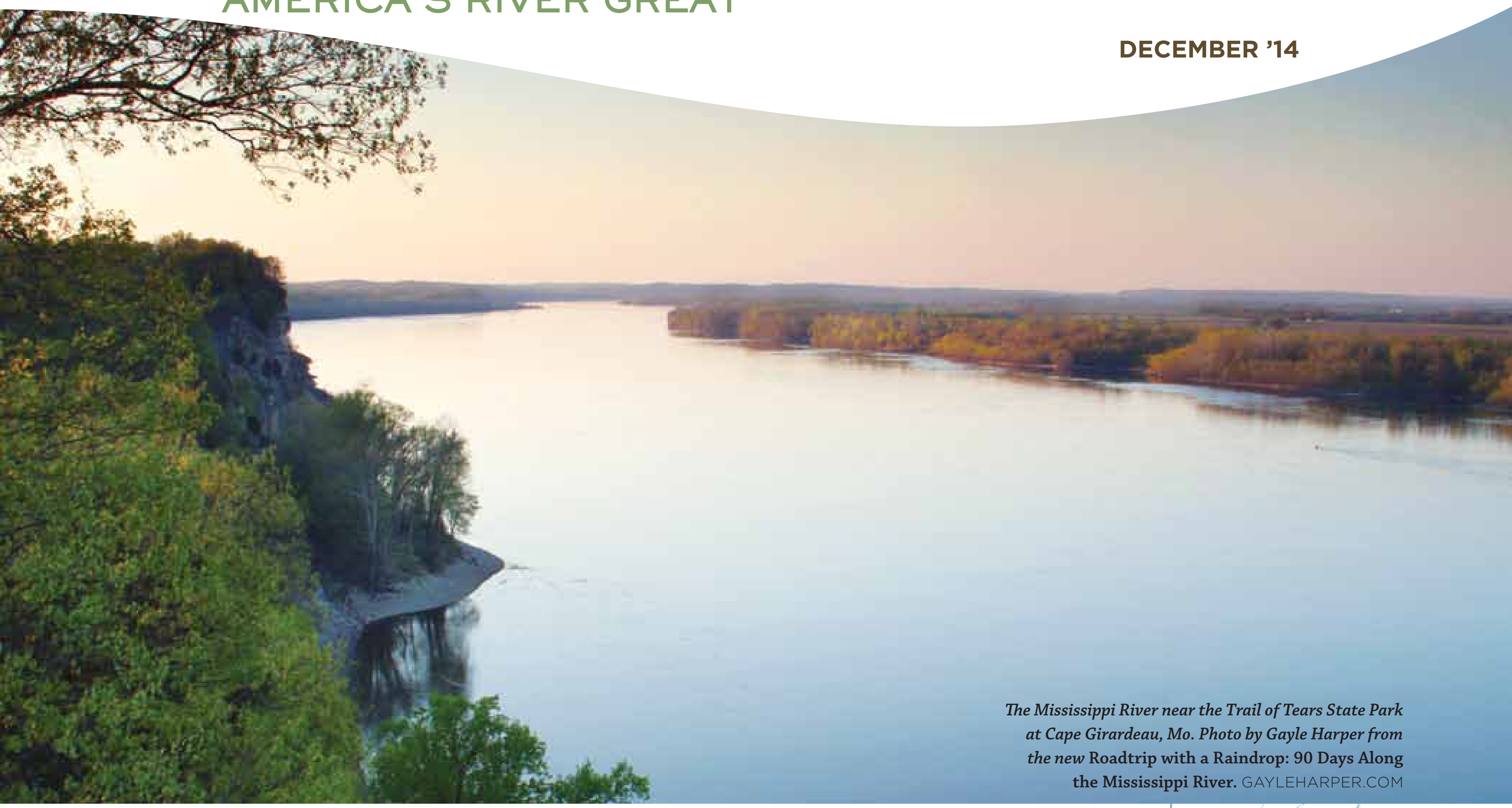
Our Mississippi

PARTNERING TO KEEP AMERICA'S RIVER GREAT

DECEMBER '14



The Mississippi River near the Trail of Tears State Park at Cape Girardeau, Mo. Photo by Gayle Harper from the new **Roadtrip with a Raindrop: 90 Days Along the Mississippi River.** GAYLEHARPER.COM

Advancing the nation's Mississippi River IQ

The Mississippi River Geomorphology and Potamology Program adds new research to the river knowledge base, science that will drive future river management.

IT MAY NOT BE TRUE, as some have suggested, that we "know more about the moon than the Mississippi River." But the storied waterway still holds many scientific and geologic mysteries key to managing this, "America's Father of Waters," as both a nationally significant ecosystem and nationally significant commercial navigation system.

Maj. Gen. Wehr

The Mississippi River is the largest navigable river system on Earth. It is a huge national economic engine; it moves some of the greatest floods imaginable; it supplies water and recreation for millions of Americans; and it is an unmatched environmental treasure. Yet, scientists know so little of the river's processes and characteristics. How does the river evolve over time? What is its sediment distribution? What are the best enhancements for threatened and endangered species? And how can we work in conjunction with natural processes in a system-wide plan that serves man and nature?

LANDSCAPE: GAYLE HARPER.

"This vital river is one of the most complex systems in the world," said Maj. Gen. Michael Wehr, commander of the U.S. Army Corps of Engineers' Mississippi Valley Division. "Yet we have a large knowledge gap in our understanding of the major ingredients in this national asset—sediments, water, the environment. We need to close the knowledge gap to help us learn how to better manage the river as we face future challenges."

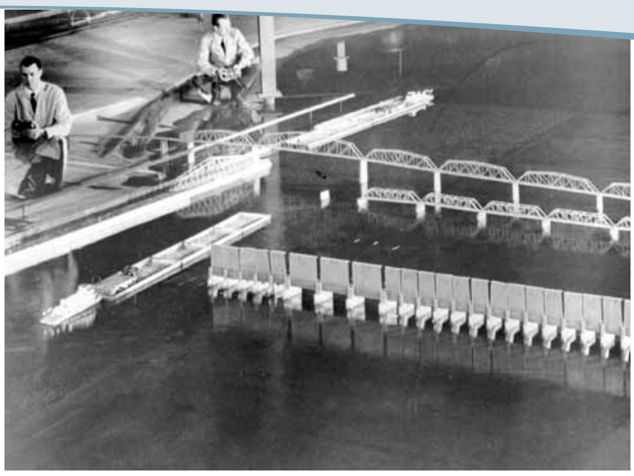
New River Research

In 2013, the Corps of Engineers initiated the Mississippi River Geomorphology and Potamology Program to address this knowledge shortfall. This new program involves such things as geomorphic assessments, or studies of ways sediment falls and builds and how various proposed river diversion projects would affect that; system-wide sampling and modeling efforts; and studies (called ecohydrology) of ways physical and biological processes are integrated.

Sediment transport models are being improved, new geomorphic assessment tools are under development, and

Continued on page 2 >>

Our Mississippi is a quarterly newsletter of the U.S. Army Corps of Engineers about its work in the Mississippi River Basin. It is published in cooperation with other state and federal agencies and other river interests with whom the Corps collaborates and partners toward long-term sustainability of the economic uses and ecological integrity of the river system.



"More importantly, we discovered that we had quietly lost nearly a generation of river experts with potamology expertise. Many of the long time 'go-to' guys with the most experience were no longer around." —MR. EDWARD BELK

TOP, LEFT AND CENTER: ***Research teams integrate research on ecosystem needs and river flows at Island 63, an innovative project site.*** TOP RIGHT: ***This scale model of Mississippi River Lock and Dam 26 was built in the early 1970s for research efforts.*** ABOVE: ***Corps leaders and members of the Mississippi River Commission, left to right: Dr. Jarrell Smith, the Hon. Dr. Norma Jean Mattei, Mr. Tom Holden, Dr. Barb Kleiss, Mr. Jose Sanchez, Mr. Edward Belk, the Hon. Sam Angel and the Hon. R.D. James check out some ongoing research at the Army Corps' Engineer Research and Development Center in Vicksburg, Miss.***

multi-disciplined engineering and scientific teams are working in conjunction on ground-breaking technologies on projects throughout the basin.

"We're up to 30 to 35 projects, and this is just the beginning," says Dr. Barb Kleiss, Technical Director of the Mississippi River Geomorphology and Potamology Program. "We're looking to develop this program into a permanent part of the division to provide science and engineering support for all management decisions within the Mississippi River and Tributaries project. Everything is for the single goal of answering scientific or engineering questions that are beyond just one single project but affect multiple projects over a large geographic area and help us manage the river better for multiple purposes."

The Army conducted some of the earliest monitoring and investigation studies of the river in the early 1800s. Most of these historical efforts were focused on site-specific locations, but the data provides a knowledge base that's still of value today. Unfortunately for consistency purposes, funding ebbed and flowed much like the river's flows.

Mr. Edward Belk, who is currently the Director of Programs for the Mississippi Valley Division and Mississippi River Commission, spent the formative years of his Corps professional career working on and with the Mississippi River, including serving as Chief of River Engineering in Memphis District. This river background has made him a particularly passionate supporter of the Mississippi River Channel Improvement and Geomorphology and Potamology programs. He notes that most Mississippi River programs, improvement initiatives and investment priorities have historically come in response to major flood events on the river.

