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Upper Mississippi River System: Environmental Management Program

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Program Rationale

The Environmental Management Program (EMP) was established by the United States Congress to provide a mechanism for improving environmental conditions on the Upper Mississippi River System (UMRS). The program fits within a broader vision for the UMRS which reflects Congressional commitment to "balanced use, development, and protection " of the river resource (USACE, 1997a). The EMP was specifically authorized as part of the Water Resources Development Act (WRDA) passed in 1986 (P.L. 99-662). This legislation also expanded the primary missions of the U.S. Army Corps of Engineers (previously flood damage reduction and navigation) to include environmental restoration, and placed responsibility for implementing the EMP with the Corps. The program was initially authorized for 10 years, but was extended by 5 years in the 1990 WRDA. To date, 24 habitat rehabilitation and enhancement projects (HREPs) have been planned, designed, constructed, and monitored under the EMP. These projects have affected 28,000 acres of river and floodplain habitat. This figure is expected to increase to 97,000 acres upon completion of an additional 26 HREPs that are currently under construction or in various stages of design.

Setting

The 1986 WRDA defined the Upper Mississippi River System as the commercially navigable portions of the Mississippi River north of Cairo, Illinois plus the Minnesota, St. Croix, Black, Illinois, and Kaskaskia Rivers. The program area includes over 1,300 miles of river extending from Minneapolis to Cairo (downstream of St. Louis) to the outskirts of Chicago (on the Illinois River) and is regulated by a series of more than 30 locks and dams. The program area is contained within the states of Minnesota, Wisconsin, Iowa, Illinois, and Missouri (see Figure 1). The character of the river varies dramatically along its many

stretches, ranging from areas with plentiful backwater habitat in scenic settings to areas with extensive channel control in industrialized settings. The counties in the program area have over 7 million residents living in communities that range from small "river towns" to major metropolitan areas. More than 28 million people live in the five UMRS states (Carlson, et al. 1995).

Program Participants

From its inception, the EMP was conceived as a partnership among various Federal agencies and the UMRS states. The District offices in St. Paul, Rock Island, and St. Louis are responsible for implementing the program. The EMP Coordinating Committee (EMPCC), which provides policy and budgetary oversight for the EMP, is co-chaired by representatives of the Corps and the U.S. Fish and Wildlife Service. Other members of the EMPCC represent the U.S. Geological Survey, each of the five State conservation agencies, and other Federal agencies that have a stake in managing the UMRS including the Environmental Protection Agency, the National Park Service, and the Natural Resource Conservation Service.

Program Goals and Objectives

The major goals and objectives of the EMP have been formally identified through six programmatic elements. In combination, these program elements are intended to provide the means for better understanding and maintaining the ecological health of the river resource within its multiple-use context:

- Plan, construct and evaluate habitat improvement projects
- Undertake a long term resource monitoring program (LTRMP)
- Establish a computerized inventory and analysis system
- Develop recreational projects
- Assess the economic impacts of recreational activities
- Monitor navigation traffic movements

The first three goals have comprised the majority of activity in the program throughout its lifetime. For the last 12 years of the program (1990-2002) annual authorizations for the program have been fixed at $19.5 million per year: $13 million for habitat projects; $6 million for long term resource monitoring; and $500,000 for recreation projects. Earlier years had differing amounts to reflect start-up costs and other considerations. Congress has not always appropriated funds to the level of the authorized amounts. Through the program’s life, only $160.6 million of the total $210.9 million authorized has been appropriated. These funds have gone to the following purposes: habitat projects ($90.3 million); LTRMP ($57.3 million); recreation projects ($9,000); economic impacts of recreation study ($750,000); navigation traffic monitoring ($206,000); and program management ($11.2 million).

Overview of Development-Related Disturbances on the UMRS

U.S. settlers have attempted to shape the UMRS to meet their needs (both natural and commercial) since the times of Territorial development. "The adherents of one movement dreamed of making the river a commercial highway. Backers of the other hoped to preserve and develop it for fish and wildlife and for its scenic beauty. The natural river met neither group's needs, and both worked to change it. The development of the upper Mississippi River thus represents a compromise--albeit an uneven one--between the proponents of these two movements and speaks to their differing visions for the river" (Anfinson, 1993).

