



SCIENCE AND PLANNING

ON THE UPPER MISSISSIPPI RIVER AND ILLINOIS WATERWAY

HIGHLIGHTS OF THE NATIONAL ACADEMIES
REPORTS ON MANAGING THE NATION'S
LARGEST LOCK AND DAM SYSTEM

NATIONAL RESEARCH COUNCIL
OF THE NATIONAL ACADEMIES

“The Mississippi is well worth reading about. It is not a commonplace river, but on the contrary is in all ways remarkable.”

—Mark Twain, *Life on the Mississippi*, 1863

AS AN ECOLOGICAL AND ECONOMIC RESOURCE of enormous size and inestimable value, the Upper Mississippi River remains as remarkable today as during the era of Mark Twain and steamboat travel. Both the Upper Mississippi and Illinois rivers are key transportation arteries for downstream shipments of corn, soybeans, and other farm products from the upper Midwest to the Gulf of Mexico and for upstream shipments of fertilizers, petroleum products, iron and steel, and other goods. In addition to commercial shipping, the river and its floodplains are used for commercial and recreational fishing, hunting, camping, jet skiing, boating, sources of municipal and industrial water, and tourism.

The U.S. Army Corps of Engineers is in charge of operating the navigation system on the Upper Mississippi River-Illinois Waterway. With 29 locks on the Upper Mississippi River and 8 locks on the Illinois Waterway, the Upper Mississippi River-Illinois Waterway is the nation’s largest lock and dam system. Unlike the much deeper lower Mississippi River, the river’s shallower northern portions have been engineered to support commercial traffic. Pursuant to 1930 federal legislation, locks and dams were built to create a navigation channel with a minimum depth of 9 feet.

Congestion has long been a problem at many locks along the lower portions of the lock and dam system. Though not constant, congestion at these locks can occasionally be severe, with barges sometimes waiting

Upper Mississippi River and Illinois Waterway locks and dams.





Inside a Lock. A tow exits one of the locks on the Upper Mississippi River. This lock is part of the nation's largest lock and dam system, built and managed by the U.S. Army Corps of Engineers. The system provides a 9-foot deep navigation channel that supports commercial shipping from the upper Midwest to St. Louis and downstream to New Orleans. The locks operate on relatively simple principles; gravity forces water into the locks through a valve, raising the water level in the lock chamber to the level on the other side.

many hours in a queue to pass through a given lock. The navigation industry contends that a primary cause of this congestion is that today's tows are longer than the 600-foot locks in the system. Many towboats push multiple barges that exceed 1,000 feet, which must be de-coupled and processed through the locks in "double lockages."

In the late 1980s, the Corps began to study this problem and evaluate the economic feasibility of extending several locks along the lower portion of the Upper Mississippi and Illinois rivers to 1,200 feet. A more comprehensive study, begun in 1993, went through several iterations and was completed in late 2004. The study was nearly unprecedented for the Corps of Engineers, as it lasted nearly 15 years and cost tens of millions of dollars. From 2000 to 2005, the National Research Council (NRC) convened two different committees (Phase I and Phase II) to review the study. The committees' four reports evaluated the Corps' plans and highlighted several important analytical and river management issues.

COMPETING AND SHIFTING DEMANDS ON THE RIVER

When it was constructed in the 1930s, backers of the 9-foot channel project saw it as crucial to national shipping and commercial interests. While the project vastly improved the means for shipping grain from the upper Midwest to New Orleans, it also fundamentally altered the river's hydrology and ecosystems. The 9-foot channel system consists of a series of dams and navigation pools along the river. The deep water in these pools enhances navigation, but the pools also have submerged backwater areas and have disrupted the natural, seasonal ebb and flow of waters that help sustain the diversity of plant and animal life along the river.

These changes in river hydrology have had negative impacts on the river ecosystem. According to the U.S. Geological Survey and other river scientists, many key indicators of ecological well-being have experienced a state of decline since the 1950s. Environmental groups have thus encouraged the Corps to vary water levels



What Gets Shipped? Grain—primarily corn, soybeans, and wheat—is the principal commodity shipped down the river. Products are shipped in barges pushed by towboats. Scrap metal ranks second to grain in downstream tonnage. Other products include iron and steel products, sand, gravel, fertilizers, sulfur, cement, sugar, and molasses. Coal and petroleum are among the main products shipped upstream. In 2000, the Upper Mississippi River carried 120 million tons of commercial cargo.

