is undammed. Each impoundment consists of three distinct ecological areas. The tailwater areas just downstream from the dams show the river in relatively unmodified form. The areas are typified by deep sloughs and wooded islands. The middle portions of most pools contain large open areas with few large trees, because stands of timber were usually cut prior to impoundment. The inundated floodplain prairies and hay meadows of the mid-pool areas now provide the best marsh habitat and are among the most productive ecosystems of the earth. The middle portions of the pools are principally flooded hay meadows. They now provide the best marsh habitat. The downstream reaches of the pools are deeper, however. They consist mainly of open water and their bottoms are heavily silted. Marsh vegetation is presently creeping downstream as the pools silt in. Marsh vegetation in the middle pool areas is being replaced, in turn, by trees and other terrestrial vegetation. The pool areas contain expansive fields of submerged or partially submerged stumps. Like wing dams, they too may lurk about propeller depth, depending on pool level.

Rising pool levels of the 9-ft channel project submerged most of the rock wing dams, closing dams, and shoreline protection that were constructed during the 1878-1907 period. Still partially functional, now lie beneath the water. The wing dams provide rocky corrugations on the river floor, so that they, in effect, have increased the total surface area of the river bottom - thus increasing its carrying capacity for invertebrates such as hydropsychid caddisflies and periphyton. When first constructed they provided excellent fish habitat, especially for smallmouth bass. Impoundment has also increased the surface area of the river, thereby increasing the area of the trophogenic zone. Below St. Louis, where the river is not impounded, wing dams still rise above the water during normal flow.

From St. Louis southward the river is flanked by agricultural levee districts within which parcels of fertile, often waterlogged, bottomland have been "reclaimed" by ringing them with flood levees. The wettest parcels are usually ditched to conduct excess water to sumps where it is collected and pumped over the levees and into the river.

For the recreational boater and fisherman, the rock structures used in the channelization of the river are of profound importance. They usually lurk, unmarked, about propeller depth. Most serious boaters have accidentally hit them - usually with dire consequences such as a mangled propeller, or a damaged lower unit.

The creation of slack-water areas and marshes improved the river corridor for furbearers and waterfowl. Significant portions of the world populations of canvasback ducks and tundra swans utilize the river for resting and feeding during fall migrations. A large portion of the river resource is presently contained within the Upper Mississippi River National Wildlife and Fish Refuge and the Mark Twain National Refuge. The U.S. Department of Interior in cooperation with adjacent state governments is responsible for its management.

Unfortunately, the ecological changes that occurred immediately after impoundment were not well documented. The concern for environmental quality, as perceived today, was not foremost in the minds of most early scientists and laymen. In addition, water quality investigations in the United States had concentrated on closed lake systems. Rivers tended to be ignored. The passage of the National Environmental Policy Act of 1969 required that governmental agencies address the environmental impacts of the operations and maintenance of all water-related projects. In response to this, the U.S. Army Corps of Engineers conducted environmental impact studies on the Upper Mississippi. These studies elucidated at least some of the problems associated with the closure of the dams 30 yr. earlier. Most investigators now perceive the river's major resource quality problems as being associated with shallow reservoir dynamics.

The Mississippi River is generally considered to be a clearwater stream with regard to sediment transport. Most of the sediment load at St. Louis is derived from the Missouri River. The closure of the navigation locks and dams and the conversion of the open river into a series of shallow pools have changed the sedimentation patterns in the river, but most of the reservoirs accumulate sediments at high rates due to the lack of current in non-channel areas during periods of normal flow. The significance of these sediment depositions in non-channel areas lies in the relationship between loss of depth and eutrophication processes. Loss of depth has facilitated the encroachment of rooted aquatic plants into open water areas. In turn, they have accelerated sedimentation rates by retarding water flow. The net result has been an increase in sedimentation rates, particularly in many of the highly valued, biologically productive areas. Furthermore, a decrease in biotic diversity has occurred in many of these areas due to the introduction of unstable substrata. Finally, increased sedimentation rates have contributed significantly to eutrophication processes that also appear to be occurring at increasing rates.

Many of the wetlands created by the 9-Foot Channel Project are located great distances from the main channel, and water circulation through them is usually poor during low-flow conditions. Entrapment and accumulation of allochthonous materials occur in these areas mainly during periods of high river discharge when surrounding landforms are overtopped with water. This results in the accumulation of sediments and associated nutrients and in the stimulation of the growth of aquatic plants. Collectively, these processes lead to increased inputs of nutrients and in accelerated rates of eutrophication. It is clear that nutrient recycling plays a dominant role in the eutrophication processes. The growth and distribution of aquatic plants have changed significantly during the past 30 yr as a result of wind and/or loss of depth. Furthermore, the progression toward hypereutrophy as a result of impoundment has resulted in the reduction in diversity of benthic invertebrate communities.

The locks and dams have produced many beneficial effects. By impounding the river, they have increased the water surface per linear mile of river, thus increasing the total photosynthetic area of the river. As a consequence, the river now produces more pounds of fish per linear mile than it did before the impoundment. Moreover, the tailwaters of the dams are virtual feed lots for fish. The fish, which congregate in the tailwaters of a dam, receive food produced in the huge expanse of the impoundment above. Not only have the dams provided more fish, they have also concentrated the fish so that they may be harvested more efficiently. Because the river is so productive, sport fishermen are able to fish year around, with two lines, for most river fish. Catch limits are more liberal in most instances than they are in inland waters.

By dedicating almost 100% of the lands in the river bottoms to public ownership and control, the 9-foot project brought to fruition a long-sought dream of conservationists from all walks of life for the preservation of the bottom lands as a haven for wildlife and fishes. It also made the lands available for all times to lawful and legitimate public use, the foremost of which has been for general recreation.

The project removed farming operations from a high-risk area. Crop production, haying and grazing were always subject to flooding, and access was often difficult or impossible in high water. Consequently, flood plain farming operations were submarginal at best.

Prior to the project, a large-scale program of fish rescue was carried out each year. The rescue work was made necessary by fluctuating water levels, which caused fish to be stranded in flood plain pools. Stabilization of water levels made this work unnecessary.

Complete federal ownership of bottomlands permits efficient designation of sanctuaries and open hunting areas to the welfare of migratory waterfowl populations during the hunting season.

The navigation dams have increased waterfowl habitat and made pleasure boating possible. In some pools, the sand from dredging has made beaches that are intensively used by swimmers, campers, and boaters.

Complete federal ownership of the bottomlands assures the continued free use of the area by the public. In an era when 1!no trespassing" signs are becoming increasingly prevalent, it is refreshing to know that such signs will not appear in the Mississippi River Refuge, and 9-foot navigation project lands and waters.

The existence of the pools has led to greater cooperation between state natural resource departments, enabling the states to manage fish and wildlife resources more efficiently. The present impoundments usually extend, to the railroad tracks, which flank the river on either side. The tracks serve as easily recognized boundaries to the area of fishing reciprocity, which lies between states.

The locks and dams are impressive structures and most people enjoy viewing them. Many people also enjoy watching tows pass through the locks. The play of spotlights and the sound of amplified radio messages are dramatic and exciting. Visitors from most of the 50 states and many foreign countries heavily patronize the viewing stands at the locks. The sight of a modern towboat with a full complement of barges lends beauty and contrast to the naturalness of the river setting.

The project has enhanced the opportunities for boating on the river. It is unlikely that water skiing and the use of personal watercraft, for example, would be as popular under natural river conditions. The inundated bottom lands presently offer a labyrinth of channels and back water lakes which are available to pleasure boaters, fishermen and hunters.

Increased water areas have caused populations of valuable fur bearers, such as muskrat and beaver, to increase. In addition to being valuable monetarily, the animals provide a distinct recreational resource for trappers.

Unfortunately, the extent or abundance of many key native biotic communities and organisms has decreased along substantial reaches of the river in recent years or decades; these communities include floodplain forests, submersed plants, clams, fingernail clams and other bottom-dwelling invertebrates, certain fishes, migratory waterfowl, colonial waterbirds, songbirds, and mink. Abundance of certain nonindigenous plants and animals have increased recently.

Prior to 1973, dredge-spoil deposits were often placed by the dredge at the nearest available point to reduce costs. This was detrimental to marsh areas that have become covered with sand. The sand flowed directly into the marsh from the discharge pipe, or it was carried there by normal currents, floods, or by the wind. Slough openings were closed and spawning beds and food producing areas were covered with sterile sand. Many acres of forest were killed or stunted by the deposits. The above changes were continual, accumulative and, in most cases, irreversible.

Many channels of the river have been intercepted by flood levees, railroads, highways, and barrier islands of dredge spoil. Such channels stagnate in the summer and the deeper ones stratify thermally. The rich organic ooze, which collects on the bottom, consumes oxygen from the lower stratum of water until it becomes a death zone. Most forms of life, clams included, fail to live in such areas. Because of the lack of circulation in such areas, organic matter accumulates rapidly on the bottom under anaerobic conditions. The isolated channels, which have become extremely rich eutrophic lakes, now have bottoms consisting of deep deposits of unproductive organic ooze.

Towboats scour the channel with their propellers, increase turbidity, erode shorelines, and entrain and impinge fish. Their barges pose the threat of toxic spills and may damage riparian and littoral habitats at fleeting areas.

Floodplain forests

As it relates to forest communities, the floodplain is defined as that area of a river valley covered with materials deposited by floods. Floodplain forests benefit the riverine ecosystem in many ways. They serve as rich habitats for fish and wildlife during floods. They reduce soil erosion, improve water quality, and beautify and diversify the landscape. Fallen leaves that arise from the floodplain or wash in from the tributaries are an important energy source that fuels complex food webs that culminate in organisms as diverse as mayflies, walleyes, and eagles.

Floodplain forests in the Upper Mississippi River valley are now confined to a riparian zone a few kilometers wide at most. By 1989 the proportion of the Upper Mississippi River valley covered by forest had decreased spatially from upstream to downstream as follows: 18.9% between Minneapolis, Minnesota, and Bellevue, Iowa; 13.5% between Bellevue and Alton, Illinois; and 7.3% downstream from Alton. In many reaches, especially downstream from Bettendorf, Iowa, most of the remaining floodplain forest occurs on islands. The floodplain forest of today represent only a small portion of presettlement forests. Floodplain forests decreased rapidly in the 1800s because of the conversion to agricultural land and the harvesting of trees for fuel and lumber.

In northern reaches, floodplain tree species include silver maple, willow, cottonwood, elms, green ash, and river birch. Pin oak, bur oak, and swamp white oak may dominate well-drained higher grounds and terraces. Common associates include shagbark hickory, bitternut hickory, box elder, and mulberry. The complex understory includes small tree species, shrubs, and poison ivy. Frost grape and poison ivy may climb 30 feet into the trees. Wood nettles are the most conspicuous herbaceous plants.

In southwestern Illinois, the floodplain forests include swamp cypress communities dominated by bald cypress. The ground cover of the floodplain forest includes tree seedlings and herbaceous plants - especially wood nettles.

Recently, large floodplain forest areas are recovering from the great Midwest flood of 1993. While most floodplain trees can survive inundation for a week or two, prolonged flooding can be deadly for species like pin oak and hackberry that require well-drained soils.

Changing species composition of floodplain forests

The composition of dominant tree species in floodplain forests of the Upper Mississippi River has changed considerably in the last 200 years. American elm declined markedly after 1960 because of Dutch elm disease. Eastern cottonwood, green ash, and oaks (mainly pin, swamp white, and bur oaks) have become less abundant, compared with silver maple. During early European settlement, the floodplain forests at the tristate border of Iowa, Minnesota, and Wisconsin were codominated by green ash and silver maple. Floodplain forests at the confluence of the Mississippi and Illinois rivers, codominated by hackberry, elm, pecan, willows, and eastern cottonwood during early European settlement, are now dominated by silver maple. Similarly, eastern cottonwood and sycamore dominated floodplain forests just upstream from the mouth of the Ohio River during early settlement times but are now dominated by silver maple and willow. The amount of floodplain forest in pioneering and transitional successional stages has decreased greatly, and much of the present floodplain forest in the Upper Mississippi River valley is mature.

Many species, such as hackberry, pecan, elm, willow, and cottonwood have decreased in abundance since presettlement. This indicates that reproduction and/or establishment of these species is poor. This is probably due to a lack of suitable site conditions due to effects of impoundment, as well as to a lack of an abundant seed source due to past logging activities. These species probably will continue to decline in importance in the floodplain forests. Floodplain forests through the entire Upper Mississippi River are increasingly lacking in diversity, trending toward forests dominated by silver maple.

The silver maple, a fast-growing swamp species that may attain a height of 120 feet, is well adapted to dominate the floodplain forest. Its shallow root system enables it to flourish in moist soils, but it also does well on drier sites. It has a wide tolerance to temperature extremes and is abundant throughout the entire Upper Mississippi River all the way north to the river's source in northern Minnesota. It is relatively shade tolerant and can withstand prolonged submersion during floods. If cut by loggers or beavers, it clones readily from the stump, creating multiple trunks. If partially buried by sediment, it develops adventitious roots. It blooms early in the spring, long before leaves appear, sometimes while there is still ice on the river. Winged seeds mature in late spring and are spread by the wind, but also by river currents during the usual "June rise." As river levels drop, the seeds may be stranded on fresh sediment deposits where they germinate at once and, like a ring in the bathtub, show how high the water was. They also germinate on the forest floor, where they may persist for years in dense stands of stunted seedlings, waiting in reserve for a sunlit opening to be created by the demise of a tree of the overstory. Once an opening is created, they grow rapidly. The loss of elms due to Dutch elm disease opened new habitat for silver maples during the last 40 years. Unlike the silver maple, willow and cottonwood are not shade tolerant and require new sediment deposits and sunlight to flourish.

Extreme flooding during a single growing season can severely disturb floodplain forests. Such disturbance through flooding was illustrated by the effects of the Flood of 1993, a year when unusually heavy, persistent rainfall caused extreme flooding that lasted from early spring through much of the growing season along a significant portion of the Upper Mississippi River. The Flood of 1993 caused substantial tree mortality in the floodplain forests, particularly in the lower reaches of the Upper Mississippi River. In general, young trees were more vulnerable to flooding than older trees. For older trees, the longer the flood the greater the mortality.

The mortality of trees and saplings due to flooding also varied greatly among species. The least flood-tolerant trees were hackberry, Kentucky coffeetree, sugarberry, river birch, and white mulberry. Pin oak, silver maple, American elm, and slippery elm were moderately tolerant. Sycamore, hawthorn, green ash, black willow, swamp white oak, and eastern cottonwood were most tolerant. The effects of the Flood of 1993 on floodplain forests along the Upper Mississippi River are expected to persist for decades.

Aquatic vegetation

The following is excerpted from a paper written by William Green on ecological changes within the Upper Mississippi River Fish and Wildlife Refuge since inception of the 9-foot channel.

The Upper Mississippi River valley is unique in its flora and fauna. It enjoys conditions not generally associated with its geographic location. What has been referred to as a "pseudo-Carolinian zone" extends north along the Mississippi into the Alleghanian Zone. Thus, refuge flora and fauna, although primarily Alleghanian, have representatives of Carolinian species as well as occasional Canadian forms. A feature making the refuge even more interesting is the overlapping of eastern and western species and subspecies. There are also several high "sand prairie" areas scattered along the length of the refuge, offering habitat conditions normally found much farther west. These sand areas reach elevations high enough to protect them from severe floods, and consequently have developed a flora very distinct from that of the true flood plain, with plants of dry upland prairie predominating.

River bulrush, which was the most common marsh species prior to impoundment, has continued to be an important marsh plant. Coming in dense, solid stands for several years following impoundment, this species deliquesced for a few years, but has since made a comeback and is at present an important marsh species, especially for muskrats. Although this species seldom sets seed to any extent on the river, there have been years when it seeded heavily, and then it was of considerable value to waterfowl also.

Emergent and submersed aquatic plants were present but not abundant in the Upper Mississippi River before the locks and dams constructed during the 1930's flooded thousands of hectares of former agricultural areas, lowland hardwood forests, and shallow marshes. The creation of navigation pools abruptly altered the hydrology of the river; similarly, the diversity, abundance, and distribution of aquatic plant species changed markedly in the decades after impoundment. The downstream reaches of the newly created pools provided stable habitat for aquatic plant species. In midpool regions, conditions after impoundment were also favorable to marsh vegetation. Upstream reaches, in contrast, remained similar *to their preimpoundment conditions.*

Extensive, dense beds of water smartweed developed in the year after impoundment, often in such dense beds that the bottoms took on the reddish tinge of the blooms. The smartweed remained productive for about 5 years. Thereafter, remnant stands were sterile and reproduced only vegetatively. Eventually, water smartweed was replaced by various species of pondweeds, mostly longleaf pondweed and sago pondweed.

The abundance of submersed plants changed notably after drawdowns of water in several pools during the winters of the early 1940's. Pool 8, for example, was drained from 1 January to 15 February 1944 and from 10 January to 15 March 1945. Although Congress ended this practice by the passage of an Anti-Drawdown Law in 1948, the lower water levels apparently stimulated the germination of seeds. The most common submersed plants to become established during this period were long-leaf pondweed, sago pondweed, narrow-leaf pondweed, flatstemmed pondweed, curly leaf pondweed, coontail, elodea, water star grass, and wildcelery. Of these, long-leaf pondweed was most abundant and most widely distributed, occurring in habitats ranging from shallow water to deep, flowing channels.

