Shedding Light on Our Estuary & Our Economy

Environmental Indicators in the Barataria-Terrebonne Estuary System **2010**

BTNEP
BARATARIA-TERREBONNE
NATIONAL ESTUARY PROGRAM

Courtesy of Diane Baker

Courtesy of Guy Fanguy

Friends:

The Barataria-Terrebonne National Estuary Program's first environmental indicators report, *Healthy Estuary, Healthy Economy, Healthy Communities... Environmental Indicators in the Barataria-Terrebonne Estuary System: 2002*, provided a valuable overview of the environmental health of the Barataria-Terrebonne Estuary System (BTES), and remains one of the Program's most popular products. It is therefore a great pleasure for me to introduce an update to this report.

The general format remains the same. A series of ten focus questions that residents of the BTES commonly have posed to the BTNEP Partnership is used to organize the environmental indicators presented in this report. The indicators under each focus question represent some of the BTES' vital signs. They tell us how our estuary is doing and establish an associational link to how the BTNEP Partnership's restoration efforts are working.

The devastation brought to the BTES—our home—by the 2005 and 2008 hurricane seasons only emphasizes how important the health of our estuary is to the safety and sustainability of our communities. Post-storm analysis has shown that intact, healthy wetlands can protect homes and businesses from hurricane surge much better than degraded wetlands. The horrific experience of Hurricanes Katrina and Rita highlights the real tragedy for BTES residents and for the nation: the fact that this region is being lost to the Gulf of Mexico at an extraordinary rate. Our land loss problem will only make our communities, businesses, and entire infrastructure increasingly vulnerable to future hurricanes.

When we originally developed this publication, I hoped it would increase awareness about the BTES, our land loss problem, and the need to protect our estuary, our people, and our way of life. Now, with the stark new reality of oil on our beaches and in our marshes, I hope this report also can help us track and remediate the economic, social, and ecological consequences of the oil spill.

We welcome your questions, comments, and participation in the BTNEP Partnership!

Sincerely,

Kerry M. St. Pé

Kerry M. St. Pé, Director
Barataria-Terrebonne National Estuary Program

The Barataria-Terrebonne National Estuary Program

The Barataria-Terrebonne Estuary System (BTES) is a biologically rich and productive ecosystem encompassing 4.1 million acres of upland forests, swamps, marshes, bayous, bays, and barrier islands, bound on the west by the Atchafalaya River and on the east by the Mississippi River.

The BTES produces a half-billion pounds of fish and oysters annually, and supplies 10-15% of our nation's oil production. Its expansive marshes provide habitat for previously endangered species such as the brown pelican and the bald eagle, as well as other waterfowl and migratory birds. Recreational opportunities for residents and visitors from around the world abound.

The health of the estuary and the quality of its bayous and bays, fish and wildlife are critical to our regional economy and the sustenance of our nationally-unique culture. In 1990, the Barataria-Terrebonne National Estuary Program (BTNEP) summarized threats to the BTES as seven Priority Problems (at right). Since then, the BTNEP Partnership—BTNEP and its government, business, environmental, academic, and citizen partners—has been working together to understand these problems, implement action plans to address them, and improve the environmental health of our estuary.

Priority Problems of the BTES

1. **Hydrologic modification** – human changes to water flows in the estuary
2. **Reduced sediment flows** – reductions in sediment inputs to the estuary
3. **Habitat loss** – land loss and marsh deterioration
4. **Changes in living resources** – population reductions in important species & introductions of non-native species
5. **Eutrophication** – excess nutrients in the estuary's waters
6. **Pathogen contamination** – discharge of untreated sewage and stormwater to the estuary
7. **Toxic substances** – contamination by heavy metals and pesticides in runoff and oil spills to the estuary

BTES & Parish Overview

The BTES is located in southeastern Louisiana, between the Mississippi and Atchafalaya Rivers. Sixteen parishes fall within its boundaries.

Unless otherwise noted, analyses in this report typically are based on the 13 parishes contributing significant land area to the BTES:

- Ascension
- Assumption
- Iberville
- Jefferson
- Lafourche
- Plaquemines
- Pointe Coupee
- St. Charles
- St. James
- St. John the Baptist
- St. Mary
- Terrebonne
- West Baton Rouge

Only small portions of three parishes—Iberia, St. Martin, and Orleans—fall within the BTES; unless otherwise noted, these parishes were excluded from the analyses presented here.

How to Interpret Our Environmental Indicators

This report uses a small suite of environmental indicators to represent the environmental health of the BTES and, in certain instances, the effect of restoration and enhancement efforts by the BTNEP Partnership. These indicators present some of the system's **vital signs**, telling us how the estuary is doing and establishing an associational link to how our restoration efforts are working.

There are inherent difficulties and risks in using a small suite of indicators to represent overall environmental health of the BTES. These indicators offer a simplified view of a few components of an extremely complex natural ecosystem. Because the natural environment is continually changing, it is sometimes difficult to know if changes observed in indicators reflect natural or human influence; for example, fluctuations in several indicators simply may reflect natural variability in the estuary. Lastly, management actions undertaken to restore and enhance the BTES do not always have a simple relationship to results, especially considering the system's size and complexity.

Despite these difficulties and risks, BTNEP feels it is important to periodically check and report on these vital signs – and to use this information carefully and in the appropriate context as we try to understand trends in these key environmental indicators. We hope this report will help you better understand how activities in the estuary directly impact the vitality of our regional economy, culture, and way of life.

Courtesy of Louisiana GIS CD: A Digital Map of the State, Version 2.0

Courtesy of BTNEP

FOCUS**QUESTION 1**

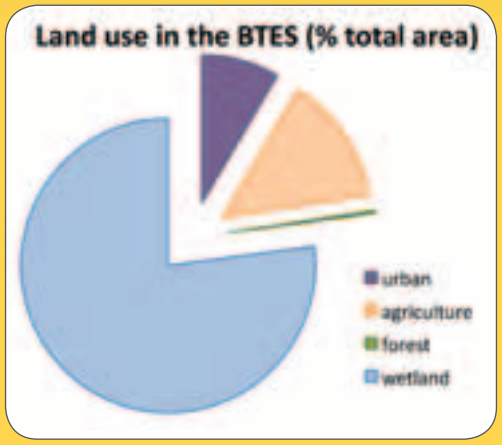
Are we losing land, and if so, where?

The BTES is largely an enormous expanse of coastal wetlands (see land use graph at left)—and due to massive conversion of wetlands to open water and erosion of our barrier islands, this region we call home is disappearing into the Gulf of Mexico. This land loss has significant repercussions for our quality of life, as these coastal areas provide critical habitat for fish and wildlife and protect us and our homes, businesses, and infrastructure from storm surges and hurricanes.

By analyzing historical photographs and satellite images of the BTES, scientists are able to determine how much land has been lost and where that land loss is occurring.

Indicator 1: Land area change in the BTES

Since 1985, land area in this section of the BTES has decreased by 219 square miles—an average rate of land area loss of approximately 10.4 square miles per year. When fastlands (levee-protected developed and agricultural areas) are excluded from the assessment, loss rates increase to 11.2 square miles per year. The majority of land being lost in the BTES is coastal marsh land.



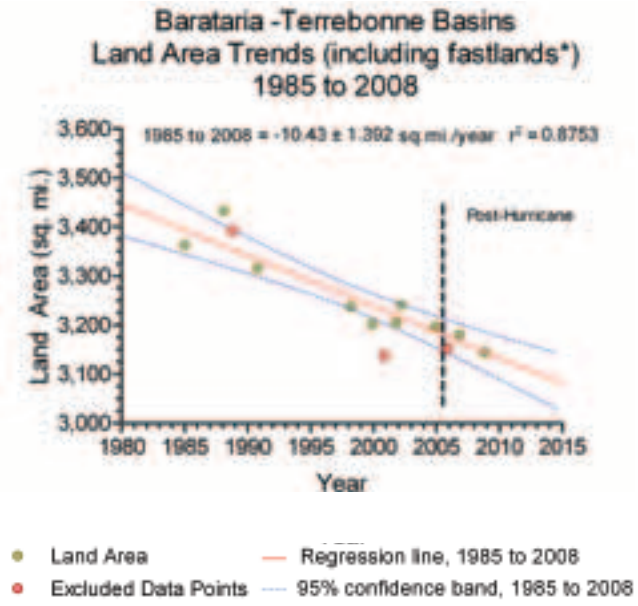
** Data represent averaged values for Terrebonne/Timbalier and Barataria Bays. Source: Bricker S, Longstaff B, Dennison W, Jones A, Boicourt K, Wicks C, and Woerner J. 2007. Effects of Nutrient Enrichment In the Nation's Estuaries: A Decade of Change. NOAA Coastal Ocean Program Decision Analysis Series No. 26. National Centers for Coastal Ocean Science, Silver Spring, MD. 322 pp.*

Land area change in a 5,187 mi² section of the BTES, 1985-2008

Fastlands are developed and agricultural areas surrounded by levees, that generally are considered non-wetlands and thus excluded from trend analysis; they are included here in an effort to show trends for a larger portion of the BTES. It is important to note that inclusion of these normally stable areas may impose an artificial stability on the data.

Three data points were excluded from the analysis (red circles): the 1988 and 2000 datasets lacked the consistent data source methodology of the other datasets; the 2005 imagery was collected shortly after Hurricane Katrina and may have represented temporary effects of that storm.

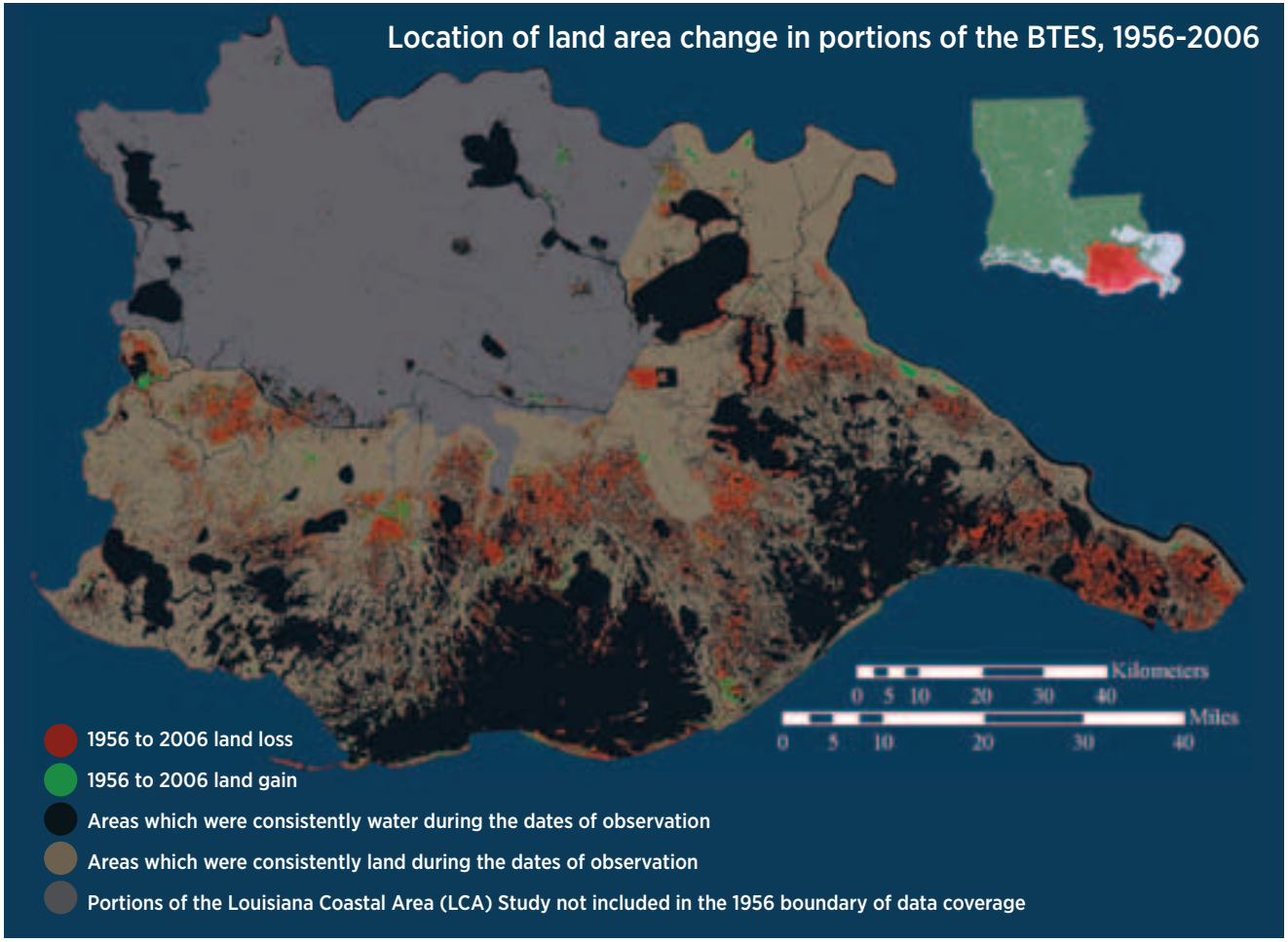
Source: Barras JA, Bernier JC, and Morton RA. 2008. Land area change in coastal Louisiana—A multidecadal perspective (from 1956 to 2006). U.S. Geological Survey Scientific Investigations Map 3019, scale 1:250,000, 14 p. pamphlet.



Indicator 2: Location of land loss in the BTES

While much of coastal Louisiana is losing land, the BTES experiences more than 50% of the state's total land loss. The map below shows where this land loss has occurred (in red).

