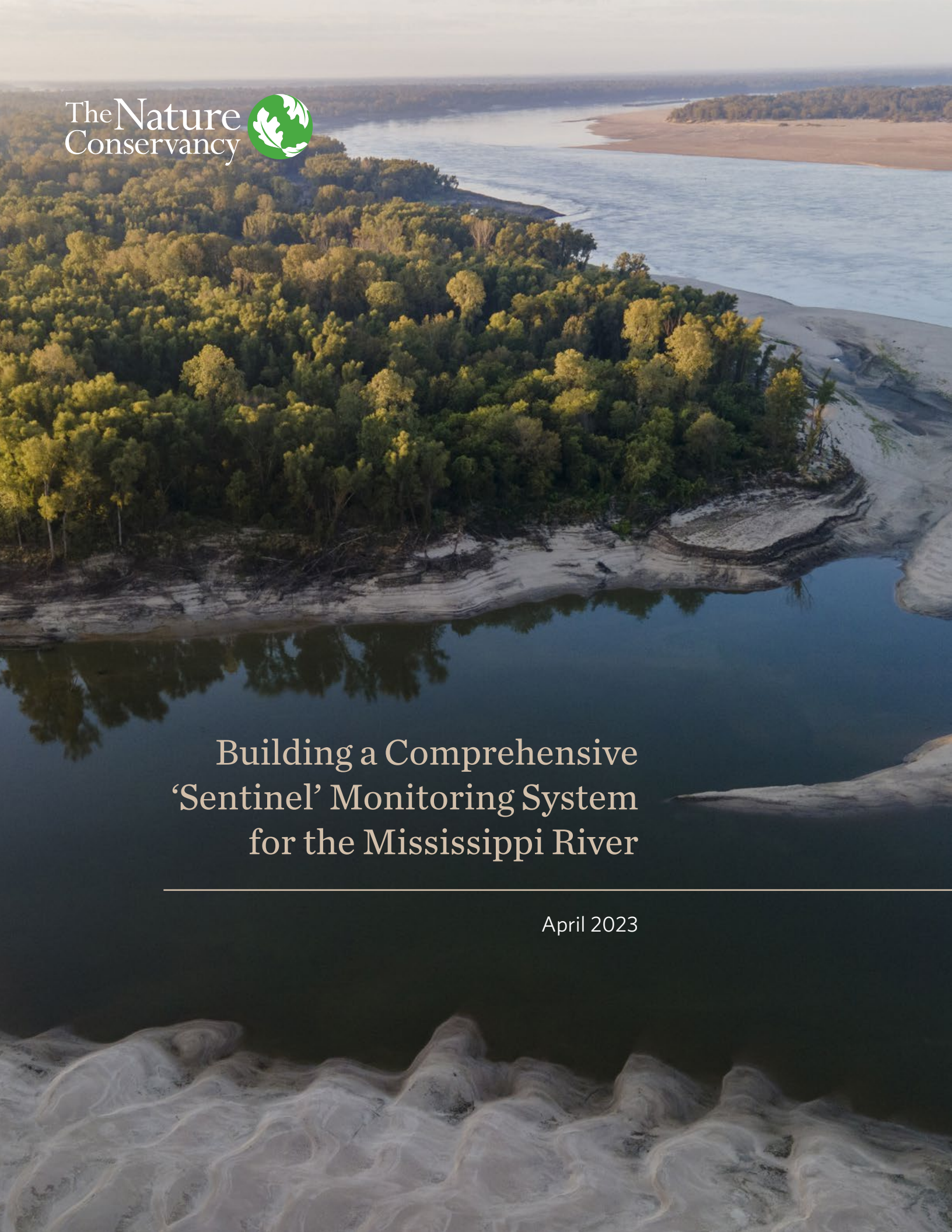

The Nature Conservancy

Building a Comprehensive 'Sentinel' Monitoring System for the Mississippi River

April 2023

Goal:

A fully funded, constructed, and staffed monitoring system across the Mississippi River in the next five years.