Wildcelery, which produces a vegetative tuber important as food for migratory waterfowl, became the dominant submersed plant around 1960 in much of the river between Pools 4 and 19. No stands of water smartweed were identified, indicating a marked change in species composition since the 1940's. In lower Pool 8, wildcelery contributed nearly 50% of the relative biomass of submersed plant species in 1975. Most of the remaining 50% of biomass was collectively contributed by coontail, long-leaf pondweed, water star-grass, sago pondweed, and elodea.

Until the late 1980's, a submersed plant community dominated by wildcelery covered large areas of lower Pool 8 and Lake Onalaska (Pool 7). The wildcelery beds were maintained by production of overwintering buds that emerged each spring. By early summer, wildcelery beds were well established and so dense that they significantly affected the hydrology and water quality of the lake. The perimeters of the beds functioned as a sediment screen, making the water inside the beds normally quite clear. Submersed plants grew in all areas of the lake where water was less than 2 meters deep. Several other submersed plants were common in these beds, including water star-grass, sago pondweed, Richardson pondweed, narrowleaf pondweed, flatstemmed pondweed, curlyleaf pondweed, and Eurasian watermilfoil.

The abundance of many submersed plants, including wildcelery, declined markedly in much of the Upper Mississippi River in the late 1980's and continued to decline through 1994. This decline coincided with the severe midwestern drought of 1987-1989, which affected water quality in the Upper Mississippi River.

In Lake Onalaska (Pool 7), the abundance of wildcelery changed little during 1980-1984 but declined greatly after the extremely dry, hot summer of 1988. Most of the submersed vegetation, mainly wildcelery, disappeared in Lake Onalaska during 1988 and 1989 after the plants failed to produce winter buds during the late summer and fall of 1988.

The declines of submerged aquatic plants were observed throughout the Upper Mississippi River. Large beds of submersed vegetation also disappeared in the lower half of Pool 19, where plant beds dominated by wildcelery, water star grass, sago pondweed, and coontail had generally been expanding since the 1960's. In early September 1990, small patches of Eurasian watermilfoil were the only submersed vegetation found in the lower half of Pool 19.

Today, much of the area formerly occupied by wildcelery remains unvegetated, although Eurasian watermilfoil, a nuisance nonindigenous species, now occupies some of the shallower sites. The abundance of Eurasian watermilfoil has seemingly increased since the mid 1980's. In Pools 8 and 13, monotypic beds of Eurasian watermilfoil have been found near areas where wildcelery had occurred. In Pools 4-8, 13, and 26, Eurasian watermilfoil is occasionally found near or with other submersed plants, including sago pondweed, wildcelery, and coontail.

The recent decline in submersed plants in the Upper Mississippi River coincided with the severe drought of 1987-1989. Although information on drought-related conditions in the river is limited, a number of potential causes have been identified. Blooms of planktonic or attached algae during the drought, particularly in the summer of 1988, may have severely limited the depth to which sufficient light penetrated the water column to support the growth of rooted aquatic plants. High concentrations of dissolved nutrients in water, retained in backwaters because of extremely low flows, and abnormally high solar radiation during the drought may have stimulated the production of epiphytes or planktonic algae, thereby reducing light penetration in the water column. Concentrations of orthophosphorus at several main-channel sites were high during the summer of 1988, possibly contributing to the prolific bloom of the blue-green alga Aphanizomenon. The bloom extended from Lake Pepin (Pool 4) to Pool 11.

Conversely, there is evidence that submersed aquatic plants may benefit from conditions caused by moderate drought. During summer 1985, for example, water clarity markedly increased in Pool 8 in apparent response to reduced runoff caused by a summer drought, and the mean depth of the light zone during that growing season increased to 1.3 meters. That summer, the distribution of submersed plants, including wildcelery and Eurasian watermilfoil, increased in Pool 8 in apparent response to the increased availability of light. Similar increases in submersed aquatic plants occurred in 1977 in Pool 19, coincident with a period of increased water clarity, low flow, and stable water levels during spring and summer.

The availability of sediment nutrients may have been reduced by low flows during the drought. The possible depletion of sediment nutrients, particularly nitrogen, during the low flows of 1987, 1988, and 1989, in combination with above-normal water temperatures, may have reduced plant growth and reproduction in some areas of the river.

The reestablishment of submersed aquatic plants in the river may be inhibited by grazing fish, particularly common carp that often forage in beds of submersed plants where they resuspend bottom sediments, increase turbidity, and uproot some submersed plants, particularly species with shallow root systems. Feeding waterfowl, especially tundra swans, uproot vegetation and cause turbidity. Many observers have noted expansive plumes of silt downstream from large flocks of swans that probe deeply with their long muscular necks for duck potatoes buried in the sediments.

The Flood of 1993 also affected the river's submersed aquatic plant communities. During the 1993 growing season, most species of submersed plants decreased in frequency of occurrence at monitoring sites in Pools 4, 8, 13, and 26. The decreases were greatest in Pools 13 and 26, which had more severe flooding than Pools 4 and 8. In 1994 submersed aquatic plants had recovered to pre-flood frequencies in Pools 8 and 13, but not in Pool 26, where the duration and magnitude of the flood were greatest. Interestingly, the distribution and abundance of wildcelery in Pools 8 and 13 were greater after the flood year than before the flood.

The environmental factors that regulate submerged aquatic plants are complex, interconnected, and poorly understood. Of necessity, most conclusions have been based on anecdotal evidence because Upper Mississippi River aquatic habitats are so vast. Happily, many areas have shown a resurgence of submerged aquatic plants, especially wildcelery, in 1998 and 1999.

Bottom-dwelling macroinvertebrates

Macroinvertebrates include a wide range of invertebrate fauna including adult and immature insects, crustaceans, mollusks, and worms. They inhabit all riverine habitats, including the water column, sand, mud, and the surfaces of rocks, plants, and debris. They occupy the submerged surfaces of manmade structures like locks and dams, bridges, navigation buoys and their anchoring chains, barges, towboats, and pleasure craft. Towboats and their barges are especially important because their rough, rusted hulls are excellent substrate for many species. They transport sedentary species upstream, enabling them to colonize new areas throughout the entire commercial waterway. Modern cruisers and houseboats with smooth fiberglass hulls provide less surface for attachment, but the roughened metal of their propulsion units suffices as substrate for many species. Because they travel long distances, they too can disseminate species throughout the river system.

Adult insects are also transported by watercraft. For example, hordes of Hexagenia mayflies emerging at one locality may be transported over 100 miles on barges before they lay their eggs on the evening following emergence.

Bottom-dwelling macroinvertebrates are called benthos. Because: 1) they are widely distributed, 2) are important as food for fish and wildlife, and 3) can exhibit dramatic community changes when exposed to water and sediment pollution, they are commonly used as indicators of environmental quality. Fingernail clams and burrowing mayflies (e.g. Hexagenia) have been target organisms for most studies. They are important food for migrating diving ducks and coots, as well as many fish species. Unfortunately, macroinvertebrates are laborious to sample, identify, count, and weigh.

Macroinvertebrate communities that live on submerged hard surfaces such as rocks are called epilithic. In the unmodified river they would have been found on the rocks below falls and in rapids, and on cobble sediments in fast-water areas. Rock substrates in the untamed river were scarce. They occurred mainly at the Falls of St. Anthony, and in the rapids at Rock Island and Keokuk. Submerged fallen trees and woody debris were abundant, and provided additional substrate. Before the river's immense clam populations were devastated by commercial exploitation and pollution, the shells of living mussels and dead shells furnished hard substrate for epilithic fauna in a mud and sand environment.

Epilithic communities were enhanced by early channelization projects in the 1878-1912 period that provided immense quantities of rock in the form of wing dams, closing dams, and shoreline protection. Lock and Dam 19 at Keokuk, completed in 1913, and the 9-foot channel dams, completed in the 1930s, provided great expanses of submerged concrete. Their tailwaters created a fastwater rapids-like environment, usually full of huge stones placed there to prevent scouring. Navigation buoys and their anchoring chains, located at regular intervals along the edge of the navigation channel, serve as excellent substrate in the relatively fast current of the tailwaters and in the moderate current of impounded areas. They are especially important for hydropsychid caddisflies, indicators of good water quality. Since about 1995, zebra mussels have increasingly displaced most ipilitheic fauna on most of the aforementioned structures

The construction of Lock and Dam 19 at Keokuk, Iowa, created an interesting combination of habitats for aquatic insects. Prior to impoundment, hydropsychid caddisflies (filter feeders that require swift water and hard substrate) must have thrived in the rocky Des Moines Rapids. Hexagenia mayflies (detritivores that require a muddy substrate for construction of their burrows) were probably not very abundant. When the dam was finished in 1913, creating Lake Cooper and its rich, muddy bottom, Hexagenia mayflies flourished. The rocky tailwaters of the dam, as well as the concrete and steel structure of the dam and powerhouse, provided habitat for hydropsychid caddisflies. Although other river cities have nuisance problems with mayflies, only Keokuk has problems with both mayflies and caddisflies.

For decades, benthic invertebrates were absent or scarce in reaches where water quality was degraded by sewage. The river downstream from the Twin Cities all the way into Lake Pepin, for example, suffered severe oxygen depletion caused by sewage, and pollution-sensitive organisms, such as burrowing Hexagenia mayflies, were absent or scarce. Burrowing mayflies began recolonizing riverine reaches downstream from the Twin Cities in the early 1980's when dissolved oxygen concentrations increased in response to improved wastewater treatment.

In Pool 19, where fingernail clam and burrowing mayfly populations have been tracked for over 20 years, population biomass has been cyclical. Declines in the mid-1970s were followed by recovery in the mid-1980s. Severe declines in the late 1980s were followed by recovery after the 1993 flood.

Native freshwater mussels (clams)

The Upper Mississippi River is one of a few large rivers that still has a substantial freshwater mussel fauna. Their abundance and species richness in the Upper Mississippi exceeds that of many other midsize to large North American rivers. Historically, about 50-60 species of freshwater mussels have been documented in the Upper Mississippi River-Illinois River System, but only about 30 species have been found recently. Because they are sedentary, long-lived and pollution sensitive, their decline reflects past abuse of the river.

Commercial exploitation of freshwater mussels was greatest in the late 1800s and early 1900s. The pearl button industry began in 1889 when the German button maker John Boepple pioneered the use of the Mississippi's freshwater mussel shells. By 1898, 49 button-making plants in 13 river cities employed thousands of people and processed thousands of tons of mussels. First centered around Muscatine, the industry spread to Keokuk, Prairie du Chien, La Crosse, Lake Pepin, and other areas. Harvests declined as pressure on the resource increased, and the industry failed rapidly after 1930. The advent of plastic buttons hastened its demise.

The decline of clam species richness in the Upper Mississippi River mirrors a broader continental pattern. Almost half of the 292 pearlymussel species in North America are either extinct or at serious risk of extinction. Factors contributing to these declines include habitat modification and degradation, pollution, over-harvest, commercial and recreational navigation, and the recent invasion of exotic zebra mussels.

Fingernail clams

Populations of fingernail clams have declined in certain reaches during recent decades. Significant declines were evident in five of eight pools examined along the reach of river from Hastings, Minnesota, to Keokuk, Iowa. Densities in Pool 19, which had the longest historical record on fingernail clams, averaged 30,000 per square meter in 1985 and decreased to zero in 1990. The declines of fingernail clams occurred chiefly during low-flow periods associated with drought.

Fingernail clam population declines do not seem to be directly linked to the periodic depletion of dissolved oxygen that occurs in backwater areas. Although fingernail clams are much more tolerant of low dissolved oxygen concentrations than are burrowing Hexagenia mayflies, they have not readily recolonized the reaches recolonized by Hexagenia mayflies. Their subsequent slow rate of recolonization was seemingly caused by the uninhabitability of bottom sediments-perhaps due to the presence of one or more toxic substances. Fingernail clams are sensitive to many toxicants, including un-ionized ammonia.

Recent studies by the U.S. Geological Survey have shown that surficial sediments add considerable amounts of nitrogen to the reach of the Upper Mississippi where populations of fingernail clams have declined. The production of ammonia by microbial decomposition in the sediments would presumably be increased by the conditions of high temperature and nutrient enrichment associated with low-flow, drought periods. High microbial activity (decomposition), stimulated by high temperature and an abundant supply of organic matter, would greatly increase the concentration of toxic ammonia in the sediments, possibly causing episodic toxicity in fine-grained sediments during periods of drought and low flow.

Hexagenia mayflies

Impoundments have provided habitat for Hexagenia mayflies that thrive in areas where there is a silt bottom and well-oxygenated water. There is no doubt that Hexagenia mayfly populations have increased because of Lock and Dam 19 and the dams of the 9-foot channel project. The insects are a nuisance to most people, but are excellent fish food organisms, as reflected in fish abundance. However, as pool areas and backwaters are lost to sedimentation, Hexagenia populations will decrease.

Fishes

The fossil record shows that the Mississippi River has long provided suitable habitat for many fishes, some of ancient lineage. Although major changes in climate, including the Pleistocene glaciations, have occurred, there have been few fish extinctions. Most fishes probably retreated ahead of southward-moving glaciers and repopulated northern reaches of the basin as the glaciers receded. An estimated 67 fish species inhabit the Headwaters, and an estimated 132 species inhabit the Upper Mississippi River.

The Upper Mississippi River provides many aquatic habitats, including main channel, tailwater, main-channel border, side channel, navigation pool, floodplain lake or pond, slough, and tributary mouth. These habitats can differ markedly in current velocity, depth, temperature, water quality, bottom substrate, vegetative structure, food resources, and other characteristics. The main channel has a swift current, coarse-sand or gravel substrate, and deep water. Tailwaters, which extend about 0.8 kilometers below each dam, have well-oxygenated water, rapid currents, and coarse substrates. Walleye, sauger, white bass, freshwater drum, and catfishes concentrate in these tailwaters. Dike fields (wing dams) along the main-channel border provide rocky substrates where walleye, sauger, channel catfish, smallmouth bass, white bass, black crappie, bluegill, redhorse, freshwater drum, and smallmouth buffalo concentrate. Main-channel borders have multiple substrates, including silt, sand, wing dikes, snags, and riprap. Abundance of fishes in main-channel borders varies with season and river stage. The flow of side channels links them to other habitats during most of the year, and these channels are used by many species. Nearshore zones in main-channel borders, side channels, and pools provide important nursery areas for many fish species, especially including bluegill, crappie, and largemouth bass.

Most fishes require several different habitats to complete a life cycle. The quantity and quality of certain habitats, however, have diminished in many reaches. Overwintering habitats for fish have declined as sedimentation reduces water depth. Recent die-offs of aquatic vegetation have reduced the suitability of many areas as nursery habitats for fishes. In many places, declines of invertebrate prey organisms associated with soft bottom sediments and aquatic vegetation have diminished food resources for fishes.

Lack of suitable winter habitat is a threat to bluegills, crappies, and largemouth bass in ice-covered northern reaches of the Upper Mississippi. Bluegills and crappies require off-channel areas where water temperatures exceed 34 degrees F (1 degree C), current velocities below 0.4 inches per second (1 cm per second), and dissolved oxygen above 2 ppm (mg/L).

Ice fishermen are experts at exploiting sunfish, crappie, and largemouth bass populations in overwintering habitats, some of which may be smaller than one-fourth acre. An army of prospectors sets out to find these sanctuaries in early winter when the ice is barely thick enough to support their weight. Most of them hike to get there, but some use outboard motor boats, airboats, picker boats, and hover craft. When the ice gets a little thicker they employ snowmobiles and all-terrain vehicles. Like seagulls, fishermen converge on the overwintering areas. Armed with sophisticated gear including sonar, ultra-light graphite rods, thin monofilament line, and tiny lures enhanced with insect larvae, they exploit the fish that bite aggressively in early winter. In their portable darkened shelters, they can watch the fish bite if the water is shallow and clear enough. It is unlikely that many overwintering panfish habitats remain unknown to these fishermen.

At first ice, some of the habitats may be less than three feet deep. Water temperatures at the mud surface may be as high as 39 degrees F. because water is densest at 39 degrees F. However, the water temperature right under the ice is 32 degrees because water is least dense at that temperature. By March, the ice may have thickened to three feet in northern pools, especially in winters with little insulating snow. The habitats seldom freeze to the bottom, but the space under the ice may be scarcely deeper than the fish are tall. Light penetration decreases as the ice thickens, especially if heavy snows cover it. Lessened photosynthetic activity results in decreased levels of dissolved oxygen. To make matters worse, heavy snows may depress the ice, causing water to ooze upward through cracks, creating translucent slush that further decreases light penetration and dissolved oxygen concentrations. The fish become lethargic and refuse to bite, but they may still be curious enough to scrutinize lures. Sometimes the fish succumb on site, but they most often vacate their sanctuaries, often entering areas where increased current further stresses them.

In most fish, the production of disease-fighting antibodies falls off at winter temperatures, and after a prolonged winter, stressed fish are doubly susceptible to bacterial infections. Their deaths usually go unnoticed because the spring ice has become too rotten for most observers. The crows, eagles, ospreys, and gulls quickly clean up the mess.

Below St. Louis, levees have isolated the river and its fisheries from its floodplain in most areas. Levees have encouraged development, and, as a result, fisheries habitat behind levees has been drained and filled. Flood control works have greatly decreased the amount of floodplain available as nursery, spawning, and feeding habitat. Further, many floodplain lakes have been isolated from river overflow and no longer serve as habitat for river fishes.