BTES residents, state environmental managers, and the U.S. Congress have begun to recognize the land loss crisis confronting coastal Louisiana, and we have taken important steps towards addressing this problem, especially through programs such as Coast 2050, the Coastal Wetlands Planning, Protection, and Restoration Act.



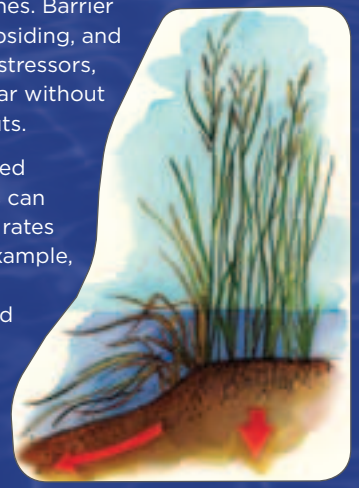
Data were filtered to depict areas of loss and gain greater than approximately 1.4 ha in size to remove noise and increase the confidence of the depicted trends. Data were adapted from USGS SIM 3019 by collapsing loss and gain from multiple time periods into loss or gain categories during the entire period of record to facilitate ease of interpretation. Data are intended only for visual interpretation. Neither "loss" nor "gain" implies permanence of that condition outside of the bounds of the observation period.

Adapted by USGS from: Barras JA, Bernier JC, and Morton, RA. 2008. Land area change in coastal Louisiana—A multidecadal perspective (from 1956 to 2006). U.S. Geological Survey Scientific Investigations Map 3019, scale 1:250,000, 14 p. pamphlet.

Why is the BTES losing land?

The most important factor contributing to land loss in the BTES is subsidence, a complex process in which marsh sediments compact and sink under their own weight. Historically, annual floods over the banks of the Mississippi River provided freshwater and sediment inputs to BTES marshes and kept them above water. Levees were constructed to protect communities across the nation from these floods, but they also prevent water and sediment from reaching BTES marshes.

Subsidence drowns coastal marshes, causing chemical changes in wetland soils which eventually kill marsh vegetation. Without plant roots to hold it together, marsh soil breaks up and is carried away by wave action. The end result is that marsh is converted to open water. This additional volume of water causes an increase in the tidal prism, forcing passes to enlarge and reducing the lengths of barrier islands, which protect interior marshes from wave action and hurricanes. Barrier islands are also subsiding, and due to both these stressors, ultimately disappear without new sediment inputs.



Courtesy of Diane Baker

Other human-caused and natural factors can influence land loss rates in the BTES. For example, canals and raised roadbeds, breached natural ridges, and other hydrologic modifications can interrupt tidal exchange and allow salt water intrusion. Researchers suspect that drought conditions in 1999 and 2000 severely stressed marsh plants throughout the BTES, resulting in large tracts of marsh dying in a phenomenon dubbed the brown marsh syndrome. Feeding by nutria also can damage marshes (see Indicator 17).

Courtesy of BTNEP

Courtesy of BTNEP

Courtesy of Wendy Billiot

Courtesy of NRCS

FOCUS**QUESTION 2**

Are fish and wildlife habitats being protected and restored?

The BTES provides habitat for approximately 735 species of birds, finfish, shellfish, reptiles, amphibians, and mammals. These species are **estuarine-dependent**, in that they need a healthy estuary for at least some critical portion of their life cycle.

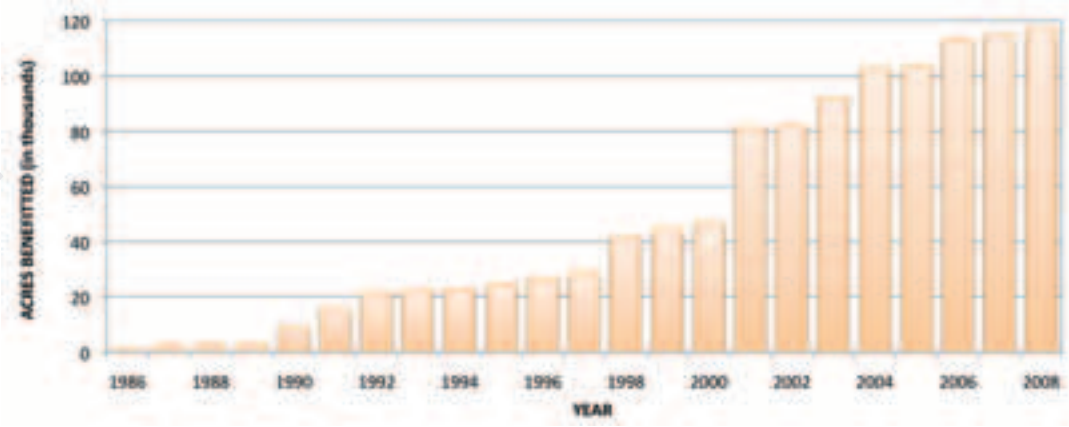
Species diversity and abundance are highest in barrier island, marsh (and associated bayou and lake), second-growth bald cypress swamp, and bottomland hardwood forest habitats. Although many natural and human-caused factors can lead to species declines, habitat destruction associated with coastal land loss is, or is predicted to be, the most significant contributor to declining fish and wildlife populations in the BTES.

Indicator 3: Acres of habitat restored

Over the past 22 years, nearly 120,000 acres in the BTES have benefitted from habitat restoration projects made possible through several state and federal programs. Most of these projects have focused on habitats with high rates of loss, such as the barrier islands, interior marshes, bays, and bayou shorelines of Plaquemines, Jefferson, Lafourche, and Terrebonne parishes. For more information on specific restoration projects in the BTES, visit the Louisiana Office of Coastal Protection and Restoration at http://dnr.louisiana.gov/crm/ocpr.asp.

Cumulative acres of habitat restored in the BTES through state & federal restoration projects, 1986-2008

Source: Louisiana Office of Coastal Protection and Restoration



FOCUS**QUESTION 3**

Are fish and wildlife populations stable?

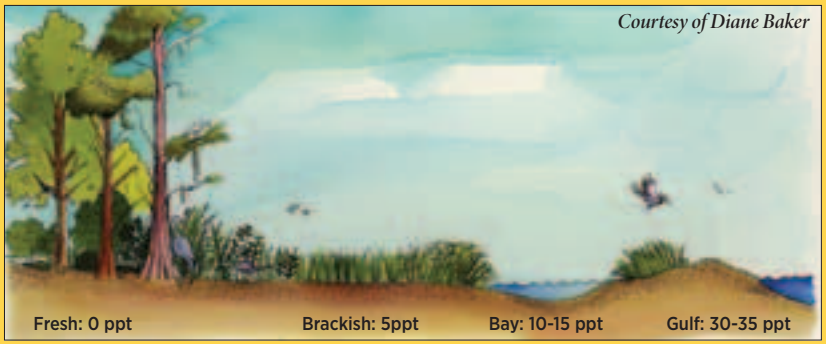
The BTES provides critical habitat for many fish and wildlife species, including those that are commercially and recreationally important and several that are threatened or endangered. Here we present a selection of ecologically, commercially, and recreationally important species for which long-term population data are available.

People have put tremendous pressure on fish and wildlife habitat in the BTES. Despite these pressures, most species in the BTES for which data are available have not experienced continuous population declines over the last 30 years, and some actively managed species, such as the alligator and the bald eagle, have shown increasing population trends. In the short term, land loss—the break-up of healthy marsh and its eventual conversion to open water—actually increases productive marsh edge habitat, which may explain why we are not yet seeing significant declines in fish and wildlife populations, even though we are losing massive areas of healthy marsh. However, most scientists agree that there will be some threshold of marsh loss, after which rapid population declines of our most valued fisheries species are likely to occur.

Keep in mind that these data are far from complete, and that we lack sufficient data for many critical fish and wildlife populations (e.g., freshwater fish and amphibians). Also keep in mind that these catch per unit effort values (see right) provide simplified snapshots of what is happening to organisms in our complex estuarine system. Natural fluctuations in environmental conditions, such as temperature and salinity, can cause significant year-to-year variability in population abundances. Climatic variables (e.g., rainfall patterns and extreme events like hurricanes) and changes in parasite and predator populations also can influence species dynamics. In many cases, it is difficult to assess the relative importance of natural variability compared to human-caused contributors such as habitat loss, and the level and timing of harvest.

What is salinity?

Salinity refers to the concentration of salts dissolved in water, typically measured in parts per thousand (ppt). Because estuaries are where freshwater rivers and saltwater oceans mix, they experience a wide range of salinities across different habitat types.



Courtesy of BTNEP

What is Catch Per Unit Effort (CPUE)?

CPUE is a relative measure of the number of organisms caught in standardized samples. Assuming the same sampling methods are used through time, CPUE provides a long-term indicator of relative population abundance.

For example, if researchers consistently take a 10-minute drag of a 6-foot trawl at a sampling station, the number of organisms they catch each time can be used to examine relative population changes through time.

Courtesy of Guy Fanguy

Courtesy of Guy Fanguy

Indicator 4: White and brown shrimp abundance

More shrimp are caught in Louisiana waters than anywhere else in the United States, and the shrimp harvest is the largest, most valuable fishery in the BTES. White shrimp (*Litopenaeus setiferus*) and brown shrimp (*Farfantepenaeus aztecus*) are two of the most abundant crustacean species in the BTES ecosystem. Both species spawn in Gulf of Mexico waters. Larvae migrate to estuaries, where they grow into juveniles before moving back to the Gulf to mature into adults; thus, the marsh and its adjacent shallow-water habitats serve as critical nursery areas for both species. These two shrimp populations appear to be healthy, although there is considerable year-to-year variability in both species due to factors such as water salinity, water temperature, and tidal action.

Average catch per unit effort for white and brown shrimp in the BTES, 1971-2008

CPUE for white shrimp is based on 16-foot trawl samples at inshore stations in LDWF Areas 3 (Barataria Bay estuary), 4 (Terrebonne/Timbalier Bay estuary), and 5 (Caillou/Fourleague Bay estuary) in July; CPUE for brown shrimp is based on 6-foot trawl samples at the same sites in April.

Source: LDWF Office of Fisheries

Indicator 5: Blue crab abundance

The blue crab (*Callinectes sapidus*) is one of the most abundant crustaceans in coastal Louisiana, and a key recreational and commercial species in the BTES. The population appears to be relatively stable, but year-to-year variability is high due to both environmental and biological factors. For example, blue crab abundance generally increases as the amount of freshwater entering the BTES increases, and the potential downward trend in abundance from the late 1980s through the early 2000s may be associated with increased water salinity and related increases in marine fish predator abundance.

Average annual catch per unit effort for blue crab in the BTES, 1971-2008

CPUE is based on individuals with carapace widths < 125 mm, captured in 16-foot trawl samples at inshore stations in LDWF Areas 3 (Barataria Bay estuary), 4 (Terrebonne/Timbalier Bay estuary), and 5 (Caillou/Fourleague Bay estuary), January through December.

Source: LDWF Office of Fisheries

Indicator 6: Oyster availability on public oyster seed reservations

Harvesting oysters is a part of history in the BTES, as well as big business. Oyster reefs also enhance recreational fishing, provide habitat for many additional invertebrate species, and may improve local water quality by filtering large volumes of water. The Louisiana Department of Wildlife and Fisheries (LDWF) is charged with managing Louisiana's oyster resources. Part of the agency's management program includes cultch planting (see below), which enhances oyster habitat in public oyster seed reservations like Caillou (Sister) Lake.

Oysters in public oyster seed reservations are available for direct harvest or transplant to private oyster leases during managed seasons set annually by the LDWF. Because oyster abundance in public oyster seed reservations is intensively managed and subjected to high levels of fishing effort and associated mortality, it is not representative of oyster population stability and health across the entire BTES.

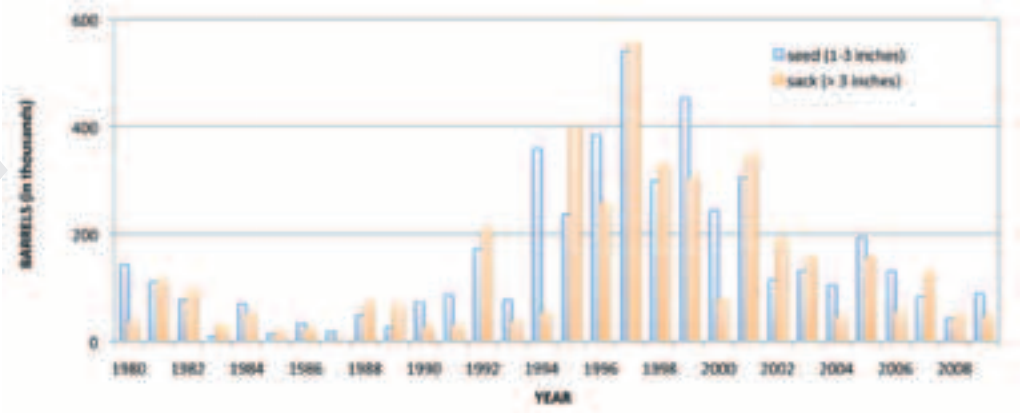
What factors affect oyster populations on intensively managed areas, as well as private leases? Environmental conditions such as salinity, water temperature, dissolved oxygen concentrations, and food availability influence oyster reproduction, spat set, and mortality. For example, overall oyster abundance is higher in estuaries with significant freshwater input. Economic factors (e.g., dockside price) influence fishing effort and thus population levels. Extreme weather events, such as hurricanes, can cause increased sedimentation and mortality on oyster reefs.

Since 2002, oyster populations generally have been declining statewide. It is unknown whether this is due to natural environmental cycles, increased fishing mortality and disruption of habitat, or other causes.

Courtesy of Patrick Banks

Estimated availability of seed and sack oysters in the Caillou (Sister) Lake Public Oyster Seed Reservation, 1980-2009

Source: LDWF Office of Fisheries



What is cultch?