The Nature Conservancy with technical contributions from:
U.S. Geological Survey
U.S. Army Corps of Engineers
National Oceanic and Atmospheric Administration | National Weather Service
Tulane University, School of Science and Engineering

Mississippi River Basin Comprehensive Monitoring System Executive Summary

Context

Flowing across 1.245 million square miles in 31 U.S. states and two Canadian provinces, the Mississippi River and its tributaries nourish crops, transport goods, offer recreational opportunities, and sustain robust fisheries, providing food, jobs and economic security to millions of Americans.

The lands and waters of the Mississippi River Basin are vital to our nation's well-being. Unfortunately, the river basin faces a number of threats that impact communities, agriculture, infrastructure, and the environment, including flooding, runoff from agricultural activities and sewage, and sinking land.

Our communities depend on a healthy river. To protect the river and our communities, we must have timely, integrated, and actionable information to drive sound decision making and infrastructure investments throughout the Mississippi River Basin.

The Challenge: Why This? Why Now?

The Mississippi River Basin faces threats on several fronts:

- Intensive flooding across the basin strains the infrastructure on the river and threatens homes, businesses, and communities. This flooding is a result of extreme variability in hydrologic events, resulting in record floods and droughts across the basin. Scientists predict that this variability will continue to increase in the future. Models project "a larger fraction of land areas to be affected by an increase in river floods than by a decrease in river floods."[1]
- Massive amounts of nitrogen and phosphorus runoff from aging sewage treatment plants, farms and other sources enter the river. The runoff poses health hazards to people and wildlife, raises the costs of water treatment, and contributes to an annual "dead zone" that costs the Gulf of Mexico seafood and tourism industries $82 million a year.[2]
- Invasive species like Asian carp degrade habitat and displace native species.
- Rising seas and sinking land are driving a massive loss of coastal wetlands in Louisiana, creating a need for strategic water and sediment management to sustain coastal wetlands and fisheries.
- Inadequate or conflicting navigation-focused sensor availability or improperly referenced river stage datums impede routine navigation and contribute to maritime accidents, resulting in vessel allisions with fixed structures or vessel collisions incurring substantial costs to recover vessels, dams, bridges, loss of life, and community impact.

1 IPCC 6th Assessment Report. August 9, 2021, Climate Change 2021: The Physical Science Basis. Working Group I.

2 Rabotyagov, S.S., Kling, C.L., Gassman, P.W., Rabalais, N.N., and Turner, R.E. 2014. The economics of dead zones: causes, impacts, policy challenges, and a model of the Gulf of Mexico Hypoxic Zone. *Review of Environmental Economics and Policy* 8: 58–79.

The Goal

To meet the challenge facing our river and our communities, it is urgent that we fund and deploy a comprehensive monitoring system that will be a 'sentinel for the basin.' This system will provide critical infrastructure for the nation through standardized information on present and future flooding and flood risk, water quality and sediments, ecosystem health, coastal restoration, and navigation efficiency and safety.

The nation already spends a considerable amount of money measuring water levels and quality within the Mississippi River Basin. However, the data collection is performed by a patchwork of agencies and is hampered by a legacy of inconsistent and insufficient funding. The monitoring network is incomplete and inequitable, and it does not meet the needs of its multiple users. Incremental additional funding can turn the disparate pieces of the current monitoring network into a valuable, highly effective, internationally admired monitoring network for the nation's most economically and environmentally important watershed.

Specifically, the current system includes these deficiencies:

- Data are compiled from different stations, counties, and states, frequently using different methods that are incompatible with one another.
- There are significant gaps in monitoring coverage. Currently there are incomplete and inconsistent data to accurately measure stream flow and water quality and to provide real-time information to manage flooding and navigational efficiency and safety.
- There is lower investment in monitoring some areas (for example, portions of the Lower Mississippi River Basin), leaving low-income communities more vulnerable.

A fully integrated 'Sentinel System' will address the shortfalls of this piecemeal network. It will provide critical and standardized information on present and future flooding and flood risk, water quality and sediments, as well as data to support the assessment of ecosystem health over the long-term. It will provide improved critical information for river forecasting, flood inundation mapping, sediment transport and deposition, community resilience, conservation, restoration and navigation across the entire basin.