The epic 1927 river flood, for example, led to the creation of the 1928 Mississippi River and Tributaries Project that ultimately fostered most of the modern-day Corps river projects and includes components still in use today. In addition to levees and other flood risk reduction efforts, this project also constructed meander cutoffs that shortened and straightened the main river channel by more than 150 miles between just south of Memphis, Tenn., to south of Natchez, Miss.

"These cutoffs were implemented in the 1930s and 1940s," Belk said. "Believe it or not, the river is still responding to those cutoffs 75 years later."

The Corps was a leader in Mississippi River research from the 1930s well into the 1980s, using field studies, sampling efforts, and physical hydraulic models. But there were always spikes in funding and interest, usually tied to intermittent major flood events, such as the Old River Control studies in the 1950s and the 1973 flood. The Mississippi River became a dormant giant in the 1980s with relatively stable average flows and fewer major floods on the main river channel, and the nation and the Corps became complacent on river issues.

That changed dramatically in 2011 when an epic flood exceeded historic levels, pushing Corps projects to their limits and shaking up the status quo in river knowledge.

"The 2011 flood was a wake-up call," said Belk. "While the record flood flows were passed relatively safely throughout the valley, we were faced with some problem areas and flood response questions we couldn't readily answer. More importantly, we discovered that we had quietly lost nearly a generation of river experts with potamology expertise. Many of the long time 'go-to' guys with the most river expertise were no longer around."

Modern Research

The Mississippi River Geomorphology and Potamology Program focuses on advancing river knowledge in several major areas. This research is pulling information together on the sediment budgets of the middle and lower river and the Missouri River, river gauge analyses, dredging records analyses and other data for regional and basin-wide use.

The program also supports and informs the Mississippi River Commission, the Presidentially-appointed commission that has provided the Corps with engineering direction and policy advice on Mississipi River programs since 1879. Dr. Norma Jean Mattei, a Commissioner and a Professor of Engineering at the University of New Orleans, recognizes the importance of this effort. She noted: "Any increased understanding of the geomorphic and hydrodynamic characteristics of the river helps the commission provide good advice to the Corps of Engineers and to help prioritize future expenditures. It also helps us focus the best available technologies and brightest professionals on this national effort."

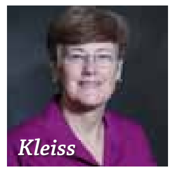
Technology transfer benefits are another major benefit of this research thrust. An ever-growing number of historic river potamology reports are being digitized and posted to a new web site (WWW.MVD.USACE.ARMY.MIL/MRGP) for easy access by governmental agencies, non-governmental agencies, river partners and the public.

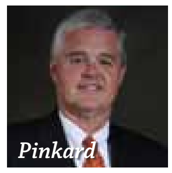
Senior Project Manager Freddie Pinkard from Vicksburg District commented: "What may very well turn out to be the most important Mississippi River Geomorphology and Potamology Program product revolves around people. A key project thrust is fostering and mentoring new river engineers and scientists to ensure that historical information and emerging technologies are carried forward and that there will no longer be that missing gap in river knowledge and understanding."

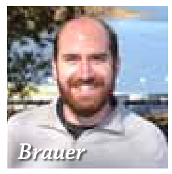
Adds Wehr: "The Mississippi River Geomorphology and Potamology Program is already providing technologies and expertise that is aiding current river projects and will be particularly important to meet new challenges like changing climate. We are using this new-found energy and focus to expand our knowledge and understanding. We're seeing immediate benefits in navigation, flood risk reduction and most importantly, environmental projects. We're excited about the ongoing potential for this great river and the nation." —W.S.

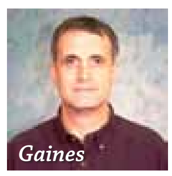
MORE: www.mvd.usace.army.mil/mrgp

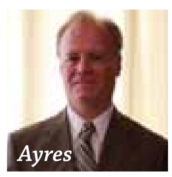
GEOMORPHOLOGY & POTAMOLOGY *A team effort*











The record 2011 Mississippi River flood fostered a renewed interest in river knowledge to advance understanding of the complex natural and man-made processes that impact the Mississippi River.

Out of that came the Mississippi River & Tributaries Mississippi River Geomorphology and Potamology Program, designed to address science and engineering issues necessary to best manage the Mississippi River for its many, varied purposes, including navigation, flood risk reduction and protection of its rich ecosystem. A team of experts has been selected from each of the four lower districts of the U.S. Army Corps of Engineers' Mississippi Valley Division. Team members share the perspective and specific needs of the river reach within their respective district and also help to understand the river as a system.

The management team includes Dr. Barb Kleiss, Technical Director; Freddie Pinkard, Senior Project Manager and Vicksburg District representative; Eddie Brauer, St. Louis District representative; Dr. Andy Gaines, Memphis District representative; and Steve Ayres, New Orleans District representative.

The heart of the program staff lies well beyond the management team, though, says Kleiss. One major program emphasis is to mentor young scientists and engineers and introduce them to potamology as a scientific field option. Each district has been required to supply a young engineer or scientist for field work, and young engineers have been paired with older employees as service mentors.

"After the last flood, we realized a lot of our potamologists had retired; this is one way we're trying to address that." —K.S.

Geomorphology and Potamology

DEFINITIONS

- Potamology: the study of rivers
- Geomorphology: the study of the physical features of the surface of the earth and their relation to its geology

STUDY HIGHLIGHTS

- Potamology includes the hydraulic, physical, chemical and biological aspects of rivers.
- Flood-risk reduction projects, based on potamology input, have saved billions of dollars in potential damages.
- Mississippi River environmental and ecosystem restoration projects rely heavily on potamology data.
- USACE has conducted potamology studies since the early 1800s; a vast amount of data in many locations need to be utilized.
- Reinvestment in a USACE potamology program will grow expertise and knowledge that will have national implications.

Learning from the Mississippi's might

AS THE MOST FORCEFUL floodwaters in the history of the lower Mississippi River raged into Northern Tennessee in Spring 2011, floodwaters crashed through a private levee near Tiptonville and sought a new, straighter connection to the other side of a river bend.

The damage wasn't limited to the once fertile farmlands that suddenly contained an 80-foot deep gorge, almost a mile long. The river's potential new path also threatened some $60 million in channel improvements already completed to maintain a river channel that meandered in a nine-mile curve.

The U.S. Army Corps of Engineers spent $60 million shoring up one of the Mississippi River's meandering pathways, and then the river carved itself a shortcut. *Now what?*

Left to its own devices, the river's new path at what's known as the Merriwether-Cherokee Bend could additionally have serious implications both upstream and downstream, says Dr. Andy Gaines, a Memphis District research civil engineer and regional technical specialist for the Mississippi Valley Division. Those implications, here and elsewhere on the river, are the subject of a new Mississippi River Geomorphology and Potamology Program research study.

"The river always operates in a cause/effect relationship," said Gaines, the lead for the Merriwether-Cherokee study and a member of the Mississippi River Geomorphology and Potamology Program's management team. "If one reach is changed, you can expect change elsewhere. If a cutoff is formed, it would change reach dynamics in a way that could potentially affect our flood risk management, navigation and environmental responsibilities."

Forecasting the future

Immediately following the levee break, the Corps of Engineers repaired damage in the main area of break. That will offer protection in times of regular flow, Gaines notes, but not in times of flooding. Then, the river as it flows down from further upstream will likely be split into two directions, some of it heading into the new channel and other flows continuing around the meandering bend.

More sediment will likely be deposited in the current navigation channel because there is less water to keep it moving, he said. That puts at risk features established to maintain navigation, such as revetments and training structures that helped to train eroding sediments and keep a predictable water highway.

Other potential impacts of the new river condition formed by the levee break, study documents say, include navigation "outdraft" conditions, or currents that dangerously sweep tow boats and barges toward an embankment; increased need for dredging; potential hydrodynamic changes that could threaten the mainline Mississippi River levee in addition to endangering those existing channel improvement features; some $18.5 million in post-flood crevasse repairs; and $9.5 million in planned repairs.

A geomorphology and potamology study by definition requires you to step back and look at a larger picture over time, Gaines said. The team will do that, looking at whether there's anything atypical about this particular river reach (for example, a structural feature that no longer exists). Researchers will employ several models to help assess how quickly a cutoff channel might develop as well as changes in sediment volume, long-term deposition and erosion.

By summer 2015, the scheduled study completion timeframe, researchers expect to be able to make recommendations on future action at the river reach, Gaines said. Further protecting the failed private levee is one option being explored, as is further degrading it and spreading the river flood energy over a wider reach. Other potential solutions are also being explored.

"There is a significant investment in the river as it is today," he said. "The Geomorphology and Potamology study will enable the team to make recommendations on how to achieve the most viable solution." —K.S.