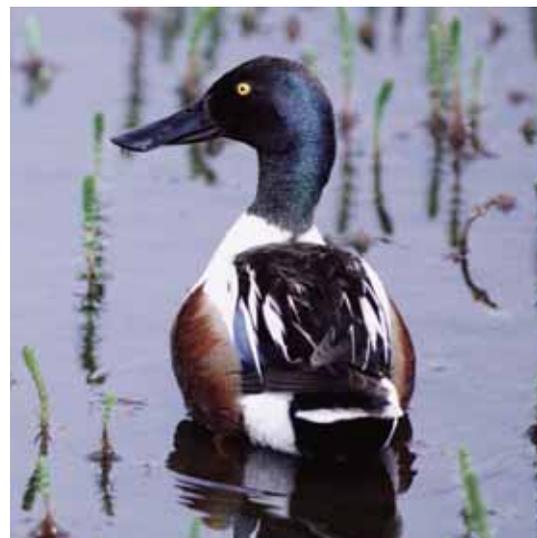
in the navigation pools behind the dams to help simulate more natural river conditions. Decisions regarding these efforts to improve river ecology are complicated by the fact that many other changes across the river basin—such as deforestation and agricultural practices—have also affected the river-floodplain ecosystem.

The needs of other river users further complicate river management decisions. Recreational boating and other forms of flat-water recreation (e.g., jet skiing) have increased in popularity and economic importance. In general, these users enjoy the benefits of the deep and reliable navigation channel

created by the locks and dams. On the other hand, recreational and commercial fishermen place a high value on protecting river ecology and generally prefer to see more variability in channel depths.

These types of trade-offs are central to uses along the river, but the means for evaluating them are not always clear. How does one consider, for example, the various costs and benefits associated with a river channel that is shallower than the current minimum 9 feet? Shallower and more variable river channel depths may benefit river ecology, but these benefits are often difficult to determine. How might flat-water recreation be affected by such changes? Would riverfront landowners be affected? What extra costs might shippers incur and would they have the flexibility to accommodate such conditions, or would they use alternative shipping options?

Protecting River Ecology. While the lock and dam system has provided an important commercial transportation option, it has also fundamentally altered the river's hydrology and ecosystems. In response to concerns raised by environmental groups, the Corps of Engineers has been varying water levels in some navigation pools behind the dams to support the needs of a wide variety of wildlife such as waterfowl. Varying water levels can create new wetland habitats, provide for species that forage at different water levels, and can be used to manage seed production, control vegetation growth rate, and maintain diversity of plant life.



WATERWAY CONGESTION AND NAVIGATION SYSTEM MANAGEMENT

In its navigation feasibility study, the Corps attempted to gauge future levels of U.S. grain exports and demands on the waterway. Within its study, the Corps devoted considerable resources to developing and applying economic models to help forecast future demands on the waterway and to evaluate the benefits of constructing larger lock facilities. Both NRC committees reviewed these models and concluded that the models generally did not yield credible results. Some advances were made in these modeling exercises and applications; however, flaws were also noted, including unrealistic assumptions, inadequate conceptual bases, and limited and inconsistent data used as input.

A key recommendation that emerges from the NRC studies is that the Corps should work toward developing a scheduling and sequencing system for better managing waterway traffic. The current system for passing towboats through the locks is primarily “first come, first served,” although lockmasters employ some clever variants on this theme to help expedite lockages. They also use other means to help speed passage through the locks, such as helper boats and permanent mooring facilities. Although the lock and dam system is unique in many ways, these reports point to examples of other transportation sectors—such as the airline industry—that have developed sophisticated scheduling systems to better manage congestion. The studies conclude that the benefits of extending locks cannot be evaluated until a more sophisticated traffic management system is first implemented.

A complex set of laws, executive branch guidance, and congressional reports guide river management decisions. This body of “water policy” is not fully consistent, as some of these directives have different implications for river flows and channel depths. The 1930 law authorizing the 9-foot channel project allows the Corps to maintain the river at this depth. Subsequent laws, such as the Endangered Species Act (1973) and the Mississippi River Management Act (1986), authorize a broader set of river management



Competing Demands on the River. In addition to competing environmental needs, the river system also supports a wide range of recreational uses. While boaters and jet skiers generally benefit from the deeper channels created by the lock and dam system, fishermen place a higher value on protecting river ecology.