In 1866, Congress authorized major efforts to improve the navigability of the river by directing the Corps of Engineers to remove hazards from the river by dredging, removing snags, clearing overhanging trees, and removing sunken vessels. These efforts proved to be limited in their success, and by 1878 a much more significant project was authorized: the 4 1/2 foot channel project. Development of that project fundamentally changed the upper Mississippi's physical and ecological character. To achieve the 4 1/2 foot channel, the Corps built wing dams and closing dams, protected shorelines, and dredged stubborn bars. These actions constricted the river, gradually moving its banks inward, changing its landscape and ecology. Constricting the channel caused faster flows and isolated backwater areas, causing concern among conservationists for the health of the fish and wildlife. These concerns were compounded by changes outside the river corridor which were increasingly the source of serious environmental threats to the river's ecosystem (Anfinson, 1993).

River pollution increased with regional development. Carlander cites deforestation, clearing of land, drainage, reclamation of swamp lands, leveeing of river banks, dredging and straightening of channels as changes attenuating the normal annual fluctuations of the river, leading to greater floods, less water during dry seasons, and siltation (Carlander, 1954). Urban development also degraded the river environment. In 1930, average untreated sewage flows from the Twin Cities metropolitan area into the river were 144 million gallons per day, with the ratio of sewage to river water as high (under computed extreme conditions) as one gallon of sewage for each 5.8 gallons of river water (Wicks, 1930) resulting in drastic reductions in fish populations (Minnesota State Board of Health, 1928, in Carlander, 1954). The effects of watershed development and pollution were seen as a direct threat to the natural health of the river, and to the recreation it supported. Conservationists sought institutional protection for the resource, and led a movement which ultimately established the Upper Mississippi River Wildlife and Fish Refuge in 1924. The refuge covers a stretch of 260 miles of river from Wabasha, Minnesota to Rock Island, Illinois (Anfinson, 1993).

The River and Harbors act of July 3, 1930 initiated the most fundamental change that would take place in the upper Mississippi River valley. The act authorized the development and maintenance of a nine-foot channel for navigation and initiated the construction of 26 locks and dams between Minneapolis and St. Louis. The river's landscape would be permanently changed. "By 1940 the Mississippi between St. Louis and Minneapolis was no longer a part of American's greatest free-flowing river. It had been turned into a canal, and engineered stairway with twenty-six locks and dams. Behind each step was a slack-water pool, a man-made lake with a regulated shoreline" (Merritt, 1980).

Concerns about sewage concentrating in the pools behind the dams were realized almost immediately, threatening the health of aquatic animals and humans dependent on the water supply. These concerns eventually led to control and treatment of sewer wastes discharged into the river. Productivity for fish and wildlife increased during the initial decades because of the increases in aquatic areas, but these gains have decreased through time. This is a common pattern for reservoirs. Evidence of decline has been reported in numerous sources (USACE, 1997a).

Current River "Health" and Targeted Resources

Despite the alterations and disturbances experienced on the UMRS over the past 150 years, the river system "retains a complex longitudinal and lateral mosaic of communities and exhibits processes characteristic of large floodplain river systems" (Sparks et al., 1990). The impoundments have changed the river characteristics in the permanent reservoir pools immediately behind them, but have less influence further upstream. In each pool an upstream zone essentially retains the characteristics of the natural river with multiple side channels and unleveed floodplains, including islands. In the downstream zone of each pool floodplains and islands have typically been permanently inundated to some degree (Sparks et al., 1990). Today's river is not considered to be as healthy as a natural system, however. The Upper Mississippi River Conservation Committee has warned of a potential ecosystem collapse (Upper Mississippi River Conservation Committee, 1993) similar to the one that occurred on the Illinois River in the 1950's.