RIGHT: *Scour and bankline erosion at Merriwether-Cherokee Bend. During flooding, the river attempted to straighten the bend and create a new channel. Repairs recreated the protective shoreline where the river scoured out the previous bank, creating a huge opening.*

MISSION INCLUSIVE

Integrated science merges multiple river interests

Inter- *pref.* 1. Between or among 2. Mutually: together <interdisciplinary <interagency <intertwine <interactive

"Inter-" is the overarching element for the Island 63 study. These key words describe an innovative project through which an interdisciplinary team of river engineers, biologists, scientists and other experts are working as one team across organizational and professional lines to determine how a pristine habitat is closely intertwined with the river's various flows. Technologies developed at Island 63 will be applied up and down the lower Mississippi River to enhance management strategies and to improve knowledge of the river's impacts and importance to the environment.

The wild and scenic Island 63 is located at river mile 639, roughly 12 miles northwest of Clarksdale, Miss. The study area includes thousands of acres of floodplain between the main river channel and the river levee along a 35- to 40-mile reach of the river. Island 63's secondary channels, chutes, scour holes, lakes and borrow pits are greatly dependent on and impacted by variations of the Mississippi River. Floods can inundate the entire area; low river stages leave the woodlands dry except for the area's numerous water bodies.

But while Island 63 is a productive habitat for many diverse animal and fisheries communities, human activities and river operations have greatly influenced water flow, sediment transport and habitat complexity. That all comes together to make this the perfect pilot for this two-year initial, interdisciplinary effort, to see how it can all continue to thrive together.

Geomorphology

Charlie Little, a research hydraulic engineer at the Army Corps' Engineer Research and Development Center, is the co-lead for the Island 63 geomorphic assessment. This covers all the natural and man-made impacts on the geology and water flows in the main river channel and the backwater areas in the vicinity of Island 63.

"We are studying the geomorphic and hydraulic connections of the Mississippi River to all the water bodies in and around Island 63 at all river stages," he said. "This includes monitoring and determining the characteristics that impact the fisheries."

The team installed temporary gauges at various locations to monitor connectivity between the river and Island 63 water bodies. This will determine how water moves through the entire area including frequency, timing and volume.

"The new Mississippi River Geomorphology and Potamology Program is focused on the entire lower river, looking at changes in river channel alignment, depth and width; sediment load and diversity; and river stages and other factors.

"We use the data to determine what the river has gone through, how it is today and what to expect in the future," said Little.

As part of the Island 63 geomorphology assessment, the team has historic river data and readings dating back to 1915 to determine river changes and trends.

For example, from just south of Memphis, Tenn. to south of Natchez, Miss., river cutoffs shortened the original meandering river channel by more than 150 miles. While improving navigation and reducing flood heights, the river is still responding to these cutoffs by cutting or deepening its channel to adjust for the changes in slope as water flows to the Gulf of Mexico.

Ecohydrology

The ecohydrology study is an ecological assessment focused on relating the diversity of the Island 63 habitats to the hydrology of the river. That includes how the various river flows connect the main channel to the backwater areas and how this connectivity influences habitat diversity and the ability of fish to spawn and rear their young.

Dr. Jack Killgore, a Research Fisheries Biologist at the Engineer Research and Development Center and team leader for the ecohydrology effort, is managing a wide range of sampling activities and habitat analyses.

"No one ever put together a joint effort like this," said Killgore. "The Mississippi River Geomorphology and Potamology Program is making this happen. This is a whole new opportunity for a comprehensive, holistic effort."

As part of its research, the team uses baited lines and various nets to sample large fish. Adult fish are measured then marked with external tags and released. Floating light traps are used to collect larval fish and aquatic invertebrates. Juvenile and larval fishes and the invertebrates are preserved and transported back to the laboratory for analysis, and a statistics package is used to collect and analyze the data. Findings help determine which environments are most conducive to good habitat.

"We are developing guidance that will be useful on the entire lower Mississippi," said Killgore. "There are more than 10 river cutoffs that still have connections to the river that are unimpeded by levees. These important cutoff areas still function as a natural part of the river.

"We have a whole generation of new biologists that are growing up with new river engineers. The future looks great for Mississippi River projects from an interdisciplinary standpoint."

Numerical Modeling

The final piece, numerical modeling, is at a very early stage. Expected completion is 2015 for the effort connecting the river hydrodynamics, sediment issues and environmental habitat, according to Dr. Andy Gaines, a research civil engineer and regional technical specialist with the U.S. Army Corps of Engineers' Memphis District.

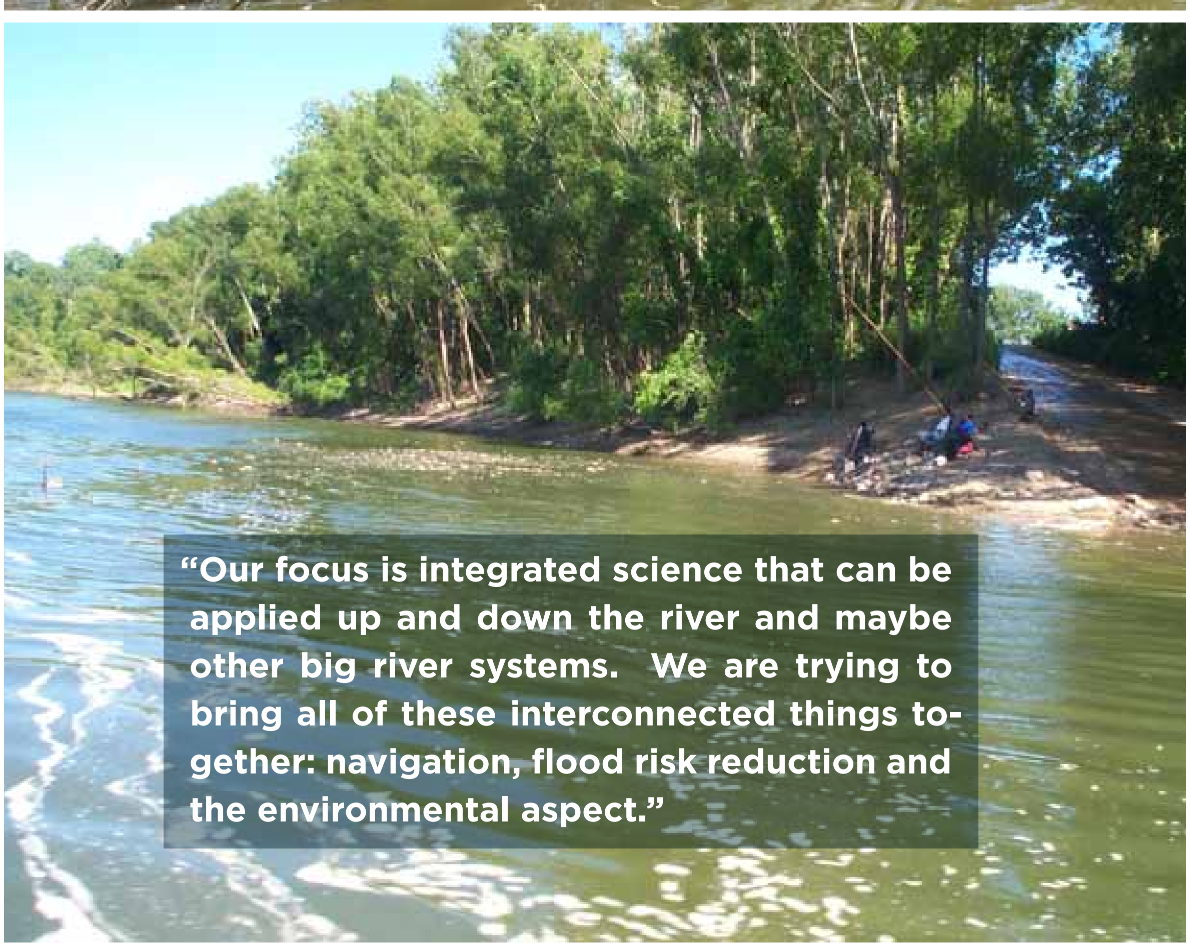
This modeling effort has two major elements. One is focused on the interaction of the river and floodplain with the environment. The other element is supporting current and future operations to restore water flow in secondary river chutes and channels.

"In 2006 a dike was notched at Island 63," said Gaines. "How did the notch improve habitat conditions? How can the success at Island 63 be applied elsewhere on the river?"

Over the last decade or so, Killgore's fish teams identified the environmental habitat importance of secondary channels, smaller chutes and channels off the main river channel, for example. The lower Mississippi River has more than 750 rock dikes to enhance navigation and reduce dredging. However, these dikes accumulate sand and sediment, effectively blocking many secondary channels from vital river flow. Today, many dikes are notched with small cuts to allow water flow into secondary channels and backwater habitat areas, even during low river levels.

Notes David Biedenharn, a 30-plus year veteran of Corps river studies, now the principal of a consulting firm specializing in river and potamology projects: "There has never been such a joint study on the lower Mississippi, so the focus here is on integrated science that can be applied elsewhere. Bringing all these interconnected things together is very important. How can we tweak navigation or flood projects for aquatic habitat improvement, for example? It is critical for the future of the river."—W.S.