Cultch is any hard material placed on water bottoms to enhance oyster habitat or create oyster reefs. Usually shell or limestone is deposited to serve as substrate for new spat set, or the initial attachment of oyster larvae.

Courtesy of Patrick Banks

Bay anchovy, courtesy of LDWF Marine Fisheries Division

Atlantic croaker, courtesy of LDWF Marine Fisheries Division

Spotted seatrout, courtesy of Duane Raver, USFWS

Spotted seatrout, courtesy of Duane Raver, USFWS

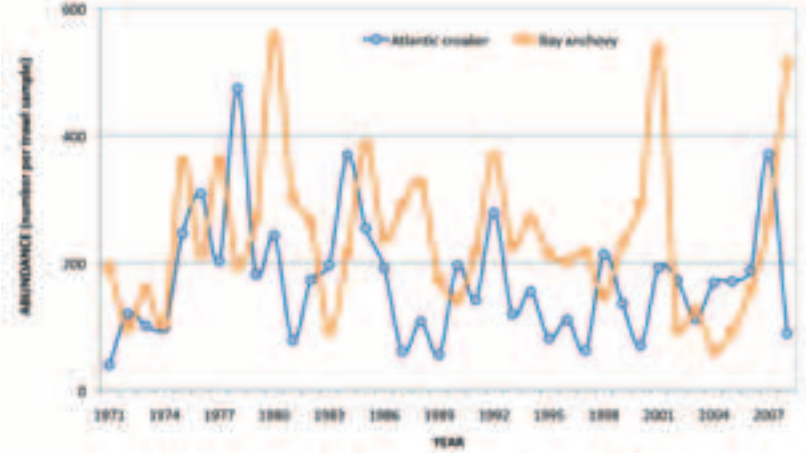
Indicators 7 & 8: Bay anchovy & Atlantic croaker abundance

The surface-dwelling bay anchovy (*Anchoa mitchilli*) and the bottom-dwelling Atlantic croaker (*Micropogonias undulatus*) are the two most abundant fish species in the BTES, and both are key components of the estuarine food web. Based on available data, populations appear to be stable, and the high year-to-year variability probably reflects the natural variability of estuaries (e.g., annual differences in river discharge and temperature, the occurrence of extreme events such as hurricanes).

Average annual catch per unit effort for bay anchovy and Atlantic croaker in the BTES, 1971-2008

CPUE is based on 16-foot trawl samples at inshore stations in LDWF Areas 3 (Barataria Bay estuary), 4 (Terrebonne/Timbalier Bay estuary), and 5 (Caillou/Fourleague Bay estuary), January through April.

Source: LDWF Office of Fisheries



Indicators 9 & 10: Red drum & spotted seatrout abundance

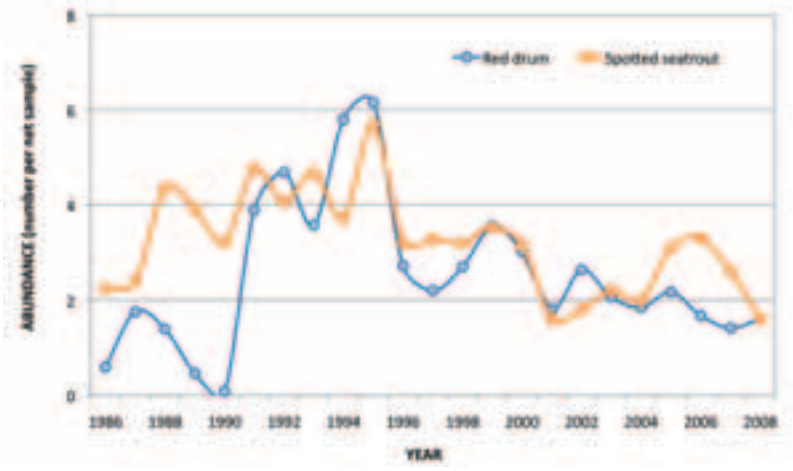
The BTES supports over 200 species of finfish, but red drum (*Sciaenops ocellatus*), or redfish, is one of the most abundant and most popular recreationally. Individuals can live for more than 35 years, making it one of the more long-lived, estuarine-dependent species. Low red drum abundance in 1990 reflected massive fish kills from the catastrophic freeze of December 1989. Marked increases in population levels from 1990 to 1995 may reflect changes in harvest regulations, as well as environmental conditions more favorable for juvenile red drum survival.

The spotted seatrout (*Cynoscion nebulosus*), or speckled trout, is another recreationally popular estuarine fish species in the BTES. Like red drum, it is a fast-growing species that remains in estuaries until about four years of age. Moderate year-to-year variability in both red drum and spotted sea trout abundances likely is associated with environmental factors such as temperature and salinity.

Average annual catch per unit effort for red drum and spotted seatrout in the BTES, 1986-2008

CPUE for red drum is based on fish < 16 inches in length, captured in trammel net samples at inshore stations in LDWF Areas 3 (Barataria Bay estuary), 4 (Terrebonne/Timbalier Bay estuary), and 5 (Caillou/Fourleague Bay estuary), October through March; CPUE for spotted seatrout is based on 2-inch stretch mesh gill net samples taken at the same sites, January through December.

Source: LDWF Office of Fisheries



Indicator 11: Largemouth bass abundance

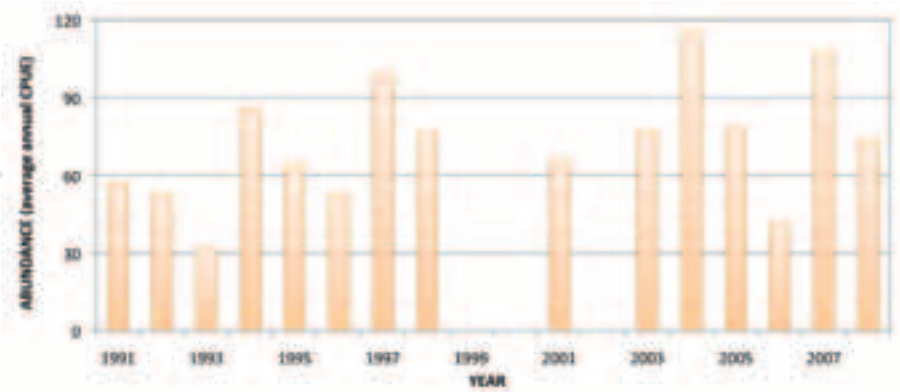
Largemouth bass (*Micropterus salmoides*) is an extremely popular sportfish in BTES lakes such as Lac des Allemands, Lake Boeuf, Lake de Cade, Lake Cataouatche, Lake Penchant, Lake Salvador, Lake Theriot, and Lake Verret. Adult largemouth bass can tolerate brackish water, but they nest along quiet freshwater lake and bayou shorelines, suggesting that coastal land loss and saltwater intrusion may affect this species. Populations are influenced by environmental variables such as water quality, water level, and the availability of spawning habitats, food, and cover.

Because it is possible that land loss and saltwater intrusion in the BTES could cause populations of freshwater species to decline, BTNEP will continue to track largemouth bass in those lakes where data are available. Currently, long-term relative abundance data are available for Lake Verret in the Terrebonne Basin. It is suspected that lower production in 1993 was due to a massive fish kill caused by Hurricane Andrew in 1992. Since 1993, there has been a 14-inch minimum size restriction on the harvest of largemouth bass in Lake Verret. It is difficult to draw definitive conclusions about the health of the largemouth bass population in the BTES based on available data, but generally the population is thought to be stable.

Average annual catch per unit effort for largemouth bass in Lake Verret, 1991-2008

CPUE is based on number of individuals collected by electrofishing, March through December; missing bars indicate no data were available for those years.

Source: LDWF Inland Fisheries Division



Courtesy of Kim Comeaux

Largemouth bass, courtesy of Duane Raver, USFWS

Blue catfish, courtesy of Duane Raver, USFWS

Channel catfish, courtesy of Duane Raver, USFWS

Courtesy of Guy Fanguy

Indicator 12: Freshwater catfish abundance

Freshwater catfish are an important recreational and commercial species in the BTES, and residents and visitors alike enjoy them as a local delicacy. Channel catfish (*Ictalurus punctatus*), and to a lesser extent blue catfish (*Ictalurus furcatus*), are abundant in freshwater lakes such as Lac des Allemands, Lake Boeuf, Lake de Cade, Lake Cataouatche, Lake Penchant, Lake Salvador, Lake Theriot, and Lake Verret.

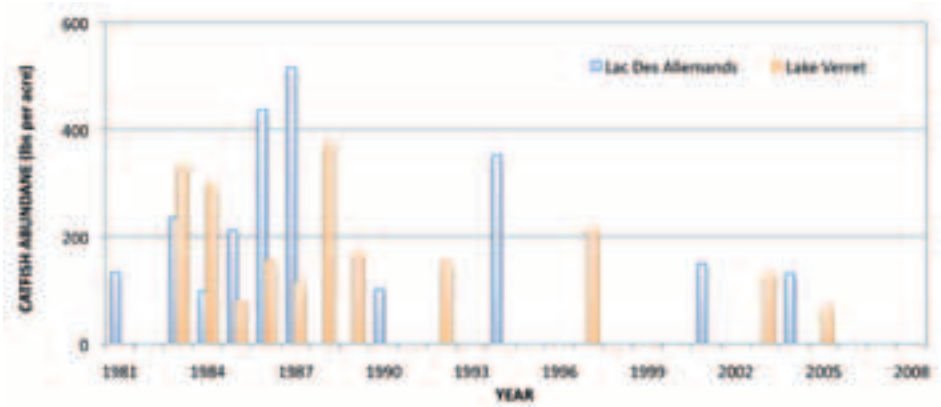
Limited long-term abundance data for blue and channel catfish are available for two BTES lakes: Lac des Allemands in the Barataria Basin and Lake Verret in the Terrebonne Basin. The Lac des Allemands and Lake Verret catfish fisheries are consistently among the most productive in the nation.

From 1981 to approximately 1993, existing rotenone data indicate that both populations were probably stable. The variability represented in the graph is not unexpected for a healthy catfish population in an estuarine system, and most variability likely was due to salinity and water flow changes from weather-related factors such as drought. Both lakes are subject to noxious algae blooms, generally thought to be caused by runoff containing high nutrient concentrations (for example, from excessive fertilizing). Increasing residential and agricultural development in the upper basins may exacerbate this condition, which could harm catfish populations and give catfish fillets an unpleasant taste. Land loss and saltwater intrusion also may negatively impact catfish populations.

Average annual catch per unit effort for freshwater catfish in Lac Des Allemands/Bayou Des Allemands and Lake Verret, 1981-2008

CPUE is based on pounds of blue and channel catfish collected on day 1 of rotenone application to 1-acre plots, May through September. Missing bars indicate no data were available for those sites and years.

Source: LDWF Inland Fisheries Division



Indicator 13: Alligator nest density

The American alligator (*Alligator mississippiensis*) is the largest resident reptile in the BTES, where it is found from swamps in the north to brackish marshes in the south. Alligators eat virtually anything, but nest in predominantly freshwater (< 10 ppt salinity), marshy habitats. This makes alligator populations sensitive to land loss in the BTES: without healthy coastal wetlands acting as a buffer between land and sea, inland portions of the BTES will be exposed to higher salinity waters, eventually affecting alligator nesting success. Nest density data indicate that the BTES houses a stable number of alligator nests (note that in the graph, a lower number of acres per nest translates to a higher density of alligator nests in the BTES). The number of nests in any given year, however, depends upon environmental conditions, and probably does not reflect annual population fluctuations. Drought, which generally lowers water levels and increases marsh salinity, was the probable cause for relatively lower nest densities in 1998 and 2000.

Alligators are hunted for their soft belly skin, which produces high quality leather, but past extreme hunting pressures have subsided due to new harvesting restrictions. The harvest of wild alligators and the collection of alligator eggs, a cultural tradition in the BTES, are generally lucrative. Hide, meat, and egg prices fluctuate, particularly in 2009 when the world economic recession greatly reduced alligator skin prices. Demand and price of alligator skins likely will increase as economic growth rebounds, although it may take a number of years to return to pre-recession values.

Indicator 13: Alligator nest density (cont.)

American alligator nest density in the BTES, 1991-2009

Number of nests is determined by LDWF personnel flying north/south transects across Terrebonne, Lafourche, Jefferson, St. Charles, St. John the Baptist, Plaquemines (West) and Plaquemines (Delta) parishes, and counting nests in surveyed areas. The number of acres surveyed each year ranged from 23,851 (1991-1998) to 37,417 (2003-2009) acres.