Mississippi River dams are hindrances to fish migration, and none of them have engineering works designed to allow fish passage. Lock and Dam 19, the oldest navigation dam on the Upper Mississippi River, also has a hydroelectric power Plant. It creates a formidable obstruction for migrating fish because it has a head of about 40 feet, and water must flow either through the dam via turbines or over the top of the regulatory gates. The first documentation of the dam's impact on river ecology was the blocked migration of the skipjack herring, the only known host of the larvae of the ebony shell mussel which has consequently been nearly eradicated above Lock and Dam 19. Some fish may pass through the dam during lockage.

Recent evidence establishes that some species do migrate through other navigation dams, most of which have roller gates that cause water to flow under the gates rather than over the top. Dams may have blocked lake sturgeon spawning movements, but the length of the sturgeon's immature life (18-20 yr.) and its susceptibility to nets and boat propellers have also been important to its decline. The same may be true for paddlefish, which frequently swim near the surface and therefore seem especially vulnerable to propellers.

Completion of the locks at St. Anthony Falls in 1963 provided access for all species previously excluded from the Headwaters, and the dam at Coon Rapids, Minnesota, completed in 1906, is now the principal migration barrier and serves to maintain distinct fish communities in the Upper Mississippi and Headwaters.

Anoxic zones have also served as barriers to fish movement. Lock and Dam 1, completed in 1917, collected most of the raw sewage of Minneapolis and St. Paul. Lock and Dam 2, completed in 1930 at Hastings, accumulated the remainder of the Metro sewage and that of the suburbs, packinghouses, and stockyards. The Bureau of Fisheries reported that during August of 1927, 73 km of the river below St. Paul lacked sufficient oxygen to sustain fish life of any kind. Although navigation dams did not cause the pollution problem, they exacerbated the situation and focused attention on the deteriorating quality of the water. A sewage treatment system built in 1938 improved water quality, and most fish species could again live in the reach below St. Paul.

Flooding

Flood stages have increased along the Middle Mississippi River due mainly to contraction of the high water channel by dikes and loss of floodplain capacity due to leveeing and development. Ironically, present day river elevations during low flows are lower than they were in the pre-modification days, mainly due to scouring of the low-water channel by wing dikes. River stage fluctuates as much as 50 feet annually, effectively dewatering some secondary channels during low flow.

Man's physical impact on the Upper and Middle Mississippi River was dramatically and tragically illustrated in the great flood of 1993, reported in the media as a 500-year flood. Actually, the greatest flood in history at St. Louis was in 1844 when the river's flow was about 1,300, 000 cfs and the crest (stage) was 41.3 ft. In 1993, the peak flow was only about 1,000,000 cfs, but the crest was 48.58 ft.

Sedimentation

Today, many tributaries (especially the Chippewa) flow through extensive deposits of glacial alluvium that stand poised and ready to wash into the Mississippi. With the notable exception of the Illinois River, most tributaries of the Mississippi have steeper gradients than the master stream, and they deliver sediments faster than the Mississippi can remove them, causing the valley to aggrade. The agricultural activities of man in the watershed and construction projects on the river floodplain have accelerated the process.

When the 9-foot channel impoundment were created in the 1930s, they also impounded the lower reaches of tributaries that entered in the downstream portions of pools. This hydraulic damming action reduced tributary gradients, causing their beds to be raised. Reduced current velocity resulted in deposition of sediments, causing formation of deltas and new wetlands in the lower reaches of tributaries.

The construction of Lock and Dam 19 in 1913 exacerbated natural sedimentation rates. Sediment accumulations in Pool 19 have been extreme, with about 36 feet of sediment deposition occurring in one area since 1891 (1 1/2 miles upstream from Lock and Dam19 near the Illinois shore. This high rate is not representative of the entire river, and the rate of accumulation has decreased with time.

Sedimentation is among the most critical ecological problems in the UMR. Various studies have predicted that the ecologically productive backwaters will fill and disappear within 50-100 years. Sedimentation studies are complex, expensive, and are usually limited to relatively small sample areas. Anecdotally, I have seen many of my prime fishing and hunting areas of Pools 5, 5A, and 6 degrade and disappear in 40 years. Numerous channels that accommodated houseboats in the 1960s can now scarcely handle fishing boats. The loss of channels and marshes is seldom, compensated by the natural creation of new ones. Increasingly we see airboats being employed, as well as Louisiana-style "digger boats" that can not only handle extremely shallow water, but can tear open new channels through soft sediments and semi-terrestrial habitats, creating new problems.

In general, waves and currents redistribute sediments, eroding shallow areas and filling deeper areas, thus simplifying bottom topography. As islands erode and disappear, the wind has a longer fetch that causes allowing waves to build, resuspending soft sediments, increasing turbidity, and limiting aquatic plant growth. When redeposited, flocculent bottom sediments provide an unstable substrate for rooted aquatic plants that may be torn up by wave action or ripped out by ice in the spring. In most pools, the general trend in the rich mosaic of habitats is toward monotony.

A classic example of this is the Weaver Bottoms twelve miles upstream from Winona, where the Whitewater River, a notorious sediment contributor, created a huge delta and expansive wetlands in historic time.

The pools differ in their ability to transport sediment, depending on sediment input of tributaries and land use. In LTRMP studies of Pool 13 in 1995, for example, 97% of flow and 67% of sediment came from mainstem sources. Pool 13 exported nearly all the sediment that came from upstream sources.

The Missouri River, which drains the Great Plains Region, is the Mississippi's largest tributary, and it greatly alters the unimpounded Mississippi River below St. Louis. It drains 74% of the Upper Mississippi River Basin and supplies about 40% of the long-term discharge below St. Louis. Its drainage area is more than twice that of the Upper Mississippi River above St. Louis, and its suspended load is more than double that of the Upper Mississippi River.

At St. Louis, the sediment load of the Mississippi has declined 66% from pre-1935 levels, mainly due to sediment entrapment in Missouri River impoundments. Today, the Middle Mississippi receives about 80% of its average suspended sediment load from the Missouri and about 20% from the Upper Mississippi. Suspended sediment load of the Mississippi at St. Louis averages 47% clay, 38% silt, and 15% sand. Bed material is approximately 70% medium-to-coarse sand.

REFUGES

Primarily because of the enthusiastic sponsorship of the Izaak Walton League, the United States Congress on June 7, 1924 authorized appropriations aggregating $1,500,000 for purchase of Mississippi bottom lands on a willing seller basis to be administered as the Upper Mississippi River Wildlife and Fish Refuge. The refuge, which was originally intended primarily as a refuge primarily for protection of smallmouth bass, extended from the foot of Lake Pepin to Rock Island, Illinois.

By 1930, the Upper Mississippi River Wildlife and Fish Refuge encompassed about 87,000 acres of flood plain land. The 9-foot channel project enabled the U. S. Army Corps of Engineers to condemn land to obtain flowage rights and it became obvious that it was needless for federal wildlife interests and federal navigation interests to compete for land. Consequently, the Bureau of Sport Fisheries and Wildlife gave the U.S. Army Corps of Engineers flowage rights on refuge land in return for wildlife management rights on land owned by the Corps. By this means, the Upper Mississippi River Wildlife and Fish Refuge was increased to about 195,093 acres.

Today, the UMR contains three National Wildlife Refuges: UMRWFR - 78 975 ha (1924); Trempealeau National Wildlife Refuge - 4 415 ha (1943); and Mark Twain National Wildlife Refuge - 13 090 ha (1958). Today, their major emphasis is migratory waterfowl management rather than fish management as envisioned by the Isaak Walton League.

HABITAT MANAGEMENT AND MITIGATION

Beaver, which had been trapped to near extinction before the turn of the century, were experimentally introduced at various points in the Upper Mississippi River Wildlife and Fish Refuge during the late 1920's. One small colony established in 1929 had increased to about 100 individuals four years later. Beavers are now abundant throughout the refuge.

An interesting beaver-managed area lies on the Minnesota-Iowa border where Winnebago Creek enters Pool 9 from the west. Because Pool 9 is 31 miles long, this upper reach does not lie within the permanently impounded portion of the pool, and water levels fluctuate wildly, sometimes within 24 hours, depending on how many gates on L&D 8 are open. The delta of Winnebago Creek is laced with tributaries that are dammed by beavers. Some of the interconnected low-head dams are over one-half mile long. Together they create about a square mile of rich, heavily vegetated, shallow ponds that are prime habitat for wood ducks, teal, mallards, widgeon, herons, great egrets, mink, muskrats, and raccoons. When the gates of Lock and Dam 8 restrict river flow, and most of the tailwaters reach below the dam has been reduced to a mudflat, the ponds remain brimming with water like oases in a sea of mud. The beaver are, without doubt, the most cost effective habitat managers on the UMR. They work the night shift, industriously and unobtrusively cutting trees for food and building materials, as they build and maintain their dams and lodges. In the process they manage the marsh and the floodplain forest. They are on call 24 hours per day, but receive no wages, vacations, fringe benefits, sick leaves, or coffee breaks. Thankfully, they aren't required to attend meetings, write grant proposals and progress reports, or plead to state and federal governments for funding. I doubt if they worry about reciprocity between states.

Prior to environmental legislation of the late 1960s (National Environmental Policy Act), only minor attempts were made to manage MR habitats. Public Law 697, passed in 1948 and known as the Anti-Drawdown Law, was probably the most significant habitat management completed during that period. It ordered the Corps of Engineers to maintain Upper Mississippi River navigation pools "as though navigation was carried on throughout the year. " In earlier years, pools were drawn down in winter to increase capacity for spring floods; the result was devastating losses to fish and wildlife populations.

The Mississippi is the only river in the United States that has been designated for two major federal purposes - commercial navigation and wildlife refuges. Conflicts between these two authorizations and project purposes peaked in the 1970s when growing public support for environmental protection and management led to lawsuits over operation, maintenance (dredging), and expansion of the $2.7 m navigation project. The lawsuits, in turn, led to major interagency studies (GREAT 1, 1980; GREAT 11, 1980; GREAT III, 1982; and UMRBC, 1982). Habitat management and rehabilitation became a major thrust of these studies as biologists proposed new techniques such as opening and rehabilitating backwaters, altering wing dikes and closing dams, using larger rock for revetments, creating islands, protecting shorelines, and evaluating their effectiveness.

THE GREAT STUDIES

GREAT I, II, and III

The Great River Environmental Action Team (GREAT) formed in 1974 through the efforts of the Corps of Engineers, Fish and Wildlife Service, and the Upper Mississippi River Basin Commission. They created a partnership to work out a long term management strategy for the River's multi purposes. The Team was composed of representatives for the five river basin States and the five resource-oriented Federal Agencies. They operated under the authority of the Upper Mississippi Basin Commission. The Team established in 1974 studied the river from Minneapolis to lock and Dam 10. It was called GREAT I. GREAT II was organized in 1976 and studied the river from lock and dam 10 to Saverton, Missouri. GREAT III was organized in 1977 and studied the area from Saverton to the mouth of the Ohio River. The studies focused on several objectives:

- Develop ways to significantly reduce the volume of dredged material removed for the navigation project.
- Open backwaters that have been isolated from freshwater flow as a result of navigation maintenance.
- Ensure the capability to maintain the total river resources on the Upper Mississippi River.
- Contain or stabilize all floodplain dredged material placement sites to benefit river resources
- Assure that all navigation project authorizations include fish, wildlife, and recreation as project purposes.
- Develop physical and biological base-line data to identify factors controlling the river system.
- Identify sites that can be developed to provide for fish and wildlife habitat irretrievably lost to water development projects.
- Identify and develop ways to use dredged material as a valuable resource for productive uses.
- Implement programs to provide for present and projected recreation demands on the river system.

- Strive to comply with Federal and State water quality standards.
- Strive to comply with Federal and State floodplain management standards.
- Develop procedures for ensuring an appropriate level of public participation.

The GREAT organizational structure was typical of intergovernmental river institutions, it was large, complicated and had diverse representation. It had representatives from the States of Iowa, Minnesota, Illinois, Wisconsin, and Missouri, the Fish and Wildlife Service, Corps of Engineers, Environmental Protection Agency, Department of Transportation, Soil Conservation Service, the Minnesota-Wisconsin Boundary Area Commission, and the Upper Mississippi River Conservation Committee. Its organizational structure was bilateral. On one side the Chief of Engineers was over the North Central Division, who oversaw the District Corps of Engineers offices. On the other side, the Water Resources Council, was over the Upper Mississippi River Basin Commission, which oversaw the Great River Study Committee. Both chain of commands oversaw the specific GREAT study teams. Each study team also had and Internal Overview Committee. The Study Team then sat over a Plan Formulation Work Group, which oversaw the Functional Work Groups. The Functional Work Groups consisted of, Commercial Dredging Requirements, Dredged Material Uses, Fish and Wildlife Management, Floodplain Management, Material and Equipment Needs, Public Participation and Information; Recreation, Sediment and Erosion, Side Channel, and Water Quality.

The GREAT studies resulted in volumes of results and recommendations. It resulting in a major change in the management of dredged material, its placement and beneficial use. Today river communities utilize dredge material as a principle source of sand for road construction, road maintenance, and building construction. In some areas secondary uses of dredged material exceed its availability. The studies elevated and focused both public and governmental concern over the river and the management of its ecological components. It highlighted the problems of sedimentation resulting from watershed and agricultural practices, and the resulting habitat losses within the floodplain. It systematically laid out the problems, their causes, and management needs. In all, it was a successful government partnership both in its management and informational outcomes. It was the foundation for the next major partnership effort, the Master Plan.

The Master Plan

In 1968, the District Engineer of the St. Louis District, Corps of Engineers office recommended replacement of the locks at Dam 26. It recommended construction of a new dam and 1200 foot locks at Alton Illinois. This project was approved the Corps of Engineers and it received several appropriations through 1975. On August 6, 1975, the Izaak Walton League, the Sierra Club, and 21 western railroads filed lawsuits to prevent the Corps from beginning construction of the locks and dam 26. The suit contended that the Corps did not receive due Congressional authorization, the environmental impact statement did not consider system effects, and that the Corps had ignored the objectives of the national economic development and environmental quality requirements, improperly and inadequately assessed project costs and benefits, and failed to consider feasible alternatives. Major national and congressional debate followed these actions. On October 21, 1978, President Carter signed into law the Inland Waterways Authorization Act, which authorized the construction of locks and dam 26, established an inland waterway user tax, and directed the Upper Mississippi River Basin Commission (UMRBC) to prepare a Comprehensive Master Plan for the Management of the Upper Mississippi River.

The Master Plan was to include:

- Identify the economic, recreational, and environmental objectives of the Upper Mississippi River System.
- Recommend guidelines to achieve such objectives.
- Propose methods to assure compliance with such guidelines and coordination of future management decision.
- Include any legislative proposal which may be necessary to carry out such recommendation and achieve such objectives.
- Define the navigation carrying capacity of the Upper Mississippi River Systems.
- Define the relationship of capacity expansion to national transportation policy.
- Define the effect of expansion of navigation capacity on the railroads.
- Define the transportation costs and benefits to the nation from expanded navigation capacity.
- Define the economic need for a second lock at Alton.
- Define the systemic ecological impacts of present and expanded navigation capacity on fish and wildlife, water quality, wilderness, and recreational opportunities.
- Defined the means and measures to prevent such impacts.
- Define the immediate environmental effects of a second lock at Alton.
- Define the benefits and costs of disposing of dredged material in areas outside of the floodplain.
- Develop a computerized analytical inventory and analysis system.

The UMRBC responded by creating a management framework and Action Plan. The framework had the Commission overseeing its implementation by the Great River Study Committee. The Committee formed work teams for specific study responsibilities. They included the Environmental Studies, Navigation/Transportation, Dredged Material, Computer Inventory and Analysis, and Public Participation and Information Work Teams. The resulting plans and recommendations were published in the Comprehensive Master Plan for the Upper Mississippi River System on January 1, 1982. The Master Plan recommended:

- authorization of the 600 foot second lock at Lock and Dam 26;
- Congress exclude the second lock from further action under the National Environmental Policy Act of 1969;
- immediate action to reduce erosion rates to tolerable levels; a habitat restoration program;
- a long term resource program;
- immediately implement a computerized river information center,
- implement a program of recreation projects and assess the economic benefits of recreation to the UMRS;
- increase the capacity of the navigation sysem through implementation of non-structural and minor structural measures;
- update traffic projections,
- verify lock capacities, and refine justifications for future expansion;
- continue implementation of current GREAT I disposal recommendations;
- develop a State and Corps of Engineers coordination program to develop economically feasible and productive uses of dredge material;
- finally, the States should develop a coordinative arrangement to maintain coordination and management activities for water and related land resources within the UMRS.

The five UMR States, Minnesota, Wisconsin, Illinois, Iowa, and Missouri formed the Upper Mississippi River Basin Association following the end of the UMRBC. The UMRBA provides a forum for its members to discuss issues related to river management and advocate consensus positions to Congress. The UMRBA also invites Federal Agencies to participate as non voting members. The UMRBA also plays an important role in coordinating the Environmental Management Program.

