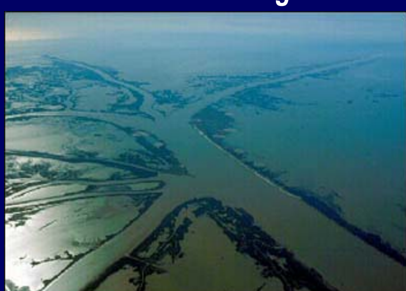
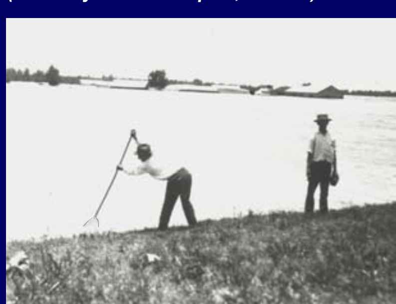
Fisheries Implications of Freshwater Reintroductions

In Review...

- ***Historical aspects of Louisiana fisheries***
- ***How have levees altered fisheries production?***
- ***Fisheries impacts from the Caernarvon diversion project***
- ***Balancing coastal restoration and fisheries management***



Prior to the 20th century, the tremendous estuarine productivity of coastal Louisiana was sustained by the alluvial deposition of sediments and nutrients from the Mississippi River's distributaries and periodic floodwaters.
(Photo by Michael Maples, USACE)



Breaches in early levees along the Mississippi River, known as "crevasses," were a common occurrence and eventually became associated with enhanced fisheries productivity. Above, state fisheries biologists sample near the site of the Poydras crevasse in 1927.

BACKGROUND

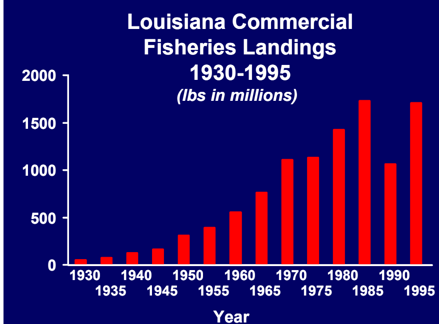
Large-scale coastal wetland restoration projects involving the re-introduction or diversion of fresh water from the Mississippi River require several years of planning and evaluation, and can cost hundreds of millions in construction and operating expenditures. Despite the enormous time and expense involved, such projects may represent the best available technology for combating Louisiana's high rate of coastal wetlands loss, which, at 24 square miles per year, comprises about 90% of coastal wetlands loss nationally.[1] Yet, as these projects have been implemented, questions have emerged over their effect on various coastal fisheries. The geologic history of south Louisiana and its corresponding fisheries provides an initial context for evaluating this issue.

FLOODS AND FISHERIES

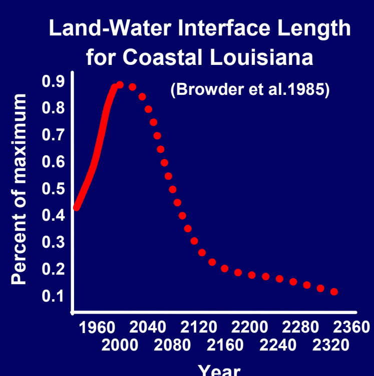
The expansive coastal wetlands of Louisiana are situated at the terminal end of the world's third largest river basin. This strategic location on the Mississippi River has made Louisiana the perennial leader in fisheries landings among the lower 48 states. Prior to the 20th century, the tremendous estuarine productivity of this region was sustained by the river's distributaries and periodic floodwaters, which deposited millions of tons of sediments and nutrients on adjacent coastal marshes. The beneficial impact of this alluvial re-nourishment to fisheries was recognized by early native inhabitants and is documented in formal reports dating back to 1906.[2]

