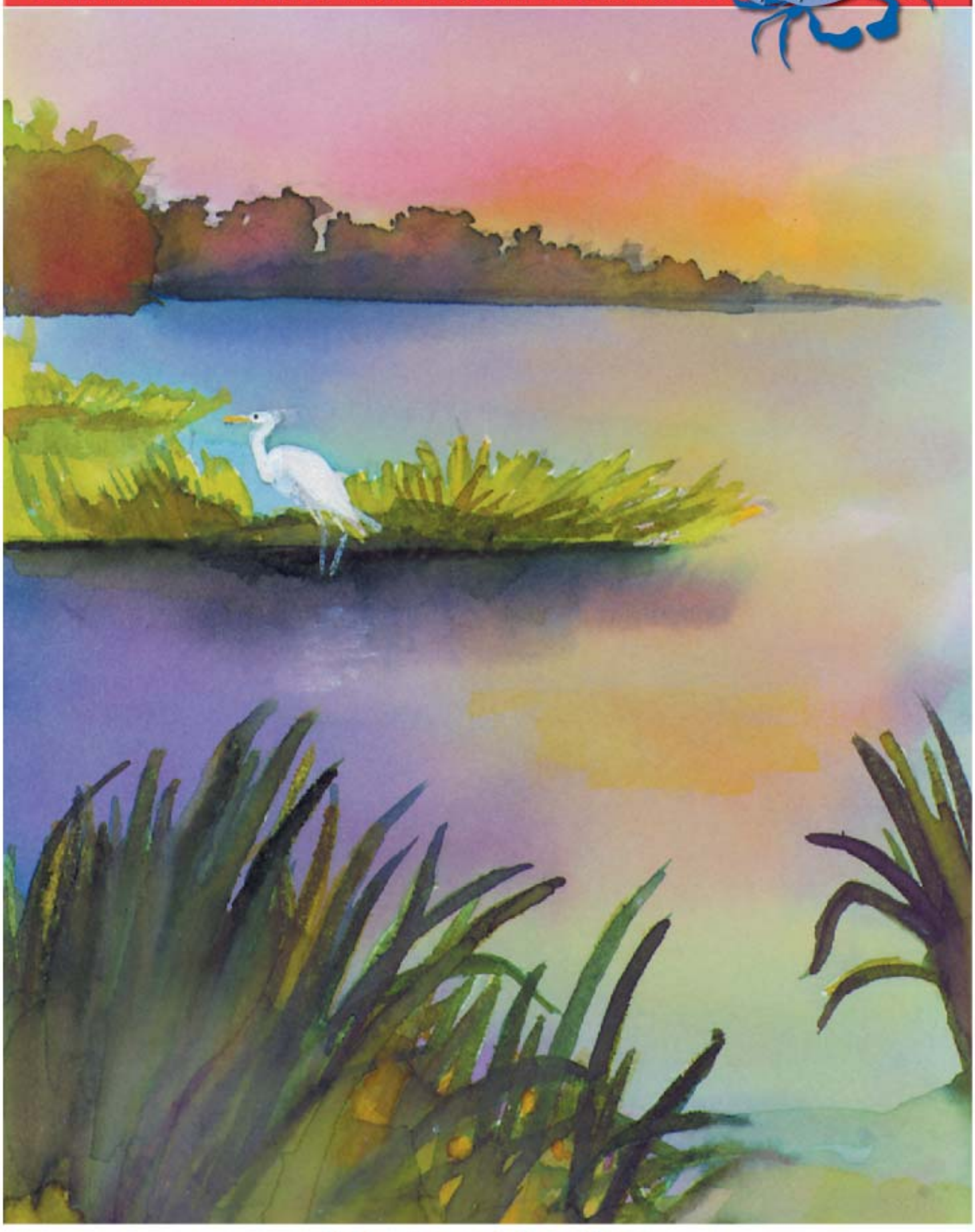
Healthy *Estuary*, Healthy *Economy*, Healthy *Communities* ...

Environmental Indicators in the Barataria-Terrebonne Estuary System: 2002



Barataria-Terrebonne
NATIONAL ESTUARY PROGRAM

Dear Residents of the Barataria-Terrebonne Estuary System:

The Barataria-Terrebonne Estuary System (BTES) is a biologically rich and productive ecosystem encompassing 4.1 million acres of uplands, swamps, marshes, bayous, bays, and barrier islands, bound on the west by the Atchafalaya River and on the east by the Mississippi River. The expansive BTES marsh provides habitat for previously endangered species such as the brown pelican and the bald eagle, commercially important fish and oysters, and abundant waterfowl and migratory birds. The natural productivity of the BTES produces a half a billion pounds of fish and oysters annually and provides countless recreational opportunities for residents and visitors from around the world. The BTES also supplies 10 to 15 percent of our nation's oil production. Most of us know that the health of this estuary and the quality of its bayous and bays, fish and wildlife are critical to our regional economy and our unique culture. We know this to be a special place. It is a National Estuary. Most importantly, it is our home!

Unfortunately, there are environmental threats to the health of the BTES. These threats were summarized in the seven Priority Problems identified in 1990 by the Barataria-Terrebonne National Estuary Program (BTNEP). The tragedy for us and for the nation is that this region is being lost to the Gulf of Mexico at an extraordinary rate. Our land loss issue makes our communities, businesses, and entire infrastructure increasingly vulnerable to hurricanes, and threatens our fish and wildlife populations. And at the same time, contamination of our waters with excessive nutrients, sewage, and toxic substances decreases habitat quality for fish and wildlife and increases risks to human health.

BTNEP and its government, business, environmental, academic, and citizen partners are working together to understand the estuary's seven Priority Problems and to implement 51 Action Plans to address them. These 51 Action Plans were the end product of a collaborative process to develop a Comprehensive Conservation and Management Plan (CCMP) to restore and enhance the environmental health of the BTES.

Using a small suite of **environmental indicators**, this report presents an overview of the environmental health of the BTES and, in certain instances, the effect of restoration and enhancement efforts by the BTNEP Partnership. Consider an analogy to medicine where the BTES is the patient and efforts to restore and enhance health – CCMP implementation – are the course of treatment. This Indicators Report presents some of the system's *vital signs*, telling us how the patient is doing and establishes an associational link to how our restoration efforts are working. The environmental indicators presented in this report are organized by a number of general questions (called Focus Questions) that residents of the BTES have posed to the BTNEP Partnership.