THE ENVIRONMENTAL MANAGEMENT PROGRAM

Public Law 99-662 (1986) designated the Upper Mississippi River System as a nationally significant ecosystem and a nationally significant commercial navigation system. It also authorized a $124.6-M, 10-yr habitat rehabilitation and enhancement program for the Upper Mississippi River as part of a larger $190-M Environmental Management Program for the Upper Mississippi and selected navigable tributaries. The program is being implemented through an interagency (state and federal) effort. General program oversight is governed by the Environmental Management Program Coordinating Committee (EMPCC), made up of many UMRBA members, the Corps of Engineers, the Fish and Wildlife Service, U.S. Geological Service, Department of Transportation, Department of Agriculture, and Coast Guard. This group meets quarterly, usually in conjunction with the UMRBA meetings, due to the broadly shared membership. The EMPCC oversees the program, its adherence to its operating plan and annual work plans, and provides management priority recommendations to the Corps of Engineers. An EMPCC subgroup is the Analysis Team (A-Team). The A-Team is the field, biologists level advisory group that provides informational needs definitions to the Long Term Resource Monitoring Program.. They advise the Program manager on program priorities, which are subsequently integrated into the Program's annual work plan.

The Program covers the Upper Mississippi River system, which is defined as the commercially navigable portions of the Mississippi River north of Cairo, Illinois: the Minnesota, Black, St. Croix, and Kaskaskia Rivers, plus the Illinois River and Waterway. St. Paul District projects are located along the Mississippi River from Guttenberg, Iowa, to Minneapolis-St. Paul, Minnesota (about 250 river miles). Projects have included backwater dredging, dike and levee construction, island creation, bank stabilization, side channel openings and closures, wing and closing dam modifications, aeration and water control systems, waterfowl nesting cover, acquisition of wildlife lands, and forest management.

Habitat Rehabilitation and Enhancement Program

The Habitat Rehabilitation and Enhancement Program (HREP) builds habitat projects within the EMP boundaries, based on the State and Federally defined resource management priorities. The Program is managed and construction implemented by the Corps of Engineers, Mississippi River Division in Vicksburg, Mississippi. The St. Paul, Rock Island, and St. Louis Districts are each very involved in the management and project development within their respective river reaches. Since 1987 24 habitat projects have been built affecting approximately 28,000 acres. Projects are varied in size, objective, and distribution. Projects are designed to address four main areas of habitat loss or degradation. They are: tributary effects related to increased flood flows and sediment/nutrient transport; decreased floodplain structural diversity, including Island erosion, sediment deposition, hydraulic training structure effects, and effects of levees; altered hydrology including, flood zone reduction, water level alterations, and river-floodplain connectivity; and water/sediment quality as defined by increased suspended sediment, nutrients, and toxics. The types of project features designed to address these concerns included: backwater dredging; water level management, including dikes and water control structures; Island construction to restore physical conditions necessary for the re-establishment of aquatic vegetation and reduction in wind and wave energy; shoreline stabilization to prevent erosion and to create fish habitat; secondary channel modifications to preserve habitat through reducing sedimentation in backwater areas; aeration to restore aquatic habitat through improved water quality; and physical modifications like potholes, wing dams, and land acquisition. Once project design is completed a monitoring plan is developed and implemented to ensure both pre and post project assessment is completed.

Project monitoring contains several components. The physical responses to the project are assessed to measure effectiveness in meeting the physical project objectives. The monitoring typically includes flow velocity and distribution, water levels, water quality, and sediment transport. Biological response monitoring includes the projects effects on plants, fish, and wildlife. Monitoring responses are evaluated and summarized in the Performance Evaluation Reports. These would include the natural resource managers reports on the project's success.

In general, the HREP has been very successful. Both the public and resource management community believes it is meeting or exceeding its intended objectives. The Program has fostered an environment of cooperation, partnership, and shared vision amongst the resource management community previously only dreamed of. The effectiveness of project features, designs and objectives is also growing as a result of experience, lessons learned, improvement in techniques, and refinement of management processes. The HREP portions of the EMP are truly one of the river's great success stories and "good buys" for both the Government and the people of this Country.

Long Term Resource Monitoring Program

The Long Term Resource Monitoring Program was authorized under the Water Resources Development Act of 1986 (Public Law 99-662) as an element of the U.S. Army Corps of Engineers' Environmental Management Program. Original authorization provided for a 10-year Program starting in 1987; Section 405 of the Water Resources Development Act of 1990 (Public Law 101-640) extended the Program an additional 5 years.

The Long Term Resource Monitoring Program is being implemented by the U.S. Geological Survey (USGS) in cooperation with the five Upper Mississippi River System states (Illinois, Iowa, Minnesota, Missouri, and Wisconsin), with guidance and overall Program responsibility provided by the U.S. Army Corps of Engineers. A directive outlining the mode of operation and the respective roles of the agencies is embodied in a 1988 Memorandum of Agreement.

The U.S. Geological Survey's Upper Midwest Environmental Sciences Center administers both the Long Term Resource Monitoring Program and the Computerized River Information Center components of the Environmental Management Program. Six remote state-operated field stations have been established for data collection. Water levels and quality, sedimentation, fish, vegetation, and invertebrates are being monitored, as well as land cover/use. To document system-wide ecological trends, resource monitoring data are being collected in five separate 25- to 30-mile reaches of the Mississippi River and in one reach of the Illinois River. Scientific guidance is being provided by an international committee of scientists.

Significant resource problems are being investigated, including navigation impacts, sedimentation, water level fluctuation, lack of aquatic vegetation, and reduced fisheries populations.

THE GREAT COORDINATION NETWORK

We have discussed the UMRBC, the UMRBA, the EMPCC, the COE (Division, St. Paul, St. Louis, and Rock Island Districts), LTRMP, HREP, and GREAT I, II, and III. However, there are still a host of other coordinating groups that must be considered when trying to understand UMR management. The State resource management agencies have an organization called the Upper Mississippi River Conservation Committee (UMRCC), a forum for discussing and sharing issues, management efforts, lessons, and needs. It has subsections for fisheries, wildlife, recreation, water quality, and law enforcement. The UMRCC independently comments on River management efforts and issues and is not considered a representative of any participating State or Federal agency. The UMRCC is actively involved in navigation and resource management issues. It also maintains a library of agency and managers reports prepared on a great variety of river related subjects.

Each River State maintains staffs of resource management personnel responsible for the States fish, wildlife, water quality, and environmental management within their respective portions of the River floodplain in their States. The States maintain primary management authority over these resources within their boundaries. The exceptions are for migratory birds which are the management responsibility of the U.S. Fish and Wildlife Service and the forest resources on lands owned by the Corps of Engineers and by the Fish and Wildlife Service. Generally, the States maintain responsibility for water quality management, regulation of public drinking water supplies, floodplain management, regulation of water withdrawal and uses, management of state lands, fish and wildlife management, coordination with commercial and federal agencies on issues affecting navigation, participation in the EMP, boating safety programs, wetland protection and regulation, programs promoting soil conservation, emergency response for floods and other natural disasters, and response to oil and hazardous materials spills.

The major Federal authorities on the Upper Mississippi River include the following:

- Army Corps of Engineers. The Corps is responsible for construction, operation, and maintenance of the commercial navigation system, flood control projects, wetland regulation under the Clean Water Act's Section 404, the management of COE project lands, implementation of EMP, and the construction of projects under Section 1135 of the Water Resources Development Act.
- Fish and Wildlife Service. The FWS is responsible for managing the River's Upper Mississippi, Trempealeau, and Mark Twain National Fish and Wildlife Refuges, implementing the National Wetland Inventory, protecting threatened and endangered species, managing migratory species, evaluation of fish and wildlife impacts of projects under the authority of the Fish and Wildlife Coordination Act, and participation in developing habitat restoration projects under the EMP.
- Geological Survey is responsible for implementing the EMP's Long Term Resource Monitoring Program, operating stream gauging networks throughout the basin, and conducting water quality studies both in the River and in selected sub-basins under the National Water Quality Assessment.
- Environmental Protection Agency. EPA is responsible for ensuring water quality standards are met as defined under the Clean Water Act, they serve as the primary Federal response agency for oil and hazardous materials spills from land-based sources, and oversees other Federal Agency's compliance with the Clean Water Act and the National Environmental Policy Act.
- Department of Agriculture. DA regulates wetlands under the Swampbuster provisions of the 1985 Farm Bill, it administers the Conservation Reserve and Wetland Reserve programs, it constructs small watershed and flood control projects, and provides technical assistance to land owners.
- Coast Guard. The Coast Guard is the primary Federal responder to oil and hazardous materials spills from vessels and from marine transfer facilities. They regulate river traffic and maintain aids to navigation, inspect commercial vessels and marine transfer facilities, sponsor recreational boater safety classes, and license commercial vessel operators.
- Federal Emergency Management Agency. FEMA is responsible for coordinating Federal emergency response operations, administering the National Flood Insurance Program including monitoring community compliance with floodplain standards, and they implement floodplain mapping, mitigation, and other floodplain management activities.
- National Park Service. NPS administers the National Wildlife and Senic Rivers program (Upper portion of the St. Croix River) and management of the Mississippi National River and Recreation Area in the Minneapolis/St. Paul area.
- Federal Energy Regulatory Commission. FERC regulates and permits non-federal
- Maritime Administration. This agency administers federal programs in support of river born shipping.

This vast and often disjunct coordination system continues to struggle to manage the multitude of Federal and State programs that impact the Upper Mississippi River and its rich natural and cultural resources. Attempts to integrate and create efficiency are typically interlaced with personal and agency agendas and politics. There are a large number of both Federal and State employees who primary job is to attend the great number of resulting meetings this network generates. These folks try their best to represent their agencies', but it is a daunting and difficult task.

The current effort attempting to coordinate this vast network of programs and its varied sets of often obscure objectives, is the Upper Mississippi River Stewardship Initiative. One of its objective is to create a process to systematically coordinate Federal, State, and local programs resulting in a set of multi-scaled Watershed management objectives. It also proposes public involvement to the overall process, and increased Federal resources to address the issues of watershed management. This effort was developed by many organizations and individuals, and then organized and presented to the Basin network and Congress by the Resource Studies Center at St. Mary's University of Minnesota. Parts of the Initiative have been introduced by Congressman Ron Kind as H.R. 4013. The politics and debates continue.

THE FUTURE OF THE RIVER SYSTEM

Unimpounded, open river systems have the ability to traffic energy and nutrients through their biological systems at somewhat predetermined rates. Sediments are periodically flushed and rearranged during periods of high discharge, particularly when landforms on the floodplain are-overtopped by flooding. Sediments are commonly exposed to the atmosphere for prolonged periods of time during periods of low flow.

This provides a mechanism whereby oxidation processes can occur in the sediments and subsequently reduce the biochemical oxygen demand (BOD) within the system. Rivers and streams meander as a function of bed slope and composition of bed material. This results in the natural creation of new wetlands. Rivers discharge sediments at their mouths and commonly approach or reach an equilibrium with regard to sediment input and discharge.

When rivers such as the Upper Mississippi are impounded, however, their capacity to accomplish these functions is reduced or eliminated. In other words, the processes that normally occur in flowing water environments are changed to reflect those which occur in lake environments. Assimilative capacities become reduced, and nutrients accumulate in excessive quantities, particularly in non-channel areas. Flushing of sediments during flood stages is reduced in non-channel areas. Water levels become stabilized and low flow conditions occur less frequently. This retards the rate of oxidation of sediments that have a high biochemical oxygen demand. Accumulations of sediments in downstream reaches of the pools reduce the intra-pool slope and cause meandering processes to either be attenuated or stopped altogether. Increased trapping efficiencies caused by the closure of the dams result in sedimentation and concomitant increases in rates of eutrophication within the pools.

These processes have been observed in the Upper Mississippi River system and are probably responsible for the observable decline in the general quality of the resource. It is apparent that the value of the river resource will continue to decline unless the inputs of sediments, nutrients, and toxic substances are reduced or eliminated. The most obvious result of the aforementioned processes will be an accelerating rate of transformation of productive wetlands to relatively unproductive floodplain forests.

Any obstruction in a stream, which lessens the stream's competence, will promote deposition. The rate of aggradation of the flood plain of the Upper Mississippi was increased by the early channel improvement structures. The dams associated with the 9-foot channel have further increased the rate. Following the closure of a dam, sedimentation begins. Usually, sedimentation can be expected to continue until the sediment level throughout most of the pool reaches the crest of the spillway of the dam. Bed level can be expected to be raised upstream to the point at which the water surface of the reservoir intersects the original bed.

On the Upper Mississippi River, where the watershed is intensively agricultural, and the river's tributaries often run heavy with sand and silt, the slackwater navigation pools make excellent sediment traps, severely curtailing their useful life. The ecological prognosis for the Upper Mississippi River is poor. Generally, degradation of a river begins downstream and proceeds upriver, and this especially true of the Upper Mississippi River. To see what the Upper Mississippi will look like in the future, one must only see the modern Illinois River, which has a longer history of abuse.

We now maintain barge habitat at the expense of other habitats. Tributary streams have had 60 years to adapt to navigation pools, and their lower reaches have adjusted their base levels upward. They have stored massive amounts of sediment in the floodplains of their lower reaches and as deltas. Removing the navigation dams would result in lowering Mississippi water levels and base level. Consequently, tributaries would cut their beds downward, pouring countless tons of stored sediment into the Mississippi.

Most of the states that border the Upper Mississippi River have floodplain zoning laws in effect and in the future non-water-dependent developments will be difficult to locate there. Farm economics may even dictate that some levee and drainage districts be sold back to the government for fish and wildlife habitat. Navigation enhancement projects will be limited by the 1986 enactment of the Waterways Trust Fund whereby new expansion must be costshared by the industry. Mississippi River resources will apparently be increasingly difficult to exploit without providing adequate mitigation.

Ecologists generally agree that "Dust Bowl" conditions may be far from unusual for the Great Plains and the Upper Mississippi River Basin. The region has suffered repeated droughts for thousands of years, but the last 700 years have in fact been unusually wet. Studies of lake sediments reveal that in the past, extreme dry spells not only persisted for centuries at a time but occurred much more frequently than they do today. No one knows what caused the cycle of droughts in the past. Today humans are apparently altering the climate with greenhouse gases, and doing things to the climate that have never happened before.

General circulation computer models indicate that central North America is likely to become warmer and drier, probably causing northern Minnesota's coniferous forests to be replaced by hardwood forests. Mid- or short-grass prairies may replace present tallgrass prairies. Agriculture will be forced to adapt to the climate change, with farmers growing very different crops, perhaps cotton and peanuts. Wetlands and lakes will lose water, and many will dry up. We can be sure that these natural and/or human-induced changes will profoundly impact the Mississippi River.

In 1999, for only the second time since monitoring began in 1912 after the sinking of the Titanic, no icebergs were reported in the North Atlantic shipping lanes. Normally, several hundred or even several thousand bergs drift from Western Greenland to the Grand Banks off Newfoundland during the iceberg season from February to the end of July. Although global warming could be to blame, local winds and natural climate cycles also play a role. Although most scientists agree that global warming is upon us, no one yet knows how much of it - if any - could be due to a recurring natural temperature cycle.

We can only be sure of two things, first, the River in some form will be here, and second, human beings will be here exerting significant impacts on it.

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Stream assessments are prepared for the U.S. Congress under Section 305b of the Clean Water Act to:

- estimate the extent to which Minnesota waterbodies meet the goals of the Clean Water Act and attain state water quality standards, and
- share this information with planners, citizens and other partners in basin planning and watershed management activites.

These assessments are a fundamental part of MPCA's state water quality management program.

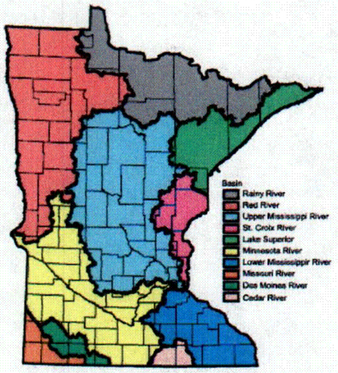
A major shift in 305b assessments in Minnesota occurred for the 2004 assessment reporting cycle. The USEPA had requested States integrate their reporting for sections 303d and 305b of the Clean Water Act and Minnesota has sought to comply by preparing an integrated assessment report in 2004. In order to accomplish this all streams in the state for which data were available were assessed instead of making assessments on a rotating basin cycle as was done in previous assessments.

Two major goals of the Clean Water Act: 1) fishable waters, and 2) swimmable waters, are assessed here in terms of three types of use supports, Aquatic Life, Aquatic Consumption, and Aquatic Recreation, with each use assessed as either:

- fully supporting (FS)
- partially supporting (PS)
- not supporting (NS)
- not assessed (NA)

To view stream assessments, select the major river basin from the map or list files shown below. The stream reaches are grouped by major watershed. New to the stream assessments is a column containing a category, which reflects the overall categorization an assessment unit receives in the integrated assessment process based on the assessments of individual use supports. For a complete description of the categorization process and for the determination of impairment, please read the Guidance Manual for Assessing the Quality of Minnesota Surface Waters (note pages 92 through 95). More information is available on the Total Maximum Daily Load (TMDL) Web page.

Basins in Minnesota



Basin Reports

2004 Integrated Report: Surface Water Section (Abbreviated Narrative Report) - Report to the Congress of the United States: Water Years 2002-2003. This report integrates 305b assessments, which measure attainment of standards for fishable and swimmable waters, and 303d (TMDL) listings of impaired waters. Assessments are organized by basin for the entire state and the report also presents statewide summaries. The report describes Minnesota's monitoring and assessment strategy, assessment tools, and the integrated assessment process. It also briefly describes the state's response to these assessments in terms of development and implementaion of TMDLs and special state strategies.