The same floods that revitalized Louisiana's coastal productivity also caused tremendous losses of life and property. Levees constructed for flood protection first appeared in New Orleans in 1717. By 1800, a network of crude embankments extended more than 100 miles north of the city.[2] Breaches in those earlier levees, historically referred to as "crevasses," were quite common and over time became associated with subsequent increase in local fisheries landings. In 1927, Percy Viosca, Jr., state director of the agency that would eventually become the Louisiana Department of Wildlife and Fisheries (LDWF), described the effect of a crevasse in an address to the American Fisheries Society *"…a crevasse in reality results in the restoration of our wet lands …the effect of a crevasse is akin to the cultivation and fertilization of farm lands and might be termed wholesale aquiculture*." [3]

After the Great Flood of 1927, the US Army Corps of Engineers initiated an aggressive campaign of contiguous levee development on the Mississippi for the purposes of flood control and navigation.



Despite an accelerated wetlands loss rate caused by leveeing the Mississippi, fisheries landings have increased by an average of 6.4% per year since 1930. This is attributed primarily to increasingly efficient harvest technologies, a growing demand for seafood, and the open-access nature of commercial fishing in Louisiana.



Louisiana fisheries landings may have been temporally enhanced by the expanding land-water interface resulting from coastal land loss. However, geologic simulations indicate that Louisiana's coastal land-water interface, (and associated fisheries carrying capacity) may have finally begun to decline.

Levees and Landings

After the disastrous flood of 1927, the US Army Corps of Engineers initiated an aggressive campaign of contiguous levee development on the Mississippi River for the purposes of flood control and navigation. Crevasses became a thing of the past, and the floodwaters that once nourished coastal marshes were now confined to the river's main channel until reaching the Gulf of Mexico. Seventy years of subsequent levee fortification resulted in major disruption to the river's natural deltaic cycle. Processes such as subsidence, saltwater intrusion, and wave erosion were no longer offset by accretion. Lack of alluviation would become the primary factor in the loss of 1500 square miles of coastal wetlands.[4]

In apparent contradiction to this coastal wetland loss, fisheries landings have increased by an average of 6.4% per year since 1930.[5] This increase, however, is consistent with the tremendous expansion of the US commercial fishing industry during the 20th century. During this period, increasingly efficient harvest technologies were developed in response to a growing demand for seafood, and the open-access nature of the resource encouraged an expansion of the range and effort of commercial fishing.

In Louisiana, increased landing trends may have been enhanced by an expanding land-water interface resulting from coastal land loss.[6] The break-up of vegetated marsh causes a short-term increase in the ingress routes and edge habitat so vital for juvenile estuarine fish. Yet this sort of productivity may be short-lived.[7] Indeed, geologic simulations indicate that Louisiana's coastal land-water interface has recently begun to decline.[5,8] This loss of habitat does not bode well for future fisheries production.

Further complicating the paradox of levees and landings is the inland migration of fisheries and fishermen. As Louisiana's coastal landscape has retreated, areas of marsh once classified as predominately fresh/intermediate have transformed to brackish/saline, and many brackish/saline marshes have been completely converted to open water. In adjusting to this habitat redistribution, some fishermen have become accustomed to harvesting in the upper reaches of the estuary. This adaptation has placed many of them in direct conflict with restoration proponents advocating diverted river water as the primary strategy for restoring natural hydrology and stemming the rate of coastal land loss.

FROM CREVASSES TO DIVERSIONS

Several restoration techniques have emerged in response to Louisiana's dramatic coastal land loss crisis, including: barrier island restoration; shoreline stabilization using rocks, dredge spoil, or vegetation; and hydrological improvements to drainage and flow. The most widely advocated remedies hinge on strategic re-diversions of waters from the Mississippi River. The concept of using the river for the purpose of coastal restoration is not new, and various structures have been proposed and implemented over the past 50 years. Controlled diversions are the modern equivalent of a small crevasse, and many diversions are indeed situated where the river once breached its bank.