FAR LEFT: ***Island 63 is a popular destination for local paddlers, illustrated by this photograph taken by the Quapaw Canoe Company, for the way environmental restoration efforts have led to a thriving aquatic wildlife population. Integration of various missions is key to the restoration success and various research projects.*** THIS PAGE, TOP: ***Researchers complete survey work for a temporary gauge installation. Other teams*** (ILLUSTRATED IN THE PHOTOS WITH FISH AND NETS) ***use trotlines, trawls, seines and traps to collect larval fish and aquatic invertebrates. The research on river flows, sediment, aquatic wildlife and more will be combined into models that will help river managers see how various improvements affected habitat and other conditions and could be applied elsewhere on the river.***



"Our focus is integrated science that can be applied up and down the river and maybe other big river systems. We are trying to bring all of these interconnected things together: navigation, flood risk reduction and the environmental aspect."

MY MISSISSIPPI

Bill Lancaster, 63, Sunflower, Miss., Commercial/Research Fisherman

"I started fishing full-time when I was about 35, and I've been fishing ever since. In the spring or fall in the early '90s, I was coming out from fishing on the Sunflower River. When I got to the boat ramp, there was a group of people there getting ready to put boats in and go and sample fish. I had a boatload of fish, a lot of fish on the boat. They were really interested in some of the species I had, how I caught them and if I might be interested in collecting fish for them. That's how my work with the Corps of Engineers got started.

"Probably the biggest contribution I've made to them is with the pallid sturgeon project on the Middle and Lower Mississippi River. I was catching a lot of sturgeon on trotlines at that time, and it just so happened there was a lot of interest in pallid and shovelnose sturgeon. It's grown from that time on and it continues today. Each fish is tagged and weighed and released in hopes of recapture. There are a lot of population studies, seeing what's out there. I was pretty familiar with the fish, and they learned a lot just by watching me, going out with me."

Potamology Timeline

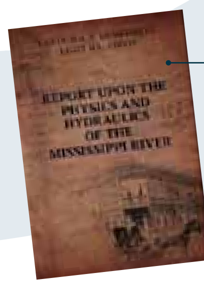
Mississippi River potamology (the science of rivers) advances understanding of how natural and man-made factors combine to impact current and future flood damage reduction, navigation, and environmental and coastal wetland projects. Geomorphology—the geologic study of the configuration and evolution of land forms—covers processes such as sedimentation, river flows and hydraulics, man-made alterations like levees and dike fields, and the river's reactions to those factors. Every day on the Mississippi River brings a notable discovery, but major dates in river potamology include:

1717
First levee on the Mississippi River built by Europeans near New Orleans.

1817
First river discharge records are recorded by the Corps of Engineers.

Since 1817, the Corps has intermittently collected vast amounts of data on the river, including hydrographic surveys, sediment sampling, velocity and current measurements, boring data, flow data, bed form data, geologic information, water surface slopes, and geomorphic assessments.

1822
Bernard and Totten Report, the first official U.S. survey of the Mississippi River.



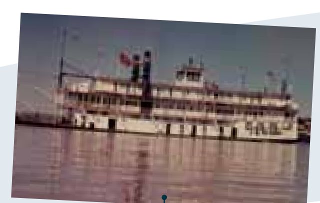
1861
A. A. Humphreys and Henry L. Abbot complete the *Report Upon the Physics and Hydraulics of the Mississippi River*, commonly referred to as the Delta Survey, which influenced flood control policy into the 20TH century.

1879
Creation of Mississippi River Commission by Congress to develop and oversee navigation and flood control plans on the Mississippi River.

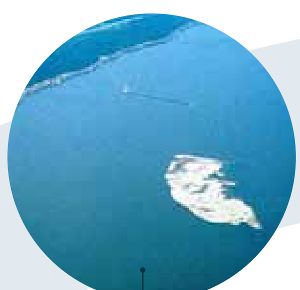
1927
The Great Mississippi Flood of 1927 devastates the valley, driving legislative policy and engineering changes.

1946
The first official Corps "Potamology Investigations."

71 reports were published under this program.



1957
The Mississippi River Commission Potamology Board is established.



1962
The Corps Committee on Channel Stabilization is established. It sponsors studies of channel problems over the next decade.

1963
The Mississippi River Commission establishes a Potamology Research Branch to coordinate studies with the Potamology Board. Both ceased to function in the 1970s.

1973
The Mississippi River floods, producing river stages up to five feet higher than expected at some locations.

This cast doubt on the previous stage-discharge relationships used to establish levee grades and other flood control projects, showing possible significant reduction in flood capacity.

1974
The 1973 flood drives new Corps potamology studies.

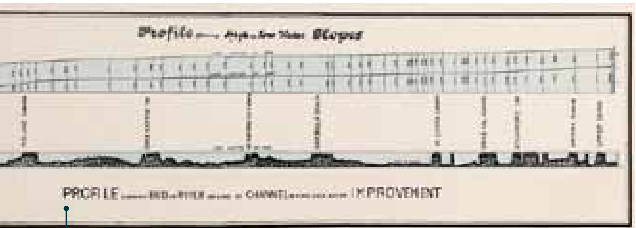
The T-1 Potamology Study provides a "snapshot" of existing 1973 flood conditions; the P-1 reports define short- and long-term changes in the river's stage-discharge relationships.

1995
The Corps establishes the Applied River Engineering Center with the intent to conduct applied river engineering studies.

2011
The epic Mississippi River flood renews interest in potamology. Lessons learned and projects implemented based on 1940s–1980s potamology studies help pass the record-setting 2011 flows.

2013 and beyond
The Corps establishes the Mississippi River Geomorphology and Potamology Program to advance river understanding and research, fund new technologies and interdisciplinary projects and mentor a new generation of river scientists and engineers. New studies are notably including environmental components in what traditionally focused on levees, locks and dams and channel alignment work; that includes a focus on environmental restoration, coastal land loss, water quality and supply (surface and aquifer), threatened and endangered species, recreation and invasive species.

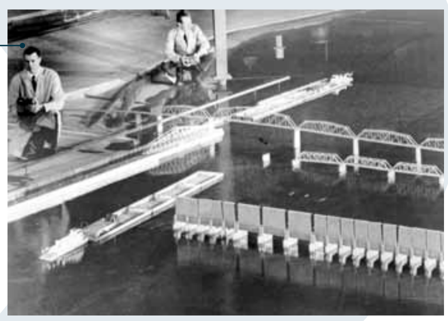
FOR HISTORIC REPORTS
www.mvd.usace.army.mil/mrst



The MRT construction program includes levees, floodways and diversion structures, tributary basin improvements, and channel improvement features that are still used on the river today.

1928
The Mississippi River and Tributaries Project is enacted under the 1928 Flood Control Act.

1929
Corps creates the Waterways Experiment Station, the nation's hydraulics laboratory.

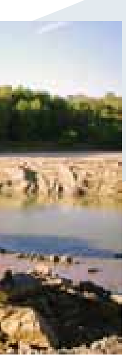


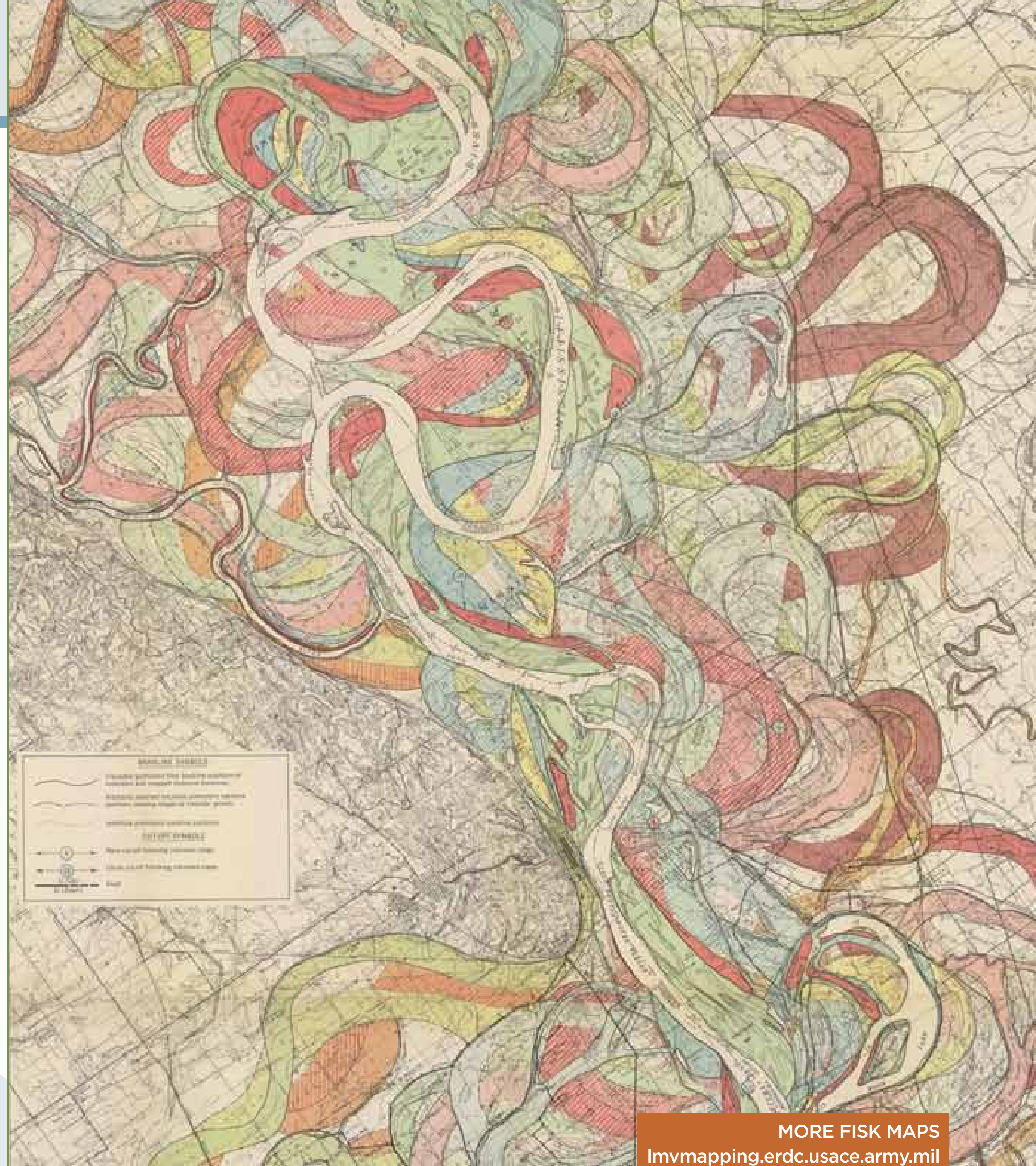
1932
The Corps initiates a channel rectification program to lower flood stages on the river.