The ecological characteristics of the river differs between pools as well as within pools, which have been described across five distinct reaches (USACE, 1997a). Three of these reaches are on the mainstem Mississippi River. The upper impounded reach, stretching from Minneapolis, Minnesota to Clinton, Iowa, has a narrow floodplain (less than 3 miles wide) bounded by steep bluffs and many backwater areas. Only three percent of the floodplain in this stretch has been isolated by levees. The lower impounded reach, stretching from Clinton, Iowa to Alton, Illinois, has an average floodplain width of 5.6 miles. Fifty-three percent of the floodplain is restricted by levees, supporting land uses including urban areas, agricultural fields, and conservation lands. The unimpounded reach of the UMR, stretching from St. Louis, Missouri to Cairo, Illinois, is significantly influenced by water and sediment flowing from the Missouri River. Agricultural levees segregate 82 percent of the floodplain from the river.

The upper reach of the Illinois River lies above the Starved Rock Lock and Dam. This reach has been drastically altered, through canalization (reversing flow direction and connecting to Lake Michigan) and pollution from municipal and industrial sources. Land use along this stretch is primarily urban, and opportunities for restoring habitat in this stretch are considered limited. The lower reach of the Illinois river stretches from the Starved Rock Lock and Dam to the confluence with the Mississippi River. This reach has a wide floodplain, 60 percent of which has been isolated behind levees for primarily agricultural uses.

In general, the ecological health declines from the upper reach of the Mississippi River to the lower reaches, and the Illinois River is considered generally unhealthy. These assessments have been made by developing an "ecological report card" for the UMRS (USACE 1997a). The level

of ecological constraints, ranging from none to a level that is ecologically unhealthy, have been assessed for the following criteria:

- Presence of habitats and viable native animal and plant populations
- Ability to recover from disturbances
- Ability of the ecosystem to sustain itself
- The reach's capacity to function as part of a healthy basin
- Annual channel/floodplain connectivity and exchange
- Ability of infrequent natural events to maintain ecosystem structure and processes

The assessments between reaches are differentiated largely by the extent of floodplain that has been isolated by levees, the extent of suspended sediment loads and sedimentation rates, the resilience of aquatic and riparian vegetation, and the level of invasion by exotic species. All areas of the UMRS are considered to be limited by the restrictions on channel-forming ability caused by infrequent floods, due to channel training structures and dams.

The most pressing system ecological needs have been summarized in four targeted areas of concern (USACE 1997a):

- **Tributary effects:** increased flood inflows; sediment/nutrient/toxics transport
- **Decreased floodplain structural diversity:** island erosion; sediment deposition; training structure effects; floodplain sequestering by levees
- **Altered hydrology:** flood zone reduction; water level alterations; river-floodplain connectivity
- **Water/sediment quality**: increased suspended sediments, nutrients, and toxics

Rehabilitation and Enhancement Practices

Programs and policies external to the EMP exist to manage trends in tributaries, water and sediment quality/quantity, and point/non-point pollution sources in the UMRS basin. The HREP program of the EMP is the only program to address floodplain structure and hydrology for restorative purposes. Eligible project types under the HREP, and their primary purposes, are listed below (USACE 1997a):

- **Backwater dredging:** increase overwintering fish habitat; add to depth diversity.

- **Water level management (dikes and water control structures):** reduce sediment deposition in backwater and wetland areas; manipulate water levels to promote aquatic plant and invertebrate production; restore waterfowl resting and feeding habitat.

- **Island construction:** provide physical conditions for re-establishment of aquatic plant growth; reduce wind and wave action.

- **Shoreline stabilization:** prevent bank erosion; create fish habitat

- **Side channel openings or closures:** preserve aquatic habitat by reducing sedimentation in backwaters.

- **Aeration:** restore aquatic habitat through improved water quality.

- **Other (notched wing dams, potholes, land acquisition, planting, etc.):** complementary to above actions.

Projects that are considered for inclusion in the EMP are initially nominated by State natural resource agencies and/or the USFWS. These nominations are based on agency management objectives, habitat needs, professional judgment, funding availability, and social considerations. Meetings were organized early in the program's history to develop both regional and site-specific goals for potential projects, which were used to screen and prioritize potential HREPs (USACE, 1997a). If the EMP is reauthorized, a Habitat Needs Assessment will be developed to identify current and desired future conditions to help establish priorities for new projects to establish goals for judging program success.