Small scale, siphon-type diversions have been in operation on the Mississippi River below New Orleans for almost 30 years. However, some of the commercial fishing sectors that once acknowledged the fisheries enhancement potential of crevasses have begun to question the fisheries benefits of large-scale, gated-structure diversions. High flow structures have the potential to cause basin-scale fisheries redistribution. Fishermen who have transitioned into the central and upper reaches of the estuary may lack the financial flexibility to forego short-term income for the prospect of long-term fisheries enhancement. [8]

Freshwater Diversion Structures
(South of New Orleans)

Structure	Date	CFS
Bayou Lamoque (phase 1)	1956	4000
Bayou Lamoque (phase 2)	1978	8000
Siphon at Whites Ditch	1956	250
Siphon at Violet	1978	500
Caernarvon	1991	8000
Siphon at LaReussite	1992	2100
Siphon at Point A La Hache	1992	2100
Davis Pond	2001	10600
Siphon at Myrtle Grove		2100 - 15000*

* *Proposed*

The concept of using the Mississippi River for the purpose of coastal restoration is not new, and various structures have been proposed and implemented over the past 50 years.

The Caernarvon freshwater diversion is located south of New Orleans on the east bank of the Mississippi River near the boundary of St. Bernard and Plaquemines parishes. The structure has the capacity to redirect 8,000 cubic feet per second (CFS) of Mississippi River into the marshes and bays of the Breton Estuary.

Since 1992, study areas in the Breton Estuary nearest the Caernarvon outfall have had a dramatic increase in above-ground vegetative biomass.

Reduction, Displacement, and Enhancement

The initial influx of fresh water from a diversion results in an inevitable shift in the salinity of receiving waters and can also shift the associated frequency and distribution of fisheries. The degree of this displacement depends on species-specific variables, structure location, flow-rate, and environmental conditions. Temporary reductions in harvest may occur as some fisheries migrate to new zones of optimal productivity. Adjusting to these changes has been costly for some commercial fishermen, but the ultimate merit of a diversion on fisheries cannot be measured by short-run impacts alone.

Beyond the temporal reduction and displacement effects related to initial salinity changes, the lagged potential of diversions is an overall increase in estuarine productivity. Depending on the rate of flow, accretion of mineral sediments can help to counteract the effects of marsh erosion and subsidence nearest the diversion outfall. Nearest the structure, freshwater-borne nutrients can enhance primary and secondary productivity. Additional vegetation provides more cover for larval fish and decomposition of vegetation augments the detrital food web. The positive impact of these effects on fisheries productivity is described in historical accounts and supported by scientific research.[9,10] Yet the pattern of *reduction-displacement-enhancement* does not affect all fisheries equally. A review of one large-scale diversion project provides more insight on the implications of this pattern for various commercial and recreational fisheries.

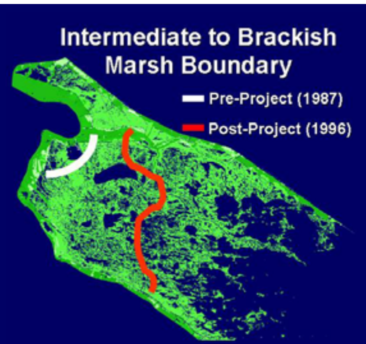
CONSIDER CAERNARVON

The Caernarvon freshwater diversion structure provides a case study for evaluating the fisheries implications of large-scale freshwater diversions. The Caernarvon diversion was first authorized under the Flood Control Act of 1965 and constructed between 1988 to 1991 at a cost of $26 million. The structure is located south of New Orleans on the east bank of the Mississippi River near the boundary of St. Bernard and Plaquemines parishes. The diversion has the capacity to redirect 8,000 cubic feet per second (cfs) of Mississippi River water into the marshes and bays of the Breton Estuary. The original project objectives included nourishment of emergent marsh vegetation, reduction of marsh loss, and enhancement of fisheries and wildlife productivity through re-establishment of historical salinity patterns.[11]