Source: LDWF Coastal & Nongame Resources Division

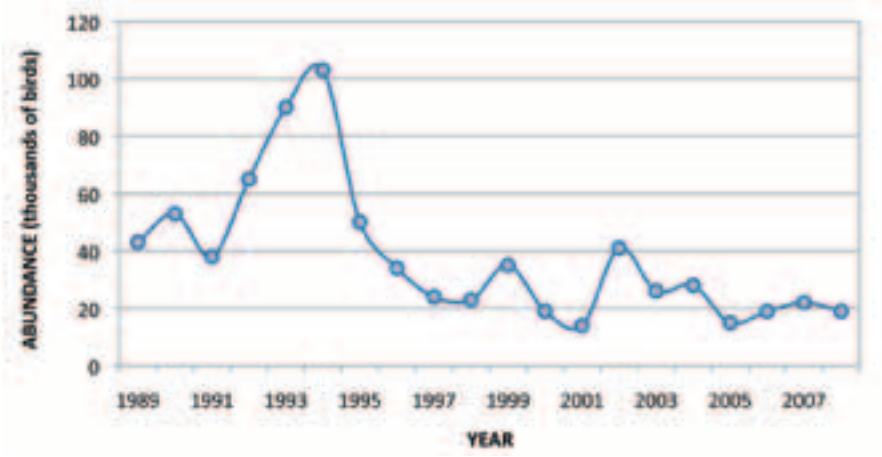
Indicator 14: Mottled duck abundance in southeast LA

The BTES provides habitat for many migrating waterfowl species, but the mottled duck (*Anas fulvigula*) is its only resident waterfowl species. Scientists estimate that over half of the North American mottled duck population resides in Louisiana. Mottled duck population indices vary widely from year to year, and there are many factors that affect annual populations, including drought, marsh loss, development, and predation. Degradation of freshwater and brackish marshes by erosion, saltwater intrusion, and general land loss may pose the most significant concern: mottled ducks live and nest primarily in freshwater and brackish marshes and adjacent agricultural habitats, and ducklings seem to survive best when raised in waters with < 9 ppt salinity. Scientists tell us that the mottled duck population in southeastern Louisiana is currently stable, but there is growing concern about an emerging downward trend. Hunting is not thought to have a large impact on the population, but daily bag limit was reduced from 3 to 1 per day in 2009 in response to confirmed population declines in other parts of the mottled duck's range.

Estimated mottled duck abundance in southeast Louisiana, 1989-2008

Estimates are made by flying similar coastal transects each November.

Source: LDWF Wildlife Division



Courtesy of Len Blumin

Courtesy of USFWS

FOCUS**QUESTION 4**

How are threatened and endangered species faring?

Under the Endangered Species Act of 1973, a species may be listed as endangered or threatened, based on its biological status and threats to its existence. An endangered species is one that is in danger of extinction throughout all or a significant portion of its range; a threatened species is one that is likely to become endangered in the foreseeable future. The purpose of the Endangered Species Act is to conserve and restore listed species and the ecosystems upon which they depend—including the BTES.

Indicator 15: Bald eagle nesting success

The bald eagle (*Haliaeetus leucocephalus*) is listed as an endangered species under the federal Endangered Species Act. Declines in bald eagle populations largely were caused by persistent toxic substances, such as DDT (a pesticide) and polychlorinated biphenyls, or PCBs (a manufacturing product). As top carnivores in the estuary food web, bald eagles accumulated these compounds in their tissues, at concentrations high enough to impair their reproductive ability. Thus, nesting success of the bald eagle is an important indicator of recovery efforts for this species.

The number of successful bald eagle nests rose from less than 50 in the early 1990s to more than 125 in the early 2000s (more recent data were not available). Recovery of bald eagle populations allowed them to be downlisted in Louisiana in 1995, from endangered to threatened. Banning the use of DDT, protecting bald eagle habitat, and increasing public awareness and education are major factors behind their population recovery.

Bald eagle nesting success in the BTES, 1990-2002

Counts are based on annual aerial surveys conducted by LDWF personnel, across Assumption, Iberville, Jefferson, Lafourche, St. Charles, St. James, St. John the Baptist, and Terrebonne Parishes. Approximately 70% of the surveyed area occurs within the BTES. Fledglings are young eagles that successfully reach flight stage, typically at 10-12 weeks of age.

Source: LDWF Coastal & Nongame Resources Division

Indicator 16: Brown pelican nest abundance

The brown pelican (*Pelecanus occidentalis*) is a long-time inhabitant of coastal Louisiana and the BTES, where it nests on black mangrove on Queen Bess and Last Islands. However, persistent toxic pesticides (e.g., Endrin) reduced nesting of native pelican populations to zero in the early 1960s, and the species was listed as endangered under the federal Endangered Species Act. With the ban of key persistent toxic pesticides in the 1970s, a focus on restoring Louisiana's barrier islands, and public education, the brown pelican population has rebounded in Louisiana.

In the BTES, specific barrier island restoration projects involving rock breakwater placement at the east end of Last Island and around Queen Bess Island have reduced wave erosion of critical nesting habitat. The number of successful nests in the BTES has risen from 830 in 1992 to 6,800 in 2008, and the population appears stable. The dramatic decrease in nests in 2000, shown in the graph below, was due to high tides inundating nests in April of that year; nesting activity increased to expected levels in 2001.

Number of successful brown pelican nests on Queen Bess and Last Islands, 1992-2008

Counts are based on annual aerial surveys.

Source: LDWF Coastal & Nongame Resources Division

Courtesy of Guy Fanguy

Courtesy of Steve Van Riper, USFWS

An ecological success story

Given increases in brown pelican populations, the U.S. Fish and Wildlife Service removed the brown pelican from the List of Endangered and Threatened Wildlife in July 1998.

What is a non-native species?

A non-native species is one that is intentionally or unintentionally introduced (or moved) beyond its natural range. Commonly used synonyms include nonindigenous, foreign, invasive, and alien species.

Courtesy of BTNEP

What does it cost to control non-native species?

Both state and federal agencies now spend considerable amounts of public money to control the spread of invasive aquatic plant species, particularly water hyacinth, hydrilla, and common salvinia.

For example, the Louisiana Department of Wildlife and Fisheries reports spending nearly $1.5 million annually on non-native aquatic plant control. Cost information is not available for most invasives, but this example illustrates that controlling nuisance non-natives requires considerable expenditure of public funds.

FOCUS**QUESTION 5**

Are non-native species a problem?

Many plants and animals native to other states and countries are now living and multiplying in the BTES. These non-native species are introduced, both intentionally and unintentionally, through many human activities. For example, recreational boaters can pick up pieces of non-native aquatic plants on their boat trailers and deposit them into new waters; large ships can introduce non-native plants and animals when they discharge ballast water taken from foreign ports into Louisiana waters; local residents can release non-native plants and animals purchased at nurseries and pet stores.

Only a few of these introduced species ever become established in the BTES, but those that do may invade native ecosystems. The consequences of these invasions usually are very costly—both ecologically and economically (see left). Preventing non-native species introductions is the best way to avoid harmful effects on the health of the BTES and our regional economy.

Indicator 17: Acres of marsh damaged by nutria

The nutria (*Myocastor coypus*) is a large semi-aquatic rodent native to South America, that was brought to Louisiana in the 1930s to create a fur-farming industry. It was released from captivity (accidentally and possibly intentionally), and a large nutria population is now well-established in the marshes of coastal Louisiana. As their population size increases, so does their damage to BTES marshes, harm to native species, and impact on regional agricultural productivity.

Because nutria are herbivores that eat the roots of marsh plants, the areas they damage often do not recover. As a result, nutria herbivory can contribute to erosion and land loss in the BTES. Nutria also eat agricultural crops such as sugarcane, and have damaged rice field irrigation dikes. With only alligators as natural predators, nutria populations continue to grow and outcompete native muskrats.

The Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA) funds the Coastwide Nutria Control Program, which provides incentive payments to registered participants for each nutria taken during the open trapping season. Surveys by Louisiana Department of Wildlife and Fisheries scientists show that estimates of nutria damage have declined since 1999, indicating that the Coastwide Nutria Control Program has reduced acres of marsh damaged by nutria. For more information about this program, please visit http://www.nutria.com.

Observed number of marsh acres damaged by nutria in the BTES, 1993–2009

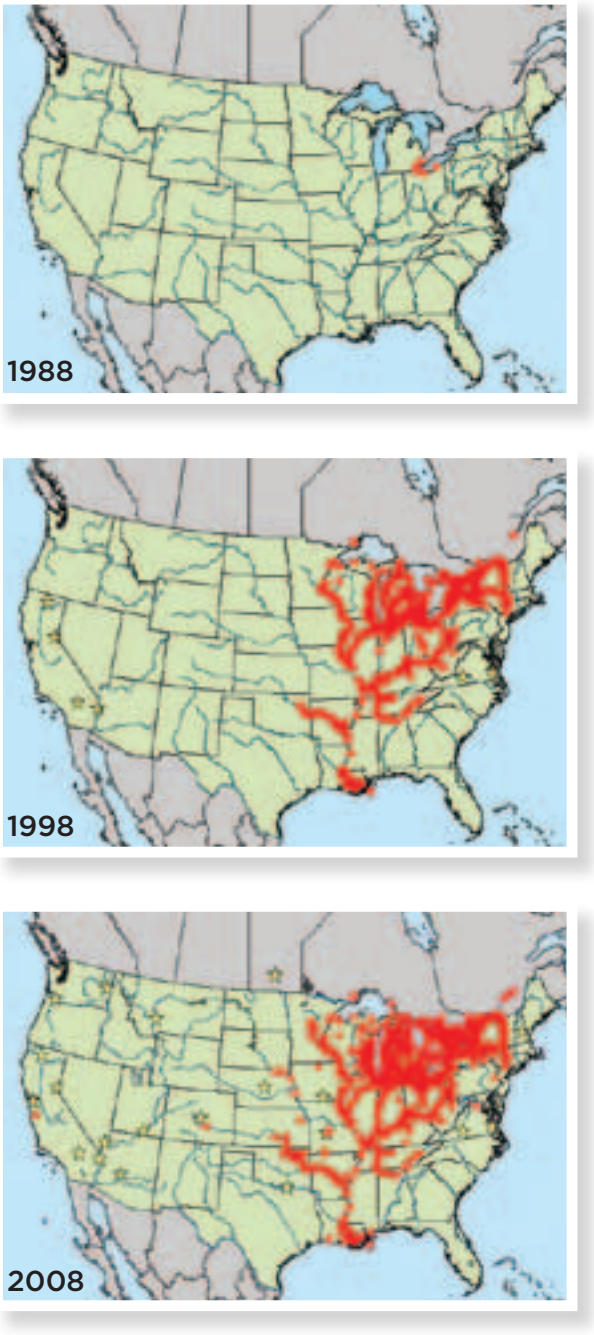
Values are based on aerial surveys conducted in Terrebonne, Jefferson, Lafourche, Plaquemines, St. Charles & St. John parishes.

Source: LDWF Coastal and Nongame Division, Nutria Control Program

Indicator 18: Zebra mussel distribution in the Mississippi River watershed

The zebra mussel (*Dreissena polymorpha*) is a freshwater bivalve native to the Balkans, Poland, and the former Soviet Union. Zebra mussels were first found in Lake St. Clair in 1988, after being introduced to the Great Lakes via ballast water discharges from large ships. They have since spread rapidly to freshwater lakes, streams, and rivers throughout the United States. In 1995, just seven years after their introduction, zebra mussels were reported in over 15 states in the Mississippi River watershed. That same year, zebra mussels were reported in both the Mississippi and Atchafalaya Rivers in Louisiana.

By 2001, there were several reports of zebra mussels within the BTES, and it is now assumed to be a permanent resident. The zebra mussel is a well-documented nuisance species, competing with native mussels for food and substrate and fouling water intakes, filtration systems, and other infrastructure. Its full impact on the BTES remains to be seen.



Distribution of zebra mussels in the Mississippi River watershed in 1988, 1998, and 2008

Red dots represent locations where zebra mussels have been collected; stars represent documented overland transport of zebra mussels on trailered boats.

Source: USGS (http://nas.er.usgs.gov/taxgroup/mollusks/zebramussel/)

Courtesy of BTNEP

Rio Grande cichlid, courtesy of BTNEP

Managing tilapia introductions

In 2009, tilapia (a fish native to Africa) were discovered in public waterways near Port Sulphur, Plaquemines Parish. The Louisiana Department of Wildlife and Fisheries quickly responded to this discovery by closing commercial and recreational fishing in the area and applying rotenone (a fish toxicant) to affected waterways. Captured tilapia were removed, and native fish currently are being stocked in these waterways, which will be monitored for at least two years to ensure tilapia do not become established.

Indicator 18a: Non-native species reported in the BTES

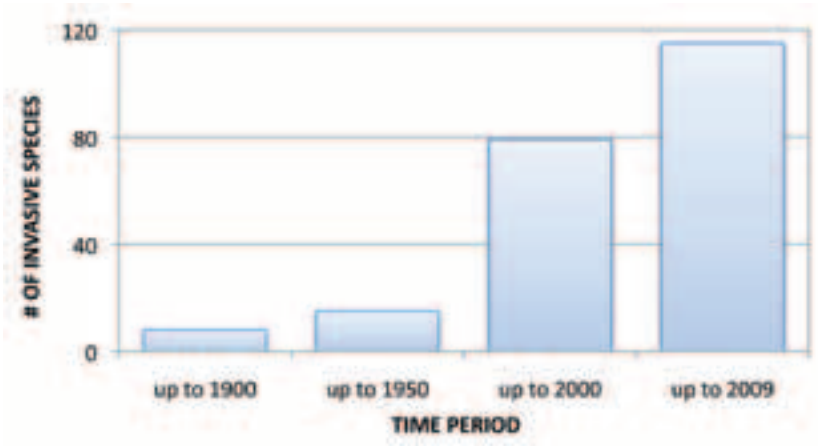
GROUP	COMMON NAME	SCIENTIFIC NAME	HABITAT
Animals	Rio Grande cichlid	*Cichlasoma cyanoguttatum*	Freshwater
	Asian clam	*Corbicula fluminea*	Freshwater
	Grass carp	*Ctenopharyngodon idella*	Freshwater
	Common carp	*Cyprinus carpio*	Freshwater
	Water flea	*Daphnia lumholtzi*	Freshwater
	Zebra mussel	*Dreissena polymorpha*	Freshwater
	Greenhouse frog	*Eleutherodactylus planirostris*	Freshwater
	Silver carp	*Hypophthalmichthys molitrix*	Freshwater
	Bighead carp	*Hypophthalmichthys nobilis*	Freshwater
	Titan acorn barnacle	*Megabalanus coccopoma*	Brackish-marine
	Black carp	*Mylopharyngodon piceus*	Freshwater
	Nutria	*Myocastor coypus*	Freshwater
	Tilapia	*Oreochromis spp.*	Freshwater
	Asian tiger shrimp	*Penaeus monodon*	Marine
	Australian spotted jellyfish	*Phyllorhiza punctata*	Marine
	Island applesnail	*Pomacea insularum*	Freshwater
	Cane toad	*Rhinella marina (Bufo marinus)*	Freshwater
Plants	Alligatorweed	*Alternanthera philoxeroides*	Freshwater
	Wild taro	*Colocasia esculenta*	Freshwater
	Brazilian waterweed	*Egeria densa*	Freshwater
	Water hyacinth	*Eichhornia crassipes*	Freshwater
	Hydrilla	*Hydrilla verticillata*	Freshwater
	Dotted duckweed	*Landoltia (Spirodela) punctata*	Freshwater
	Marshweed	*Limnophila x ludoviciana*	Freshwater
	Uruguay water primrose	*Ludwigia grandiflora*	Freshwater
	Peruvian watergrass	*Luziola peruviana*	Freshwater
	Parrot feather	*Myriophyllum aquaticum*	Freshwater
	Eurasian watermilfoil	*Myriophyllum spicatum*	Freshwater
	Yellow floating heart	*Nymphoides peltata*	Freshwater
	Asian rice	*Oryza sativa*	Freshwater
	Duck lettuce	*Ottelia alismoides*	Freshwater
	Torpedo grass	*Panicum repens*	Freshwater
	Water lettuce	*Pistia stratiotes*	Freshwater
	Water spangles	*Salvinia minima*	Freshwater
	Giant salvinia	*Salvinia molesta*	Freshwater
	Chinese tallow tree	*Triadica sebifera*	Freshwater

Data for HUCs 80903 & 80703 in the USGS Nonindigenous Aquatic Species information resource (http://nas3.er.usgs.gov/); accessed 11/4/2009

Louisiana is particularly susceptible to invasion by non-native species. Its international ports serve as pathways for introduction, and its mild climate gives potential invaders a better chance to survive and reproduce.