Stream Assessments

Basin	Basin Reports	Maps
Cedar River	Assessment of Stream Water Quality	Map of Cedar River Basin for Swimming Map of Cedar River Basin for Aquatic Life
Des Moines River	Assessment of Stream Water Quality	Map of Des Moines River Basin for Swimming Map of Des Moines River Basin for Aquatic Life
Lake Superior	Assessment of Stream Water Quality	Map of Lake Superior River Basin for Swimming Map of Lake Superior River Basin for Aquatic Life
Minnesota River	Assessment of Stream Water Quality	Map of Minnesota River Basin for Swimming Map of Minnesota River Basin for Aquatic Life
Missouri River	Assessment of Stream Water Quality	Map of Missouri River Basin for Swimming Map of Missouri River Basin for Aquatic Life
Rainy River	Assessment of Stream Water Quality	Map of Rainy River for Swimming Map of Rainy River Basin for Aquatic Life
Red River	Assessment of Stream Water Quality	Map of Red River Basin Stream Assessment for Swimming Map of Red River Basin Assessment for Aquatic Life
St. Croix River	Assessment of Stream Water Quality	Map of St. Croix River for Swimming Map of St. Croix River Basin for Aquatic Life

c04

Upper Mississippi River, Lower Portion	Assessment of Stream Water Quality	Map of Upper Mississippi River, Lower Portion for Swimming Map of Upper Mississippi River, Lower Portion for Aquatic Life
Upper Mississippi River, Upper Portion	Assessment of Stream Water Quality	Map of Upper Mississippi River, Upper Portion for Swimming Map of Upper Mississippi River, Upper Portion for Aquatic Life

Map Shapefiles

The zipped (compressed) file below contains shapefiles which represent the Minnesota 2004 stream assessments (per Section 305(b) Clean Water Act). These files were created for those interested in preparing computerized maps of the 305(b) stream assessments. To use these files you will need Geographic Information System (GIS) computer software. The zipped file contains shapefiles and metadata for aquatic life use support and aquatic recreation use support for streams. The projection for these shapefiles is UTM extended zone 15, NAD83. The shapefiles were created by the Minnesota Pollution Control Agency using the 1:100,000 scale National Hydrography Dataset. If you have any questions or comments, please contact Carrie Bartz at 651-296-9323.

Map Shapefiles of Minnesota 2004 Stream Assessments (Zip file size = 1.9 MB)

More Information

For more information about the 305b assessments of stream water quality in Minnesota's major river basins, contact Elizabeth Brinsmade at the Minnesota Pollution Control Agency, at 651-296-7312.

MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Mississippi River (Headwaters-Lake Winnibigoshish)																									
07010101-501	Y	5C	MISSISSIPPI RIVER	Vermilion R to Blackwater/Pokegama Lake	10.05	NA	PS	FS		PS	FS	FS			FS		FS					OK	OK	OK	EN
07010101-504	Y	5C	MISSISSIPPI RIVER	Headwaters to Schoolcraft R	54.66	NA	PS	FS	FS	PS	FS	FS		FS	FS		FS					EN	EN	EN	EN
07010101-507	N	2	MISSISSIPPI RIVER	Cass Lk to Lk Winnibigoshish	10.42	NA	FS	FS	FS	FS	FS				FS		FS					OK	EN		
07010101-508	N	2	MISSISSIPPI RIVER	Schoolcraft R to Lk Bemidji	2.03	NA	FS	FS		FS	FS				FS		FS					OK	EN		
07010101-509	N	2	SCHOOLCRAFT RIVER	Headwaters to Mississippi R	34.22	NA	FS	NA	FS	FS	FS	FS			FS							EN	OK		OK
07010101-510	N	3A	TURTLE RIVER	Headwaters to Cass Lk	45.79	NA	NA	NA																	
07010101-512	N	2	MISSISSIPPI RIVER	Lk Bemidji to Stump Lk (04-2001)	3.77	NA	FS	NA		FS	FS	FS			FS							OK	EN		
07010101-513	N	2	MISSISSIPPI RIVER	Stump Lk to Wolf Lk	5.95	NA	FS	FS		FS	FS	FS			FS		FS					OK	EN	EN	OK
07010101-516	N	3A	Unnamed Ditch	Headwaters to Grant Cr	8.43	NA	NA	NA																	
07010101-524	N	3A	MISSISSIPPI RIVER (LAKE WINNIBIGOSHISH)	Lk Winnibigoshish	16.00	NA	NA	NA																	
07010101-526	N	2	THIRD RIVER	Skimmerhorn Lk to Lk Winnibigoshish	18.66	NA	FS	NA	FS																
07010101-573	N	2	BIRCH CREEK	Lk Hattie Outlet to Schoolcraft R	5.39	NA	FS	NA	FS																
07010101-574	N	3A	NICOLLET CREEK	Headwaters to Lk Itasca	1.35	NA	NA	NA																	
07010101-581	N	2	MOOSE CREEK	Unnamed Cr to Third R	6.89	NA	FS	NA	FS																
07010101-592	N	3A	UNNAMED CREEK	Headwaters to Upper Pigeon Lk	1.80	NA	NA	NA																	
07010101-609	N	3A	SIMPSON CREEK	Headwaters to Little Cut Foot Sioux Lk	2.75	NA	NA	NA																	
07010101-618	N	2	ISLAND LAKE CREEK	Island LK to Hansen Lk Outlet	1.37	NA	FS	NA	FS																

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA): Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-Ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Leech Lake River (Leech Lake)																									
07010102-505	N	2	BUNGASHING CREEK	T145 R33W S34 south line to Necktie R	6.94	NA	FS	NA	FS																
07010102-513	N	4D	LEECH LAKE RIVER	Bear R to Mississippi R	7.26	NA	NS	FS		NS	FS	FS			FS		FS					OK	OK	EN	OK
07010102-520	N	2	BOY RIVER	Inguandona Lk to Boy Lk	8.37	NA	FS	NA	FS																
Mississippi River (Grand Rapids)																									
07010103-501	Y	5A	MISSISSIPPI RIVER	Sandy R to Willow R	27.42	NS	PS	FS	FS	FS	PS				FS		FS	NS				EN	EN		
07010103-502	Y	5A	MISSISSIPPI RIVER	Prairie R to Split Hand Cr	23.10	NS	PS	FS	FS	FS	PS	FS			FS		FS	NS				EN	EN	OK	EN
07010103-503	Y	5A	MISSISSIPPI RIVER	Grand Rapids dam to Prairie R	2.85	NS	PS	FS	FS	PS	FS				FS		FS	NS				EN	EN		
07010103-504	N	3A	SANDY RIVER	Big Sandy Lk to Mississippi R	1.22	NA	NA	NA																	
07010103-505	Y	5C	MISSISSIPPI RIVER	Swan R to Sandy R	31.73	NS	NA	NA										NS							
07010103-506	Y	5A	SWAN RIVER	Swan Lk (31-0067) to Mississippi R	65.71	NS	PS	NA		PS	FS	FS			FS			NS				EN	OK	EN	EN
07010103-507	Y	5C	MISSISSIPPI RIVER	Split Hand Cr to Swan R	13.50	NS	NA	NA										NS							
07010103-508	N	2	PRAIRIE RIVER	Prairie Lk to Mississippi R	7.46	NA	FS	FS		FS	FS	FS			FS		FS					EN	EN	OK	OK
07010103-510	Y	5C	MISSISSIPPI RIVER	Cohasset dam to Grand Rapids dam	3.39	NS	FS	FS		FS	FS				FS		FS	NS				OK	EN		
07010103-512	N	3C	SANDY RIVER	Headwaters to Big Sandy Lk	26.98	NA	NA	NA														EN	EN		EN
07010103-514	N	2	WEST SAVANNA RIVER	Headwaters (Little Red Horse) to Prairie R	14.26	NA	FS	NA	FS					FS								OK	EN		EN
07010103-515	N	2	PRAIRIE RIVER	Tamarack R to West Savanna R	8.06	NA	FS	NA	FS					FS								EN	EN		EN
07010103-516	N	3C	PRAIRIE RIVER	Prairie Lk to Tamarack R	23.29	NA	NA	NA														EN	EN		EN
07010103-517	N	3A	UNNAMED DITCH	Unnamed Cr to Mississippi R	9.30	NA	NA	NA																	
07010103-518	N	3C	MINNEWAWA CREEK	Unnamed Ditch to Lk Minnewawa Outlet Cr	3.83	NA	NA	NA														EN	EN		EN

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA): Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Mississippi River (Grand Rapids) - cont'd																									
07010103-519	N	3C	MINNEWAWA CREEK	Lk Minnewawa Outlet Cr to Sandy R (Flowage Lk)	2.24	NA	NA	NA														EN	EN		EN
07010103-520	N	3C	UNNAMED STREAM	Minnewawa Lk outlet to Minnewawa Cr	0.50	NA	NA	NA														OK	OK		
07010103-521	N	3C	TAMARACK RIVER	Headwaters (Flower Lk) to Prairie R	24.20	NA	NA	NA														OK	OK		
07010103-541	N	2	PRAIRIE RIVER	Day Br to Prairie Lk	33.51	NA	FS	NA	FS																
07010103-542	N	2	DAY BROOK	Headwaters (Day Lk) to Prairie R	19.85	NA	FS	NA	FS																
07010103-545	N	2	HAY CREEK	Headwaters to Swan Lk	10.90	NA	FS	NA	FS																
07010103-554	N	2	UNNAMED CREEK	Headwaters to Willow R	3.29	NA	FS	NA	FS																
07010103-556	N	3A	UNNAMED DITCH	Unnamed Ditch to Unnamed Ditch	1.00	NA	NA	NA																	
07010103-560	N	3A	UNNAMED DITCH	Wetland to Unnamed Ditch	2.21	NA	NA	NA																	
07010103-561	N	3A	UNNAMED CREEK	Bartlett Lk outlet to Bluebill Lk	2.24	NA	NA	NA																	
07010103-572	N	3A	UNNAMED DITCH	Unnamed Ditch to Unnamed Ditch	2.02	NA	NA	NA																	
07010103-575	N	3A	WELCOME CREEK	Carlz Pit (31-1239) to Reservoir #2N (31-1228)	1.62	NA	NA	NA																	
Mississippi River (Brainard)																									
07010104-501	Y	5A	MISSISSIPPI RIVER	Pine R to Brainerd dam	20.38	NS	PS	NA		PS	FS							NS				EN	EN		
07010104-502	Y	5C	SWAN RIVER	Headwaters (Big Swan Lk) to Mississippi R	30.08	NA	FS	PS		FS	FS	FS		FS	FS		PS					OK	EN	OK	OK
07010104-503	Y	5A	MISSISSIPPI RIVER	Rice R to Little Willow R	16.08	NS	PS	FS	FS	FS	PS				FS		FS	NS				EN	EN		
07010104-505	Y	5C	RICR RIVER	Headwaters (Porcupine Lk) to Section 5 Cr	13.16	NA	NS	NA	NS																

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA): Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Mississippi River (Brainard) - cont'd																									
07010104-512	Y	5C	MISSISSIPPI RIVER	End of previous HUC (07010103 below Willow R) to Rice R	12.04	NS	NA	NA										NS							
07010104-513	Y	5C	MISSISSIPPI RIVER	Fletcher Cr to Little Elk R	4.26	NS	FS	FS		FS	FS				FS		FS	NS				OK	EN		
07010104-515	Y	5C	MISSISSIPPI RIVER	Crow Wing R to Nokasippi R	8.52	NS	FS	NA	FS									NS							
07010104-516	Y	5C	MISSISSIPPI RIVER	Brainard dam to Crow Wing R	13.90	NS	FS	NA	FS	FS								NS				OK	EN		
07010104-517	Y	5C	MISSISSIPPI RIVER	Little Willow R to Pine R	25.71	NS	FS	NA	FS									NS							
07010104-519	Y	5C	MISSISSIPPI RIVER	Little Falls dam to Swan R	4.47	NS	FS	FS		FS	FS				FS		FS	NS				OK	EN		
07010104-520	Y	5C	MISSISSIPPI RIVER	Little Elk R to Little Falls dam	2.66	NS	NA	NA										NS							
07010104-521	N	2	LITTLE ELK RIVER	T129 R30W S1 north line to Mississippi R	2.45	NA	FS	FS		FS	FS				FS		FS					OK	EN		
07010104-522	N	2	PIKE CREEK	T129 R30W S21 west line to Mississippi R	6.40	NA	FS	FS		FS	FS				FS		FS					OK	EN		
07010104-523	Y	5C	BUFFALO CREEK	Headwaters to Mississippi R	5.29	NA	NS	NA	NS																
07010104-524	N	3A	UNNAMED DITCH	Headwaters (Cranberry Lk) to Mississippi R flood diversion channel	12.31	NA	NA	NA																	
07010104-530	N	2	LITTLE ELK RIVER	South Br Little Elk R to T130 R30W S36 south line	12.28	NA	FS	NA	FS																
07010104-534	N	2	DAGGETT BROOK	Headwaters to Nokasippi R	17.48	NA	FS	NA	FS																
07010104-565	N	3A	MOLLY CREEK	Unnamed Cr to Swan R	2.21	NA	NA	NA																	
07010104-566	N	2	SPRING BRANCH	Headwaters to Unnamed Cr	3.87	NA	FS	NA	FS																
07010104-571	N	3A	UNNAMED DITCH	Headwaters to Unnamed Ditch	0.97	NA	NA	NA																	
07010104-577	Y	5C	MISSISSIPPI RIVER	T42 R32W S3 north line to Fletcher Cr	8.15	NS	FS	FS		FS	FS	FS	FS		FS		FS	NS				OK	EN		

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA): Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
Based on the 2004 MN 305(b) Report to Congress of the United States

						USES:			Indicators of Impairment:													Ecoregion Data:			
National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	Aquatic Consumption	Aquatic Life	Aquatic Recreation	Fish	Oxygen Depletion	Turbidity	Un-ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Pine River																									
07010105-501	N	2	PINE RIVER	Cross Lake Dam to Little Pine R	13.10	NA	FS	NA	FS			FS													
07010105-504	N	2	PINE RIVER	Little Pine R to Mississippi R	5.74	NA	NA	FS									FS								
07010105-507	N	2	LITTLE PINE RIVER	Headwaters to (Little Pine Lk) Mud Br	21.28	NA	FS	NA	FS																
07010105-509	N	2	ARVIG CREEK	Rice Lk to Unnamed Cr	1.11	NA	FS	NA	FS																
Crow Wing River																									
07010106-501	Y	5C	CROW WING RIVER	Gull R to Mississippi R	4.22	NS	FS	FS		FS	FS	FS			FS		FS	NS				EN	EN	EN	EN
07010106-502	N	2	GULL RIVER	Gull Lk to Crow Wing R	15.25	NA	FS	FS		FS	FS	FS			FS		FS					OK	OK	EN	OK
07010106-506	Y	5C	CROW WING RIVER	Seven Mile Cr to Gull R	7.83	NS	NA	NA										NS							
07010106-507	Y	5C	CROW WING RIVER	Long Prairie R to Seven Mile Cr	6.53	NS	FS	NA	FS									NS							
07010106-508	Y	5C	CROW WING RIVER	Mosquito Cr to Long Prairie R	1.92	NS	NA	NA										NS							
07010106-509	Y	5C	CROW WING RIVER	Swan Cr to Mosquito Cr	10.68	NS	FS	NA	FS	FS			FS		FS			NS				EN	EN		EN
07010106-510	Y	5C	CROW WING RIVER	Partridge R to Swan Cr	6.73	NS	NA	NA										NS							
07010106-511	Y	5C	CROW WING RIVER	Leaf R to Partridge R	0.92	NS	NA	NA										NS							
07010106-512	Y	5C	CROW WING RIVER	Farnham Cr to Leaf R	8.71	NS	NA	NA										NS							
07010106-513	Y	5C	CROW WING RIVER	Beaver Cr to Farnham Cr	12.33	NS	NA	NA										NS							
07010106-514	Y	5C	CROW WING RIVER	Cat R to Beaver Cr	3.23	NS	NA	NA										NS							
07010106-515	Y	5C	CROW WING RIVER	Big Swamp Cr to Cat R	2.65	NS	FS	FS	FS	FS	FS	FS			FS		FS	NS				EN	EN	EN	EN
07010106-516	Y	5C	CROW WING RIVER	Shell R to Big Swamp Cr	20.38	NS	NA	NA										NS							
07010106-519	N	3A	UNNAMED CREEK	Headwaters to Cat R	3.06	NA	NA	NA																	
07010106-521	N	3A	UNNAMED CREEK	Headwaters to Bear Cr	9.68	NA	NA	NA																	
07010106-522	Y	5C	FARNHAM CREEK	Unnamed Cr to Crow Wing R	0.54	NA	NS	NA	NS																
07010106-523	Y	5C	CROW WING RIVER	Headwaters (Eleventh Crow Wing Lk) to Shell R	28.04	NS	NA	NA										NS							
07010106-524	N	2	HOME BROOK	Headwaters to Lk Maragaret	14.34	NA	FS	NA	FS																