BTES = Barataria-Terrebonne Estuary System
BTNEP = Barataria-Terrebonne National Estuary Program
Environmental Indicator – An environmental measure that relates the condition or *health* of a natural resource. Watching this measure over time can tell us about changes in the condition of the natural resource.

We realize that there are some inherent difficulties and risks in presenting a small suite of indicators to represent overall environmental health in the BTES. For example, the indicators presented in this report offer only a simplified view of a few components of the BTES, an extremely complex natural ecosystem. In addition, the natural environment is continually changing, and it is sometimes difficult to know if changes observed in simple indicators reflect natural factors, such as weather, or reflect human abuses or restoration actions. It is often the case that considerable fluctuations seen in several indicators presented in this report may simply reflect natural variability in an estuary. Lastly, management actions undertaken to restore and enhance the BTES do not always have a simple relationship to results, especially considering its size and complexity.

Despite these difficulties and risks, BTNEP feels that it is important to periodically check and report on some *vital signs* of the BTES. That is, it is important to use this information carefully and in the appropriate context to understand the trends in key environmental indicators of a sustainable system. We hope that these indicators will help you better understand the results of management actions being used to address our environmental problems and how they directly impact the vitality of our regional economy, culture, and way of life.

Using data that are available today, 10 Focus Questions (FQ) and 34 indicators were selected by the BTNEP Management Conference and associated partners to present an overview of the environmental health of the BTES. BTNEP plans to release an updated Indicators Report every three years, and it is anticipated that this group of indicators will grow and evolve over time, as more and better scientific data become available.

Sincerely,

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

Shrimp boats, courtesy of BTNEP.

Cover art and other illustrations, courtesy of Diane Baker.

An estuary is a coastal area where freshwater from rivers (white arrow) mixes with saltwater from the ocean (blue arrow).

Priority Problems in the Barataria-Terrebonne Estuary System

- Hydrologic modification (human changes to water flows in the estuary)
- Reduced sediment flows (reductions in the amount of sediment inputs to the estuary)
- Habitat loss (land loss and marsh deterioration)
- Changes in living resources (population reductions in important species and introductions of non-native species)
- Eutrophication (too many nutrients in the estuary's waters)
- Pathogen contamination (untreated sewage and stormwater discharged to the estuary)
- Toxic substances (heavy metals and pesticides in runoff, and oil spills, to the estuary)

Focus Questions and Associated Environmental Indicators

Focus Questions and Associated Environmental Indicators

FQ 1: Are we losing land in the BTES, and if so, where?
1. Land versus open water in the BTES.
2. Location of land loss in the BTES.

FQ 2: Are fish and wildlife habitats being protected and restored?
3. Acres of habitat restored in the BTES.

FQ 3: Are fish and wildlife populations stable?
4. White and brown shrimp abundance in the BTES.
5. Blue crab abundance in the BTES.
6. Oyster density on BTES public seed grounds.
7. Bay anchovy abundance in the BTES.
8. Atlantic croaker abundance in the BTES.
9. Red drum abundance in the BTES.
10. Spotted seatrout abundance in the BTES.
11. Largemouth bass abundance in two BTES lakes.
12. Freshwater catfish abundance in two BTES lakes.
13. Alligator nest density in the BTES.
14. Mottled duck abundance in southeast Louisiana.

FQ 4: How are threatened and endangered species faring?
15. Bald eagle nesting success in the BTES.
16. Brown pelican nest abundance in the BTES.

FQ 5: Are non-native species a problem?
17. Acres of marsh damaged by nutria in the BTES.
18. Zebra mussels in the Mississippi River watershed.

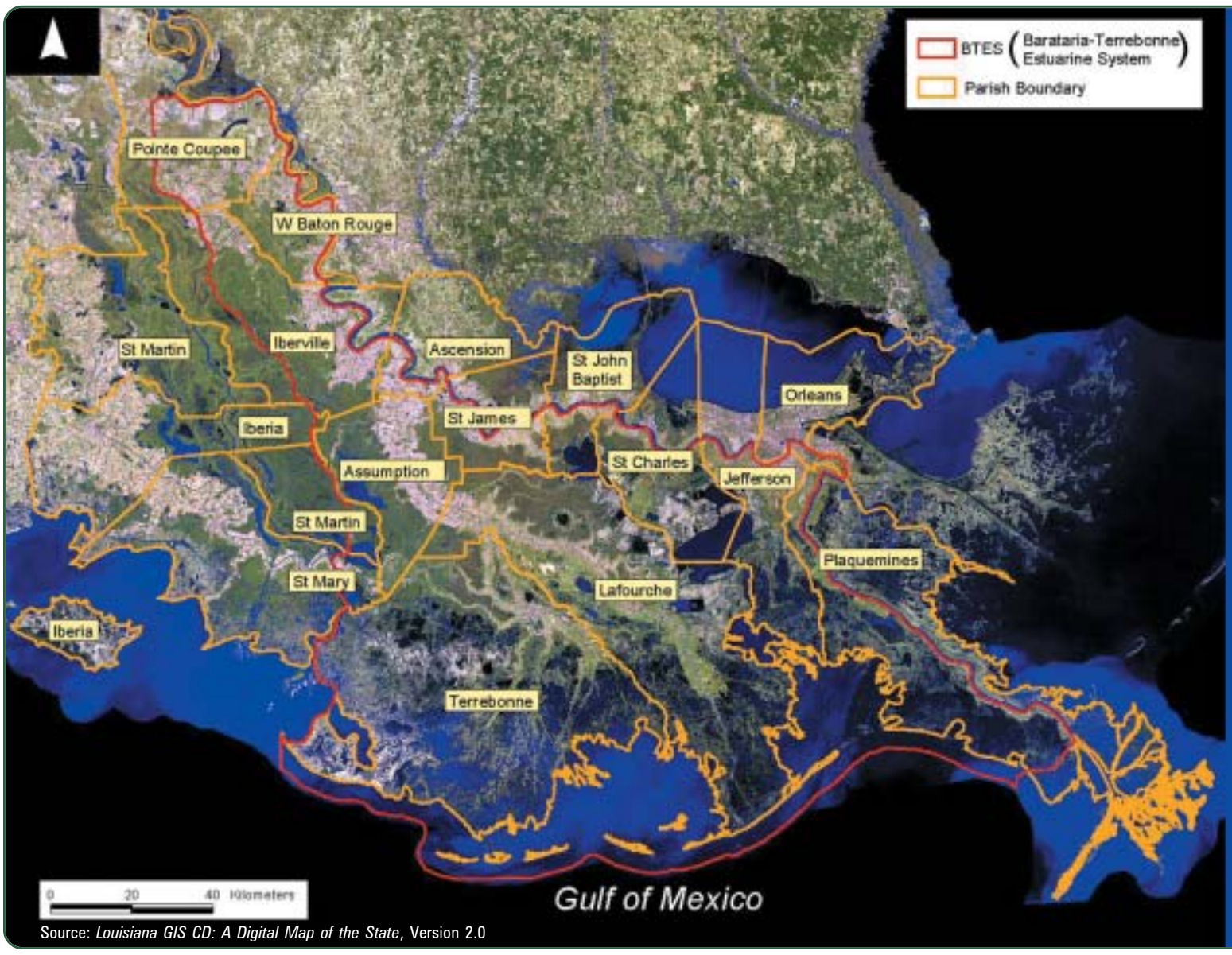
FQ 6: Are concentrations of toxic substances increasing or decreasing?
19. Atrazine concentrations in northern BTES surface waters.
20. Number of petroleum and chemical spill reports in the BTES.