Managing Traffic on the River.

Tows carrying more than nine barges—the maximum number that can pass through a lock—must be separated to travel through the locks in “double lock-ages.” A cable is used to pull the first set of barges and the second set is pushed by the towboat. Deckhands, shipping companies, and lockmasters have developed many clever ways to help speed the passage of barges through the locks, including the use of helper boats and permanent moorings. However, little attention has been paid to implementing more comprehensive scheduling methods for system-wide traffic management.

objectives that may entail changes to the current regime of river flows and channel depths. These legislative inconsistencies pose ambiguities for the Corps, forcing it to decide which laws and directives should receive precedence over others. The reports thus recommend that the Administration and the Congress clarify the federal intent for managing the various and interacting resources on the Upper Mississippi River-Illinois Waterway.

FUTURE USES OF RIVER RESOURCES

There are many complex and far-reaching issues regarding the economic benefits of larger locks

and possible reductions in congestion. Future levels of grain shipped on the river, for example, is a key issue. Will those levels remain relatively steady, will they increase, or might they possibly decrease? Factors that affect these grain shipments include future levels of Midwest corn and soybean production, grain shipping costs and alternatives, future U.S. domestic demands for grain, and amounts of grain produced in other regions such as Argentina and Brazil. The 2005 energy bill, which calls for increased production of ethanol from U.S. domestic corn, is one example of how these factors can affect Mississippi River and Illinois Waterway shipping demands and traffic levels.

The Corps of Engineers completed its study in late 2004, recommending substantial improvements and expenditures for the lock and dam system and for ecosystem restoration projects. Future trends in grain demand, recreational use, and environmental needs and concerns will affect the river in ways that are not easy to predict. As the benefits and users of the river system continue to change, the Corps will continue to be challenged in considering trade-offs between different river users in decisions about lock and dam system operations. To help the Corps maintain some flexibility in this setting of uncertainties, the reports recommend that the Corps incorporate flexible, adaptive management principles—such as careful monitoring and evaluation of previous actions—through its entire water planning program.

CONCLUSION

Although it is not clear if the U.S. Congress will ultimately appropriate resources for all the improvements recommended in the Corps feasibility study, the Corps made several important advances in its study. The study began in the late 1980s as a narrowly focused investigation of the lock and dam system. During the next 15 years, it evolved to include ecosystem restoration options and ultimately reflected extensive interagency coordination and citizen input. The Corps also broadened the study to incorporate adaptive principles that should help manage the project more flexibly. Challenges remain, however, especially in addressing some key analytical inadequacies within the study and in better integrating river management decisions across the wide variety of resource users.

ABOUT THE NATIONAL RESEARCH COUNCIL REPORTS

PHASE I

Inland Navigation System Planning: The Upper Mississippi River-Illinois Waterway (2001) This report assesses the economic data and modeling within the Corps feasibility study. The report concludes that the spatial model being developed by the Corps to help forecast future levels of grain production and trends in shipping and waterway traffic levels, and a related model (named ESSENCE) for estimating changes in barge shipping costs, were flawed and should not be used the feasibility study. The report recommends that the Corps aim toward a more comprehensive study that integrates navigation and environmental components. The report also recommends that nonstructural options for improving the flows of waterway traffic—such as better scheduling—be fully evaluated before the potential benefits of extending locks to 1,200 feet are calculated.

PHASE II

Review of the U.S. Army Corps of Engineers Restructured Upper Mississippi River-Illinois Waterway Feasibility Study. First Report (2004); Second Report (2004); and **Water Resources Planning for the Upper Mississippi River and Illinois Waterway (2005)**

After the Phase I report was issued, the Corps began restructuring its feasibility study. The study was changed in many ways, but perhaps the most important was the inclusion of ecosystem restoration considerations. The Phase II NRC committee began in 2003 and was composed almost entirely of new members. Like the Phase I report, the Phase II reports also find the Corps' ESSENCE model to be unfit for use in the study and recommend prompt development and implementation of nonstructural means for better managing waterway congestion. The reports support the Corps' decision to include restoration goals, but find that activities designed to restore river ecology are not well integrated with activities and side-effects of the commercial navigation sector.

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