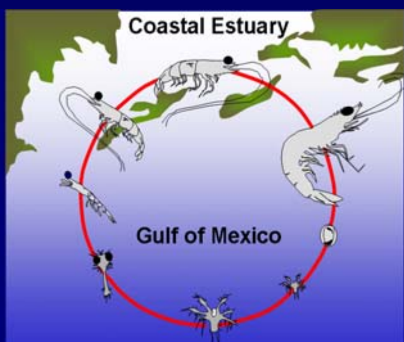
The Louisiana Department of Natural Resources (LDNR) manages the structure with oversight from a Caernarvon Interagency Advisory Committee (CIAC) comprised of various state and federal resource management agencies, local governments, private landowners, and representatives from commercial fishing sectors. A biological monitoring report on Caernarvon was published in 1999, and a subcommittee of the CIAC was convened to discuss monitoring data on marsh enhancement, salinity, and fisheries. A summary of this report and the subcommittee findings is provided in the following sections.

Marsh Enhancement

Nine sample sites monitored near the Caernarvon diversion outfall from 1991 to 1998 depicted a land gain of 406 acres, an 18% increase compared to pre-diversion operation.[12] Though some of this was caused by mineral accretion and organic fertilization, the primary contribution has simply been river water. Reduced salinities have allowed for significant increases in submerged vegetation, emergent vegetation, and marsh area. In the first four years of operation, the vegetative composition of the study area nearest the structure experienced a sixfold increase in the area of fresh marsh, with 12% of the saline marsh having transitioned to brackish. Initial concerns regarding the threat of nutrient pollution from river water have abated, and no problems with eutrophication have emerged. Recent analysis of nitrogen and phosphorus inputs at Caernarvon indicate rapid and near complete assimilation of these nutrients, suggesting that more water may be introduced into the Breton Estuary without detrimental effects to water quality.[13]



Caernarvon has resulted in salinity reductions as high as 85% at some interior locations in the Breton Estuary. The intermediate to brackish marsh boundary has moved further south and eastward since 1992.



Brown shrimp, white shrimp, and blue crab all spawn in the highly saline waters of the Gulf of Mexico. After their eggs hatch they proceed through various larval stages while drifting back toward the estuary. Juveniles rely heavily on interior marshes for food and shelter.

Overall, commercial landings of shrimp and crabs at ports in the Breton Estuary have shown no detectable post construction effect and have cycled upward or downward in accordance with statewide landings.

Salinity

As expected, salinity has been the water quality variable most influenced by the Caernarvon diversion. In the easternmost portion of the Breton estuary, tides, winds, and frontal passages confound this effect. Depending on the rate and duration of flow, the diversion can have a significant impact on salinities in the central basin, and considerable reductions in salinity have occurred in the interior marshes to the immediate east and southeast of the structure. Compared to pre-diversion levels, mean salinity reductions of 33% to 85% have been recorded at finfish sampling stations between Bay Gardene and Lake Lery.[14]

Fisheries Monitoring

Salinity data were collected in conjunction with fisheries independent sampling by the LDWF. Samples were collected from 1988 to 1991 as part of the pre-construction biological monitoring program. Combined with commercial harvest records, these samples help depict how fisheries have adjusted to the post-construction salinity regime.

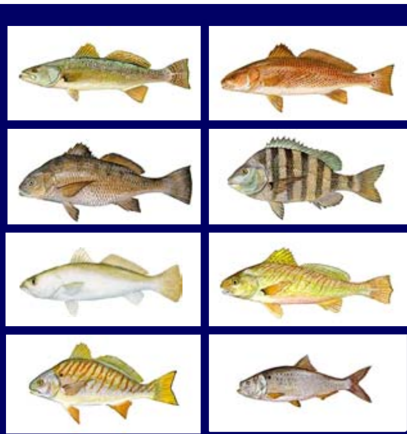
Crustaceans

Three species of crustaceans are of major commercial and recreational importance in the coastal waters of Louisiana, brown shrimp (*Farfantepenaeus aztecus*), white shrimp (*Litopenaeus setiferus*), and blue crab (*Callinectes sapidus*). Each of these species follows a circular migration which encompasses a broad range of estuarine salinities. Because commercial harvesting targets the late juvenile and adult stages, productivity is often incorrectly equated with higher salinities. Though higher salinities tend to favor harvestability, they are not directly linked to absolute productivity.