Strategies

We will employ five strategies to develop this system:

- **Expand and improve** upon the present system at strategic locations to add to the present monitoring network, with a focus on monitoring key, high-need sites, and standardizing and integrating information data sources.
- **Ensure a long-term, stable funding source** for these strategic sampling sites, and streamline data use for researchers and stakeholders.
- **Increase monitoring density** in the Lower Mississippi River Basin to equal that of the Upper Basin, and ensure that information is consistent and integrated across the entire basin.
- **Bolster support** for the system by convening government, non-governmental organizations, and private experts to define standards, develop local models and design a consistent, integrated monitoring plan.
- **Develop a government-hosted, publicly accessible data portal** that provides timely, accurate information that meets the needs of multiple audiences.

System Design

To effectively meet the needs of a wide array of users, the system must be easy to understand and use, build upon the best parts of existing monitoring systems, and provide timely public access to data. The system should also equitably invest in under-resourced areas, providing information relevant for populations that are most at risk, with equitable input and buy-in. As data are collected by different entities, the system must promote coordination and aligned action across government, non-governmental organizations, private partners, and landowners across the Mississippi River Basin.

Based on these needs, we identified two primary objectives to guide the design of the system:

1. Obtain consistent and comparable information on loads and trends in streamflow, water-quality, and sediment to understand how changes in climate, land use, and landscape management are affecting the Mississippi River, its major tributaries, and inputs to the Gulf of Mexico.
2. Provide real-time information needs to guide decisions on navigation, flood control, and diversions on the mainstem Mississippi River.

To meet these objectives, we based the design of the system on three criteria:

1. What data we need to collect
2. How frequently we need to collect those data
3. Where monitoring sites should be located.

We propose that the system include the following monitoring sites:

- **38 U.S. Geological Survey (USGS) stations** along the Mississippi River mainstem and major tributaries that monitor streamflow, water quality, and sediment. Of these, 35 stations exist, 11 existing stations need upgrades, and three are proposed new stations.
- **12 National Oceanic and Atmospheric Administration (NOAA) sensors** in the Lower Mississippi River Basin that support navigational safety, coastal resource management, and storm flood forecasting. Of these, two exist and are funded, one has funding to be installed, and nine are proposed new sensors. Of those nine, three are new air gap gages and six are new current meters.
- **Eight USGS Coastal Ocean Dynamics Applications Radar (CODAR) sensors** for monitoring high-priority navigation points along the Mississippi River mainstem and major tributaries.
- **1,414 U.S. Army Corps of Engineers (USACE) stations** and gages within the Corps' 13 districts responsible for monitoring flooding and navigation along the Mississippi River mainstem and major tributaries, of which all have sustainable funding, with the exception of projected inflationary increases for the St. Paul District.

Technical advisors from the USGS, NOAA, and USACE, in conjunction with scientific experts from Tulane University's School of Science and Engineering and The Nature Conservancy, selected sites for monitoring water quality and flow, forecasting storm flooding, and improving navigational safety along the Mississippi River mainstem and major tributaries. To select sites, we drew on existing data and expertise and established additional, new standards.

We also identified the need for a new data interface for users to access data real-time and in formats that are readily usable, understandable for their needs, and in one location for all data sources.

In addition, The Nature Conservancy has been discussing with agencies the need to create a fully integrated system for years. One of the first steps in the implementation would be to work with local entities to refine site locations and support other important monitoring efforts. For example, the Hypoxia Task Force Report of 2021 specified a set of priority 1 and 2 monitoring sites with a slightly different set of criteria. That having been said, there are 17 sites in our recommendations that overlap with the Hypoxia Task Force Priority 1 and 2 sites and where our monitoring specifications will support their efforts.