FQ 7: Are seafoods safe to eat?
21. Number of active fish consumption advisories in the BTES.
22. Bacteriological water quality of oyster harvesting waters in the BTES.
23. Number of boat sewage pumpout facilities in the BTES.

FQ 8: How are natural resource-based business patterns changing?
24. Revenues and jobs generated by tourism in the BTES.
25. Value of sugarcane and cattle agriculture in the BTES.
26. Value of crude oil and natural gas production in the BTES.
27. Value of commercial fishing landings in the BTES.
28. Number of commercial fishing licenses in the BTES.
29. Number of recreational fishing licenses in the BTES.
30. Estimated economic impact of recreational fishing in the BTES.

FQ 9: How are environmental changes affecting our quality of life?
31. Number and duration of high-chloride events in source water to the Clotilda Drinking Water Plant.
32. Number and value of flood insurance claims in the BTES.
33. Area of hypoxia, or dead zone, off the Louisiana coast.

FQ 10: How strong is public support for a healthy estuary?
34. Number of educational materials distributed by BTNEP.



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

The **Barataria-Terrebonne Estuary System (BTES)** is located in southeastern Louisiana, nestled between the Mississippi River and the Atchafalaya River. Two hydrologically distinct basins make up the BTES, the Barataria Basin on the east side and the Terrebonne Basin on the west side, separated by Bayou LaFourche. There are 16 parishes that fall either partially or entirely within the BTES. All analyses in this report use the following 13 parishes to represent the BTES: Ascension, Assumption, Iberville, Jefferson, Lafourche, Plaquemines, Pointe Coupee, St. Charles, St. James, St. John, St. Mary, Terrebonne, and West Baton Rouge. Only a small portion of three parishes – Iberia, St. Martin, and Orleans – falls within the BTES, and they were consequently excluded from analyses in this report (unless otherwise noted).

FOCUS QUESTION 1: Are we *losing land* in the BTES, and if so, **where**?

The region we call home is disappearing into the Gulf of Mexico. The enormous expanse of coastal marsh in the BTES – which provides critical habitat for fish and wildlife and protects us from storm surges and hurricanes – is rapidly deteriorating. Massive conversion of wetlands to open water and the erosion of our barrier islands, is something most fishermen, oystermen, duck hunters, and trappers have seen over the years.

Scientists are able to analyze historical photographs and satellite images of the BTES to determine changes caused by land loss over the last fifty years. They tell us that the annual rate of land loss increased from 18 mi^2 per year between 1956 and 1978 to 22 mi^2 per year between 1978 and 1988. The most recent analyses – between 1990 and 2000 – indicate that the BTES is still disappearing at the incredible rate of 15.4 mi^2 per year.

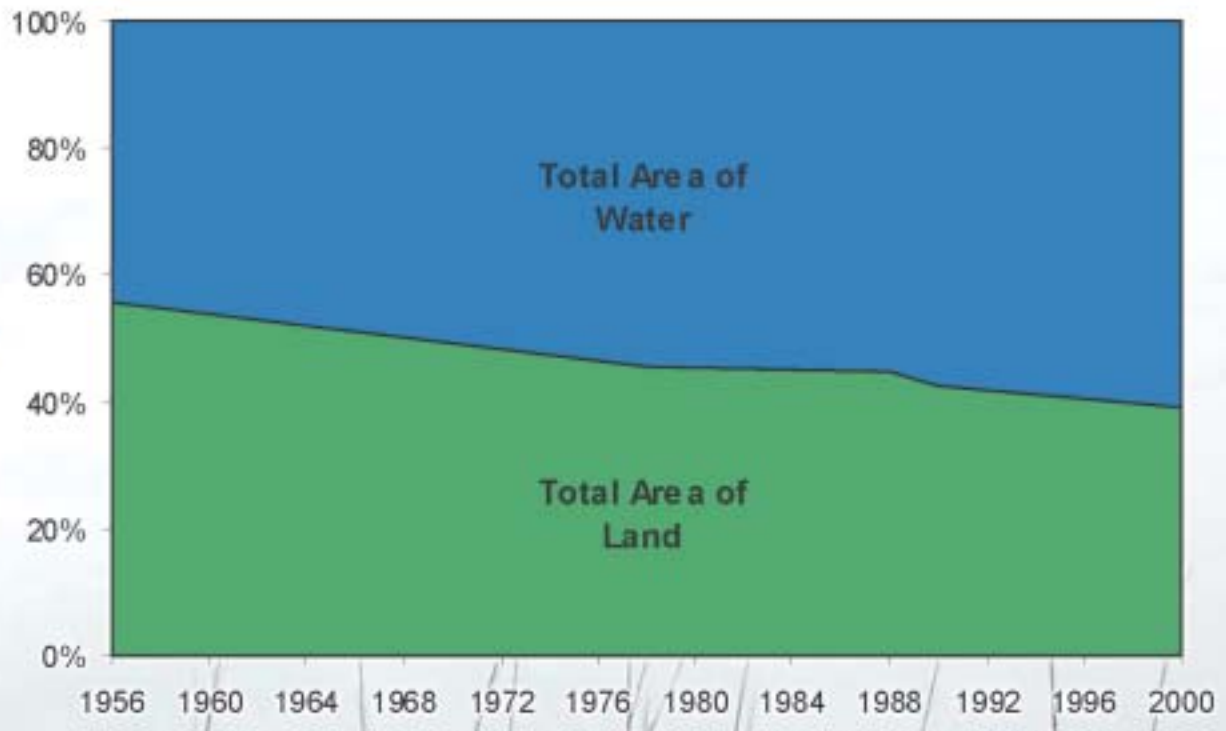
Indicator #1: Land versus open water in the BTES

The majority of land being lost in the BTES is coastal marsh land. This coastal marsh habitat is critical to the health of fish and wildlife populations, and provides a considerable buffer from flooding, storms, and hurricanes that periodically threaten homes, businesses, and oil and gas production infrastructure.