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA); Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-Ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Crow Wing River - cont'd																									
07010106-526	N	2	MOSQUITO CREEK	Headwaters to Crow Wing R	16.34	NA	FS	NA	FS																
07010106-535	N	2	SHELL RIVER	Fishhook R to Crow Wing R	11.64	NA	FS	NA	FS																
07010106-541	N	2	KETTLE RIVER	Unnamed Cr to Blueberry R	15.19	NA	FS	NA	FS																
07010106-543	N	2	FISHHOOK RIVER	Park Rapids dam to Straight R	5.24	NA	FS	NA	FS																
07010106-550	N	3A	BEAR CREEK	CD 15 to Little Partridge R	4.44	NA	NA	NA																	
07010106-553	N	2	UNNAMED CREEK	Headwaters to Shell R	4.12	NA	FS	NA	FS																
07010106-554	N	2	BLUEBERRY RIVER	Unnamed Cr to Kettle R	5.44	NA	FS	NA	FS																
07010106-555	N	3A	UNNAMED DITCH	Unnamed Cr to Unnamed Cr	2.27	NA	NA	NA																	
Redeye River (Leaf River)																									
07010107-501	N	2	LEAF RIVER	Redeye R to Crow Wing R	8.07	NA	FS	NA		FS	FS	FS			FS							EN	EN	OK	EN
07010107-507	N	2	WING RIVER	Headwaters (Wing River Lk) to Leaf R	39.09	NA	FS	NA	FS																
07010107-517	N	3A	UNNAMED CREEK	Unnamed Cr to Unnamed Cr	1.55	NA	NA	NA																	
07010107-519	N	3A	UNNAMED CREEK	No connection	3.55	NA	NA	NA																	
Long Prairie River																									
07010108-501	Y	5A	LONG PRAIRIE RIVER	Fish Trap Cr to Crow Wing R	8.47	NS	PS	FS		PS	FS	FS	FS		FS		FS	NS				EN	EN	EN	EN
07010108-502	Y	5A	LONG PRAIRIE RIVER	Moran Cr to Fish Trap Cr	7.28	NS	NA	NA										NS							
07010108-503	Y	5A	LONG PRAIRIE RIVER	Turtle Cr to Moran Cr	4.94	NS	PS	NA		PS								NS							
07010108-504	Y	5A	LONG PRAIRIE RIVER	Eagle Cr to Turtle Cr	13.08	NS	NS	NA	NS									NS							
07010108-505	Y	5A	LONG PRAIRIE RIVER	Spruce Cr to Eagle Cr	47.05	NS	NS	NA	NS	PS								NS							

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA): Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-Ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Long Prairie River - cont'd																									
07010108-506	Y	5A	LONG PRAIRIE RIVER	Headwaters (Lk Carlos) to Spruce Cr	11.57	NS	NS	NA	NS									NS							
07010108-507	Y	5A	EAGLE CREEK	Headwaters to Long Prairie R	20.24	NA	NS	NA	NS																
07010108-511	N	2	MORAN CREEK	Headwaters to Long Prairie R	19.34	NA	FS	NA	FS																
Mississippi River (Sartell)																									
07010201-501	Y	5C	MISSISSIPPI RIVER	End of huc (07010104 below Swan R) to Two R	7.72	NS	FS	NA	FS	FS	FS	FS		FS	FS			NS				OK	OK	OK	EN
07010201-502	Y	5C	MISSISSIPPI RIVER	Watab R to Sauk R	2.49	NS	NA	NA										NS							
07010201-505	Y	5C	MISSISSIPPI RIVER	Platte R to Little Rock Cr	10.53	NS	NA	NA										NS							
07010201-507	N	2	PLATTE RIVER	Headwaters (Platte Lk) to Skunk R	36.48	NA	FS	NA	FS																
07010201-508	Y	5C	MISSISSIPPI RIVER	Spunk Cr to Platte R	1.95	NS	NA	NA										NS							
07010201-509	Y	5C	MISSISSIPPI RIVER	Two R to Spunk Cr	3.85	NS	FS	NA	FS									NS							
07010201-513	Y	5C	MISSISSIPPI RIVER	Little Rock Cr to Sartell Dam	4.74	NS	NA	NA										NS							
07010201-514	Y	5C	MISSISSIPPI RIVER	Sartell Dam to Watab R	0.08	NS	NA	NA										NS							
07010201-520	N	2	SKUNK RIVER	Headwaters (Skunk Lk) to Hillman Cr	18.52	NA	FS	NA	FS																
07010201-522	N	2	HILLMAN CREEK	Headwaters to Skunk R	14.94	NA	FS	NA	FS																
07010201-525	N	2	SPUNK CREEK	Headwaters (Lower Spunk Lk) to Mississippi R	18.41	NA	FS	NA	FS																
07010201-526	N	2	WATAB RIVER	North & South Fk Jct to Rossier Lk	1.55	NA	FS	NA	FS																
07010201-532	N	2	SOUTH TWO RIVER	Schwinghammer Lk to Two R Lk	4.56	NA	FS	NA	FS																
07010201-537	N	2	COUNTY DITCH 12	Unnamed Cr to Watab R	5.24	NA	FS	NA	FS																
07010201-538	N	3A	UNNAMED CREEK	Unnamed Cr to Zuleger Cr	3.67	NA	NA	NA																	

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA): Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-Ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Mississippi River (Sartell) cont'd																									
07010201-546	Y	5C	PLATTE RIVER	Rice-Skunk Lakes Dam to Unnamed Cr (abv RR Bridge)	3.77	NA	NS	NA	NS	FS	FS	FS			FS							EN	EN	OK	OK
07010201-548	Y	5C	LITTLE ROCK CREEK	T39 R30W S22 south line to T38 R31W S28 east line (trout stream)	17.18	NA	NS	NA	NS																
Sauk River																									
07010202-501	Y	5A	SAUK RIVER	Mill Cr to Mississippi R	16.21	NS	FS	PS		FS	FS	FS	FS		FS		PS	NS	NS			EN	EN	EN	EN
07010202-502	Y	5A	SAUK RIVER	Headwaters (Lk Osakis) to Sauk Lk	19.44	NS	NA	NA										NS							
07010202-505	Y	5C	SAUK RIVER	Adley Cr to Getchell Cr	11.90	NS	NA	NA										NS							
07010202-506	Y	5C	SAUK RIVER	Melrose dam to Adley Cr	2.54	NS	FS	NA	FS									NS							
07010202-507	Y	5C	SAUK RIVER	Sauk Lk to Melrose dam	15.46	NS	NA	NA										NS							
07010202-508	Y	5C	SAUK RIVER	Getchell Cr to State Hwy 23	31.11	NS	NA	NA										NS							
07010202-517	Y	5C	SAUK RIVER	Knaus Lk to Cold Spring dam	1.49	NS	NA	NA										NS							
07010202-519	Y	5A	SAUK RIVER	Cold Spring dam to Cold Spring WWTP	0.54	NS	NA	NA										NS	NS						
07010202-520	Y	5A	SAUK RIVER	Cold Spring WWTP to Mill Cr	5.66	NS	NA	NA										NS	NS						
07010202-521	Y	5C	COUNTY DITCH 6	Unnamed Cr to Ashley Cr	4.30	NA	NS	NA	NS																
07010202-522	N	3A	HOBOKEN CREEK	Headwaters to Sauk Lk	9.90	NA	NA	NA																	
07010202-526	N	2	GETCHELL CREEK (CD 26)	Headwaters to Sauk R	17.29	NA	FS	NA	FS																
07010202-552	N	2	CROOKED LAKE DITCH	Unnamed Cr to Lk Osakis	2.28	NA	FS	NA	FS																
07010202-553	N	3A	UNNAMED CREEK	Unnamed Cr to Unnamed Cr	0.88	NA	NA	NA																	
07010202-554	N	2	UNNAMED CREEK	Unnamed Cr to Unnamed Cr	2.22	NA	FS	NA	FS																

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA): Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-Ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Mississippi River (St. Cloud)																									
07010203-501	Y	5C	MISSISSIPPI RIVER	Sauk R to St. Cloud dam	3.59	NS	FS	FS		FS	FS	FS	FS		FS		FS	NS				OK	EN	OK	EN
07010203-503	Y	5A	MISSISSIPPI RIVER	Elk R to Crow R (07010204)	5.28	NS	NA	NA										NS	NS						
07010203-505	N	3C	ST FRANCIS RIVER	Headwaters to Elk R	72.16	NA	NA	NA														EN			
07010203-506	Y	5C	ELK RIVER	Rice Cr to St. Francis R	23.83	NS	FS	NA	FS									NS							
07010203-507	Y	5C	ELK RIVER	Mayhew Cr to Rice Cr	13.17	NS	NA	NA										NS				EN			
07010203-508	Y	5C	ELK RIVER	Headwaters to Mayhew Cr	24.23	NS	NA	NA										NS							
07010203-509	Y	5C	MAYHEW CREEK	Headwaters (Mayhew Lk) to Elk R	13.98	NA	NS	NA	NS																
07010203-510	Y	5A	MISSISSIPPI RIVER	Clearwater R to Elk R	33.36	NS	NS	PS	NS	FS	FS	FS	FS		FS		PS	NS				OK	EN	OK	EN
07010203-511	N	3A	CLEARWATER RIVER	Clearwater Lk to Mississippi R	11.35	NA	NA	FS									FS								
07010203-512	N	3C	RICE CREEK	Rice Lk to Elk R	6.19	NA	NA	NA														EN			
07010203-513	Y	5C	MISSISSIPPI RIVER	St. Cloud dam to Clearwater R	13.67	NS	FS	NA	FS									NS							
07010203-517	N	3C	UNNAMED STREAM	Unnamed stream outlet of Cedar Lk to Clearwater Lk	0.38	NA	NA	NA														OK			
07010203-522	N	3C	TIBBETS BROOK	Rice Lk to Elk R	6.64	NA	NA	NA														EN			
07010203-525	Y	5C	ELK RIVER	Orono Lk to Mississippi R	1.11	NS	NA	NA										NS							
07010203-529	N	3C	SNAKE RIVER	Unnamed Cr to Eagle Lk Outlet	2.84	NA	NA	NA														EN			
07010203-531	N	3A	UNNAMED CREEK	Headwaters to Unnamed Cr	1.55	NA	NA	NA																	
07010203-535	N	2	BATTLE BROOK	CD 18 to Elk Lk	4.29	NA	FS	NA	FS																
07010203-538	N	2	BRIGGS CREEK	T35 R29W S2 east line to Briggs Lk	5.21	NA	FS	NA	FS																
07010203-544	N	3C	THREEMILE CREEK	T122 R28W S35 east line to Otter Lk	0.27	NA	NA	NA														OK			
07010203-548	Y	5A	ELK RIVER	St. Francis R to Orono Lk	12.23	NS	PS	NA		PS	FS	FS			FS			NS				EN	EN	OK	EN

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MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
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National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Mississippi River (St. Cloud) cont'd																									
07010203-549	Y	5A	CLEARWATER RIVER	CD 44 to Lk Betsy	7.68	NA	NA	NA																	
Crow River, North Fork																									
07010204-501	Y	5A	JEWITTS CREEK (CD19, CD18, CD 17)	Headwaters (Lk Ripley) to N Fk Crow R	10.80	NA	NS	NA	NS	NS		FS		FS	FS							EN			
07010204-502	Y	5A	CROW RIVER, NORTH FORK	S Fk Crow R to Mississippi R (07010206)	25.05	NA	NS	PS	NS	FS	NS	FS	FS	FS	FS		PS					EN	EN	EN	EN
07010204-503	Y	5A	CROW RIVER, NORTH FORK	Mill Cr to S Fk Crow R	13.42	NS	NS	NA		NS	NS	FS		FS	FS			NS				EN	EN	EN	EN
07010204-504	Y	5C	CROW RIVER, NORTH FORK	Lk Koronis to Middle Fk Crow R	8.67	NS	FS	NA	FS	FS		FS		FS	FS			NS				OK			
07010204-506	Y	5C	CROW RIVER, NORTH FORK	Jewitts Cr to Washington Cr	21.94	NS	FS	NA		FS		FS		FS	FS			NS				EN			
07010204-507	Y	5C	CROW RIVER, NORTH FORK	Middle Fk Crow R to Jewitts Cr	10.94	NS	FS	NA		FS		FS		FS	FS			NS				EN			
07010204-508	N	2	CROW RIVER, NORTH FORK	Headwaters (Grove Lk) to Lk Koronis	47.61	NA	FS	NA	FS	FS		FS		FS	FS							EN			
07010204-509	N	2	EAGLE CREEK	Lk Francis Outlet to North FK Crow R	2.43	NA	FS	NA	FS																
07010204-511	N	2	CROW RIVER, MIDDLE FORK	Green Lk to North Fk Crow R	15.51	NA	FS	NA		FS		FS		FS	FS							EN			
07010204-514	Y	5A	GROVE CREEK	Unnamed Cr to North Fk Crow R	8.15	NA	NS	NA	NS	PS		FS		FS	FS							EN			
07010204-515	Y	5C	MILL CREEK	Buffalo Lk to North Fk Crow R	3.58	NA	NS	NA		NS		FS		FS	FS							EN			
07010204-527	Y	5C	UNNAMED CREEK	Unnamed Ditch to North Fk Crow R	2.97	NA	NS	NA		NS				FS	FS							EN			

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA); Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
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National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Crow River, North Fork - cont'd																									
07010204-529	N	2	TWELVEMILE CREEK	Dutch Lk to North Fk Crow R	7.75	NA	FS	NA	FS	FS				FS								EN			
07010204-536	N	3A	COUNTY DITCH 37	Unnamed Cr to Middle Fk Crow R	6.82	NA	NA	NA																	
07010204-542	Y	5C	UNNAMED CREEK	Unnamed Cr to Crow R	2.09	NA	PS	NA		PS		FS		FS	FS							EN			
07010204-543	N	3A	UNNAMED CREEK	Unnamed Cr to Unnamed Cr	3.87	NA	NA	NA																	
07010204-546	N	2	UNNAMED CREEK (BIG SWAN LAKE OUTLET)	Big Swan Lk to North Fk Crow R	1.32	NA	FS	NA		FS				FS	FS							EN			
07010204-548	N	3A	UNNAMED CREEK	Unnamed Cr to Unnamed Cr	3.55	NA	NA	NA																	
07010204-552	Y	5C	UNNAMED CREEK	T120 R31W S32 south line to Jewitts Cr	6.38	NA	NS	NA	NS																
07010204-556	Y	5C	CROW RIVER, NORTH FORK	T120 R28W S31 west line to Mill Cr	47.41	NS	FS	NA		FS		FS		FS	FS			NS				OK			
Crow River, South Fork																									
07010205-501	Y	5A	BUFFALO CREEK	JD 15 to South Fk Crow R	49.90	NS	NS	NA	NS	FS		FFS		FS	FS			NS				EN			
07010205-502	Y	5A	BUFFALO CREEK	Headwaters to JD 15	34.60	NS	NS	NA	NS	FS				FS	FS			NS				OK			
07010205-504	N	3A	JUDICIAL DITCH 67	Headwaters to Buffalo Cr	5.52	NA	NA	NA																	
07010205-505	N	3A	COUNTY DITCH 13	Headwaters to South Fk Crow R	17.51	NA	NA	NA																	
07010205-506	N	3A	JUDICIAL DITCH 29	Headwaters to South Fk Crow R	5.72	NA	NA	NA																	
07010205-508	Y	5A	CROW RIVER, SOUTH FORK	Buffalo Cr to North Fk Crow R	31.40	NS	NS	NA	NS	FS	NS			FS	FS			NS				EN	EN	EN	EN
07010205-510	Y	5C	CROW RIVER, SOUTH FORK	Hutchinson dam to Bear Cr	17.17	NS	FS	NA		FS		FS		FS	FS			NS				EN			
07010205-511	Y	5C	CROW RIVER, SOUTH FORK	Bear Cr to Otter Cr	13.65	NS	FS	NA		FS		FS		FS	FS			NS				EN			

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MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Crow River, South Fork cont'd																									
07010205-512	Y	5C	CROW RIVER, SOUTH FORK	Otter Cr to Buffalo Cr	3.08	NS	NA	NA										NS							
07010205-513	N	3A	JUDICIAL DITCH 15	T115 R32W S32 west line portion to Buffalo Cr	11.18	NA	NA	NA																	
07010205-528	N	3A	COUNTY DITCH 4	Unnamed Ditch to Buffalo Cr	2.70	NA	NA	NA																	
07010205-529	N	3A	UNNAMED CREEK	Unnamed Cr to Boon Lk Outlet	0.70	NA	NA	NA																	
07010205-540	Y	5A	CROW RIVER, SOUTH FORK	Headwaters to Hutchinson dam	49.82	NS	NS	NA	NS	FS		FS		FS	FS			NS				EN			
07010205-546	N	3A	UNNAMED DITCH	Unnamed Cr to South Fk Crow R	5.97	NA	NA	NA																	
Mississippi River (Twin Cities)																									
07010206-501	Y	5A	MISSISSIPPI RIVER	Lock & Dam #2 to St. Croix River (RM 815.2 to 811.3)	3.72	NS	PS	FS		FS	PS	FS	FS	FS	FS		FS	NS	NS						
07010206-502	Y	5A	MISSISSIPPI RIVER	Rock Island RR bridge to Lock & Dam #2 (RM 830 to 815.2)	15.20	NS	PS	FS		FS	PS	FS	FS	FS	FS		FS	NS	NS	NS		EN	EN	EN	EN
07010206-503	Y	5A	MISSISSIPPI RIVER	Lower St. Anthony Falls to Lock & Dam #1 (RM 853.3 to 847.6)	5.59	NS	FS	FS		FS	FS	FS	FS	FS	FS		FS	NS				OK	EN	OK	EN
07010206-504	Y	5A	MISSISSIPPI RIVER	Metro WWTP to Rock Island RR bridge (RM 835 to 830)	3.44	NS	PS	FS	FS	FS	PS	FS	FS	FS	FS		FS	NS	NS	NS		EN	EN	EN	EN
07010206-505	Y	5A	MISSISSIPPI RIVER	Minnesota R to Metro WWTP (RM 844 to 835)	10.42	NS	PS	PS		FS	PS	FS	FS	FS	FS		PS	NS	NS	NS		EN	EN	OK	EN
07010206-506	Y	5A	SHINGLE CREEK (COUNTY DITCH 13)	Headwaters (Eagle Cr/Bas Cr) to Mississippi R	11.16	NA	NS	NA	FS	NS		FS		NS	FS							EN			
07010206-508	Y	5C	ELM CREEK	Headwaters (Lk Medina) to Mississippi R	19.76	NA	NS	NA		NS		FS		FS	FS							EN			