By 1942, 16 such cutoffs would shorten the distance from Memphis to Vicksburg and reduced flood heights. These and other construction efforts would ultimately lead to the first Corps potamology studies.

"One of the really important things we do is understand how the river is changing, and then try to understand whether it's changing because of natural reasons or whether it's responding to man-made components. Without looking within the context of history, we can't tell that."

DR. BARB KLEISS,
THE MISSISSIPPI RIVER
GEOMORPHOLOGY AND
POTAMOLOGY PROGRAM
TECHNICAL DIRECTOR





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MEET THE RIVER MAPPING PIONEER

Artistic Fisk maps drive Mississippi River engineering for decades

In 1944, Dr. Harold N. Fisk completed his revolutionary geological study of the Mississippi River Valley for the U.S. Army Corps of Engineers.

The backdrop for Fisk's geologic study and the particularly artistic maps that resulted started around the 1930s, when the Corps recognized the intertwined relationship of geology with most engineering problems. Localized geological studies gave engineers a better understanding of the river's behavior and insight for potential construction sites and materials. Building on this evolution, in 1941 the Corps employed Fisk to conduct a comprehensive geological study of the entire alluvial valley of the lower Mississippi. Nothing of such magnitude had previously been attempted.

The Fisk study included a summary of the valley's characteristics, chronology and analysis of the historical evolution of the river valley, characteristics of the alluvial plain and discussion of the river and its activities. The investigation provided a glimpse of not only the major factors that led to the establishment of the river's modern course, but also factors that would shape the river's future behavior.

Fisk's team used detailed topographic maps, extensive use of aerial photography and historical accounts of the river valley—even narratives from Spanish explorers of the 16th century—to help identify abandoned courses of the Mississippi River and its tributaries. Data from approximately 16,000 soil borings were incorporated as well.

The report's results would drive Mississippi River engineering for decades. The Fisk 44 study had a profound impact on the geological understanding of the Mississippi River valley and greatly influenced strategies to control the mighty river, including the massive Old River control complex in the 1950s and 1960s.

The most impressive aspect of Fisk's report were several volumes of colored, detailed topographical and geological maps that set a new standard for geological illustrations. These maps trace significant river course changes over the last 2,000 years, a very short period in geologic time. For instance, the river has taken at least three different routes through Louisiana to the Gulf of Mexico; its present course through New Orleans dates only to around 650 years ago.

The colorful Fisk maps are artistic wonders even today. Many fans and friends of the river frame matted Fisk maps for their beauty and relevance to America's river. —W.S.

SOME SENTIMENTS ABOUT **SEDIMENT**

WHEN MOST PEOPLE THINK OF THE MISSISSIPPI RIVER, the wide, flowing water usually comes to mind. But for nature, river engineers and scientists, and ultimately for river projects and environmental habitat, it is truly the sediment that matters.

Mississippi River sediments range in size from gravel to fine clays. Moving along the river bottom or suspended in the water, these sediments are the building blocks for the river's main channel, secondary channels, wildlife habitat, and delta and coastal development. These sediments are provided by large and small tributaries carrying sediments from 31 states and two Canadian provinces.

Sediment load drives many of the natural processes that impact the river. Sediment deposition patterns control dredging budgets, affect navigation patterns and change flood flowlines. They also are critical for a variety of wildlife habitats, such as sandbars used by the interior least tern, an endangered species on the river. River sediments are also one of key ingredients for coastal marsh restoration efforts on the Louisiana coast.

The more we understand about sediments in the river, such as distribution, particle sizes, historical data and related information, the better we can plan and work with existing natural processes to minimize navigation and flood risk reduction project impacts while enhancing environmental habitat.

Sampling Now & Then

In late 2013, the U.S. Army Corps of Engineers completed a comprehensive river bed sediment sampling effort. This sampling was designed to reproduce similar sediment sampling efforts conducted in 1932 and again in 1989 and is greatly expanding the knowledge base of river sediments.

"We took 754 samples along the river bed from north of St. Louis to the Gulf of Mexico," said Thad Pratt, a Research Physicist at the Corps' Engineer Research and Development Center. Pratt managed the bed sampling collection and analysis effort.

"We replicated the 1932 and 1989 studies. We used the same drag sampler. And all three sampling efforts were done at about the same time of year and same approximate river stages. This will allow true apple-to-apple comparisons of the current and previous sampling data. We even talked to the lone living participant from the 1989 sampling, Dr. Fred Ogden of the University of Wyoming, who was a student at the time. He gave us great insight into how it was done."

Boat crews took samples in a few feet of water up to depths of 175 feet around Baton Rouge, La. Most samples were taken from locations at the middle of the river, but every 10 river miles, samples were collected from a complete cross-section of the river. A field log recorded each sample location, date, time and type of sample (coarse, fine, etc.).

Lab Analysis

In the laboratory at Vicksburg, each individual sample was then dried, separated by particle size, weighed and the data recorded. The smallest particles were analyzed using a laser diffraction particle size apparatus, which provides a distribution function for the entire small particle sample portion. The larger particle size distribution was done using sieve analysis.

"The full data set from this sampling will be compared to the 1932 and 1989 data for the entire lower river," Pratt said. "This will give an idea of how the whole system is changing, both how sediment size changes over the years and what changes are a result of man's impacts."

ABOVE: ***Thad Pratt of the Engineer Research and Development Center and Richie McComas of the Corps' Vicksburg District, pour off excess water from a river sediment sample prior to bagging and logging.***

Sediment Knowledge Results

Why does all this matter?

Bed sediment data is used in sediment transport models and is a critical parameter for accurately simulating natural river processes. If the composition of the bed sediment changes over time, it changes the frictional characteristics of the river channel and therefore the model output. The Corps of Engineers uses these model results to evaluate the adequacy of the existing flood risk reduction system and to predict future maintenance dredging requirements.

