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Environmental Benefits of Mississippi River Dikes

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Environmental Benefits of Dike Notching in the Mississippi River Ecosystem

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The Mississippi River is about 2320 miles long and, together with the Ohio and Missouri Rivers, drains all or parts of 31 states and two Canadian provinces. Long before there were railroads or interstate highways the Mississippi was the major avenue of commerce in the central United States. Barges are the most efficient form of commercial shipping; water transportation moves 16% of the nation's freight for 2% of the freight cost. Currently, barge traffic accounts for 500-million tons of goods shipped annually down the Mississippi.

The Mississippi River Commission (MRC) oversees implementation of the comprehensive Mississippi River and Tributaries (MR&T) project under supervision of the Chief of Engineers. MR&T is arguably the most successful civil works project ever initiated by Congress. Since 1928 the nation has contributed $14.5 billion toward MR&T and has received an estimated $430 billion return on that investment, including savings on transportation costs and flood damages. However, MR&T navigation structures such as wing dikes have caused pronounced alterations to the Lower Mississippi River (LMR) ecosystem. To provide adequate river flows during low water, wing dikes redirect water into the main navigation channel of the river. This results in side channels, chutes and floodplain habitats becoming hydrologically disconnected from the river. These backwater habitats are important feeding, spawning and nursery areas for many important fish species, as well as providing habitat for other environmentally sensitive wildlife and invertebrate species.

Recognizing the importance of these off-channel habitats to the overall health of the Mississippi River, the US Army Corps of Engineers (USACE) Mississippi Valley Division (MVD) has established the Lower Mississippi River Environmental Program, a system-wide program of environmental engineering and fish and wildlife resource studies of the LMR and floodplain to provide safe and efficient navigation while improving the river ecosystem through reconnection of these important backwater areas. MVD has established a partnership with the Lower Mississippi River Conservation Committee and its collaborating agencies to collectively reach a common goal–to change the flow of the Mississippi River and restore aquatic habitats.

Wing dikes are long, linear berms of large rock constructed perpendicularly from the riverbank towards the main channel of the river. Often dikes are constructed in a series, known as a dike field, and are used to deflect or direct water flows toward the navigation channel of the river at medium to low river stages. This increases current velocity in the navigation channel, thereby increasing transport of sediments and maintaining open and safe navigation. Slack water between dikes also facilitates the deposition of sand and mud, thus further reducing sediment volume and accretion in the channel. The equivalent of over 320 miles of dikes has been constructed along the Lower Mississippi River as part of the Mississippi River and Tributaries Project (MR&T); each dike ranges from several hundred to several thousand feet in length.

Sandbar acreage has increased as more dikes have been constructed. It sometimes takes several years for the river to react to any channel improvement structures; thus, over time, more sandbars form while others change configuration. With the completion of most dikes planned for MR&T, the overall sandbar area has tended to become relatively stable; sand has simply been redistributed along and within the channel. Sandbar development between dikes is one desired feature that aids in maintaining an open navigation channel at lower river stages. However, dike construc-

Notching a wing dike at low river stage, Robinson Crusoe dike field, RM 737R, near Memphis Tennessee.


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Newly notched wing dike at rising river stage, Robinson Crusoe dike field, RM 737R.

tion severs the hydrological connections between the main river and side channels as sand and other deposits fill the chute. There has been a marked decrease in the number of side channels as the channel improvement program has progressed and the number of dikes has increased. These side channels and associated gravel bars are important foraging and spawning sites for many riverine fish species, such as sturgeon, paddlefish, gar, white bass, blue sucker, catfish, sauger and freshwater drum.

This increase in the areal extent of sandbars also provides additional nesting habitat for the endangered interior least tern once the sandbars become exposed during summer low water. However, another feature of sandbar development is that as the bars grow they tend to attach to the riverbank. This permits greater access to sandbars by humans seeking recreational opportunities and also provides access to terrestrial predators. Because of these factors, there has been great concern regarding the safety and success of tern nesting colonies and foraging areas; too much disturbance and/or predation could cause the terns to abandon the colony site.