To date, backwater dredging and water level management approaches have been employed most frequently (on 20 and 19 projects, respectively). Each of the other specified purposes (island construction, shoreline stabilization, side channel management, and aeration) has been used on between 8 and 10 projects. Supplemental measures have been used on 19 projects (USACE, 1997b).

Evaluating Success and "Technology Transfer"

Pre-project and post-project monitoring of HREPs is undertaken to determine resource conditions and project performance for both physical and biological indicators. The extent of monitoring for completed projects is limited by high costs, which is a recognized problem for many restoration and rehabilitation programs (USACE 1997a; Kelly and Harwell, 1990; Hughes et al., 1990). Although the use of adaptive management in ecosystem restoration has been recommended in several prominent Federal programs (Yozzo, 1996) a review of the EMP identified several constraints limiting program innovation and flexibility. Recommendations in the Report to Congress specifically request that factors such as project life design requirements, definitions of project failure, experimental design considerations, and any future policies and

guidance be examined for potential constraints on innovative design and management of EMP projects (USACE, 1997a).

Project performance is reported for each HREP in a Performance Evaluation Report including physical and biological response monitoring, operation and maintenance considerations, engineering design evaluation, and a performance monitoring plan. The physical response monitoring considers flow distribution and velocity, water levels, water quality parameters, and sediment transport, as appropriate. Physical response for all HREPs is checked on a regular basis by the agency responsible for operations and maintenance of the respective projects. The biological response monitoring considers plant growth, and fish and wildlife response. Intensive biological monitoring has been limited to six HREPs.

Through the experience of implementing these HREPs, participants have reported methodological advances in a number of areas: habitat quality assessment; engineering advances (such as island design); reduced costs (through beneficial use of "by-products" such as timber sales); and project performance evaluation. "Essentially, HREP engineering and design developed as the program developed, resulting in enhanced habitat benefits and reductions in most project implementation costs" (USACE 1997a). These efforts have also benefited from the data and analysis generated by the LTRMP which has undertaken longitudinal data collection at six field locations, assembled historical data to establish a GIS inventory, and conducted numerous scientific analyses of the river resources (resulting in more than 200 reports, publications, and presentations). Corps-wide advances in methods related to environmental planning have been documented in the Evaluation of Environmental Investments Research Program (EEIRP) which has prepared over 25 published manuals (Harrington and Feather, 1996).

Another outcome of the EMP that has been reported as an "invaluable success" is the increased level of partnership the program has fostered among the many federal, state, local, and non-governmental organizations that share interests in the UMRS (USACE 1997a). One of the most obvious limitations of the EMP is the restriction of project activities to within the UMRS floodplain. The EMP is therefore limited in the extent of ecosystem effects that can be impacted, and is potentially susceptible to detrimental effects imposed elsewhere in the watershed. However, the increased interaction among agencies working on the EMP has led to stronger coordination of the various efforts throughout the watershed which should result in greater ecosystem enhancements. Increased awareness has also led to beneficial activities that cross river purposes, such as using dredged material from the navigation channel to create islands for habitat enhancement, and mimicking water-level pulse through large scale pool drawdowns (Water Management Level Task Force, 1996). Additionally, the EMP partnership is believed to serve as a catalyst to increase funding levels for river enhancement activities outside the EMP, since funders often are more willing to contribute when other parties are also supportive.

One criticism of the program relates to the funding structure of the program. Program requirements place responsibility for operations and maintenance expenses of projects on local sponsors, which could result in cost inefficiencies if projects are designed to minimize these expenses at the cost of increased initial construction expenditures. Another criticism is that overall funding for HREPs is too small, especially in comparison to the amount of money spent

for maintaining the navigation system on the river. Some who want to see more radical change on the river, such as removal of the locks and dams to restore the river to a more natural state, feel that the EMP itself may be harmful as it is inadequate for restoring the river to their desired state, yet may give the impression to policymakers and the general public that the health of the river is being adequately served. On the whole, however, the EMP is generally viewed as one of the most successful and important aquatic rehabilitation programs in the nation. Its reauthorization has received enthusiastic support from the participating States and the U.S. Fish and Wildlife Service, and broad support from other river stakeholders, as documented in the Report to Congress (USACE 1997a). Habitat enhancement for the UMRS also receives broad support among the general public (Carlson, 1996).

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