Location of 4,217 square miles analyzed for the graph.

Source: USGS National Wetlands Research Center

Gross-Scale Land:Water Ratio for Approximately 4,217 Square Miles of the Lower Barataria-Terrebonne Estuary System



Source: USGS National Wetlands Research Center, Lafayette, LA, provided under a BTNEP cooperative agreement.

Coverage of Major Habitat Types in Coastal Areas of the BTES

Habitat Type	1956	1978	1988
Open water	42 %	52 %	58 %
All marsh types	49 %	37 %	30 %
Fresh marsh	na	9 %	9 %
Nonfresh marsh	na	28 %	21 %
Forested wetlands	6%	6 %	6 %

Source: Reed, D.J., Ed. 1995. Status and Trends of Hydrological Modification, Reduction in Sediment Availability, and Habitat Loss/Modification in the Barataria-Terrebonne Estuarine System. BTNEP Publication no. 20, Barataria-Terrebonne National Estuary Program, Thibodaux, Louisiana.

na = not available

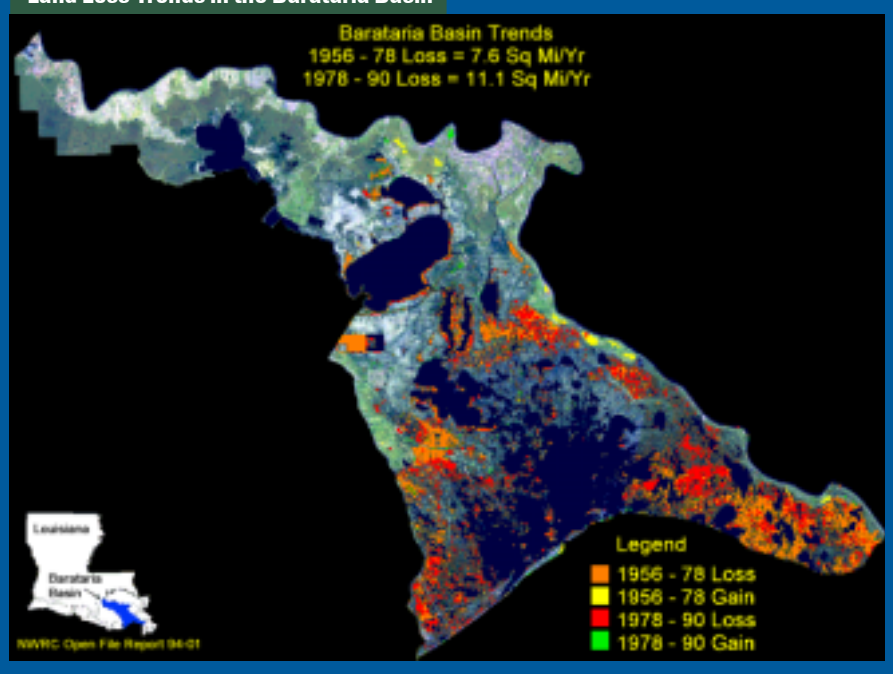
 Conversion of marsh to open water in the Pointe au Chien Wildlife Management Area, courtesy of BTNEP.

Indicator #2: Location of land loss in the BTES

While much of coastal Louisiana is losing land, the BTES experiences between 60 and 65 percent of the state's total land loss. In its study of the land loss problem, the United States Geological Survey has produced the following maps of the BTES showing the locations of land loss. Orange and red areas on the maps show us where land loss has occurred.

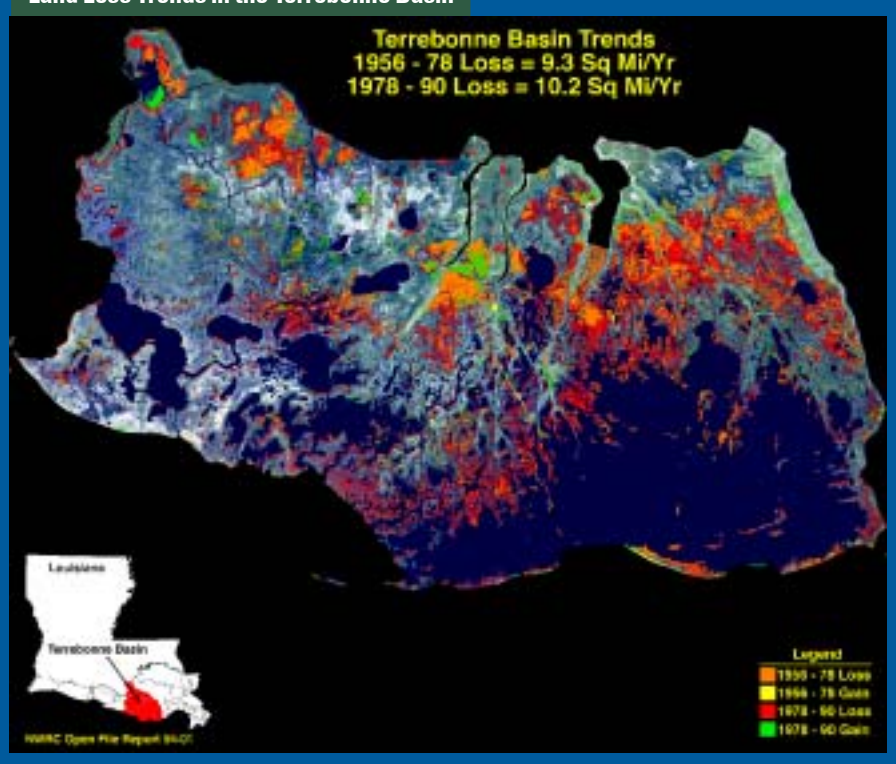
Why is this region so susceptible to coastal land loss? What is being done about it? Read on, some explanation of these questions is provided in the next two sections.