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MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
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Mississippi River (Twin Cities) - cont'd																									
07010206-509	Y	5A	MISSISSIPPI RIVER	Coon Cr to Upper St. Anthony Falls	12.14	NS	FS	FS		FS	FS	FS		FS	FS		FS	NS	NS			OK	EN	OK	EN
07010206-510	Y	5A	MISSISSIPPI RIVER	Rum R to Elm Cr	0.41	NS	FS	NA	FS									NS	NS						
07010206-511	Y	5A	MISSISSIPPI RIVER	Elm Cr to Coon Rapids Dam	4.80	NS	NA	NA										NS	NS						
07010206-512	Y	5A	MISSISSIPPI RIVER	Coon Rapids Dam to Coon Cr	1.03	NS	NA	NA										NS	NS						
07010206-513	Y	5A	MISSISSIPPI RIVER	Upper St. Anthony Falls to Lower St. Anthony Falls	0.58	NS	NA	NA										NS	NS						
07010206-514	Y	5A	MISSISSIPPI RIVER	Lock & Dam #1 to Minnesota R	3.63	NS	NA	NA										NS	NS						
07010206-516	N	3A	LAMBERT CREEK	Vadnais Lk to White Bear Lk	3.74	NA	NA	NA																	
07010206-517	Y	5C	UNNAMED CREEK	Headwaters to Mississippi R	4.67	NA	NS	NA	NS																
07010206-518	Y	5A	HARDWOOD CREEK	Headwaters to Peltier Lk	13.38	NA	NS	NA	NS	NS					FS							EN			EN
07010206-519	Y	5C	CLEARWATER CREEK	Bald Eagle Lk to Peltier Lk	5.40	NA	NS	NA	NS													EN			EN
07010206-522	N	3C	COUNTY DITCH 2	1st St SW (New Brighton) to Pike Lk	1.22	NA	NA	NA														EN			EN
07010206-525	N	3A	DIAMOND CREEK	Headwaters (French Lk) to Unnamed Lk	5.60	NA	NA	NA																	
07010206-526	N	3A	UNNAMED CREEK	Headwaters to Medicine Lk	5.76	NA	NA	NA																	
07010206-527	Y	5C	BASS CREEK	Headwaters to Eagle Cr	2.32	NA	NS	NA	NS																
07010206-528	Y	5C	RUSH CREEK	Headwaters to Elm Cr	16.46	NA	NS	NA	NS																
07010206-530	N	2	COON CREEK	Unnamed Cr to Mississippi R	23.10	NA	FS	NA	FS																
07010206-538	Y	5C	BASSETT CREEK	Medicine Lk to Mississippi R	11.99	NA	NS	NA	NS		FS														
07010206-539	Y	5C	MINNEHAHA CREEK	Lk Minnetonka to Mississippi R	20.82	NA	NS	NA	NS		FS														
07010206-540	N	3A	FISH CREEK	Carver Lk to Pigs Eye Lk	2.11	NA	NA	NA																	
07010206-541	N	3A	UNNAMED CREEK	Headwaters to Unnamed Cr	1.88	NA	NA	NA																	

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Mississippi River (Twin Cities) - cont'd																									
07010206-543	N	3A	UNNAMED CREEK (WILLOW LAKE OUTLET)	Willow Lk to Unnamed Cr	1.02	NA	NA	NA																	
07010206-552	N	3A	UNNAMED CREEK	Unnamed Lk to Bassett Cr	2.61	NA	NA	NA																	
07010206-557	N	3A	UNNAMED CREEK	Headwaters to Mississippi R	3.89	NA	NA	NA																	
07010206-558	N	2	SAND CREEK	Unnamed Cr to Coon Cr	2.13	NA	FS	NA	FS																
07010206-559	N	3C	DITCH (Anoka County 53-62?)	Unnamed Cr to Golden Lk	2.74	NA	NA	NA														EN			EN
07010206-560	N	3A	UNNAMED CREEK	Unnamed Cr to Ham Lk Outlet	2.09	NA	NA	NA																	
07010206-562	N	3A	UNNAMED CREEK	Headwaters to George Watch Lk	1.93	NA	NA	NA																	
07010206-565	Y	5C	DITCH (Ramsey/Washington JD1)	Headwaters to Bald Eagle Lk	2.33	NA	NS	NA		NS		FS			FS							EN			EN
07010206-568	Y	5A	MISSISSIPPI RIVER	NW city limits of Anoka to Rum R	2.97	NS	FS	FS		FS	FS	FS	FS	FS	FS		FS	NS	NS			EN	EN	OK	EN
07010206-571	N	3C	RICE CREEK	Headwaters (Howard Lk) to Peltier Lk	4.36	NA	NA	NA														EN			OK
07010206-583	Y	5C	RICE CREEK	Unnamed LK (02-0041) to Long Lk	6.01	NA	NS	NA	NS																
07010206-584	N	2	RICE CREEK	Long Lk to Locke Lk	3.03	NA	FS	NA	FS																
07010206-592	Y	5C	BATTLE CREEK	Battle Cr Lk to Pigs Eye Lk	5.09	NA	NS	NA	NS		FS														
Rum River																									
07010207-502	Y	5C	RUM RIVER	Cedar Cr to Trott Brook	3.43	NS	NA	NA										NS							
07010207-503	Y	5C	RUM RIVER	Seelye Brook to Cedar Cr	6.71	NS	NA	NA										NS							
07010207-504	Y	5C	RUM RIVER	Stanchfield Cr to Seelye Brook	33.71	NS	FS	FS	FS	FS	FS	FS	FSS	FS	FS		FS	NS				EN	EN	OK	EN

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MISSISSIPPI RIVER BASIN (Upper Portion)
ASSESSMENT OF STREAM WATER QUALITY
Based on the 2004 MN 305(b) Report to Congress of the United States

						USES:			Indicators of Impairment:													Ecoregion Data:			
National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	Aquatic Consumption	Aquatic Life	Aquatic Recreation	Fish	Oxygen Depletion	Turbidity	Un-ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Rum River cont'd																									
07010207-505	N	3A	FORD BROOK	Headwaters (Goose Lk) to Trott Bk	10.23	NA	NA	NA																	
07010207-506	Y	5C	RUM RIVER	Headwaters (Mille Lacs Lk) to Ogechie Lk	0.22	NS	NA	NA										NS							
07010207-508	Y	5C	RUM RIVER	Ogechie Lk to Lk Onamia	6.70	NS	NA	NA										NS							
07010207-509	Y	5C	RUM RIVER	Lk Onamia to Tibbetts Bk	20.63	NS	FS	NA	FS									NS							
07010207-510	Y	5C	RUM RIVER	Tibbetts Bk to Bogus Bk	22.67	NS	NA	NA										NS							
07010207-511	Y	5C	RUM RIVER	Bogus Bk to West Br Rum R	15.77	NS	NA	NA										NS							
07010207-512	Y	5C	RUM RIVER	West Br Rum R to Stanchfield Cr	35.18	NS	NA	NA										NS							
07010207-521	N	2	CEDAR CREEK	Headwaters to Rum R	23.80	NA	FS	NA	FS			FS		FS											
07010207-523	N	2	BOGUS BROOK	T38 R26W S23 north line to Rum R	11.02	NA	FS	NA	FS																
07010207-528	N	2	SEELYE BROOK	Headwaters to Rum R	9.88	NA	FS	NA	FS																
07010207-529	N	2	TROTT BROOK	Headwaters to Rum R	18.16	NA	FS	NA	FS																
07010207-530	N	2	MAHONEY BROOK	Headwaters to Cedar Cr	3.29	NA	FS	NA	FS																
07010207-531	N	3A	UNNAMED CREEK	Unnamed Cr to Unnamed Cr	3.47	NA	NA	NA																	
07010207-534	N	3A	COUNTY DITCH 4	Unnamed Cr to Unnamed Ditch	1.67	NA	NA	NA																	
07010207-537	N	2	MIKE DREW BROOK	Unnamed Cr to Unnamed Cr	1.75	NA	FS	NA	FS																
07010207-540	N	2	BRADBURY BROOK	North Fk Bradbury Br to Rum R	0.91	NA	FS	NA	FS																
07010207-555	Y	5C	RUM RIVER	Trott Cr to Madison/Rice St in Anoka	8.71	NS	FS	FS		FS	FS	FS			FS		FS	NS				OK	EN	OK	OK
				-End of Basin-																					

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA): Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Lower Portion)
ASSESSMENT OF STREAM WATER QUALITY
St. Croix River to the MN-IA Border
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Mississippi River and Lake Pepin (Red Wing)																									
07040001-501	N	3A	MISSISSIPPI RIVER	Trimbelle R to old Cannon R/Cannon Lk outlet	1.32	NA	NA	NA																	
07040001-502	N	3A	MISSISSIPPI RIVER	Lk Pepin above Rush R (WI)	5.73	NA	NA	NA																	
07040001-503	N	3A	MISSISSIPPI RIVER	Lock & Dam #3 (Red Wing) to Trimbelle R (WI)	2.29	NA	NA	NA														OK			EN
07040001-504	Y	5A	VERMILLION RIVER	Vermillion R/Vermillion Slough, Hastings dam to Mississippi R	22.06	NS	NS	NA		FS	NS	FS		FS	FS			NS	NS			OK	OK		OK
07040001-505	N	3A	MISSISSIPPI RIVER	Hay Cr to Lk Pepin inlet (RM 786)	6.34	NA	NA	NA														EN	EN	EN	EN
07040001-506	N	4A	VERMILLION RIVER	South Br Vermillion R to Hastings dam	11.51	NA	FS	NS		FS	FS	FS		FS	FS		NS								
07040001-507	N	4A	VERMILLION RIVER	Below trout stream portion to South Br Vermillion R	8.96	NA	FS	NS		FS	FS	FS	FS	FS	FS		NS					EN	EN	OK	OK
07040001-508	N	3A	MISSISSIPPI RIVER	Lk Pepin, Wells Cr to Chippewa R (WI)	14.74	NA	NA	NA														EN	EN	OK	EN
07040001-509	N	3A	MISSISSIPPI RIVER	Big R (WI) to Lock & Dam 3 (Red Wing)	7.79	NA	NA	NA														EN	EN	OK	EN
07040001-511	Y	5C	CANNON RIVER	HUC boundary in Rice Lake Bottoms to Vermillion Slough/Mississippi R	0.54	NA	PS	NA		FS	PS	FS		FS	FS							OK	OK		EN
07040001-512	N	3A	MISSISSIPPI RIVER	St. Croix R to Truedale Slough	2.97	NA	NA	NA																	
07040001-513	N	3A	MISSISSIPPI RIVER	Truedale Slough to Big R (WI)	3.57	NA	NA	NA																	
07040001-514	N	3A	MISSISSIPPI RIVER	Cannon R to Hay Cr	1.10	NA	NA	NA																	
07040001-515	N	3A	MISSISSIPPI RIVER (LAKE PEPIN)	Lk Pepin, Rush R(WI) to Wells Cr	2.52	NA	NA	NA																	

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA): Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Lower Portion)
ASSESSMENT OF STREAM WATER QUALITY
St. Croix River to the MN-IA Border
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Mississippi River and Lake Pepin (Red Wing) cont'd																									
07040001-519	N	2	WELLS CREEK	Headwaters to Mississippi R	23.66	NA	FS	NA		FS	FS	FS		FS	FS							OK	OK		OK
07040001-531	Y	5A	MISSISSIPPI RIVER	St Croix R to Chippewa R	48.36	NS	NS	FS			NS							NS	NS	NS					
Cannon River																									
07040002-502	Y	5B	CANNON RIVER	Pine Cr to Belle Cr	11.29	NA	PS	PS		FS	PS	FS			FS		PS					OK	OK	OK	OK
07040002-503	Y	5B	STRAIGHT RIVER	Maple Cr to Crane Cr	5.43	NA	PS	NS		FS	PS	FS			FS		NS					EN	EN	OK	OK
07040002-504	Y	5B	PRAIRIE CREEK	Headwaters to Cannon R (Lk Byllesby)	26.02	NA	NS	NS		FS	NS	FS			FS		NS					OK	EN		EN
07040002-506	Y	5C	CANNON RIVER	Straight R to Wolf Cr	11.94	NS	NA	NA										NS							
07040002-507	Y	5C	CANNON RIVER	Wolf Cr to Heath Cr	3.21	NS	NA	NA										NS							
07040002-508	Y	5C	CANNON RIVER	Heath Cr to Northfield dam	1.61	NS	NA	NA										NS							
07040002-509	Y	5A	CANNON RIVER	Northfield dam to Lk Byllesby inlet	10.21	NS	NS	PS			NS				FS		PS	NS				EN	EN	EN	EN
07040002-512	Y	5C	UNNAMED CREEK	Headwaters to Prairie Cr	2.72	NA	NA	NS									NS								
07040002-513	Y	5C	UNNAMED CREEK	Unnamed Cr to Unnamed Cr	4.69	NA	NA	NS									NS								
07040002-515	Y	5A	STRAIGHT RIVER	Rush Cr to Cannon R	12.68	NA	PS	NS			PS				FS		NS					EN	EN	OK	EN
07040002-516	Y	5C	CRANE CREEK	Headwaters (Watkins Lk) to Straight R	15.47	NA	FS	NS			FS				FS		NS								
07040002-518	Y	5C	TURTLE CREEK	Headwaters to Straight R	16.50	NA	NA	NS									NS								
07040002-519	Y	5C	MAPLE CREEK	Headwaters to Straight R	11.73	NA	NA	NS									NS								
07040002-525	N	3A	UNNAMED CREEK	Headwaters to Straight R	10.07	NA	NA	NA																	
07040002-528	Y	5C	CHUB CREEK	Headwaters to Cannon R	19.51	NA	FS	NS									NS					OK	EN		EN
07040002-533	N	3A	STRAIGHT RIVER	Unnamed Cr to CD 64	3.15	NA	NA	NA																	
07040002-534	N	3A	STRAIGHT RIVER	Headwaters to Unnamed Cr	9.93	NA	NA	NA																	
07040002-535	Y	5A	STRAIGHT RIVER	Turtle Cr to Owatonna Dam	7.40	NA	PS	NS			PS	FS			FS		NS								

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MISSISSIPPI RIVER BASIN (Lower Portion)
ASSESSMENT OF STREAM WATER QUALITY
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Cannon River cont'd																									
07040002-539	N	2	CANNON RIVER	Byllesby Dam to Little Cannon R	2.68	NA	FS	FS			FS						FS					OK	EN		OK
07040002-540	Y	5C	CANNON RIVER	Cannon Lk to Straight R	5.89	NA	NS	NA			NS				FS							EN	OK	EN	OK
Mississippi River (Winona)																									
07040003-501	N	3A	MISSISSIPPI RIVER	Zumbro R to Whitewater R	7.16	NA	NA	NA																	
07040003-505	Y	5B	WHITEWATER RIVER, SOUTH FORK	Headwaters to trout stream portion	20.37	NA	PS	NS		FS	PS	FS			FS		NS					EN	EN	OK	EN
07040003-506	N	3A	MISSISSIPPI RIVER	Trempealeau R (WI) to LD6 (Trempealeau)	2.92	NA	NA	NA																	
07040003-507	N	3A	MISSISSIPPI RIVER	Chippewa R (WI) to Buffalo R (WI)	9.09	NA	NA	NA																	
07040003-508	N	3A	MISSISSIPPI RIVER	LD5 (Minneiska) to Waumandee Cr (WI)	4.96	NA	NA	NA														EN	EN		EN
07040003-509	N	3A	MISSISSIPPI RIVER	LD4 (Alma) to Zumbro R	2.87	NA	NA	NA														EN	EN		EN
07040003-510	N	3A	MISSISSIPPI RIVER	Whitewater R to LD5 (Minneiska)	4.44	NA	NA	NA														EN	EN	EN	EN
07040003-511	N	3A	MISSISSIPPI RIVER	Buffalo R (WI) to LD4 (Alma)	1.62	NA	NA	NA																	
07040003-513	N	3A	MISSISSIPPI RIVER	Lock & Dam #6 (Trempeleau) to HUC boundary (downstream of Richmond Island)	2.81	NA	NA	NA														EN	EN	OK	EN
07040003-514	Y	5A	Whitewater River, Middle Fork	Trout Stream portion	12.10	NA	NA	NA																	
07040003-516	N	3A	MISSISSIPPI RIVER	Waumandee Cr (WI) to Garvin Bk	2.35	NA	NA	NA																	

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MISSISSIPPI RIVER BASIN (Lower Portion)
ASSESSMENT OF STREAM WATER QUALITY
St. Croix River to the MN-IA Border
Based on the 2004 MN 305(b) Report to Congress of the United States

