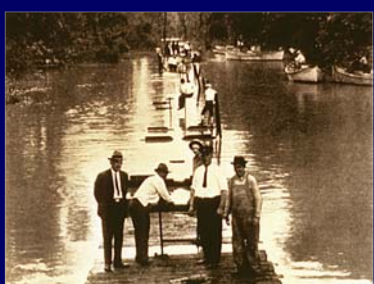
Mississippi River Water Quality:

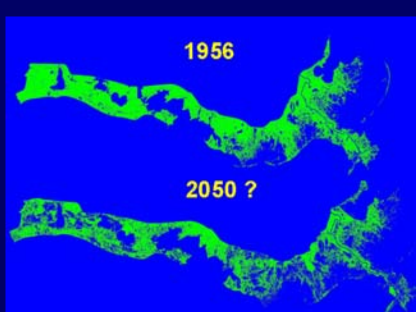
Implications for Coastal Restoration

In Review...

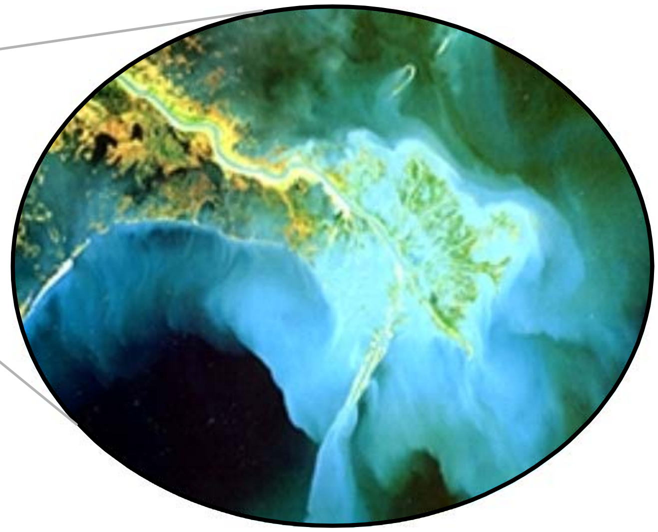
- ***River modifications and coastal wetland loss***
- ***Indicators of Mississippi River Water Quality***
- ***Diversions and salinity***
- ***A long-term perspective***



After the Great Flood of 1927, Congress authorized flood control projects and financed construction of a fully contiguous levee system on the Lower Mississippi River. Most of the alluvial sediments and nutrients that once sustained Louisiana's coastal marshes are now contained within the river's main channel and deposited into the Gulf of Mexico.



In combination with various man-made and natural causes, river levees have accelerated the rate of coastal land loss in Louisiana. Even with current restoration efforts, the state is expected to lose an additional 1000 square miles of coastal marsh by the year 2050.



ALTERED HYDROLOGY

For thousands of years the Mississippi River flowed freely in the heart of North America, draining 41% of the continental U.S. and parts of Canada. The River changed course every 1000 to 2000 years, and balanced Louisiana delta lobe deterioration with new lobe formation. With increased settlement along the River in the 1700s, people began building flood protection levees to protect their homes and property. As the levees grew larger, the "wild" nature of the River was restricted. This ultimately reduced the frequency of sediment and nutrient-rich over bank flooding and new delta lobe formation so critical to the creation and maintenance of wetlands in coastal Louisiana. After the Great Flood of 1927, Congress authorized funding for major Mississippi River flood control projects including a system of contiguous, reinforced levees that allowed for increased settlement and development along the river and its distributaries.

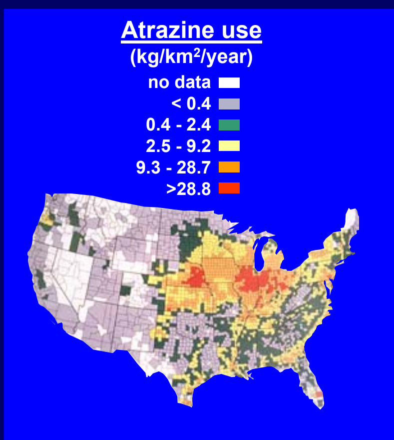
Coastal Wetlands Loss

Levees provided the needed flood protection, yet prevented vital land-building sediments from replenishing and elevating deteriorating marshes. The result was increased areas of open water and higher rates of erosion. Additional alterations have compounded the problem. The dredging of canals for improved access and navigation has accelerated saltwater intrusion. Combined with natural causes such as subsidence and hurricanes, these forces result in the loss of 24 square miles of Louisiana's coastal wetlands each year.[1]