In general, degraded habitats are more susceptible to invasion. Invasive species also tend to further degrade habitats, facilitating new invasions. This circular process, known as invasional meltdown, does not bode well for the future of coastal Louisiana, where control efforts, legislation, and outreach rarely match the unrelenting pace of human commerce and transport. At least 36 new invasive species have been identified in Louisiana in the last ten years, including six new introductions to the BTES in the last four years (see right). Resource agencies continue to spend money and effort battling invasive species that have been here for generations, as new invaders continue to arrive at an increasing rate.

By federal definition, invasive species are those whose introduction to an area causes harm to the local ecology, economy, or to human health; thus, invasive species often are indicators of poor ecological health. However, environmental impacts from invasive species can vary widely even within a particular habitat type, so simply counting the number of exotic invasive species is not always a good indicator for assessing ecological health.



Number of species introduced in Louisiana, showing increasing rates of introduction

Source: USGS

Water hyacinth, courtesy of BTNEP

Recent introductions to the BTES

There have been six new species introductions into the BTES in the past four years: tilapia, apple snails, Asian tiger shrimp, cactus moths, Rio Grande cichlids, and Asian citrus psyllids (and associated citrus greening disease).

Maximum Contaminant Level Goals

In 1974, Congress passed the Safe Drinking Water Act, requiring the U.S. EPA to determine safe levels of chemicals in drinking water. These non-enforceable levels are called Maximum Contaminant Level Goals (MCLGs). The MCLG for atrazine has been set at 3 parts per billion (ppb), which is a level the U.S. EPA believes would not cause any adverse health effects.

Based on the MCLG, the U.S. EPA set an enforceable level called a Maximum Contaminant Level (MCL) of 3 ppb. The MCLs are set as close to the MCLGs as possible, taking into account the ability of public water systems to detect and remove contaminants with suitable treatment technologies. Current regulations require water suppliers to periodically monitor atrazine levels; in cases where levels are consistently above the MCL, the supplier must take steps to reduce atrazine levels. Treatment with granular activated charcoal has been approved by the U.S. EPA for removing atrazine from drinking source waters.

FOCUS**QUESTION 6**

Are concentrations of toxic substances increasing or decreasing?

Chemicals are a necessary part of our daily lives and our economy, and they provide great benefits: for example, by protecting crops from insects, by helping us clean our homes, and by providing fuel for our cars and boats. Certain chemicals, however, can be toxic to both wildlife and humans when released to our lakes, bayous, and bays. Substances of concern usually persist—they do not break down quickly in the natural environment—and bioaccumulate—they are transferred through the food web and concentrate in top predators such as fish and birds. The presence of such persistent toxic substances in the environment is suspected of causing declines in bald eagle and brown pelican populations (Indicators 15 and 16). Humans also must be careful to avoid eating fish with high mercury levels (Indicator 21).

Monitoring the concentrations of chemical substances in surface waters, sediments, and tissues of fish, shellfish, and aquatic wildlife of the BTES is crucial for understanding the ecological and human health risks associated with exposures to these toxic chemicals.

Indicator 19: Atrazine concentrations

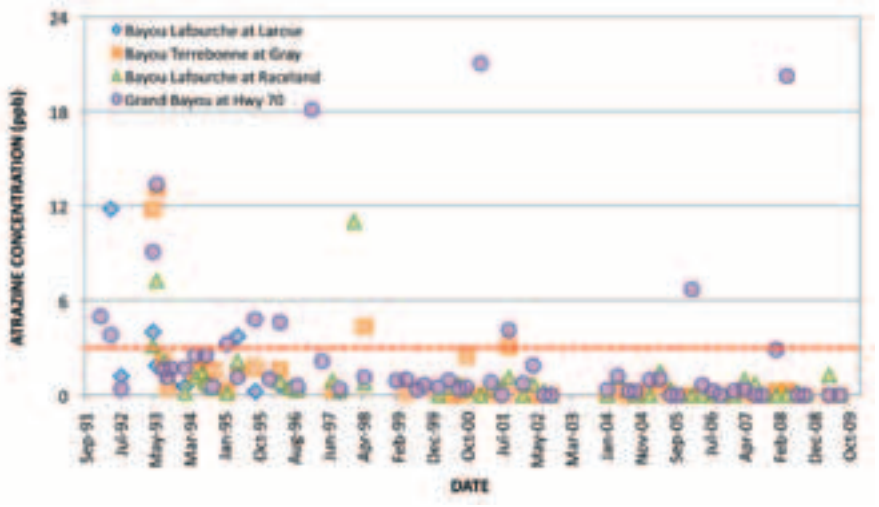
Atrazine is an herbicide used extensively on sugarcane and corn fields within and upriver of the BTES. Because atrazine does not readily break down in the natural environment, there is concern that runoff from fields treated with atrazine can contaminate lakes and bayous used for drinking water. While the potential health effects of atrazine are still being studied by scientists, the U.S. Environmental Protection Agency (U.S. EPA) has established a Maximum Contaminant Level (MCL) for atrazine of 3 parts per billion (ppb) in drinking water.

In 1992, the Louisiana Department of Agriculture and Forestry (LDAF) began a surface water monitoring project for atrazine and other pesticides throughout the state. Because the Upper Terrebonne Basin includes bayous that are the sole drinking water sources for more than 250,000 people, this program has continued (in cooperation with the Louisiana Department of Environmental Quality). Monitoring data show that atrazine occasionally reaches concentrations several times greater than the MCL of 3 ppb. Elevated levels generally occur in conjunction with atrazine application in the spring, and correspond to rainfall events.

Atrazine concentrations at four sampling stations in the Upper Terrebonne Basin, 1992-2009

Red dashed line indicates U.S. EPA MCL for drinking water (3 ppb); levels below detection limits are plotted as zeros.

Source: LDAF Office of Soil & Water Conservation



Indicator 20: Petroleum & chemical spill reports

Louisiana supports a large oil and gas industry that supplies a considerable portion of the nation's energy needs. A significant share of Louisiana's exploration, transport, and production activities occur in the BTES. The oil and gas industry works to limit accidental spills, but these events do occur in the estuary. In addition, spills significantly offshore of Louisiana also can impact the BTES, as the ongoing Deepwater Horizon BP oil spill illustrates.

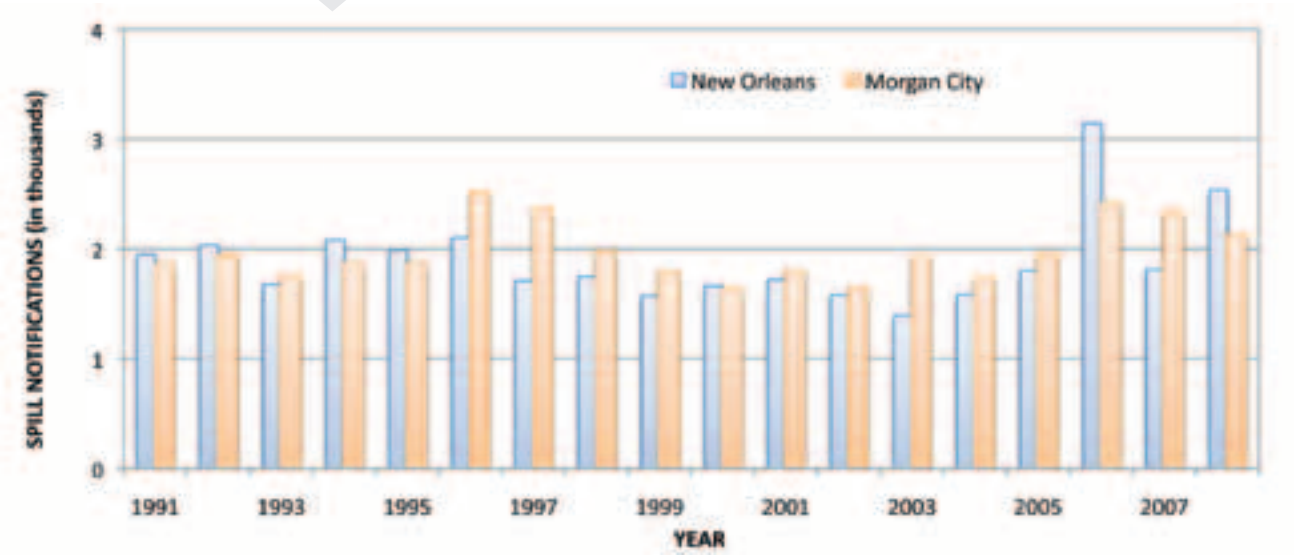
Number of petroleum and chemical spill notifications to the U.S. Coast Guard National Response Center, 1991-2008

Notifications are from two USCG NRC units adjacent to the BTES: New Orleans (Marine Safety Office [MSO] New Orleans from 1991-2005, renamed Sector New Orleans in 2006) and Morgan City (MSO Morgan City from 1991-2005, renamed Marine Safety Unit Morgan City in 2006).

Source: USCG National Response Center (http://www.nrc.uscg.mil/stats.html)

Because spills can release toxic substances to the estuary's waters and sediments, monitoring their occurrence is important for assessing any negative impacts to the estuary, as well as tracking the success of spill reduction efforts.

Two units (referred to here as New Orleans and Morgan City) under the United States Coast Guard's (USCG's) National Response Center (NRC) represent most of the area in the BTES. These units consistently rank near the top of the list based on number of oil and chemical spill notifications received. Since 1991, the number of spill notifications to these units has remained relatively constant, although the number of spills appears to have increased somewhat after 2005. Continued industry and government efforts to reduce spills will hopefully decrease the number of spills to the BTES.



Courtesy of BTNEP

Courtesy of BTNEP

Courtesy of Guy Fanguy

Where does mercury come from?

Mercury occurs in the environment naturally and is introduced via various industrial processes. In aquatic systems, microbes convert mercury into methylmercury, a toxic form that can bioaccumulate in top predators (such as many large fish species) and reach concentrations much greater than those observed in the surrounding water and sediments.

Because methylmercury interferes with normal development of the nervous system, especially in utero and in infants and young children, people who consume significant quantities of these top predators are at risk for adverse health effects.

FOCUS**QUESTION 7**

Is seafood safe to eat?

Seafood is plentiful in the BTES, and it is an important part of our culinary history and culture. The quality of Louisiana seafood, including fish and shellfish caught in the BTES, is generally excellent. To ensure that these seafoods continue to be safe to eat, many state agencies direct significant resources toward monitoring the tissues of fish and shellfish we regularly consume and the waters in which they live and grow.

Indicator 21: Number of active fish consumption advisories

Toxic substances released into our estuary, such as pesticides and heavy metals, can accumulate in the fish and shellfish we eat, making them dangerous to our health. Two state agencies, the Louisiana Department of Environmental Quality and the Louisiana Department of Health and Hospitals, coordinate the assessment of scientific information to determine human health risks from eating locally caught fish and shellfish. These agencies (along with the Louisiana Department of Wildlife and Fisheries) jointly issue a fish consumption advisory when a problem is found for a particular toxic substance, in a particular fish species, at a specific location.

Information on active fish consumption advisories in the state can be found on the Louisiana Department of Environmental Quality's website (http://www.deq.louisiana.gov/portal/tabid/1631/Default.aspx).

At present there is only **one active fish consumption advisory applicable to the BTES (versus 48 across the entire state): the statewide king mackerel advisory due to mercury contamination** (see left).

According to this advisory:

- Women of childbearing age and children less than seven years of age SHOULD NOT CONSUME KING MACKEREL and should consume no more than ONE MEAL PER MONTH of cobia, blackfin tuna and greater amberjack combined from the advisory area.
- Other adults and children seven years of age and older SHOULD NOT CONSUME KING MACKEREL GREATER THAN 39 INCHES IN TOTAL LENGTH (distance from the outermost portion of the snout to the outermost portion of the caudal fin) and should consume no more than TWO MEALS PER MONTH of king mackerel 39 inches or less in total length and no more than FOUR MEALS PER MONTH of cobia, blackfin tuna and greater amberjack combined from the advisory area.
- Unless the fish species is specifically addressed in the details of the advisory, please limit consumption of all species in an advisory area to FOUR MEALS PER MONTH.