Land Loss Trends in the Barataria Basin



Source: USGS National Wetlands Research Center

Land Loss Trends in the Terrebonne Basin



Source: USGS National Wetlands Research Center

Channelization of the marsh, courtesy of BTNEP.

Brown marsh syndrome, East of Bay Junop, courtesy of USGS National Wetlands Research Center.

Mississippi River levee, courtesy of U.S. Army Corps of Engineers.

Historically great quantities of water and sediment from the Mississippi River flowed over natural levees and through the BTES. These inputs are critical to the health of the marsh ecosystem. Over the last 100 years or so, the path and quantity of water and sediment flowing through the BTES has been significantly modified by levees and canals, making the region more hospitable for our communities and more convenient for our commercial and recreational activities. Similar modifications were made upstream of the BTES on the Mississippi River. As a result of these changes, the BTES marsh has lost its vital source of water and sediment.

Why are we *losing land* in the BTES?

The BTES is sinking through a complex process called subsidence, where marsh sediments compact and sink under their own weight. Historically, annual floods over the banks of the Mississippi River provided the freshwater and sediment inputs needed to keep the BTES marshes above water. Leveeing the river, which was necessary to protect our communities from the same flooding events, has eliminated these vital inputs. Subsidence drowns the marsh, causing chemical changes in wetland soils which eventually kills marsh vegetation. Without the plant roots to hold it together, the marsh soil breaks up and is carried away by wave action. Open water is the ultimate result. Barrier islands, which help protect the interior marsh from wave action and hurricanes, are also subject to subsidence and ultimately disappear without new sediment inputs.

The rate of land loss in the BTES is influenced by a number of natural and human-caused factors, many of which are interdependent. In addition to reduced freshwater and sediment inputs, hydrologic modifications, such as building canals and raised roadbeds and breaching natural ridges, can create interruptions of tidal exchange or allow salt water intrusion. Marsh damage by nutria herbivory is another critical factor (see Indicator 17). It is suspected that the 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." Subsidence, however, is the most important and most pervasive factor leading to land loss.

Subsidence drowns marsh vegetation, leading to erosion.

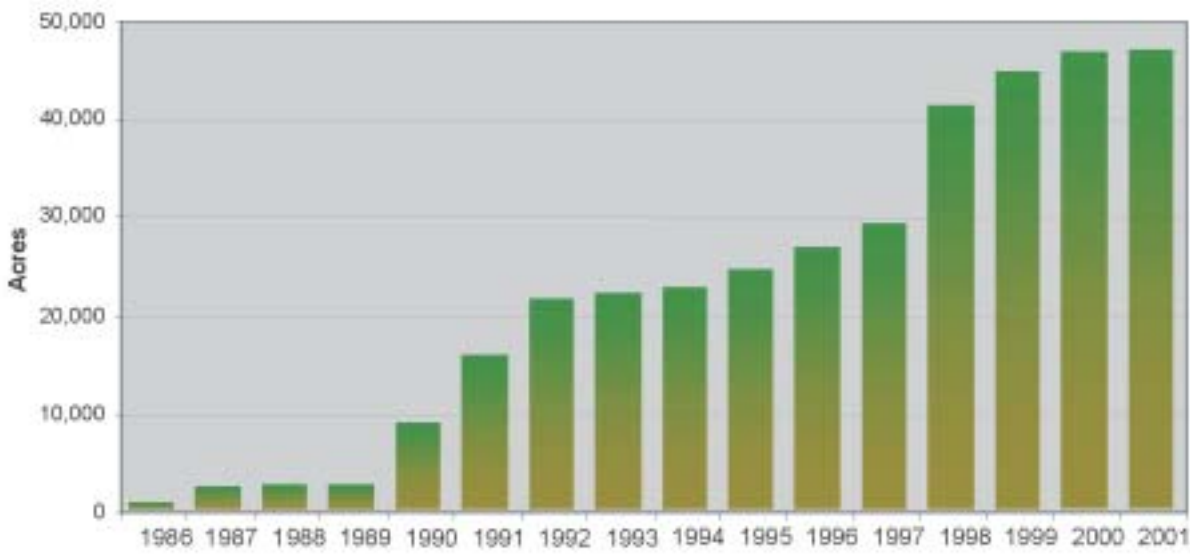
FOCUS QUESTION 2: Are *fish* and *wildlife habitats* being *protected* and *restored* ?

The BTES provides habitat for approximately 735 species of birds, finfish, shellfish, reptiles, amphibians, and mammals that depend on a healthy estuary for part or all of their life cycle. BTES habitats with the highest species diversity and abundance are the barrier islands, marshes (and associated bayous and lakes), second-growth bald cypress swamps, and bottomland hardwood forests. Many natural and human-caused factors can contribute to fish and wildlife population declines. In the BTES, habitat destruction associated with coastal land loss is, or is predicted to be, the most significant reason for the decline of fish and wildlife populations.

Indicator #3: Acres of habitat restored

Several state and federal programs are countering habitat loss by investing in large-scale habitat restoration activities. In the past 15 years, nearly 50,000 acres have benefited from local, state, and federal habitat restoration programs within the BTES. Most of these projects focus on habitats with high rates of loss, such as the barrier islands, interior marshes, bays, and bayou shorelines in Plaquemines, Jefferson, Lafourche, and Terrebonne Parishes.

Cumulative Acres of Habitat Benefited by State and Federal Restoration Projects Since 1986



Source: LDNR Coastal Restoration Division

Natural resource managers in Louisiana have gone to great lengths to make information on habitat restoration available to the public. The Louisiana Department of Natural Resources (LDNR) has a database of approved federal, state and non-federal restoration projects available on the Internet, along with associated scientific monitoring data. Anyone interested in discovering more about the restoration projects occurring in their parish can visit www.savelawetlands.org/site/alphabet.html. An interactive map at this site will allow you to view details about restoration projects in your community.

Vegetative planting, courtesy of NRCS.

Christmas tree fence restoration project, courtesy of BTNEP.

Dune restoration, courtesy of NRCS.