Sampling of brown shrimp, white shrimp, and blue crab was conducted by LDWF using trawls and seines at 21 locations throughout the Breton Estuary. Spatially, there were some changes in shrimp catch between pre- and post-construction periods. Overall catch per unit effort (CPUE) for brown shrimp has been lower during post-construction sampling. The CPUE was either equal, or slightly higher (depending on gear type), during post-construction for white shrimp. Sampling data for blue crab were inconclusive with respect to the effect of the diversion and salinity. [12]

Data on commercial landings of shrimp and crabs were obtained from seafood dealers in the Breton basin. Some of these landings, however, were likely derived from harvests outside the area and should thus be considered carefully. Overall, commercial landings of brown shrimp have shown no detectable post-construction effect and cycled upward or downward in accordance with statewide landings. It is difficult to correlate diversion impacts with white shrimp landings since they were not correlated with state landings either pre- or post-diversion operation. Local buyers have not corroborated reports by commercial fishermen of decreased blue crab harvests, and crab landings at one major port, Delacroix, have been consistently higher than the pre-diversion average.[15]

Salinity reductions caused by Caernarvon to the interior estuary have resulted in a seaward shift of the optimal harvest zones for brown shrimp. Some displacement has also occurred in white shrimp blue and crab landings, though no significant reductions in the commercial catch of these species have been recorded. Meanwhile, the low salinity marsh created by Caernarvon may be expanding the nursery habitat required for juvenile development of brown shrimp, white shrimp, and blue crab. Sampling by the Louisiana Department of Wildlife and Fisheries (LDWF) has confirmed significant nursery use by juvenile brown shrimp occurs at salinities of 0.3 to 5 parts per thousand (ppt). Juvenile white shrimp and blue crab heavily use habitats with salinities as low as 0.2 ppt.[8] An objective of the Caernarvon project is to expand this critical nursery habitat by creating additional acres of intermediate marsh.



Post-diversion catch rates increased at sampling stations for 7 of the 8 fin fish species monitored. Listed above left to right:

***Speckled trout** (Cynoscion nebulosus)*
***Red drum** (Sciaenops ocellatus)*
***Black drum** (Pogonias cromis)*
***Sheepshead** (Archosargus probatocephalus)*
***Sand seatrout** (Cynoscion arenarius)*
***Atlantic croaker** (Micropogonias undulatus)*
***Spot** (Leiostomus xanthurus)*
***Gulf menhaden** (Brevoortia patronus)*

Recreational fishing for speckled trout and red drum has not been detrimentally impacted at Caernarvon. In addition, anglers have witnessed a rejuvenation of the largemouth bass fishery since the diversion came on-line.

Oyster production is one of Louisiana's oldest industries, dating back to the early 1800s. The state has leased coastal water bottoms for private oyster production since 1902. The impact of freshwater diversions on private leases can be a contentious issue.

Finfish

Post-diversion catch rates increased at LDWF sampling stations for seven of eight fin fish species monitored (inset left). Some of this increase may have been caused by a rebound of stocks following the severe freeze of December 1989. Though spotted seatrout is the species likely most affected by the freeze of 1989, post-construction commercial landings in St. Bernard Parish depicted a greater than average decrease in comparison to the statewide average. Some of this difference has been attributed to the partial switching of commercial effort to the mullet fishery (*Mugil cephalus*).[12]

From a recreational standpoint, charter boat operators targeting spotted seatrout have reported some displacement of the fishery since the freshwater diversion began, but they point out that the overall recreational catch has not been affected detrimentally.[16] For the remaining commercial species, commercial landings data from finfish dealers in the Delacroix/Ysclosky area showed no pre/post statistical difference in comparison to the control site, Terrebonne Parish. [12]

In the wake of the diversion, two fisheries have been revived. A dip net fishery for shad (*Dorosoma cepedianum*) has developed in the diversion tail waters. Shad is typically a very low value species, primarily sold in Louisiana as commercial fish bait. Conversely, largemouth bass *(Micropterus salmoides*) is the nation's premier recreational fish species of economic importance, and the fresh and intermediate marsh expansion resulting from Caernarvon has spawned a tremendous rebound of the largemouth bass fishery that once existed in the region. The resurgence of this fishery has been documented in national media and is partly credited as the reason why the Bass Anglers Sportsman's Society (B.A.S.S) selected New Orleans in 1999 and 2001 as host city for its premier fishing tournament.