Indicator 22: Bacteriological water quality of oyster harvesting waters

To live and grow, oysters filter small organisms from the water. These organisms can include bacteria and viruses from untreated human sewage discharges, which can cause illness in healthy individuals who eat these oysters raw. Oysters also can be contaminated by naturally occurring marine bacteria such as *Vibrio*. The consumption of *Vibrio*-contaminated oysters can cause illness and even death, especially for people predisposed to liver, blood, kidney, stomach, or immune system problems.

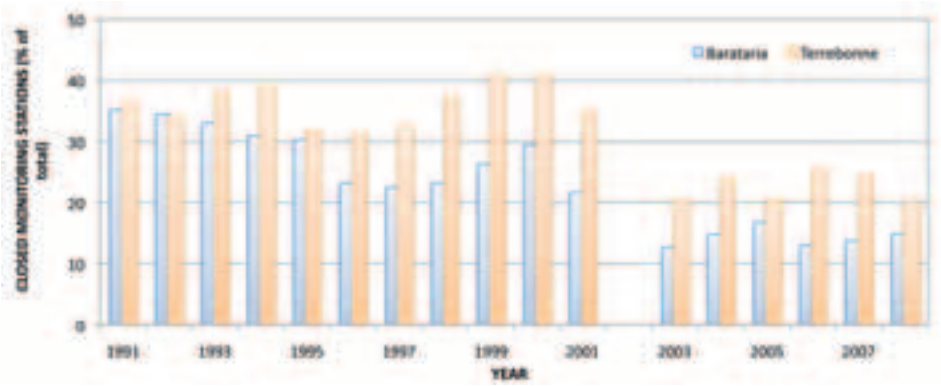
The Louisiana Department of Health and Hospitals Molluscan Shellfish Program regularly monitors the concentration of fecal coliform bacteria in oyster growing waters throughout the BTES. The presence of these bacteria indicate that waste sources—from sewage systems, as well as wild & domesticated animals—may be compromising oyster resources. Based on monitoring results and time of year, the state classifies oyster growing waters as "open" or "closed" to harvest. The conservative nature of this program has been quite effective at preventing illness from the consumption of sewage-contaminated oysters. A strong emphasis on proper handling, labeling, and refrigeration by Louisiana's oyster industry also has greatly reduced the risk of contaminated oysters entering the commercial market.

Indicator 22: Bacteriological water quality of oyster harvesting waters (cont.)

Percent of oyster growing water monitoring stations closed to harvest in the BTES, according to September-October classification, 1991-2008

The total number of stations monitored ranged from 129 to 195 in the Barataria Basin, and from 197 to 211 in the Terrebonne Basin; in both basins, the number of stations monitored was highest in 2008. Missing bars indicate no data available for that year.

Source: LDHH Molluscan Shellfish Program



Courtesy of Gulf of Mexico Program

Indicator 23: Number of boat sewage pumpout facilities

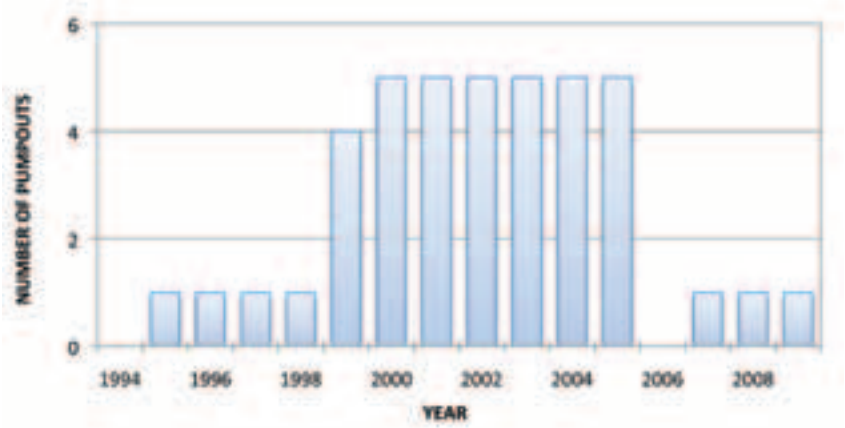
In large part it is Louisiana's waters that make it a Sportsman's Paradise, and there currently are more than 85,000 recreational vessels registered in the BTES (in addition to hundreds of commercial vessels). Pumpouts are facilities provided at marinas to remove sewage from vessel holding tanks for proper treatment. The availability and use of pumpouts is critical for reducing overboard discharges of untreated sewage, especially in oyster growing waters and swimming areas where sewage contamination can cause human illness.

Due to efforts of the Louisiana Department of Wildlife and Fisheries, the number of pumpout stations had risen considerably at both commercial and recreational marinas by the early 2000s. However, the number of pumpouts fell to zero in 2006, after Hurricane Katrina made all BTES pumpouts inoperable. Only one BTES marina, located in Houma, has re-established a working pumpout facility since Katrina. Given the extremely large number of boaters in the BTES, many more pumpout facilities need to be made available.

Number of boat sewage pumpouts available at BTES marinas, 1994-2009

Missing bars indicate no pumpouts were available in those years.

Source: LDWF Clean Vessel Act Program



Harmful algal blooms

While there has not been an occurrence within the BTES, blooms of the toxic "red-tide" alga *Karenia brevis* have caused emergency mass closures of oyster growing waters elsewhere in Louisiana. Other toxic algal species occur in the BTES, but have never reached proportions that cause contamination of shellfish.

Supporting ecotourism: Grand Isle Bird Day

Each spring, the Grand Isle Migratory Bird Festival is held to promote the area's importance as migratory bird habitat. The event allows ecotourists to witness fall out: the landing of thousands of birds on the first ground they encounter after crossing the Gulf of Mexico, on their annual northern migration.

Courtesy of BTNEP

FOCUS**QUESTION 8**

How are natural resource-based business patterns changing?

In the BTES, one can argue that ecological health and economic health are one and the same. The BTES supports a wealth of natural resources, many of which depend upon the health of BTES marshes and waters. The livelihoods of many residents rely on natural resource-associated businesses based on tourism, agricultural production, oil and gas production, and recreational and commercial fishing. Because a considerable portion of our regional economy is dependent upon these natural resource-based businesses, it literally pays for us to support restoration and protection of the BTES.

Indicator 24: Revenues & jobs generated by tourism

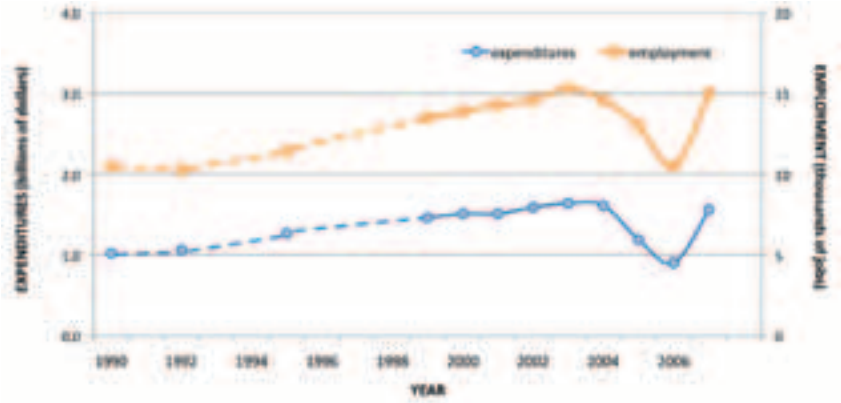
Tourism in the BTES contributes greatly to the region's economy, most significantly through the number of businesses and jobs that the industry supports. Expenditures and employment dropped in 2005 and 2006 following Hurricane Katrina, but began to increase again in 2007.

Tourists spent over $1.5 billion within the BTES in 2007, supporting approximately 15,000 jobs. With increasing national interest in nature-based tourism such as birdwatching, swamp touring, sightseeing, and guided fishing, tourism officials see this positive trend continuing for the BTES.

Expenditures and employment generated by tourism in the BTES, 1990-2007

Expenditures in each year have been adjusted for inflation to 2008 dollars; dashed lines connect data points when no data were available for intervening years.

Source: LA Office of Tourism (http://www.latour.lsu.edu/reports.html)



Courtesy of Guy Fanguy

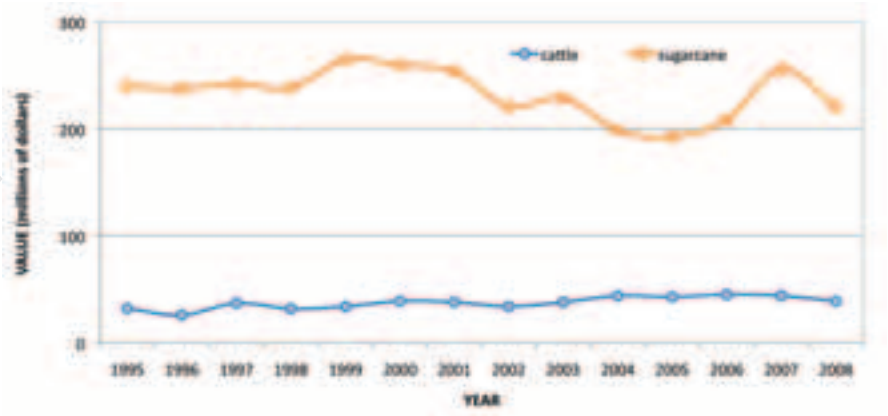
Indicator 25: Value of cattle & sugarcane agriculture

Cattle and sugarcane are the principal agricultural commodities in the BTES, and these industries are essential to the livelihoods of many of the area's residents. In general, crops account for approximately 90% of agricultural sales from the BTES, and livestock make up the remaining 10%. In 2008, sugarcane and cattle agriculture in BTES parishes was valued at $221 million and $39 million, respectively. Although agricultural acreage in the BTES has been declining for the last five decades, the value of both sugarcane and cattle production has remained relatively steady.

Value of cattle and sugarcane production in the BTES, 1995-2008

Values in each year have been adjusted for inflation to 2008 dollars.

Source: LSU Agricultural Center annual reports "Louisiana Summary: Agriculture and Natural Resources" (http://www2.lsuagcenter.com/agsummary/index.aspx)



Courtesy of Guy Fanguy

Environmental responsibility in the oil and gas industry

The Shell Pipeline Company LLC's Release Prevention Program recognizes that preventing hydrocarbon releases helps protect the environment as well as the corporate bottom line. The program teaches employees more than 70 oil spill prevention techniques, and provides a reward program for attaining environmentally friendly results. Through this program, Shell Pipeline Company LLC intends to make significant, positive progress toward protecting the health of the BTES.

Courtesy of Guy Fanguy

Indicator 26: Value of crude oil & natural gas production

Louisiana is home to numerous crude oil refineries, natural gas processing plants, and petrochemical production facilities. The oil and gas production industry provides significant economic benefit to the state, both directly (e.g., through severance taxes and lease royalties) and indirectly (e.g., through employment and income). Allied sectors, such as the refining and chemical industries, are also major contributors to the state's economy.

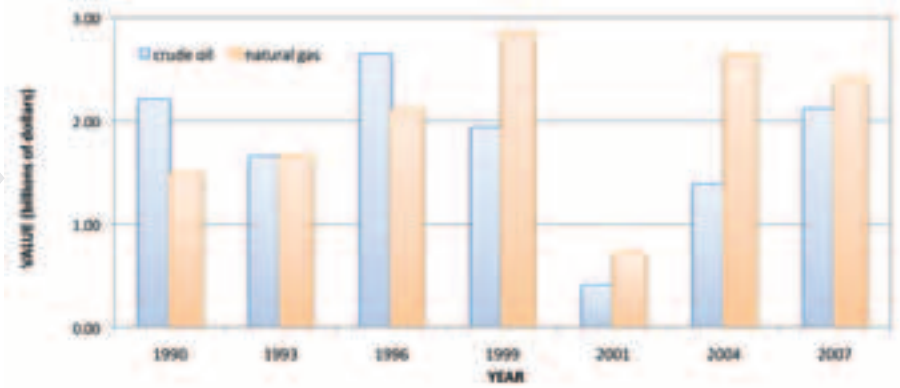
In the past three decades, production of crude oil and natural gas in south Louisiana has fallen sharply. This trend certainly has impacted the BTES economy: many of us remember the dramatic price drop in the 1980s that led to considerable unemployment and numerous citizens moving out of the BTES. The economic hardship from this decline has been lessened by the fact that more stable supplies of oil and gas produced in offshore areas are still transported to, and refined in, southern Louisiana.

Regardless of the economic benefits, it must be recognized that Louisiana's coastal areas, including the BTES, have been physically impacted by oil and gas exploration and extraction activities. Extensive dredging for exploration purposes has directly altered the hydrology of the BTES marshes, facilitating saltwater intrusion and contributing to land loss—although these activities are by no means the only factors responsible for these issues.

Value of crude oil and natural gas production in the BTES for selected years, 1990-2007

Values do not account for oil transported from foreign or offshore sources via pipelines through the BTES, and have been adjusted for inflation to 2008 dollars (inflation adjustment made by BTNEP for this report).