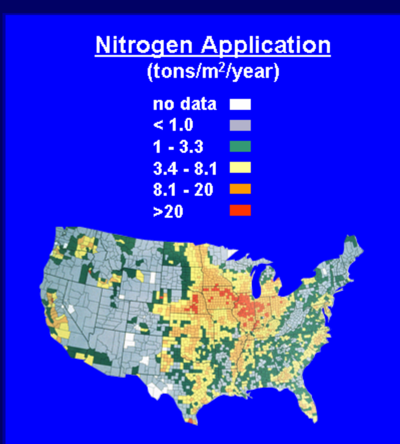
Diversions and Water Quality Concerns

Scientists estimate that from 22% to 25% of the projected land loss over the next 50 years could be reduced by the coastal restoration projects approved to date. However, even with these efforts, the state is expected to lose as much as 1,000 square miles of marsh by the year 2050.[2] There is a growing consensus among experts that controlled freshwater diversions offer the best hope for combating the severe deterioration of our coastal marshes. With adequate funding and public support, large, system-wide diversion projects could reduce these projected losses by up to 85%. Nevertheless, the perception among many citizens is that the Mississippi River is highly contaminated by a wide variety of compounds and that the adverse effects of these pollutants outweighs the benefits of additional freshwater, sediments, and nutrients. While the Mississippi River does have some problems with certain contaminants and nutrients, overall the river is cleaner and healthier than it has been in decades.

Controlled re-introduction of the sediment and nutrient-laden waters of the Mississippi River is the best large-scale tool for coastal restoration. However, concern remains over the River's water quality and the potential for adverse impacts such as fish kills.



Atrazine is a herbicide used primarily by corn producers within the Mississippi River watershed to control broad-leaf weed pests. There is public concern over higher concentrations of Atrazine detected in the Mississippi River during late spring.



Nitrogen fertilizer application within the Mississippi Watershed is highest in corn production states of the upper basin. Almost all of the total nitrogen in the River comes from sources outside Louisiana.

POLLUTION AND POLICY

Concerns regarding Mississippi River pollution first emerged after World War II as significant impacts to water quality began to accrue from an increasing human population, persistent use of agricultural chemicals, and an expanding industrial river complex. By the mid 1960s, scientists had documented serious water quality impacts from a variety of pollutants. Harmful environmental effects included mortality and population declines in both fish and wildlife resources. With increased public concern, federal water quality regulatory actions were approved in the late 1960s and early 1970s. The establishment of the U.S. Environmental Protection Agency (EPA), passage of the Clean Water Act (CWA), and the formation of state environmental improvement agencies resulted in nationwide water pollution control regulations and pollutant reduction targets.

STATUS OF RIVER WATER QUALITY

After 25 years of the CWA and other water quality improvement efforts, surface waters nationwide (including the Mississippi River) are significantly cleaner. Recent Louisiana State University studies in the Mississippi River show healthy fish populations, including important recreational and commercial species such as bass, catfish, buffalo, and shad. In a recent Louisiana Department of Environmental Quality (DEQ) tissue analyses, fish from the Mississippi River were analyzed for over 100 toxic chemicals, most which (95%) were undetected. Samples with detectable toxins were at relatively low concentrations, falling below the U.S. Food and Drug Administrations (FDA) standard for edible fish. In addition to DEQ, ongoing Mississippi River water quality monitoring efforts are conducted by the federal Department of the Interior - U.S. Geological Survey (USGS).

A USGS report titled *Contaminants in the Mississippi River, 1987-92* provides extensive information regarding a variety of contaminants including nutrients, pesticides, trace metals, bacteria, and chlorinated hydrocarbons.[3] The following summaries provide additional details regarding the few chemicals that have been detected in the River through both DEQ and USGS studies.

Pesticides and Industrial By-products

Since the late 1970s, most of the older "first generation" chlorinated insecticides, such as DDT, have been banned. Although recent studies have shown no water column detection, some of these chemicals can still be found in low concentrations in bed sediments. All sediment samples, however, fell below EPA guidelines. The older, banned pesticides were the chief toxic chlorinated organic compounds detected in Mississippi River fish sampled in the earlier DEQ fish tissue study; however, the average concentrations of these compounds did not exceed any of the FDA alert levels for fish consumption. Atrazine is the only modern pesticide found frequently enough in the Mississippi River to justify public concern. Although concentrations during the spring flux continue to cause some concern, Mississippi River Atrazine concentrations currently fall below EPA guidelines for drinking water.