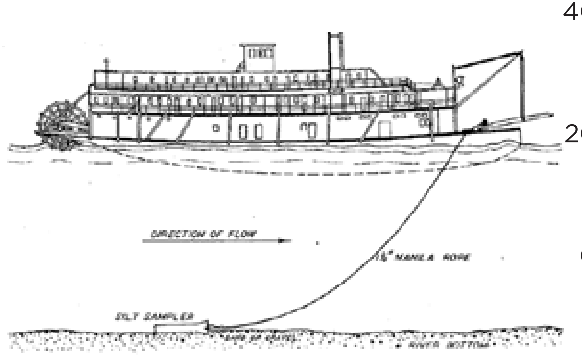
FOR MORE
www.mvd.usace.army.mil/mrgp

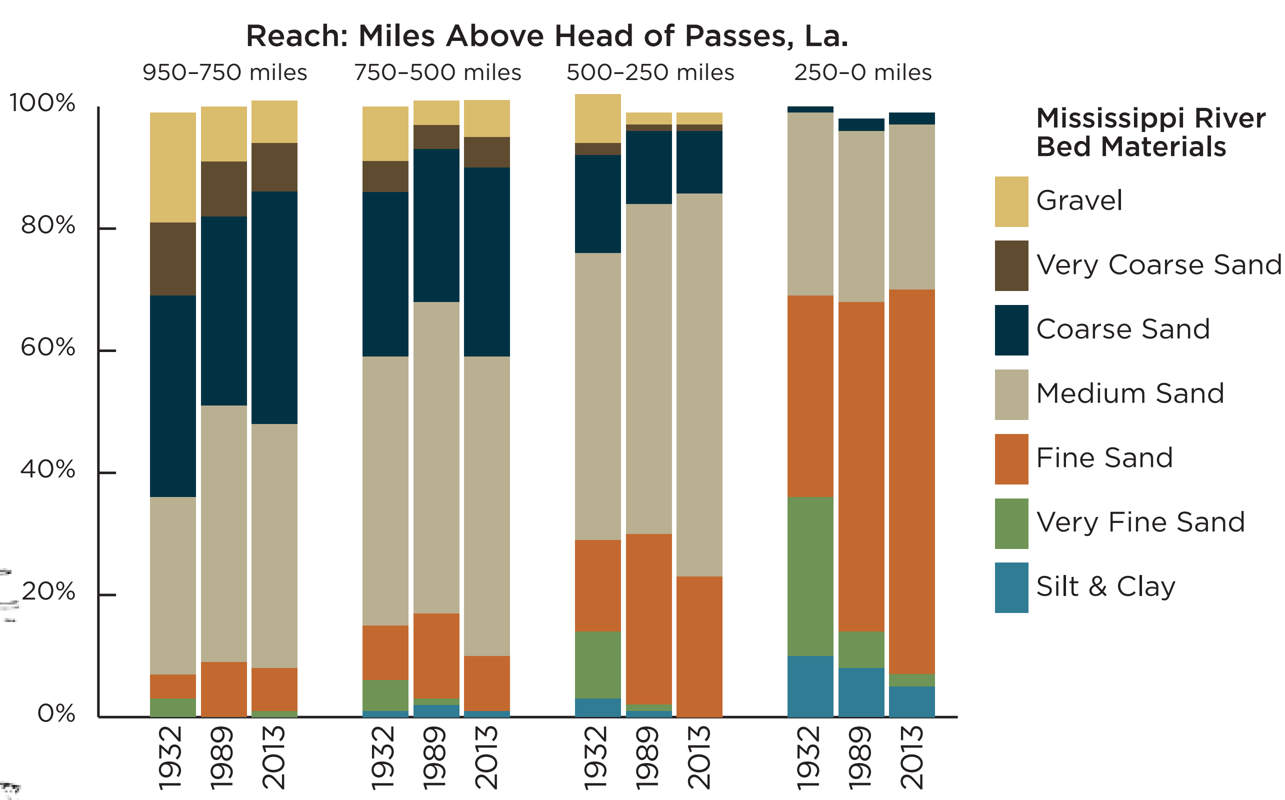
River sediment knowledge is also increasingly being applied in environmental projects, such as the recent joint U.S. Fish and Wildlife Service and Corps of Engineers conservation plan for several endangered species on the Mississippi River.

Sediments are important to the health and welfare of the river system," said Pratt. "Certain types of fish and invertebrates need certain sediments. If this sediment isn't being delivered, that fish or that invertebrate will not be living in that river reach." —W.S.

Comparison of River Bed Composition by Reach and Year: 1932, 1989, 2013

RIGHT: This graph shows the changes in the sizes of the material in the river bed, upstream to downstream. In the Memphis area, there are still gravels in the bed; by the time you get to New Orleans, the river has lost so much energy there is seldom anything larger than coarse sand. BELOW: A drawing from the report on the 1932 study where a paddlewheeler deployed the sediment sampler, which was later reconstructed and used for the 1989 and 2013 studies.





Where saltwater meets fresh, research issues abound

Where the Mississippi River flows into the Gulf of Mexico and the saltwater of the one meets the freshwater of the other, there's an inevitable co-mingling. During typical flows, saltwater might easily be found as far as 50 miles upriver.

But in times of drought or flows lower than normal on the Mississippi River, the salty sea water of the Gulf—heavier and colder than the freshwater flowing above—slowly creeps further upstream, sometimes almost twice that far, along the river bottom, separating much like you'd find with a container of oil and water. About every 10 years or so brings concern of a saltwater wedge threatening to render unusable the drinking supplies of cities as far north as New Orleans.

In 1988, 1999 and 2012, the U.S. Army Corps of Engineers responded by building an underwater sill out of river sediments, a multi-million dollar underwater dam that stopped the saltwater from traveling further. Now, a new model developed in the Netherlands and adapted by Corps Hydraulic Engineer Steven Ayres is being used to forecast and evaluate the progression of the saltwater wedge.

This model won't just predict potential threats to the drinking water; it will for the first time provide information on the potential impact of other river activities like proposed river diversions on the interaction between the salty and fresh water and also river sediments. The model will be used to study a process called flocculation, the chemical reaction between clay particles in the presence of saltwater, and how the resulting creation of larger clumps might affect river dredging needs and patterns, Ayres said.

The work complements a second, two-year study being launched in 2015. That research will look systematically at the interactions between fine sediments and the salt wedge and potential impacts of river diversions. Teams from the U.S. Army Engineer Research and Development Center in Vicksburg, Miss., will collect flow and suspended sediment measurements at 15 locations, including proposed river diversion sites and natural crevasses to determine such things as the extent of the salt wedge and seasonal variations. A camera system, digital video and direct sampling of sediments suspended in the water column will be used to gather data. One thing both projects may help determine is the extent to which flocculation contributes to river dredging needs as compared with the sediments carried downriver, an issue that's especially pressing in Southwest Pass, one spot where the river enters the Gulf.

Ayres' research started on a desktop computer; however, he quickly realized that more computing power was needed to run the complicated 3D model needed to look at flow stratification of the river from the river's mouth up to river mile 75. The 3D Mississippi delta model is now running on a supercomputer at the Engineer Research and Development Center in Vicksburg, Miss.

One use of the model is to predict what might happen, for example, if water is removed from the river for diversions intended to help with coastal restoration. Another could come from the possible deepening of the river from its 45 foot depth to 50 feet—a depth change proposed by some as a way to accommodate larger ships traversing an expanded Panama Canal.

"What that could do," he said, "is offer a deeper channel in which saltwater could proceed upstream. The model will help us determine what the river is doing now with the wedge and what it'll do in the future if we deepen the channel. There might be a more frequent need for the barrier." —K.S.

Looking to "nature's lab" for clues to coastal land building

NATURE SHOWS THE WAY

Crevasse study exemplifies efforts to understand the Mississippi River's natural processes as a way to aid design and management of environmentally compatible restoration projects.

In the last thousand years, nature built the Mississippi River delta and coastal areas using sediments carried by the river's flow into various natural channels.

By inference, many believe that diversions—the man-made re-creation of natural channels—could be the best technique for replenishing and rebuilding coastal wetlands. Those wetlands are being lost at an alarming rate.

"However, building man-made diversions is quite expensive," says Dr. Barb Kleiss, Technical Director of the Mississippi River Geomorphology and Potamology Program, "so there is value in looking for existing examples to help us learn how diversions from the river might work."

One of nature's best potential laboratory examples of this is located at a historical site known as Fort St. Philip. While researchers were studying maps of wetland loss, they noticed that this area didn't fit with the land loss trends. On the left descending bank of the Mississippi River about 20 miles north of the Head of Passes, a spot at which the Mississippi splits into three branches before entering the Gulf of Mexico, new channels or crevasses were forming from the river to the Gulf. Wetland assessment maps showed that small amounts of new land had formed in the area, indicating this area deserved more attention.

But when the Mississippi River Geomorphology and Potomology Program asked GIS expert Glenn Suir of the U.S. Army's Engineer Research and Development Center to use historical GIS data to determine how quickly land was being formed—information that could then be used to develop specifications and designs for artificial diversions—the findings weren't necessarily what was expected.

After examining images from a number of dates, Suir determined that the crevass formed sometime between 1970 and 1978, perhaps associated with the 1973 flood of the river. However, instead of finding a steady progression of new land being built, the study discovered that the initial result of the introduction of river water into the marsh via the crevasse was actually wetland loss—in fact, more than half of the wetlands in the immediate vicinity.

While land gains were eventually made, this initial loss may provide important clues into the nature of diversions, both natural and man-made, and provide more realistic expectations of the rates at which diversions may be able to build land, Kleiss said.

Findings at a Glance

To calculate land change trends, researchers used various techniques and a combination of data sets and methods developed for previous coastal land change assessments and data sets created for the new study. In 1956, research showed, the study area consisted of 5,012 acres of land and 2,379 acres of water. By 1970, the study area had experienced a 633-acre net loss in land, which was primarily the result of shoreline erosion and the construction of oil and gas access canals.

Land loss continued through 1998 (a net loss of 1,617 acres from 1970 to 1978; a net loss of 316 acres from 1978 to 1988; and a net loss of 664 acres from 1988 to 1998), most of it as a result of the breaching of the Mississippi River bank, the formation of crevasse channels and scouring and impounding of study area marsh. The only net land gains were experienced in the 1998-2008 period (a net increase of 322 acres).

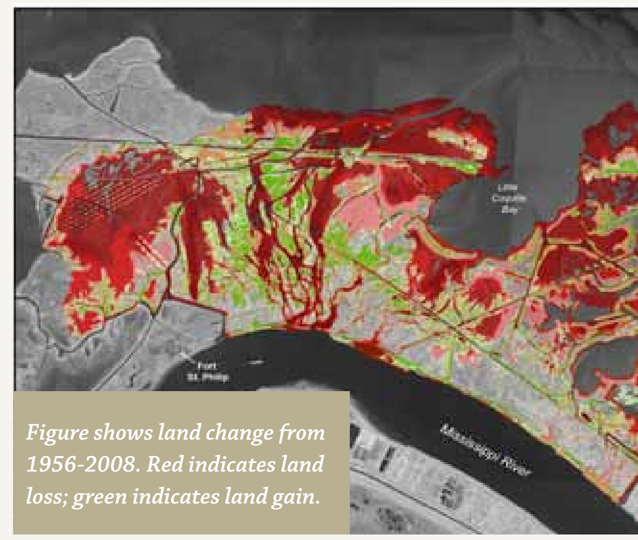


Figure shows land change from 1956-2008. Red indicates land loss; green indicates land gain.