Source: LA Mid-Continent Oil & Gas Association (http://www.lmoga.com/index.html)



Indicators 27 & 28: Value of commercial fishing landings & number of commercial fisherman licenses

The importance of the BTES to commercial fishing in Louisiana and the nation is tremendous: Louisiana ranks second in the nation for volume of commercial seafood landings, and usually ranks first for volume of commercial landings of shrimp, oysters, blue crabs, and menhaden. Commercial landings and associated revenues in the BTES parishes generally represent at least half of Louisiana's totals. As BTES residents know well, commercial fishing is a cornerstone of our economy and generations of fishermen have shaped our regional culture.

The large majority of landings in the BTES and Louisiana are of estuarine-dependent species like shrimp, blue crabs, oysters, and several fishes. Most evidence indicates that land loss actually increases productive marsh edge habitat in the short term. This phenomenon may explain why we are not seeing drastic declines in landings, even though we are losing massive areas of healthy marsh. Most scientists agree that there will be some threshold amount of marsh loss, after which rapid population declines of our most valued fisheries species will occur. Given the revenues and jobs supported by commercial fishing, the health of BTES marshes and waters are critical to sustaining this industry.

Since the early 2000s, the total number of commercial licenses sold in the BTES parishes, and throughout Louisiana, has declined. This decline has coincided with a decline in the dockside price of shrimp and other commercial seafood species, and a rise in the cost of fuel and other inputs. Some believe that renewed opportunities in the oil and gas industry also have contributed to the decline by attracting some fishermen to employment outside commercial fishing.

Courtesy of BTNEP

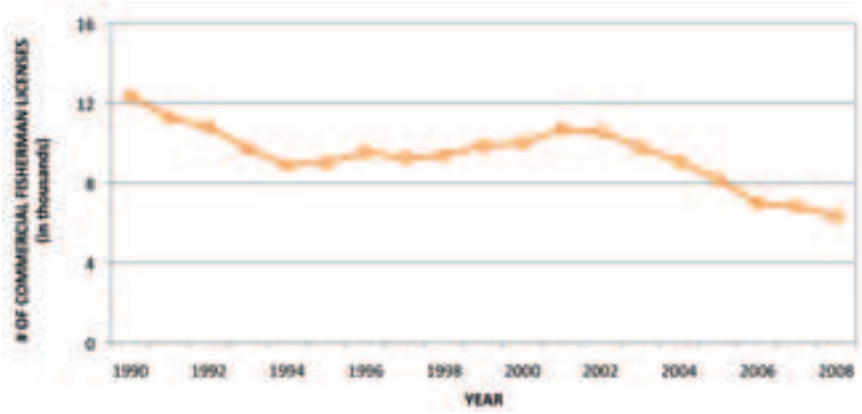
Value of commercial fishing landings in the BTES, 1995-2008

Values have been adjusted for inflation to 2008 dollars; year refers to year of the annual report (actual data are for one year prior to report year).

Source: LSU Agricultural Center annual reports "Louisiana Summary: Agriculture and Natural Resources" (http://www2.lsuagcenter.com/agsummary/index.aspx)

Number of Louisiana resident commercial fisherman licenses sold in the BTES, 1990-2008

Source: LDWF Licensing Section



Courtesy of Guy Fanguy

Indicators 29 & 30: Number of recreational fishing licenses & estimated economic impact

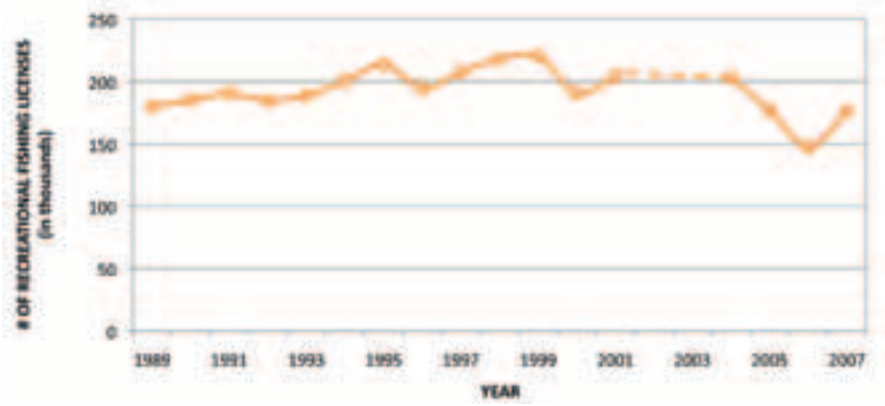
Fresh and saltwater recreational fishing are activities enjoyed by BTES residents, Louisiana residents from outside the BTES, and visitors from other states and countries, and they provide significant economic benefit to the region. In 2007, approximately 26% of the total recreational fishing licenses sold in Louisiana were issued in the BTES. The number of recreational fishing licenses sold to both residents and nonresidents in our region has been at or above 150,000 over the last decade.

Using the percentage of recreational fishing licenses sold in the BTES versus the total sold in Louisiana as a proxy for recreational fishing activity in the BTES, the total impact of recreational fishing in the BTES on the Louisiana economy was estimated at more than $470 million in 2006, supporting more than 4,000 jobs.

Number of recreational anglers licensed in the BTES, 1989-2007

The following license types were summed to calculate this indicator: resident fishing, non-resident (NR) fishing season, NR fishing trip (4-day), NR saltwater trip (4-day), NR fishing trip (1-day), NR saltwater trip (1-day), resident hook & line, disabled fishing, charter passenger (3-day), and active military fishing. Values in each year have been adjusted for inflation to 2008 dollars; dashed line connects data points when no data were available for intervening years.

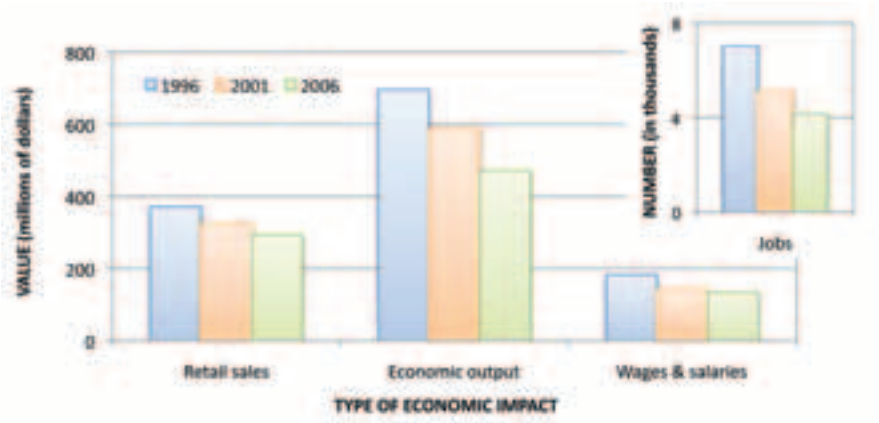
Source: LDWF Licensing Section



Estimated economic impact of sport-fishing in the BTES, 1996-2006

Values have been adjusted for inflation to 2008 dollars, and were calculated by multiplying totals for Louisiana by the percentage of total state licenses issued in the BTES.

Source: USFWS Division of Federal Aid and the American Sportfishing Association



FOCUS**QUESTION 9**

How are environmental changes affecting our quality of life?

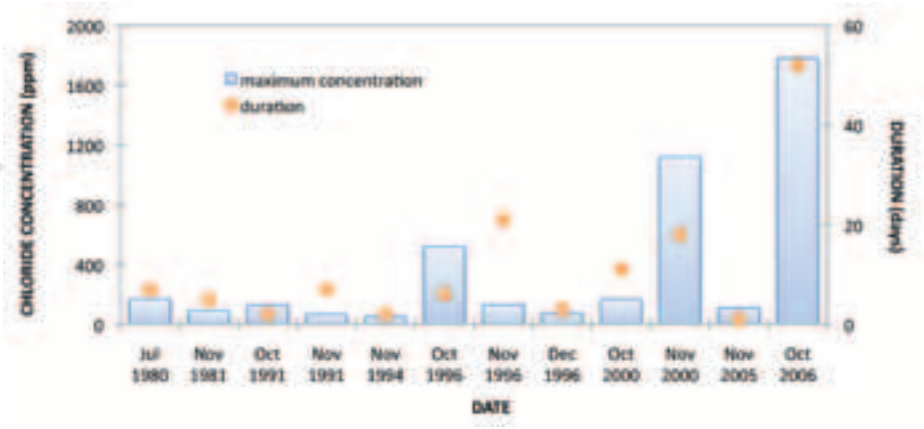
As residents of the BTES, we are surrounded by water. Its bays, bayous, and marshes have provided our livelihoods, shaped our regional culture, and given us a home that is truly unique in the United States. But we live in a precarious balance with these waters, and hurricanes, floods, land loss, and saltwater intrusion all can significantly impact our lives. It is important to recognize how large-scale environmental changes in the BTES are affecting, and will continue to affect, our families, jobs, and homes.

Indicator 31: Number & duration of high chloride events

Bayou Lafourche is the drinking water source for many residents in the BTES. The Clotilda Drinking Water Plant, the southernmost drinking water plant in Lafourche Parish, draws water from Bayou Lafourche just north of Lockport and provides treated water to surrounding communities. Normal chloride concentrations at this water intake generally are around 35 parts per million, or ppm (for comparison, the chloride concentration of Gulf of Mexico seawater is about 20,000 ppm). The U.S. Environmental Protection Agency has established a Secondary Maximum Contaminant Level (SMCL) for chlorides in drinking water at 250 ppm, above which water may have a salty taste (but not cause adverse health risks).

High chloride events occur when source water has a chloride concentration greater than 50 ppm. Twelve of these events have been reported for the Clotilda plant since 1980. Since 1996, concentrations have exceeded the SMCL threshold three times; in 2006, high chloride levels lasted for more than 50 days. Water extracted from Bayou Lafourche is always treated before human consumption, but the treatment process is ineffective at removing high levels of chlorides—meaning that high chloride concentrations make their way to our water taps.

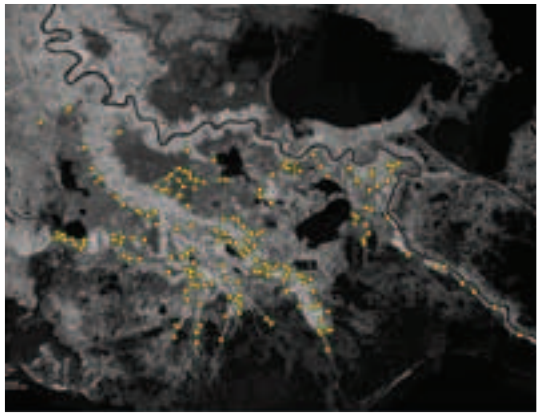
Salty Gulf of Mexico water entering Bayou Lafourche is caused by many factors (e.g., sustained south winds), interacting in complicated ways. In the long-term, however, these high chloride events are indicative of land loss and the degrading health of our marshes. One way to combat this threat to our quality of life is to increase flow of Mississippi River water down Bayou Lafourche, but this would have to happen in a manner that does not increase risk of flooding in our communities.



Number and duration of high chloride events in source water at the Clotilda Drinking Water Plant, Lafourche Parish

Source: Lafourche Parish Water District #1

Courtesy of BTNEP



Pump stations, courtesy of BTNEP

Courtesy of Guy Fanguy

Indicator 32: Number & value of flood insurance claims

Flooding has played a large role in the history of the BTES. In places like Paradis, the ground floors of many homes and businesses are five feet below sea level. In some "higher" areas, like Thibodaux and the West Bank of New Orleans, ground floors are only 15 feet above sea level. Because most communities are built on such low-lying land, an extensive system of levees has been constructed in the BTES. These levees also prevent water from draining naturally back to the marsh, so over 250 pump stations located throughout the BTES work to keep leveed areas dry (see map at left). Some 400,000 acres—about 10% of the land area of the entire BTES—are under pump.

These pumps have limits, however, and they generally cannot keep up with more than one inch of rain per hour. As a result, there have been more than 120,000 damage claims to the National Flood Insurance Program (NFIP) from the BTES, valued at nearly $4.8 billion. The May flood in 1995, which caused considerable damage in Jefferson Parish, was a significant contributor to the 1995 spike in claims. In 2005, the BTES was devastated by Hurricanes Katrina and Rita, and more than 50,000 claims, valued at roughly $3.4 billion, were filed.

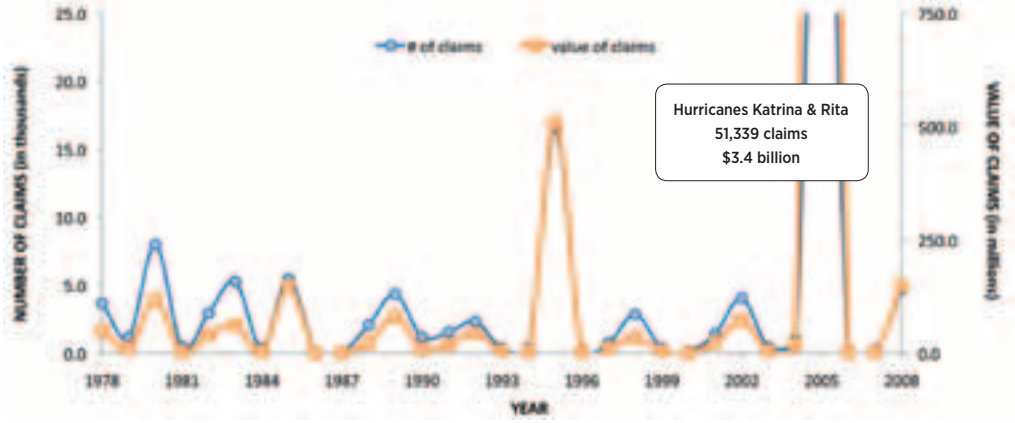
The expansive BTES marshes provide a valuable buffer from hurricanes, storms, and associated storm surges, but we're losing emergent marsh at an alarming rate due to erosion, subsidence, and saltwater intrusion (see Indicator 1). This loss increases the potential for flooding, especially in communities which fall outside the levee systems such as Grand Isle and Golden Meadow.