Hexachlorobenzene (HCB) is present in low concentrations in Mississippi River sediments, although it has not been detected in the River's water column. The source of HCB in Mississippi River sediments is suspected to be by-product industrial point-source discharges. HCB was not detected in fish sampled in the river during the three-year study of fish tissue contaminants mentioned previously.

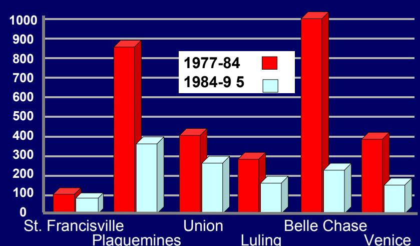
Nutrients

Nutrients such as nitrogen and phosphorus are essential to marine and freshwater environments. Some nutrient load from the Mississippi River is vital to maintaining the productivity of the extremely valuable Gulf of Mexico fisheries. Approximately 40% of the U.S. fisheries landings come from this productive zone influenced by nutrient-rich Mississippi River outflow located in the north-central Gulf of Mexico. Public concern exists over the potential for nutrient pollution (eutrophication) where river water is used in coastal restoration projects. Yet, recent research suggests that under current flow regimes these inputs are rapidly assimilated.[4]

Overabundance of nutrients can cause adverse impacts such as eutrophication (excessive algal growth). To date, nutrients have not been a problem in river diversions used for coastal restoration.

Overabundance of nutrients, however, can cause adverse impacts such as (1) excessive algal growth, (2) reduced sunlight penetration, (3) bottom-dwelling animal habitat degradation, and (4) decreased oxygen in the water. As oxygen concentrations fall below critical levels (hypoxia), organisms begin to die, and their decomposition can lead to a complete lack of oxygen (anoxia).

Since the mid 1980s, large hypoxic areas have been identified in the near-shore areas of the Gulf of Mexico off the Louisiana and Texas coasts. It should be noted that both algal blooms and resulting low oxygen conditions are natural phenomena that can periodically occur in marine environments unrelated to human-caused nutrient enrichment. Nevertheless, scientists are increasingly concerned about the size and frequency of the hypoxic zone in the Gulf of Mexico. Sources of Mississippi River nutrients include storm-water runoff from farms and cities, sewage plant discharges, atmospheric deposition from automobiles and fossil fueled plants, and natural organic matter runoff from the landscape. Nutrient concentrations in the Mississippi River are believed to be primarily derived from non-point pollution sources (NPS) - runoff from the landscape - and not attributed to point-source, or “end of the pipe” discharges.



Median fecal coliform bacteria concentrations in the Mississippi River have dropped significantly since the mid 1970s due to improved sewage treatment.

Bacteria

Median fecal coliform bacteria concentrations in the Mississippi River have dropped significantly since the mid 1970s. Much of this improvement can be attributed to the addition and upgrading of numerous municipal sewage treatment facilities, rural septic systems, and animal waste management systems all along the river and its tributaries over the past 25 years. Additionally, no known fisheries impacts are directly associated with bacterial pollution in the river.

Trace Metals

Concentrations of trace metals in the Mississippi River are well below EPA guidelines for both drinking water and aquatic life. No trace metal concentrations found in fish tissue exceeded the FDA standard for edible fish. Mercury concentrations in Mississippi River fish averaged well below the state advisory level of 0.5 parts per million (ppm) and the FDA alert level of 1.0 ppm.

THE SALINITY FACTOR

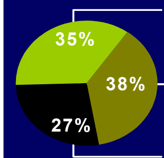
While most of the available evidence suggests that the water quality of the Mississippi River is suitable for coastal restoration uses, there are additional concerns surrounding potential habitat shifts that might result from diversions. The initial influx of fresh water from a diversion results in an inevitable shift in the salinity of receiving waters and can shift the frequency and distribution of fisheries.

Diversions help sustain the essential habitat of Louisiana’s coastal fisheries. Yet the influx of freshwater can alter salinity and cause displacement of fishery harvests. When the Caernarvon Diversion became operational in 1992, production on interior, privately held oyster lease declined; however, the net effect has been an overall increase in oyster production.

Fisheries

Salinity reduction from the Caernarvon Freshwater Diversion Project has been associated with some declines in oyster production on interior, privately owned leases. Yet overall, the structure is credited with a tremendous increase (50%) in regional oyster production. The expanded production has occurred farther seaward in the estuary on public grounds where the average salinity has become more optimal for oyster production. Commercial crab and shrimp fishermen also witnessed initial displacement of stocks because of altered salinity, but production has since stabilized or increased overall.