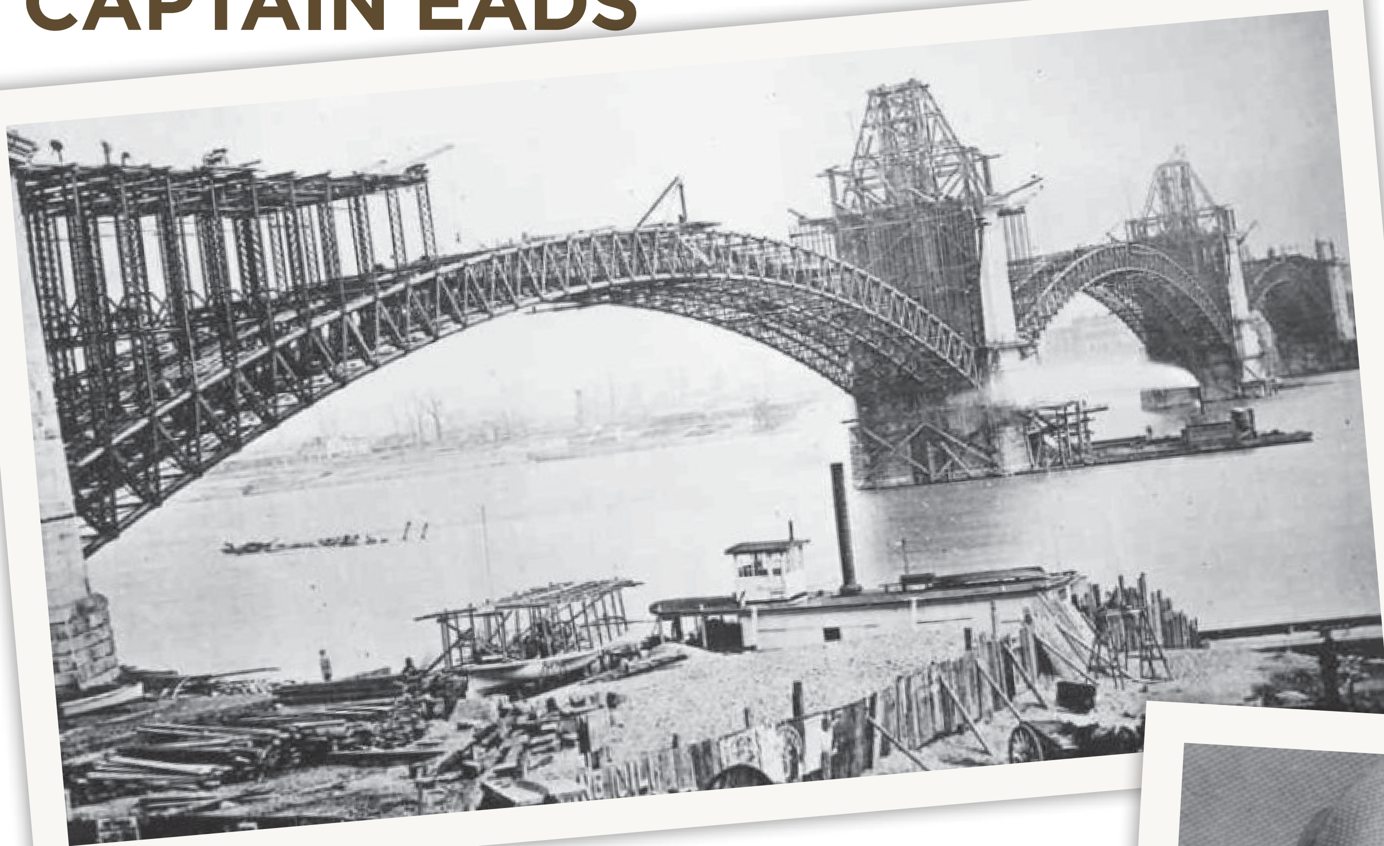
These land gains appeared to result from the crevasses and/or from management/restoration projects in the study region, Suir said.

Unexpected events possibly contributed to land loss in this region, he noted. Those included Hurricanes Betsy (1965) and Camille (1969) and the major 1973 Mississippi River flood. There were additional smaller floods in 1991, 1995 and 1997. Other factors that appeared to contribute to land change in this study area include subsidence, shoreline erosion and the impacts of oil and gas access canals. However, those appeared to be secondary land loss drivers compared to crevasse-related scouring and impounding of existing marsh, he said.

"The data show that crevasses or diversions may be a land loss accelerant in the geologic short term, which in this case was decades," he said. "The data also showed that land gains and long-term benefits from diversions may be enhanced by additional management and restoration activities. Ultimately, even when net land gains within the project area did occur, they primarily occurred in areas that were previously scoured by the diverted river flow, and then subsequently filled back in over time."—W.S. & B.K.

FOR THE FULL REPORT http://tinyurl.com/qhaxkef

Meet CAPTAIN EADS



The construction of the Eads Bridge over the Mississippi River at St. Louis set precedents in construction and design.

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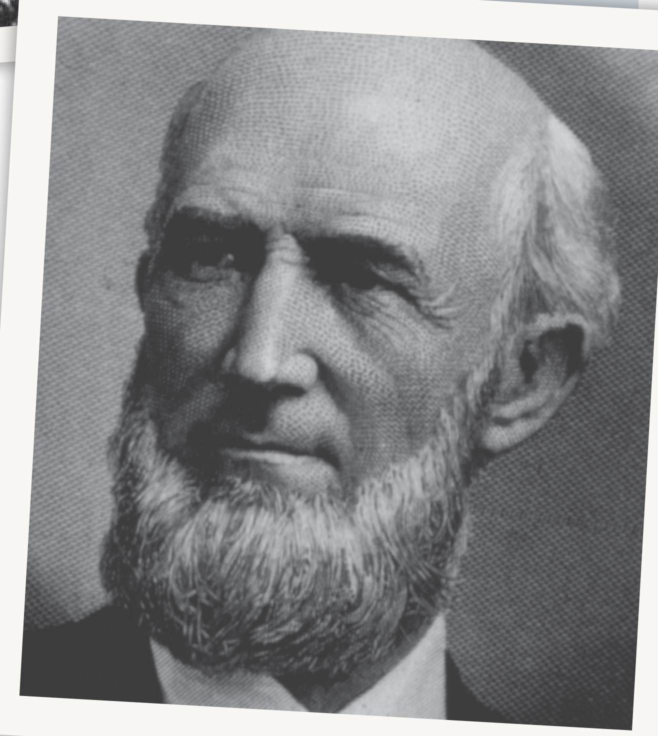


Self-taught inventor pioneers river improvements

As a boy, James Buchanan Eads liked to invent things, and he liked to surprise people. One day he showed his mother and sisters his new wagon, made from a box, that could run across the room on its own. Concealed underneath was the source of its power: a live rat.

His later inventions would be even more clever and important than that. When people told him something could not be done, Eads did it anyway.

Among his many accomplishments was a project completed in 1879 that created a year-round navigation channel from New Orleans to the Gulf of Mexico. The river frequently clogged with silt, frustrating merchants. Eads made a series of jetties, or fences, that narrowed the river and forced it to cut a deeper channel. New Orleans rose from the ninth largest to the second largest port in the nation.

"Captain Eads, with his jetties, has done a work at the mouth of the Mississippi which seemed clearly impossible," Mark Twain wrote in his memoir, "Life on the Mississippi." Twain had called the Mississippi a "lawless stream" that "ten thousand River Commissions … cannot tame." Until Eads.

Like Twain and his famous characters Huckleberry Finn and Tom Sawyer, Eads knew how hard life could be on the river. Born in Indiana in 1820, he was about 13 when his family lost everything they owned in a steamship accident. He had to quit school and sell apples on the streets of St. Louis.

Even though he couldn't go to school, Eads never stopped learning. He took a job in a store and his employer let him use his personal library. Eads read everything he could, especially science books. He experimented at home, inventing things like a six-foot-long model steamboat.

At 18, he took a job as a clerk on a Mississippi River steamboat. In a few years, he had earned enough to start his own business salvaging things from wrecked boats on the river bottom. Strong currents made that dangerous work. Eads designed his own boat and a device called a diving bell, built from a big barrel, to navigate the river floor. He was called "Captain" because he piloted the boat.

The salvage business made Eads a rich man. He continued learning about the river and inventing ways to manage it. During the Civil War, Eads designed the first ironclad gunboats built in the United States. Those helped Union forces take over Confederate forts on the river.