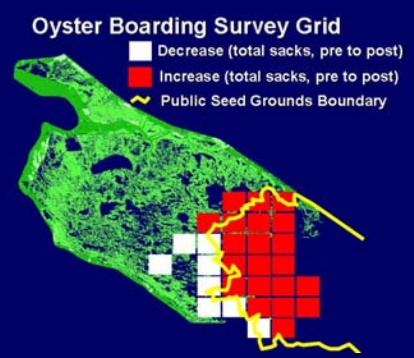
Oysters

The impact of freshwater diversions on production of the eastern oyster (*Crassostrea virginica*) is arguably one of the most controversial issues associated with coastal restoration in Louisiana. The roots of this conflict derive from the fixed bottom character of the fishery and the history of oyster lease tenure in Louisiana.

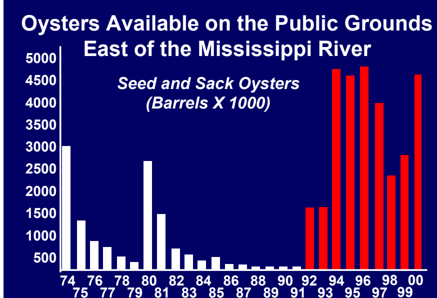
The eastern oyster is a sessile, filter-feeding mollusk that colonizes hard substrates in beds or "reefs" of the middle-estuary, usually in plankton-rich waters of 5-15 ppt salinity. Though much of this habitat has been lost due to coastal erosion and other habitat alterations, Louisiana remains a top U.S. oyster producer, with more than 350,000 acres generating around $35 million a year in economic activity.[17]

The oyster industry is also one of the state's oldest commercial sectors, dating back to the early 1800s when oysters were harvested from public reefs for local consumption. By the late 1800s, a system of private oyster mariculture had developed whereby seed oysters were transplanted onto privately maintained beds. Since 1902, the state has operated a lease program in which coastal water bottoms can be rented for private oyster production at an annual cost of $2 per acre.[18]

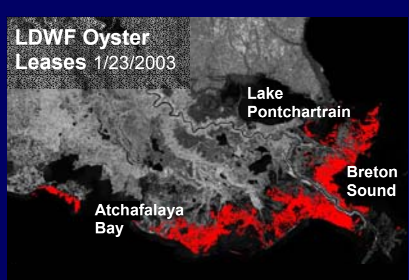
Records from LDWF show that approximately 8,200 private oyster leases were held in coastal Louisiana when the Caernarvon diversion became operational in 1991. [12] By then, as in other areas of the state, the interior marshes of the Breton Estuary had become dominated by private leases, and most of the public "outside" reefs were under state control. The public reefs of the Breton Estuary are an important source of juvenile "seed" oysters throughout southeast Louisiana. Enhancement of seed production on these outside reefs was a primary objective of the Caernarvon project.



Caernarvon has resulted in a seaward displacement of oyster production in the Breton Estuary. Private leaseholders have sued the state, requesting compensation for decreased oyster production on interior reefs.



Although some interior, privately-leased reefs have had declines in production, landings and monitoring data indicate an overall increase in oyster production in the Breton estuary since the Caernarvon diversion opened.



The eastern coast of Louisiana contains the nation's most rapidly deteriorating wetlands and the nation's most productive oyster grounds. To date, private oyster leases (shown above in red) have been a major source of conflict for coastal restoration efforts. In 2003 the Louisiana constitution was amended to limit state liability for property damage caused by coastal restoration projects.