Cost Summary

For the Sentinel System to be successful, it must be incorporated into a sustained federal program to ensure a consistent source of funding for federal agencies that are conducting the monitoring. Working with scientists, hydrologists, and engineers from The Nature Conservancy, the U.S. Army Corps of Engineers, United States Geological Survey, the National Oceanic and Atmospheric Administration, and Tulane University, we identified the current year costs for annual start-up and operating and maintenance costs for existing and proposed stations as follows:

System Design Element	A. Total current annual funding provided for existing network	B. Year 1: additional one-time cost to add probes and meters	C. Year 1: estimated one-time cost to build new stations	D. Total year 1 Sentinel System start-up costs (B + C)	E. Total year 1 annual operating and maintenance costs for new system	Gap between current and proposed year 1 start-up and O&M costs (D + E) – (A)	Total 25-year cost of existing system with no upgrades with 3% compounded inflation	Total 25-year cost of Sentinel System with 3% compounded inflation
Water flow, quality and sediment gages (USGS)	$2,448,252	$1,200,000	$6,350,000	$7,550,000	$7,921,097	$13,022,845	**$94,387,563**	**$312,932,387**
Key navigation air gap gages and current meters (NOAA)	$60,000	$0	$804,000	$804,000	$288,000	$1,032,000	**$2,313,183**	**$11,907,276**
Key navigation CODAR sensors (USGS)	$0	$0	$1,600,000	$1,600,000	$320,000	$1,920,000	**$0**	**$13,936,974**
Flooding and navigation gages (USACE)	$17,500,000	$0	$0	$0	$17,500,000	$0	**$674,678,239**	**$674,678,239**
MSR data interfaces and services	$0	$0	$4,800,000	$4,800,000	$2,600,000	$7,400,000	**$0**	**$116,737,910**
Total item cost	**$20,008,252**	**$1,200,000**	**$13,554,000**	**$14,754,000**	**$28,629,097**	**$23,374,845**	**$771,378,985**	**$1,130,192,786**
Funding gap between existing and Sentinel System over 25 years	**$358,813,801**							

Considering the cost for installing sensors, the current annual funding for USGS water quality sensors and infrastructure is 32% of what is needed to build the Sentinel System. For NOAA air gap stations, current funding is 7% of what is needed, and for the recommended additional USGS CODAR sensors, there is no funding. These percentages do not apply to operations and maintenance.

The nation already spends approximately $20 million on the existing piecemeal system that doesn't fully or efficiently meet present needs and is not sufficient to evaluate long-term trends for climate adaptation. Investing an additional $23.4 million in year one to build, operate, and maintain the Sentinel System will provide the foundation for a comprehensive integrated system that meets the growing demand for accurate, timely, and readily accessible data.

We also calculated the 25-year inflation-adjusted costs of both the existing system and the Sentinel System. Over a 25-year period, with compounded inflation at 3% per year, the total cost of the existing system would come close to $771.4 million dollars, which is taxpayer money that will already be spent. The 25-year cost of the Sentinel System is approximately $1.13 billion, so over the course of 25 years, the cost to build, operate, and maintain the Sentinel System would be just over $358.8 million in additional funds.

We are already spending 68% of the necessary funds for a new system, just to operate and maintain systems that are not providing critical information. By wisely investing 32% more, we can improve this vital national infrastructure to provide consistent, comparable, real-time information that will benefit communities, commerce, and the environment and be accessible to the U.S. taxpayer.

Conclusion

A consistent and integrated monitoring system in the Mississippi River Basin will:

- Generate and transmit real-time information that can support emergency flood alerts, detail low-water impacts to include the impact of salinity on the freshwater drinking supply, adjust the management of drinking water systems, and perhaps provide increased hydrodynamic information to advance predictive dredging and channel maintenance abilities.
- Save U.S. taxpayer dollars by optimizing the efficiency and accessibility of the data collected.
- Develop an improved understanding of changes in water discharge, channel evolution, and sediment transport in the river due to climate variability, water management decisions and land-use changes that are threatening the flood risk management, maintenance of navigation and ecological integrity of the river.
- Expand the accessibility of monitoring information (e.g., information that supports the Mississippi River Watershed Report Card) to track the health of the Mississippi River.
- Provide key monitoring data to the public to evaluate whether specific policies or practices aimed at improving conditions on the river for multiple constituencies (agriculture, navigation, municipalities, emergency management agencies, NGOs and restoration practitioners) are effective and cost-efficient.
- Create a foundation for integrated watershed planning that includes all stakeholders and promotes a healthy future Mississippi Basin that adapts to changing conditions.

The Nature Conservancy

The Nature Conservancy is a leading conservation organization working around the world to protect ecologically important lands and waters for nature and people. Visit us at **nature.org.**

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