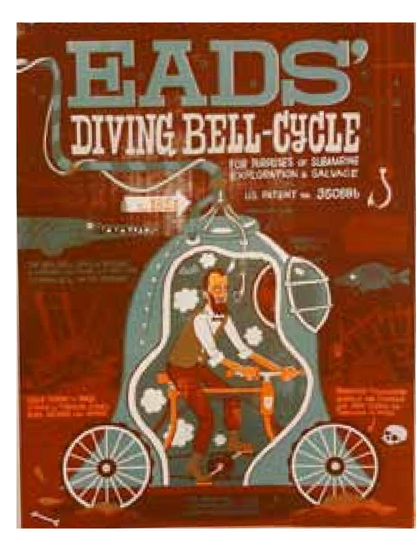
After the war, Eads began another project trained engineers said was impossible: building a bridge across the Mississippi at St. Louis. When it opened in 1874, it was called one of the man-made wonders of America. The Eads Bridge still stands.

The self-taught engineer never stopped imagining ways he could make water travel easier. His last idea was to build a "ship railroad" across southern Mexico to shorten the distance between the east and west coasts of the United States. That never happened. Eads died in 1887 at the age of 66. —K.S.

SOURCES: NATIONAL PARK SERVICE; PBS; "JAMES B. EADS" AND "LIFE ON THE MISSISSIPPI"

DIVING BELL

When he was 22, Eads had a business to salvage wreckage from sunken riverboats. He hired an experienced diver from the Great Lakes to help him with a barge in 15 feet of water. The current was so fast the diver gave up. Eads bought a 40-gallon barrel, made a seat inside it, fitted it with air pumps and attached it to a rig on his boat. Eads went down in it after the diver refused. His crew had trouble figuring out how to haul the strange bell back up, but Eads didn't panic. The air pumps were working, and when he saw a hand appear under the rim of the bell, he grabbed it and swam out.



Army Corps helps tern return

AT ONE TIME, NATURE ENTHUSIASTS feared they might never again catch a glimpse of the little bird with its distinctive black crown and yellow bill, hovering above the water before it plunged in to catch a fish. The survival of the interior least tern, the smallest of North America's tern species, was in doubt.

A geographic subspecies of least tern, the bird was listed in 1985 as in danger of extinction under the Endangered Species Act. Like the bald eagle and American alligator, it has recovered with the help of research and conservation efforts, many in this case carried out by the U.S. Army Corps of Engineers. The U.S. Fish and Wildlife Service has recommended delisting the interior least tern pending completion of strategic plans to ensure its continued survival in a range along large rivers in the central United States.

ABOVE: ***This nesting raft fashioned from a former barge was one successful Corps-sponsored way to usher in a comeback of the endangered least tern; sandbar restoration on the lower river is another.***

"This is pretty rare," said Mike Thron, a biologist with the U.S. Army Corps of Engineers helping to implement the recovery strategy. "The Fish and Wildlife Service would not delist a species without assurances that potential threats to the species would not immediately return."

Thron surveys the least tern population along the Mississippi River. The interior least tern population along the Mississippi River only was estimated at 10,150 in the 2012 census, while the target recommended in 1990 was 2,500. The population throughout the bird's nesting range of large rivers in the central United States has been above its recommended target of 7,000 since the 1995-96 census—up to 13,855 in 2012.

That comeback was influenced at least in part, experts say, by the restoration of the tern's favored habitat. Barren beaches of sand are the preferred nesting locations for the terns, and many had disappeared from large rivers in past decades with the construction of dams, reservoirs and protected banks. On the lower Mississippi, where there are no locks and dams, fluctuating river stages persist where large sandbars remain exposed. But there, and where alterations for flood control and navigation were made, the Army Corps worked with federal and state partners to provide critical habitat, such as dikes redesigned to maintain some flow through side channels or chutes during periods of lower flow. Flow through a notch may create a water barrier from predators for least terns nesting on the sandbars.

Other tactics have been employed by Corps biologists elsewhere on the river, in sometimes wildly creative ways. At the Audubon Center at Riverlands, located in West Alton, Mo., for example, the Corps outfitted an old barge with tern decoys. Solar-powered speakers play the bird's call and attract other terns to a barge used as a sandbar substitute for nesting.

"That can attract other terns to the nesting barge," said Lane Richter, senior ecologist at Riverlands. "The terns need the reassurance that others are present and the area is good."

While the highest concentration of nesting sites remains on the lower Mississippi, the stretch from Cape Girardeau to the Gulf of Mexico, the Riverlands project shows that if the welcome mat is out, the birds will find it, biologists say. The barge has hatched as many as 30 fledglings in a summer and is a popular attraction for school groups and other visitors. —S.F.

AT A GLANCE

The interior least tern is a geographic subspecies of *Sternula antillarum*, fish-eating birds that nest in open sandy areas and other bare ground along rivers and coasts.

Appearance: Black "crown," snowy white underside and forehead, grayish back and wings, orange legs, yellow bill with black tip.

Adult size: 8 to 9 inches long with a 20-inch wingspan

Flight: may hover briefly before plunging into water.

Breeding season: April through August.

Nests: Shallow scrape in sand, soil or pebbles.

Reproductive habits: Both parents incubate eggs for about 24 days. Chicks leave nest a few days after hatching; adults lead them to shelter in nearby grasses and bring them food.

Range: Breed in summer along Missouri, Mississippi, Ohio, Red and Rio Grande river systems; winter along coastal areas of Central and South America.

MY MISSISSIPPI

Ed Wong, 61, Vicksburg, Miss. teacher, Mississippi River Studies, Vicksburg High School and former Mississippi teacher of the year

"I was born in Rolling Fork, Miss., a delta town north of here, and when I moved to Vicksburg, I could see the river from home. When I was in high school you could hear the *Delta Queen* or *Mississippi Queen* come up the canal, playing the calliope. When the teacher who created our Mississippi River class at Vicksburg retired, they turned it over to me.

"It's a class without a textbook. We might have one presentation on historic floods, another on levees, another on the physical characteristics of the river. Speakers from the Corps come, and they don't just talk construction and floods, but also navigation and wildlife. The kids like the wildlife aspect and the economic aspect too. It wows them. That, and the force of the river, the idea it's not a static entity but that it has a mind of its own, that it has mood swings. We also cover the culture. We just had blues singer Bobby Rush come in. He talked about his life as a blues artist and sang with the kids.

"I was so ignorant about the river when I started. I used to think the river was one gigantic ditch that flowed from point A to B. I have a lot better appreciation for it now, a lot more respect for it, and more appreciation of the challenges the Corps has while trying to control it. That's not an easy task. It's also fun to see the Corps evolve. When I started teaching the class, high on the priorities of the Corps of Engineers was flood control and navigation. Now environmental concerns and education are high priorities. The Corps' Vicksburg District makes the class possible. They coordinate speakers and provide field trips on the river. They let our kids steer the boat, and they feed us too. It'll be the first time that some kids have been on the river." —K.S.

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NAVIGATION BRIEFS

Communication keeps commerce moving on the Mississippi River system

Near constant communication between the U.S. Army Corps of Engineers, the navigation industry and the U.S. Coast Guard allowed commercial barge traffic to safely traverse a restricted section of the lower Mississippi River in early November.

Each autumn the Mississippi Valley Division's Mat Sinking Unit begins several months of revetment work on the Mississippi River; establishing permanent locations for the constantly moving river banks using flexible concrete mattresses. For those not familiar with the process, revetment is a facing (such as of stone or concrete) to sustain an embankment.

This year's mat sinking season included the Fair Landing, Ark., site located 30 miles south of Helena, Ark. (river miles 632-635), at which critical repairs needed to be made to the severe bank erosion caused by the 2011 flood. This was high-priority work for the division because should a high-water event occur, the large scours could threaten navigation channel stability and the mainline levee system.

The revetment work must be performed when river levels permit (typically between August and December), as it can't be performed during high river stages, which typically occur during the rest of the year.

Because the narrow bend along this reach of the river only allowed for one-way traffic under normal conditions, the Corps and Coast Guard imposed river restrictions during daylight hours to allow for the bank repairs. Decisions were based on the needs of commerce and river conditions so that river traffic experienced limited delays. The Corps and Coast Guard also re-buoyed this three-mile section of river to help widen the channel.

Maj. Gen. Michael Wehr, commander of the Mississippi Valley Division, said: "We fully realize how important it is to keep commerce moving on the Mississippi River during harvest season." He added: "We are in constant dialogue with industry and the Coast Guard to minimize the impact to navigation, while accomplishing critical flood control and flood risk reduction work before the next high water hits the region." —P.V.

Season ends on upper river

The U.S. Army Corps of Engineers locked the last tow of the season for the St. Paul, Minn., area on Nov. 20 after early ice conditions became difficult for vessels to navigate. The Motor Vessel Mary K. Cavarra was locked through Lock and Dam 2 near Hastings, Minn., marking the unofficial end of the Twin Cities portion of the navigation season. The season was shorter than usual due to one of the latest Spring openings on record, caused by thick ice on Lake Pepin near Red Wing, Minn.,

Illinois Waterway lock closed for repairs

The T.J. O'Brien Lock and Dam, one of eight managed by the Rock Island District of the Corps on the Illinois Waterway, was closed Nov. 3 through Dec. 19 to address critical maintenance issue. The lock is scheduled for closure again closed again Jan. 19 through March 6 for continued maintenance.

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Send story ideas to editor@ourmississippi.org

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This newsletter is a quarterly update of ongoing efforts in the Mississippi River Watershed and does not necessarily reflect the views of the U.S. Army.