Pre and post-diversion monitoring was conducted by the LDWF at 41 stations in the Breton estuary to determine the effect of the diversion on growth and mortality of mature oysters, recruitment of seed oysters, and the density and availability of oysters on outside reefs. Commercial oyster landings were monitored using boarding surveys on the public grounds, dockside interviews, and roving surveys of commercial fishermen.

The opening of Caernarvon was delayed until late 1991 because of an excessively high river stage that led to overbank flooding and extensive oyster mortality along the southwest border of the estuary between Bohemia and Point a la Hache. Flow rates remained under 2,000 cfs throughout 1992, but then increased to more than 4,000 cfs on several occasions between December 1993 and February 1994. Monitoring data during this later period showed high levels of mortality, 100% in some cases, for oysters on sampling trays very near the structure. [12]

Abrupt oyster mortality at interior stations was likely due to extended periods of salinity below 5 ppt, the minimum threshold for oyster survival. Conversely, the outward migration of the optimal production zone has revived beds that had become dormant because of excessive salinity, and has bolstered seed production on the outside reefs. Dockside interviews and fishermen surveys indicated that overall, production of oysters in the Breton estuary increased dramatically in the first three years of diversion operation. Elevated harvest levels continue to be sustained, and the local industry is restructuring into one more reliant on public oyster grounds.

Litigation and Legislation

The seaward shift of oyster production resulting from Caernarvon was an expected outcome, and was predicted in the project's Environmental Impact Statement of 1984. However, a voluntary lease transfer program offered by the LDWF in 1990 saw only limited participation and private oyster leaseholders filed suit against the state. The leaseholders argued that the effect of the Caernarvon diversion on their leases equated to a "takings" issue, an effective condemnation of property.[19] Earlier litigation of a similar nature in federal court was decided on behalf of the state, but parish court rulings have sided with the oyster industry. In 2002, with oyster damage awards approaching $2 billion, state agencies were directed to, "*temporarily refrain from executing any new leases, permits, or other contracts that conflict with the fundamental public policy of the state to conduct coastal restoration activities...*" [22]

A record number of wetland-related bills were introduced to the 2003 Louisiana legislature, the majority of which proposed compensation and liability limits for coastal restoration activities. Ultimately, lawmakers approved a constitutional amendment that would retroactively limit the state's liability for property damage caused by coastal restoration projects. Under the new rule, the standard for compensation is set at "fair market value", which greatly reduces the amount of legal awards potentially available for damage claims.

ON DAVIS POND

Experiences with Caernarvon are influencing the implementation and management of a larger diversion located at the head of the Barataria Estuary. Long before the Davis Pond freshwater diversion became operational in 2002, the pre-diversion fisheries monitoring program was refined and expanded to include recreational creel surveys of key freshwater fisheries. Furthermore, commercial oystermen were afforded advanced opportunity to participate in a $7.5 million "oyster lease relocation program," which provides for the retention, exchange, relocation, or purchase of private leases.[22] Participation in the new oyster lease relocation program has been 100% to date.

Experiences at Caernarvon are influencing the implementation and management of a larger diversion located at the head of the Barataria Estuary. Prior to opening the Davis Pond Freshwater Diversion Project in 2002, Louisiana implemented a successful relocation program for oyster leases. Additionally, an experimental "pulsing" flow regime is being tested at the new diversion in an attempt to maximize ecological benefits while minimizing short-term fisheries impacts. Fully operational, the Davis Pond project has the potential to directly benefit up to 33,000 acres of coastal wetlands.

"…it is true that on the coast some of the oyster beds close in are destroyed by excessive amounts of freshwater, but likewise many older reefs are rehabilitated…the result in the case of oysters is largely a shifting of certain fishing grounds but the total oyster crop is decidedly increased."

Percy Visoca (1927)
American Fisheries Society

Louisiana's oyster leaseholders have been at the heart of the freshwater diversion conflict. But other fishermen, both commercial and recreational, are limiting the flow of diversions and their capacity for restoration.