National Hydrography Dataset (NHD) Assessment Reach ID	Impaired Waters List	Category	River Reach	Location	NHD Length (Miles)	USES: Aquatic Consumption	Aquatic Life	Aquatic Recreation	Indicators of Impairment: Fish	Oxygen Depletion	Turbidity	Un-ionized Ammonia	Metals	Chloride	pH	Invertebrates	Bacteria	Mercury FCA	PCB FCA	Mercury Water Column	PCB Water Column	Ecoregion Data: TOTAL PHOSPHORUS	NITRITE/NITRATE	OXYGEN DEMAND (BOD)	SUSPENDED SOLIDS
Mississippi River (Winona) - cont'd																									
07040003-517	N	3A	MISSISSIPPI RIVER	Garvin Bk to Lock & Dam #5A	2.76	NA	NA	NA																	
07040003-518	N	3A	MISSISSIPPI RIVER	Lock & Dam #5A to Gilmore Cr	2.23	NA	NA	NA																	
07040003-519	N	3A	MISSISSIPPI RIVER	Gilmore Cr to Trempealeau R (WI)	9.26	NA	NA	NA																	
07040003-533	N	3A	Rollingstone Creek	Unnamed Cr to Garvin Br	9.52	NA	NA	NA																	
07040003-537	Y	5C	WHITEWATER RIVE	South Fk Whitewater R to Beaver Cr	5.97	NS	NA	NA										NS							
07040003-538	Y	5C	WHITEWATER RIVE	Beaver Cr to End trout stream portion	4.27	NS	NA	NA										NS							
07040003-539	Y	5A	WHITEWATER RIVE	End trout stream portion to Mississippi R	6.10	NS	NS	NA		FS	PS	FS		FS	FS			NS				EN	EN		EN
07040003-542	Y	5B	GARVIN BROOK	Trout stream portion	13.99	NA	NS	NS		FS	NS	FS		FS	FS		NS					OK	OK	OK	EN
07040003-554	Y	5B	WHITEWATER RIVER, NORTH FORK	Unnamed Cr to Middle Fk Whitewater R	10.49	NA	NA	NA																	
07040003-560	Y	5A	MISSISSIPPI RIVER	Chippewa R to HUC Boundary (downstream of Richmond Island)	52.46	NS	FS	NS									NS	NS	NS						
Zumbro River																									
07040004-501	Y	5A	ZUMBRO RIVER	West Indian Cr to Mississippi R	23.43	NS	NS	PS			NS						PS	NS	NS						
07040004-502	Y	5A	ZUMBRO RIVER	Cold Cr to West Indian Cr	23.40	NS	NA	PS									PS	NS	NS						
07040004-503	N	4A	SALEM CREEK	Lower 17.24 miles (Class 2C portion) to S Fk Zumbro R	17.28	NA	FS	NS		FS		FS			FS		NS					OK	EN		OK

Full Support (FS); Partial Support (PS); Not Supporting (NS); Not Assessed (NA); Exceeds Ecoregion Norms (EN)

MISSISSIPPI RIVER BASIN (Lower Portion)
ASSESSMENT OF STREAM WATER QUALITY
St. Croix River to the MN-IA Border
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Zumbro River - cont'd																									
07040004-504	Y	5A	ZUMBRO RIVER	North Fk Zumbro R to Cold Cr	6.51	NA	NA	NS										NS	NS						
07040004-505	N	3C	ZUMBRO RIVER (ZUMBRO LAKE)	Zumbro Lk	6.68	NA	NA	NA														OK			EN
07040004-506	Y	5C	ZUMBRO RIVER	Zumbro Lk to North Fk Zumbro R	4.28	NS	NA	NA											NS						
07040004-507	Y	5B	ZUMBRO RIVER, SOUTH FORK	Cascade Cr to Zumbro Lk	12.42	NA	FS	NS		FS	FS	FS			FS		NS					OK	EN	OK	EN
07040004-519	N	3C	ZUMBRO RIVER, MIDDLE FORK	Shady Lk to Zumbro Lk	5.88	NA	NA	NA														OK			EN
07040004-533	Y	5C	ZUMBRO RIVER, SOUTH FORK	Silver Lk Dam to Cascade Cr	0.19	NA	NA	NS									NS								
07040004-535	Y	5C	ZUMBRO RIVER, SOUTH FORK	Bear Cr to Oakwood Dam	0.53	NA	NA	NS									NS								
07040004-536	Y	5C	ZUMBRO RIVER, SOUTH FORK	Salem Cr to Bear Cr	8.67	NA	NA	NS									NS								
Mississippi River (La Crosse)																									
07040006-501	N	3A	MISSISSIPPI RIVER	Pine Cr to Root R	2.66	NA	NA	NA																	
07040006-502	N	4A	MISSISSIPPI RIVER	La Crosse R to Pine Cr	1.70	NA	NA	NA														EN	EN	OK	EN
07040006-503	N	3A	MISSISSIPPI RIVER	HUC boundary (downstream of Richmond Island) to Black R	3.11	NA	NA	NA																	
07040006-505	N	3C	MISSISSIPPI RIVER	Lock & Dam 7 (Dresbach) to La Crosse R	4.32	NA	NA	NA														EN	EN		EN
07040006-506	N	3A	MISSISSIPPI RIVER	Black R to Lock & Dam 7 (Dresbach)	5.89	NA	NA	NA																	

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Mississippi River (La Crosse) cont'd																									
07040006-509	Y	5A	MISSISSIPPI RIVER	HUC Boundary (downstream of Richmond Island) to Root R	17.67	NS	FS	FS										NS	NS						
Root River																									
07040008-501	Y	5B	ROOT RIVER	Thompson Cr to Mississippi R	5.73	NA	NS	NS		FS	NS	FS		FS	FS		NS					EN	EN	OK	EN
07040008-503	N	4A	ROBINSON CREEK	Headwaters to N Br Root R	10.35	NA	FS	NS		FS		FS			FS		NS					OK	EN		OK
07040008-505	Y	5C	ROOT RIVER, MIDDLE BRANCH	Bear Cr to Upper Bear Cr	9.50	NS	NA	NA										NS							
07040008-506	Y	5C	ROOT RIVER, MIDDLE BRANCH	Upper Bear Cr to North Br Root R	1.52	NS	NA	NA										NS							
07040008-521	Y	5C	Money Creek	End trout stream portion to Root R	16.89	NA	NA	NS									NS								
07040008-528	Y	5C	ROOT RIVER, MIDDLE BRANCH	Trout Run Cr to South Br Root R	16.19	NS	NA	NA										NS							
07040008-530	Y	5C	ROOT RIVER, MIDDLE BRANCH	Rice Cr to Trout Run	6.79	NS	NA	NA										NS							
07040008-532	Y	5C	ROOT RIVER, MIDDLE BRANCH	Lynch Cr to Rice Cr	0.66	NS	NA	NA										NS							
07040008-534	Y	5C	ROOT RIVER, MIDDLE BRANCH	North Br Root R to Lynch Cr	6.03	NS	NA	NA										NS							
07040008-555	Y	5A	ROOT RIVER, SOUTH BRANCH	Canfield Cr to Willow Cr	10.31	NA	PS	NS		FS	PS			FS			NS					EN	EN		EN
07040008-557	N	3C	CANFIELD CREEK	Headwaters to South Br Root R	15.18	NA	NA	NA														OK	EN		EN
07040008-561	N	3C	JUDICIAL DITCH 1	Unnamed Cr to South Br Root R	1.32	NA	NA	NA														OK	EN		OK

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Root River cont'd																									
07040008-562	N	3C	ETNA CREEK	Unnamed Cr to South Br Root R	0.61	NA	NA	NA														OK	EN		EN
07040008-563	N	3C	FORESTVILLE CREEK	Unnamed Cr to South Br Root R	1.68	NA	NA	NA														EN	EN		EN
07040008-586	Y	5A	ROOT RIVER, SOUTH BRANCH	Headwaters to Trout stream portion	25.22	NA	PS	NS		FS	PS			FS			NS					EN	EN		EN
Mississippi River (Reno)																									
07060001-501	N	3A	MISSISSIPPI RIVER	Root R to Coon Cr (WI)	12.16	NA	NA	NA																	
07060001-502	N	3C	MISSISSIPPI RIVER	Coon Cr (WI) to Lock & Dam 8 (Genoa)	2.64	NA	NA	NA														EN	EN		EN
07060001-503	N	3A	MISSISSIPPI RIVER	Lock & Dam #8 (Genoa) to Bad Axe R (WI)	3.96	NA	NA	NA																	
07060001-504	N	3A	MISSISSIPPI RIVER	Bad Axe R (WI) to MN/IA border	1.55	NA	NA	NA																	
07060001-509	Y	5A	MISSISSIPPI RIVER	Root R to Iowa Border	20.32	NS	PS	NA			PS							NS	NS						
				-End of Basin-																					

USFWS 2005c

U.S. Fish & Wildlife Service

Crane Meadows National Wildlife Refuge

19502 Iris Road
Little Falls, MN 56345
E-mail: cranemeadows@fws.gov
Phone Number: 320-632-1575

Visit the Refuge's Web Site:
http://midwest.fws.gov/cranemeadows

Sandhill crane standing with wings spread

Crane Meadows Refuge hosts one of the largest nesting populations of greater sandhill cranes in Minnesota.

Overview

Crane Meadows National Wildlife Refuge

Crane Meadows National Wildlife Refuge was established in 1992 to preserve a large, natural wetland complex. The 1,825-acre refuge is located in central Minnesota and serves as an important stop for many species of migrating birds. It harbors one of the largest nesting populations of greater sandhill cranes in Minnesota. Habitats include native tallgrass prairie, oak savanna, and wetlands with dense stands of wild rice.

The refuge serves as the base for the Federal private lands program in Morrison County, which focuses on restoring drained wetlands through voluntary agreements with landowners. Acquisition of land for Crane Meadows is continuing as funding is available.

Getting There . . .

Crane Meadows National Wildlife Refuge is located in Central Minnesota, approximately 30 miles north of St. Cloud and 6 miles southeast of Little Falls.

From Little Falls, follow State Highway 10 south approximately 2 miles and prepare for a left lane exit to County Highway 35 East. Travel approximately 4.5 miles to the Platte River Bridge and, after crossing the bridge, take the first left to the Platte River Trailhead and refuge headquarters.

From St. Cloud, take State Highway 10 north approximately 25 miles to County Highway 35 East. Travel approximately 4.5 miles to the Platte River Bridge and, after crossing the bridge, take the first left to the Platte River Trailhead and refuge headquarters.

Recreation & Education Opportunities

Environmental Education
Interpretation
Photography
Wildlife Observation
Learn More >>

Management Activities

The refuge is still in the land acquisition phase. Management activities are directed toward restoration of altered habitats to their natural states. Prescribed fire and native prairie restoration are major programs. Exotic tree species such as Siberian elm and black locust are mechanically and chemically treated to control their invasive habits. Biological methods are used to control purple loosestrife and leafy spurge.

Regular censuses are conducted to monitor wildlife population and vegetation trends. Undergraduate and graduate students use the refuge for various biological studies.

Wildlife and Habitat

The refuge lies in the transition zone between the more heavily forested land to the north and east and the original prairie to the south and west.

Learn More>>

History

Crane Meadows Refuge has long been recognized for its wetland and wildlife values on a local, State and regional basis.

Learn More>>

U.S. Fish & Wildlife Service

Crane Meadows National Wildlife Refuge

19502 Iris Road
Little Falls, MN 56345
E-mail: cranemeadows@fws.gov
Phone Number: 320-632-1575

Visit the Refuge's Web Site:
http://midwest.fws.gov/cranemeadows

Sandhill crane standing with wings spread

Crane Meadows Refuge hosts one of the largest nesting populations of greater sandhill cranes in Minnesota.

Wildlife and Habitat

Continued . . .

As such, the area is a rich mosaic of habitat types ranging from lakes, small wetlands and bogs in the lowlands, to scattered oak, aspen, brush and grasslands on the uplands. This vegetative diversity has resulted in a corresponding diversity of wildlife, with wildlife typical of wetlands, woods, savannas and grasslands present.

The refuge area includes large expanses of sedge meadow wetland and encompasses two shallow open-water wetlands, Rice and Skunk Lakes. These shallow lakes are located at the confluence of the Platte River, Skunk River, Rice Creek, and Buckman Creek and have an abundant supply of wild rice in the fall.

This abundance of wetland habitat provides habitat for scores of wetland-dependent birds. One of the most notable inhabitants of the area is the greater sandhill crane, a bird that had all but disappeared from Minnesota at the turn of the century. The refuge area is one of the most important breeding areas for these cranes in Central Minnesota, supporting over 30 nesting pairs. In addition, hundreds of cranes stage here during fall migration.

Waterfowl are generally abundant and include most species of ducks and geese found in the Prairie Pothole Region of Minnesota. The most common nesting species are Canada goose, mallard, blue-winged teal, and wood duck. During spring and fall migration, thousands of ducks are present on Rice and Skunk lakes and their surrounding wetlands. Notable concentrations of American wigeon, gadwall, mallard, blue-winged teal, northern pintail, northern shoveler, canvasback, redhead, green-winged teal, and mergansers have been documented.

Bald eagles, a Federally threatened species, are commonly sighted during spring and fall migration periods on Rice and Skunk lakes. An active bald eagle nest exists within the refuge acquisition boundary. Other wetland-dependent birds found in the area include great blue heron, American bittern, common loon, double-crested cormorant, common snipe, sora, sedge wren, and northern harrier.

This wetland complex is also important for wetland-dependent amphibians, mammals and reptiles. Muskrat, beaver, river otter, raccoon, and mink are common in refuge wetland habitats.

Eighteen species of reptiles and amphibians have been recorded on the area, including wetland species such as tiger salamander, green frog, northern leopard frog, western chorus frog, and spring peeper. Also found in area wetlands are one State-listed endangered species, the northern cricket frog; and one State species of special concern, the snapping turtle.

Surveys on area wetlands and lakes have confirmed over 40 species of fish, including common game fish species such as northern pike, walleye, smallmouth bass, largemouth bass, bluegill, and black crappie. A large population of carp and other roughfish also exists. Little Rock Creek, located on the south end of the refuge acquisition area, is a State-designated trout stream.

Upland habitats surrounding these wetlands include a variety of habitats ranging from open grasslands to deciduous forest. Scattered remnant stands of two rare upland plant communities, tallgrass prairie and the globally endangered oak savanna, are present on the refuge. Less than one percent of both of these communities remains in Minnesota. In addition to these remnants, active restoration of these rare habitat types is underway on former agricultural lands that have been acquired.

Common upland birds found on the area include ring-necked pheasant, wild turkey, red-tailed hawk, rough-legged hawk, rreat horned owl, barred owl, and over 200 species of songbirds, including indigo bunting, eastern bluebird, savanna sparrow, and scarlet tanager. In addition, the area supports breeding populations of a number of bird species that are uncommon in central Minnesota or identified as important by bird conservation collaboratives. Le Conte's sparrow, bobolink, upland sandpiper, clay-colored sparrow, grasshopper sparrow, golden-winged warbler, and short-eared owl are examples of such species.

Mammals that frequent refuge area uplands include white-tailed deer, coyote, red fox, skunk, badger, and a variety of mice, voles, shrews, and ground and tree squirrels. Upland reptiles include one State-listed threatened species, the Blanding's turtle, and two State species of special concern, the western hognose snake and gopher snake.

Documented packs of gray wolf, a Federally threatened species, exist within 10 miles of the refuge. In addition, although none have been documented, the area is within the historic range of the Federally listed Karner blue butterfly. The refuge is also on the edge of the range of the Federally threatened Canada lynx.

The ranges of four Federally threatened or endangered plants overlap the refuge area. These are: Leedy's roseroot, Minnesota dwarf trout lily, prairie bush-clover, and western prairie fringed orchid. Although none of these species has been documented in this area, there is some potential for discovery.

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History

Continued . . .

In fact, besides having a great diversity of wetland types, the area is unique in having very little alteration from draining or development.

In the mid 1960s, the Minnesota Department of Natural Resources realized that the pressures of development would eventually come and began purchasing land for their Wildlife Management Area System. Although the State of Minnesota was successful in acquiring several large tracts of land, development pressures continued to increase. Single family homes were being built on the uplands surrounding the lakes. Isolated wetlands in adjacent agricultural fields were being drained, and more of the surrounding habitats of prairie and oak savanna were being converted to agriculture.

All of these activities threatened to change the character and productivity of this important area forever. It was also during this period that The Nature Conservancy (TNC) expressed a willingness to help preserve this important wetland area and acquired several properties within the wetland complex.

By the mid-1980s, the State of Minnesota, TNC, and local conservationists understood that there was not enough money or time for them to protect the entire complex. Shortly thereafter, this group of partners invited the U.S. Fish and Wildlife Service to evaluate the wetland complex as a potential waterfowl production area or national wildlife refuge. The formal study began in 1990 and was completed in July of 1992 with the completion of the Final Environmental Assessment.

TNC provided early acquisition support with the purchase of the first five properties. After the approval for Crane Meadows National Wildlife Refuge, these properties were managed by the Service. The first appropriation for land acquisition was $900,000 in 1994, which allowed the Service to "buy out" the properties held by TNC and add others that were available from willing sellers.

Acquisition was brisk over the following years and continues today with slow but steady progress toward the acquisition goal. Some development has come to this important area, but the efforts by the State, hunting clubs, TNC, local conservationists, and the refuge have, so far, protected the core wetland complex.

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