Even though 20 years of observations have revealed that terrestrial predation at tern colonies is minimal, attached sandbars are of concern for the nesting success of least terns. Alternatively, isolated sandbars exclude land access from the riverbank because of the water barrier between the sandbar and upland. Thus, engineering features were considered within dike fields to provide a flowing channel between sandbar and riverbank, making for an isolated sandbar. The best environmental engineering feature found for this has been the dike notch.

A notch is a trapezoidal opening in a dike that typically has a 300-foot top width, sloping sides and a 100-foot bottom width; the bottom elevation of the notch is typically at LWRP (Low Water Reference Plane, defined as the river stage that is exceeded 97% of the time) to LWRP +5 (roughly between 15 and 30 feet below the top elevation of the wing dike). Some notches are larger or smaller, being adjusted to the specific channel conditions. Notches are made either by removing rock during maintenance work on an existing dike or by leaving an open, low section when a new dike is Built. This low section permits lower river stages to pass through the notch and down the side channel 90-97% of the time. Notches reduce sedimentation in old chute channels and behind sandbars and maintain flowing water conditions at lower stages in secondary channels. Additionally, low water stages flowing through a notch result in a diversity of current velocities at the notch that increase substrate diversity (both in composition and topography/bathymetry), thereby increasing aquatic habitat and aquatic species diversity downstream of the notch.

Dike notches have been used by USACE St. Louis District in the Middle Mississippi River as habitat rehabilitation features since the late 1970s. Because of the vastly greater current volumes and velocities in the Lower Mississippi River (LMR), there originally was reluctance to notch dikes in the LMR; the concern was that a dike could fail at the notch and create serious navigation safety problems. However, after the first few notches were created, it was found that the dikes remained structurally sound. Since 1992, there have been more than 140 notches constructed in dikes in the Memphis District, over 60 in the Vicksburg District and a few in the New Orleans District (the number of side channels and rehabilitation opportunities decrease further south). Dike notching has been very successful in protecting least tern nesting colonies as well as creating aquatic habitat diversity for the endangered pallid sturgeon and fat pocketbook mussel and various wildlife, fish and invertebrates.

Dikes with notches foster diverse

aquatic ecosystems. Various substrates, water depths, current velocities and channel bottom configurations at fluctuating river stages all contribute to a diverse fishery community. This mosaic of microhabitats results in a widely varied benthic invertebrate assemblage, and the large quantities of invertebrates then serve as food for fish populations throughout the system. Nearly 70 species of fish have been found to inhabit dike fields and the main channel of the LMR. Waters within dike fields, in back channel chutes, and along revetted riverbanks function as nursery, feeding, and refuge areas for river fisheries. The calm waters within dike fields are especially productive aquatic areas; fish standing crop in LMR dike systems at slack water average nearly 900 pounds and over 19,000 fish per acre. Forage fish, particularly threadfin shad and gizzard shad, are numerically dominant; consequently, ample food is available throughout the river system, especially in areas associated with dike fields, for least terns, other birds and larger, important fish species.


Derrick Smith, John Rumancik and Darian Chasteen with the 2007 USFWS Regional Director s Conservation Award. Photo courtesy USFWS.

The USACE Memphis District River Engineering Team was awarded the 2007 US Fish and Wildlife Service (USFWS) Regional Director's Conservation Award (Region 4, Atlanta) for their innovative work in ecosystem sustainability and river rehabilitation, especially dike notching for habitat improvement. The award was in recognition of MVM's willingness to develop strategies and methodologies that linked navigation safety and environmental benefits on the Mississippi River. In the past ten years the MVM River Engineering Team has built a high level of trust with resource agencies and fostered a team environment for work on the Mississippi River as well as working toward river resource conservation. P

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