Fishermen are active in diversion outfall management and participate on the Interagency Advisory Committees for the Caernarvon and Davis Pond diversions. The current method of diversion management seeks to minimize fisheries impacts while maximizing freshwater inputs to the estuary.



"Normal"
green vegetation
137,655 acres

"Moderately Impacted"
greenish/brown vegetation
143,935 acres

"Severely Impacted or Dead"
marsh is mostly brown, black, or totally devoid of vegetation
105,570 acres

The lack of freshwater input became more critical in coastal Louisiana during the recent "Brown Marsh" crisis in which huge expanses of salt marsh began to rapidly die-back. The Barataria-Terrebonne Estuary has been especially hard-hit, with an estimated 250,000 acres (65%) of the region's salt marsh moderately or severely impacted.

The Caernarvon Freshwater Diversion (shown above) has benefited the Breton Estuary since 1992 without degrading water quality. In 2002, the Davis Pond Diversion was opened (below). The Corps of Engineers estimates 33,000 acres of wetlands will be preserved and 770,000 acres of marshes and bays will be benefited during the 50-year life span of this diversion project.

Caffey, R. H. , P. Coreil, and D. Demcheck (2002) Mississippi River Water Quality: Implications for Coastal Restoration, I*nterpretive Topic Series on Coastal Wetland Restoration in Louisiana*, Coastal Wetland Planning, Protection, and Restoration Act (eds.), National Sea Grant Library No. LSU-G-02-002, 4p.

Brown Marsh

The need for fresh water became critically evident in the spring of 2000, when large expanses of coastal salt marsh began to exhibit alarmingly high levels of die-back, primarily in stands of smooth cordgrass (*Spartina altiniflora*). Although salt marsh die-back itself is not uncommon, the recent episodes were unprecedented, potentially threatening the loss of thousands of acres of coastal wetlands within a very compressed time frame. Causes for the phenomenon, referred to as "Brown Marsh," have been attributed to a cascading of negative environmental factors (drought, heat, salinity). The most affected coastal areas are concentrated in the intertidal marshes of Barataria-Terrebonne where 65% (approximately 250,000 acres) of *Spartina altiniflora* marsh has been severely or moderately affected.

A forensic ecology panel, convened by the Governor, is investigating the extent, cause(s), impacts, and remedies for the Brown Marsh phenomenon. An emergency appropriation of $3 million was authorized by Congress in 2000 to finance short-term research and remedial action outlined in a recently issued executive order by Governor Foster. Of the six directives outlined in the order, five contain specific language calling for increased freshwater flows via expanded use of existing diversions or expedited implementation of planned diversions.[5]

IN PERSPECTIVE

The Mississippi River is much cleaner today than it was 20 years ago, yet concerns remain over the status of water quality. Nutrient and herbicide problems should continue to be investigated and managed and salinity impacts addressed where diversions are operated. However, these concerns must be weighed against Louisiana's ongoing problem of coastal land loss and the threatened acceleration of this loss with the recent Brown Marsh crisis.

Hundreds of millions of dollars have been invested in diversion projects like Caernarvon and Davis Pond, and sufficient support exist for even greater efforts at diversion-based coastal restoration. Scientists and stewardship agencies are now promoting larger scale diversions that could make the Mississippi River an even more viable restoration tool. In pursuing such projects, it has become operationally implicit that the benefits of using controlled diversions effectively outweigh the above referenced water quality risks.

REFERENCES

1 Barras et al. (2003) Historical and Predicted Coastal Louisiana Land Changes: 1978-2050, USGS Open File Report, July 2003, 11p.
2 LaDNR (1999) Coast 2050: Toward a Sustainable Coastal Louisiana, Louisiana Coastal Wetlands Conservation and Restoration Task Force, La Dept. of Natural Resources. Baton Rouge, La. 161 p.
3 Meade, R.H. and J. A. Leenheer (1996) Contaminants in the Mississippi River: 1987-92 U.S. Geological Survey Circular 1133, Reston, Virginia, 1996.
4 Lane, R.R. and J. W. Day (1999) Water Quality Analysis of a Freshwater Diversion at Caernarvon, Louisiana, Estuaries, Vol. 22, No. 2A, p. 327-336.
5 Executive Order No. MJF 2000 - 41, Saltwater Marsh Die-off Action Plan, www.state.la.us/osr/other/mjf00-41.htm

www.agctr.lsu.edu
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