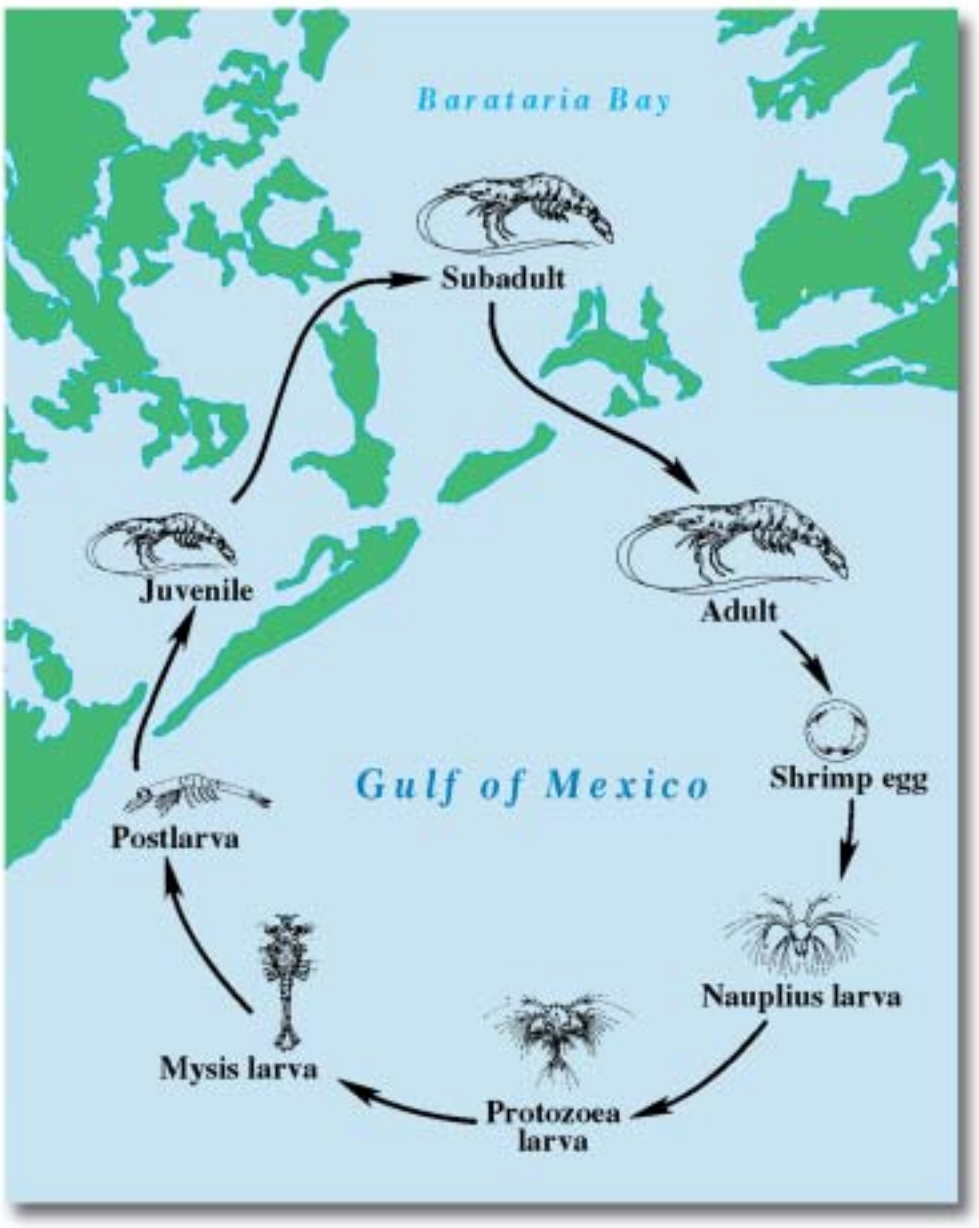
Breakwater and vegetative planting, courtesy of NRCS.

Swamp, courtesy of Guy Fanguy.

FOCUS QUESTION 3: Are *fish* and *wildlife populations* stable?

Historically people have caused tremendous stresses on the fish and wildlife habitat in the BTES. We leveed the Mississippi River and drained wetlands, harvested most of the cypress trees in our swamps, introduced competing non-native plants and animals, released persistent pesticides that accumulate in fish and wildlife food chains. The process of subsidence, greatly accelerated by flood protection levees halting water and sediment inputs from the Mississippi River, is causing massive marsh and barrier island loss in the BTES. This destroys critical habitat for both commercially and recreationally important species and threatened and endangered species.

Despite these past offenses and continuing rates of habitat loss, most species in the BTES for which there are available data have not experienced continuous population declines over the last 30 years. In fact, several species subject to targeted management, such as the alligator and the bald eagle, demonstrate an increasing population trend. Scientists say, however, that most evidence indicates that land loss – the break up of healthy marsh that ultimately converts to open water – actually increases the more productive marsh edge habitat in the short term. This phenomenon may explain why we are not yet seeing declines in fish and wildlife populations, even though we are losing massive areas of healthy marsh. Most scientists agree that there will be some threshold of marsh loss after which rapid population declines of our most valued fisheries species will occur.



How are *species* "dependent" on the BTES?

As is the case with shrimp, the life history of **estuarine dependent species** includes critical time when the animals must live, grow, and/or reproduce in a healthy estuarine system.

BTES residents, state environmental managers, and the U.S. Congress are beginning to recognize the land loss crisis confronting coastal Louisiana. We have taken important steps towards addressing this problem, especially through programs such as Coast 2050, the Coastal Wetlands Planning, Protection, and Restoration Act, and the Davis Pond Diversion Project. It is important to track the abundance of key fish and wildlife species, because they serve as indicators of the health of the estuary. They can also be general signs of the success of restoration programs, and ultimately that our homes, livelihoods, and culture are not threatened by land loss and other environmental problems.

We present on the following pages a selection of species that are ecologically, commercially, and recreationally important, and that have available long-term population data. Species population abundance, based on Catch Per Unit Effort (see text box for an explanation of this measure), presents a simplified snap shot of what is happening in a complex estuarine system. Our species population and health data are far from complete. Data gaps, particularly for freshwater fish and amphibians, do not allow us to track the status and trends of all critical fish and wildlife populations.

What is Catch Per Unit Effort (CPUE)?