One should note that the NFIP statistics only include properties which had flood insurance policies when flooding occurred, so this figure certainly underestimates the total dollar value of damages in the area each year. It seems probable that flooding from both rain events and storm surges will continue to make history in the BTES.

Number and value of flood insurance claims in the BTES, 1978-2008

Values are adjusted for inflation to 2008 dollars.

Source: NFIP



Indicator 33: Area of dead zone in Gulf of Mexico

The Mississippi River basin drains 41% of the lower United States. Runoff from this land carries sediment, waste from wildlife and domestic animals, fertilizers and pesticides from crops and lawns, oil products and metals from parking lots and roads, and many other substances into small streams, which eventually make their way to the Mississippi River. Substances such as pesticides, metals, and oil products can be toxic in small amounts. Others, such as sediment and nutrients (nitrogen and phosphorus), may be problematic only in excessive amounts.

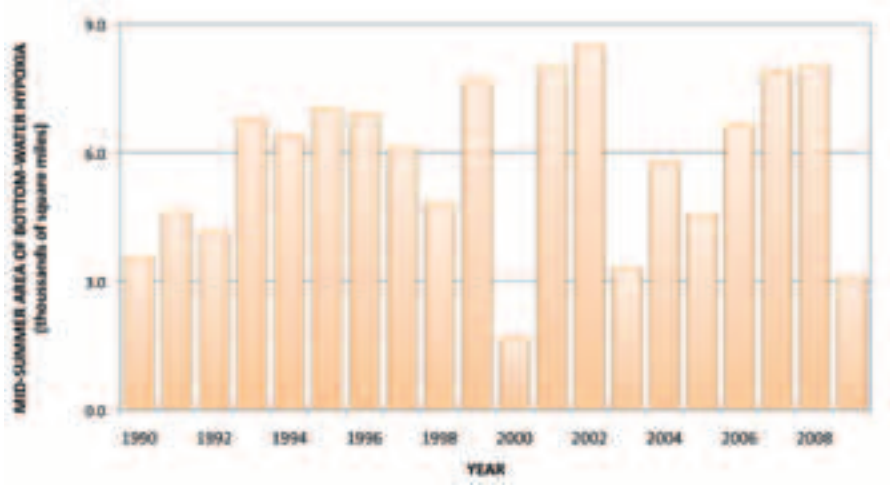
Nutrient pollution—or nutrient levels exceeding what the ecosystem can use or remove naturally—is associated with massive hypoxic, or low dissolved oxygen, events in the plume of the Mississippi River, where it enters the Gulf of Mexico. Since 1985, Louisiana scientists have monitored a large area off the coasts of Louisiana and Texas, quantifying the size and location of hypoxia that occurs each summer. These scientists also have monitored selected transects across the continental shelf, from the Atchafalaya River and Terrebonne Bay to offshore areas, on a monthly basis throughout the year. In 2008, the Gulf of Mexico dead zone was nearly the size of Massachusetts. In 2009, winds pushed the low oxygen water mass toward the east, resulting in a smaller dead zone in the Gulf of Mexico (see map at right).

The regular occurrence and massive extent of hypoxia off coastal Louisiana indicates that Mississippi River water carries large nutrient loads, which scientists say come primarily from agricultural sources. Swamps, wetlands, and riparian vegetation along the Mississippi River and its tributaries can help filter rainwater runoff and remove its associated pollutants, but many of these areas in the watershed have been bypassed or destroyed.

The effect of the dead zone on Louisiana fisheries, and specifically on communities in the BTES, has yet to be fully quantified. However, wind-caused onshore movement of these hypoxic waters has caused massive fish kills in the BTES.

Estimated area of the mid-summer Gulf of Mexico dead zone, or bottom-water hypoxia, 1990-2009

Source: Nancy Rabalais, LUMCON & Gene Turner, LSU; funding provided by NOAA, Center for Sponsored Coastal Ocean Research



Dissolved oxygen less than 2.0 mg/L in Gulf of Mexico bottom waters, July 18-23, 2009

What is hypoxia, and why does it occur?

The amount of oxygen dissolved in water can be used to gauge the overall health of an aquatic system. An area is considered hypoxic if dissolved oxygen concentrations are < 2.0 mg per liter. Large areas with low dissolved oxygen concentrations commonly are termed dead zones, since fish and invertebrates cannot survive if trapped within them.

Hypoxic events have been correlated with nutrient pollution. Eutrophication occurs when nutrient concentrations increase in a waterbody, resulting in increased primary production. Blooms of phytoplankton, or single celled algae, in the water column often indicate waters are eutrophic. Decomposition of these organisms consumes great quantities of oxygen and can result in hypoxia.

BTNEP volunteers

From May 2007 to December 2009, nearly 1,400 BTNEP volunteers logged more than 9,000 contact hours, generating more than $180,000 in matching funds.

Courtesy of BTNEP

FOCUS**QUESTION 10**

How strong is public support for a healthy estuary?

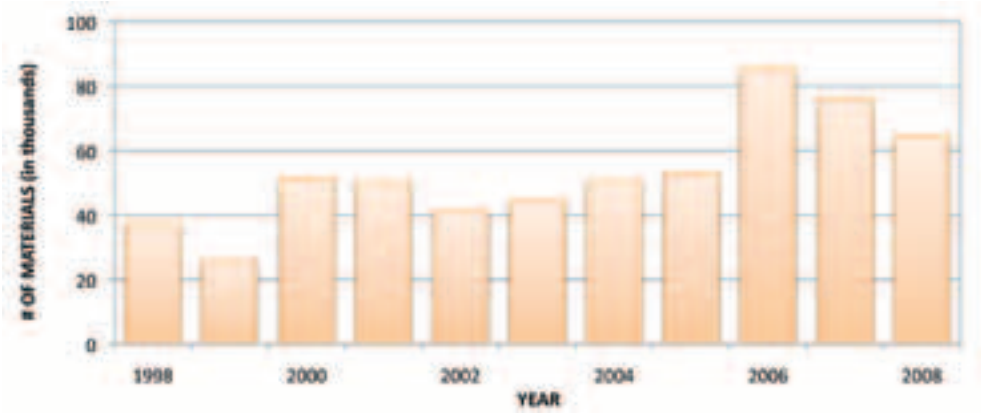
Positive environmental change in the BTES ultimately stems from public awareness of the estuary's problems and public support for programs addressing these issues. Several environmental awareness programs in the BTES work with residents and tourists to increase knowledge of and interest in the future of this ecologically important region.

Indicator 34: Number of educational materials distributed by BTNEP

A key goal of BTNEP is to increase environmental awareness in the BTES community. To accomplish this, BTNEP develops and distributes a large suite of outreach materials—such as posters, videos, scientific summaries, project summaries, and school curriculum-development materials—for the public. One measure of this educational program's success is the number of materials distributed, which has increased to more than 60,000 per year in recent years.

Number of educational materials distributed by BTNEP, 1998-2008

Source: BTNEP



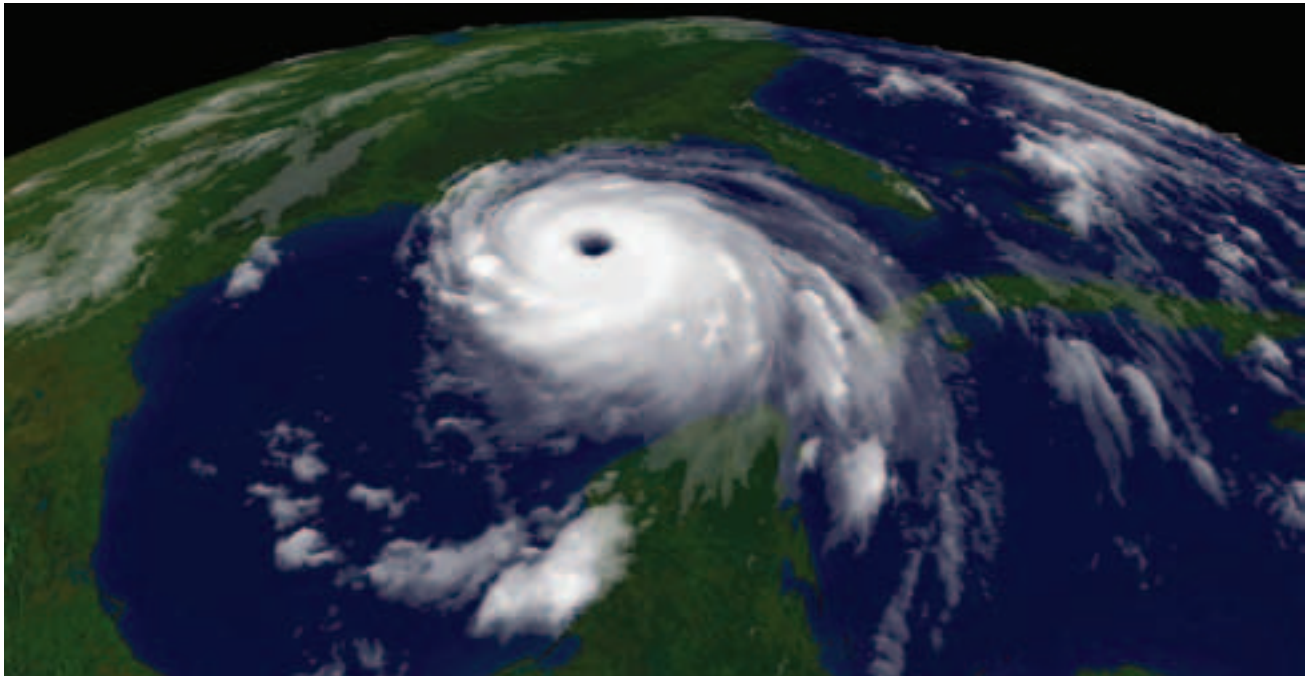
The 2005 Hurricane Season: Impacts on the BTES

Hurricane Katrina made landfall on the eastern edge of the BTES on August 29, 2005; Hurricane Rita made landfall in western Louisiana on September 24, 2005. These hurricanes devastated communities, caused massive changes to BTES ecosystems, permanently altered the lives of BTES residents, and disrupted the local, regional, and national economy.

Eighteen square miles of land were changed to water in the Barataria basin due to Hurricanes Katrina and Rita, and an additional 19 square miles of land were lost in the Terrebonne basin. The United States Geological Survey (USGS) assessed that total statewide land loss due to hurricanes in the 2005 season represents 42 percent of the total predicted land loss over the 50-year period from 2000 to 2050 (USGS Open-File Report 2006-1274, available at http://infotrek.er.usgs.gov/pubs/).

The storms' effects also can be seen in several of our indicators. The incredible peak in flood insurance claims, approximately $3.4 billion worth, demonstrates the severe impact of the 2005 hurricane season on the fabric of BTES communities (Indicator 32). Revenues and jobs generated by tourism dipped notably in 2005 and 2006 (Indicator 24) hurting an important sector of the local economy. The 2005 hurricane season wiped out all efforts to provide boat sewage pumpout facilities at BTES marinas, eliminating their use by both recreational and commercial boats (Indicator 23).

Many ecological and economic impacts of the 2005 hurricane season are yet to be fully realized, and we likely will be feeling their effects for years to come—in addition to the effects of the next big storm.



Hurricane Katrina in the Gulf of Mexico, August 28, 2005 (courtesy of NOAA)

Courtesy of BTNEP

"We've always said that the cost of not restoring this system was far greater than the cost of restoring it. These two hurricanes proved that we were absolutely correct."

Kerry St. Pé, *BTNEP Director*

Contacting BTNEP

If you are interested in receiving our newsletter, getting copies of educational posters, videos, technical documents, or curriculum-development materials, or volunteering in any capacity, please contact the Barataria-Terrebonne National Estuary Program Office.

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Project Manager

Dean Blanchard

What can I do to help?

Restoring and protecting the BTES is a long-term and complex endeavor, and your assistance is vital. The ultimate success of the BTNEP Comprehensive Conservation and Management Plan (CCMP) will be determined by public support for the Plan and federal and state dedication to restoration efforts. However, there are a number of activities that residents can undertake individually and collectively to enhance the health of the BTES.

- Learn about the BTES and its resources, and cherish it as the national treasure that it is.
- Join organizations and participate in programs that work to restore the BTES.
- Adopt an area within the BTES and help keep it clean and beautiful.
- Provide input to local, state, and federal legislation that will improve programs designed to protect and restore the BTES.
- Report observed pollution violations to the appropriate authorities.
- Minimize your use of pesticides, herbicides, insecticides, and fertilizers, and do not use these products in a manner that contributes to pollution.
- Properly dispose of garbage while in your car or boat.
- Properly dispose of household toxic materials.
- Regularly inspect, pumpout, and repair septic systems and aerobic treatment units to prevent discharges of untreated sewage.
- Use marina pumpouts instead of dumping sewage overboard when boating in the estuary.
- Observe fish and shellfish regulations.
- Teach your children about the BTES, our land loss problem, the fish and wildlife that inhabit our marshes and swamps, and their role in the ecosystem.

The BTES is our home, but its future—the fisheries and wildlife it supports and our economic prosperity, cultural heritage, and quality of life—are threatened. Only with your support can the BTES be maintained for your children and future generations to enjoy. They deserve the chance to paddle down a pristine bayou, to see a pelican in flight, to picnic on barrier island beaches, to live on land where their families have lived for generations, and to experience all the BTES has to offer. Please help us give them these opportunities.

Courtesy of Guy Fanguy

Satellite image of the BTES and surrounding areas (courtesy of Chelys, www.chelys.it)

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Courtesy of BTNEP

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