Photo by Lane Lefort

While the Davis Pond structure has a maximum capacity of 10,600 cfs, seasonal fisheries considerations are likely to continue limiting flow rates at certain times of the year. However, an alternative flow management plan recently tested at Caernarvon could possibly be used to maximize the permissible flow rate of Davis Pond. The new "pulsed" flow regime allows for very high flow rates to be maintained over short periods to help spread water and nutrients over a greater surface area of marsh. Strategically used, a pulsed flow regime could improve the prospect of providing maximum ecological benefits while minimizing short-term fisheries impacts.

SHORT-RUN VERSUS LONG-RUN

The challenge of minimizing fisheries impacts while maximizing the restoration potential of large-scale diversions is an example of the classic sustainability conflict between short-run and long-run objectives. In evaluating this conflict from a historical perspective, it is clear that levees constructed on the Mississippi River have disrupted the natural deltaic cycle that characterized coastal Louisiana prior to the 20th century. The estuarine productivity supported by that cycle has also been disrupted, a fact illustrated by Louisiana's accelerated loss of coastal wetlands.

On the surface, it would appear that estuarine fisheries landings have not been affected by Louisiana's coastal land loss. Yet landings data alone fail to reflect trends of increased harvest technology and increased harvest effort. Additionally, there is some indication that deterioration is replacing alluviation as the main driver of fisheries productivity, a recipe for eventual collapse of fisheries production.

Available monitoring data suggest that large-scale diversions can cause a range of temporal and spatial impacts to various commercial fisheries. In the long-term, many of these changes are likely to follow the pattern of reduction-displacement-enhancement consistent with Viosca's 1927 accounts of crevasses, "*…it is true that on the coast some of the oyster beds close in are destroyed by excessive amounts of freshwater, but likewise many older reefs are rehabilitated…the result in the case of oysters is largely a shifting of certain fishing grounds but the total oyster crop is decidedly increased."*

While today's large-scale freshwater diversions are similar to Viosca's crevasses, they differ in two distinct ways. The first is the accelerated inland migration of fisheries and fishermen that has occurred over the past 70 years. The second difference is that humans, rather than nature, now control the flow.

Questions to Consider

Predicting the effect of diversions on fishery species is difficult because of many complicating factors. Clearly, freshwater diversions can have negative impacts on some fisheries in the short term, just as they can enhance the productivity of other fisheries. Louisiana faces difficult questions as it attempts to reconcile short-run fisheries impacts with the long-term coastal restoration objective of diversions. Many of these questions reflect the state's traditional orientation toward the immediate value of our coastal resources: *Do temporal losses to the commercial fishing sector constitute "takings" based on tacit property rights? Should the public compensate fishermen if they are genuinely impacted?* and*...if compensation is in order, how should it be calculated?*

Beyond these short-term issues, even larger questions loom: *To what extent should short-run fisheries implications influence the flow regimes of large-scale river diversions?* and *what are the long-term environmental and economic costs associated with such accommodations?* Though many uncertainties abound regarding large-scale diversions, future use and management of these structures will clearly require a balance of fair public policy and sound ecological objectives.

The Valve Dilemma

Estuarine fisheries rely heavily on the coastal habitat that freshwater reintroduction projects are designed to restore. Fully operational, diversions have the potential to decrease the rate of coastal wetland loss, and by extension to increase the sustainability of coastal fisheries. Yet, concerns over the displacement of certain fisheries have significantly limited the operation of these projects. The Caernarvon diversion (shown above) has averaged only 15-20% of its flow capacity since opening in 1992. In the long-term, the environmental and economic consequences of short-term fishery accommodations could be costly.

(Photo by Chris Granger, nola.com)

Caffey, R. H. and M. Schexnayder (2002) Fisheries Implications of Freshwater Reintroductions, *Interpretive Topic Series on Coastal Wetland Restoration in Louisiana*, Coastal Wetland Planning, Protection, and Restoration Act (eds.), National Sea Grant Library No. LSU-G-02-003, 8p.

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