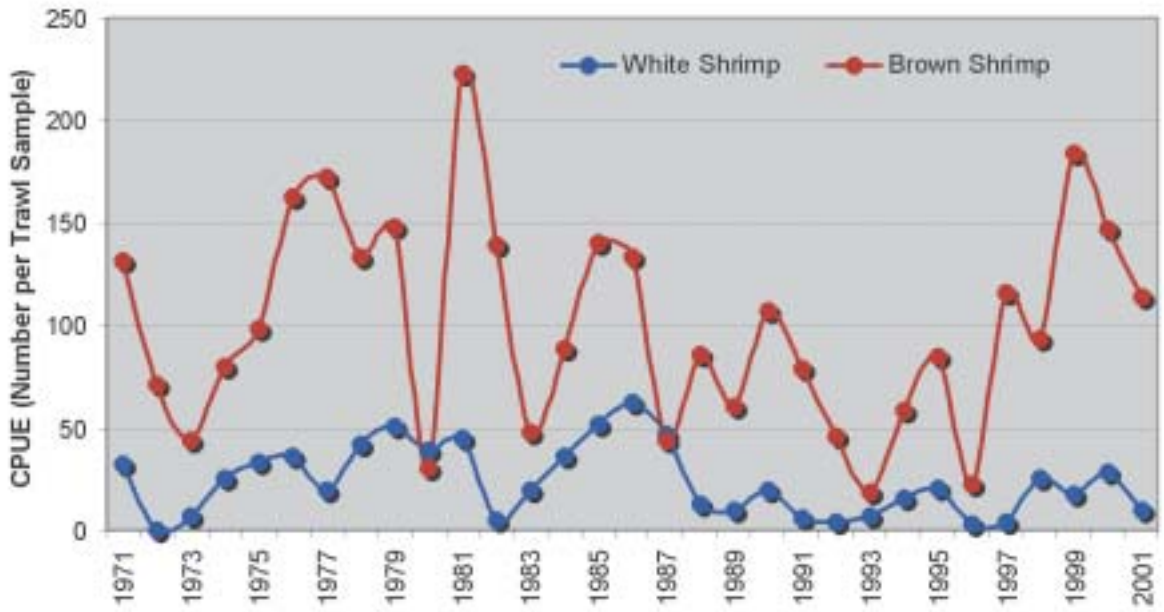
CPUE is a relative measure of the amount of organisms caught in standardized samples. For example, the number of brown shrimp caught in a 10 minute drag of a 6 foot trawl would be the CPUE for that sampling station. All CPUE measurements reported here were determined by state biologists, independent of commercial or recreational fishing effort. CPUE is one measure of the abundance of fish or wildlife populations, but CPUE alone may or may not be an accurate indicator of health of the population. Climatic conditions, level and timing of harvest, and other biological factors may cause fluctuations in population abundance. However, fisheries biologists believe that CPUE is the best long-term indicator of relative population abundance available for key species in the BTES.

Indicator #4: White shrimp and brown shrimp abundance

More shrimp are caught in Louisiana waters than any other place 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, comprising an important component of the estuarine food chain and supporting the largest shrimp fishery in the Gulf of Mexico.

Both white and brown shrimp spawn in Gulf of Mexico waters and larvae migrate to the estuaries, where they grow to juveniles before moving back to the Gulf to mature into adults. While in the BTES, the marsh and its adjacent shallow-water habitat serve as critical nursery areas for both species.

Average July Catch Per Unit Effort (CPUE) for White Shrimp and Average April CPUE for Brown Shrimp in the Barataria-Terrebonne Estuary System



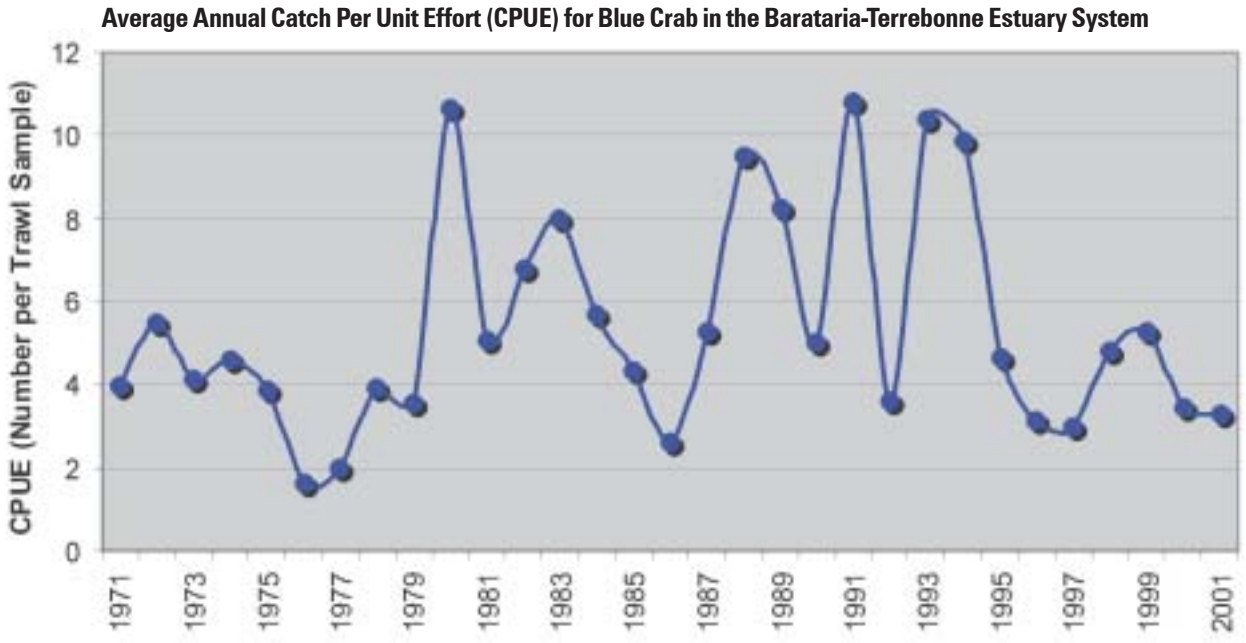
Source: LDWF Marine Fisheries Division. CPUE for white shrimp determined by sampling with a 16 foot trawl at inshore stations in LDWF Areas 3 (Barataria Bay estuary), 4 (Terrebonne/Timbalier Bay estuary), and 5 (Caillou/Fourleague Bay estuary), in July. CPUE for brown shrimp determined by sampling with a 6 foot trawl at inshore stations in LDWF Areas 3, 4, and 5, in April.

These two shrimp populations appear to be healthy, even though considerable variability occurs in the average abundance measure (i.e., CPUE) for both white and brown shrimp, due to both environmental and biological factors. Average abundance appears to be largely influenced by salinity, water temperature, and tidal action. For example, it is thought that lower brown shrimp abundance from 1972 to 1976 was influenced by the high stage of the Mississippi River and increases in regional rainfall. Likewise, the relatively high brown shrimp abundance in 1999 to 2001 was associated with drought conditions (low river stage, decreased rainfall).

Courtesy of BTNEP.

Indicator #5: Blue crab abundance

Average Annual Catch Per Unit Effort (CPUE) for Blue Crab in the Barataria-Terrebonne Estuary System



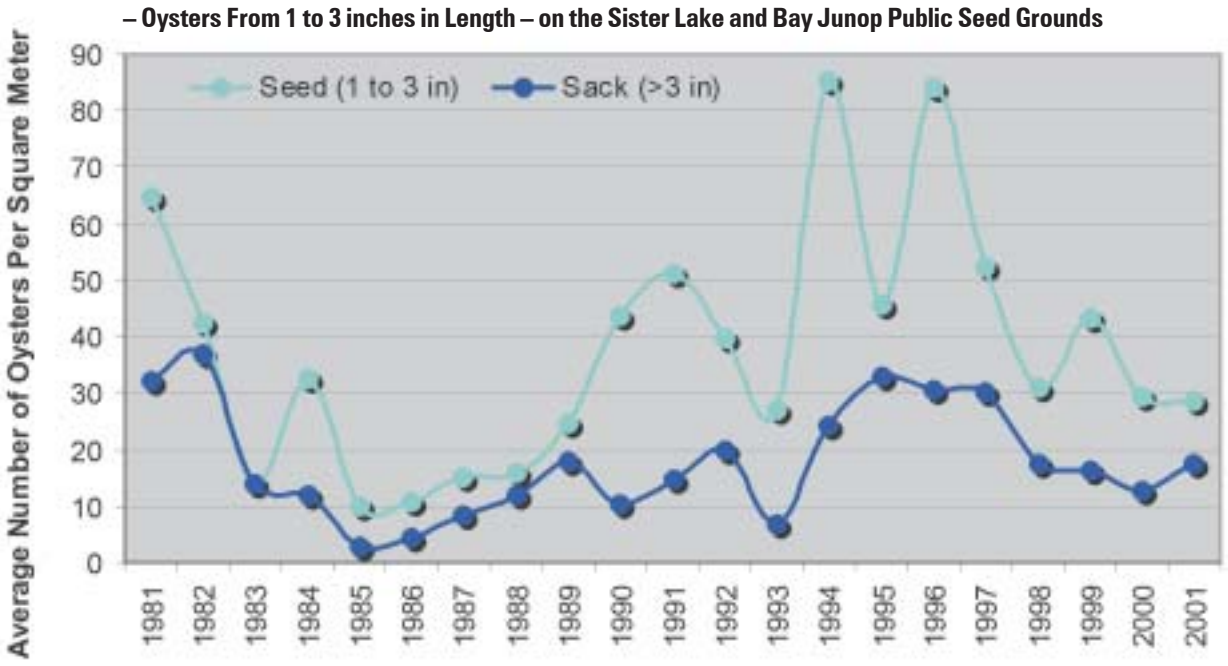
Source: LDWF Marine Fisheries Division. CPUE determined by sampling individuals less than <125 mm carapace width with a 16 foot trawl at inshore stations in LDWF Areas 3 (Barataria Bay estuary), 4 (Terrebonne/Timbalier estuary), and 5 (Caillou/Fourleague Bay estuary), in January through December.

Blue crab, courtesy of National Aquarium in Baltimore.

The blue crab (*Callinectes sapidus*) is one of the most abundant crustaceans in coastal Louisiana, including the BTES. This species is very important in the estuarine food chain, and is a key recreational and commercial species in the BTES. The population appears to be stable, even with high year-to-year variability. This variability is associated with both environmental and biological factors. The possible downward trend in abundance from the late 1980s through the 1990s may be associated with increased salinities and increased abundance of marine fish predators that occur with salinity increases. Generally, blue crab abundance increases as the amount of freshwater entering the BTES increases.

Indicator #6: Oyster density on BTES public seed grounds

Average Summer Density of Sack Oysters – Oysters Greater Than 3 inches in Length – and Seed Oysters – Oysters From 1 to 3 inches in Length – on the Sister Lake and Bay Junop Public Seed Grounds



Source: LDWF Marine Fisheries Division. Sampling conducted in June or July. Sister Lake and Bay Junop data combined.

What factors *influence* the BTES oyster population?

Average density on the Bay Junop and Sister Lake public seed grounds is variable, due primarily to changes in environmental conditions and secondarily because of management actions and market conditions. Environmental conditions such as salinity, water temperature, and dissolved oxygen concentrations influence oyster reproduction, spat set, and mortality. At high salinities disease, parasites, and predation may limit oyster populations, while at very low salinities oyster survival may be reduced. Overall oyster abundance is higher in estuaries with significant freshwater input. Economic factors (e.g., dockside price) influence fishing effort and thus population levels. Other events such as hurricanes (which lead to increased sedimentation on oyster reefs) and disease can cause population declines, while habitat enhancement efforts, such as the massive cultch deposition efforts in 1994 and 1995, can lead to population increases.

Courtesy of Gulf of Mexico Program.

Harvesting oysters is both big business and a part of history in the BTES. In any given year, around three-quarters of Louisiana oysters are landed in the BTES. In addition to being economically important, oysters enhance recreational fishing habitat and filter large volumes of water, potentially improving local water quality.

The Louisiana Department of Wildlife and Fisheries is charged with managing Louisiana's oyster resource. Part of the agency's management program includes cultch planting, which enhances oyster habitat in public seed grounds, like Bay Junop and Sister Lake. Oysters in public seed grounds are then available for direct harvest or transplanting to private oyster leases. Based upon the average annual density of oysters in Bay Junop and Sister Lake, the local oyster population appears to be stable. This measure, however, may not be representative of oyster population stability and health across the entire BTES.

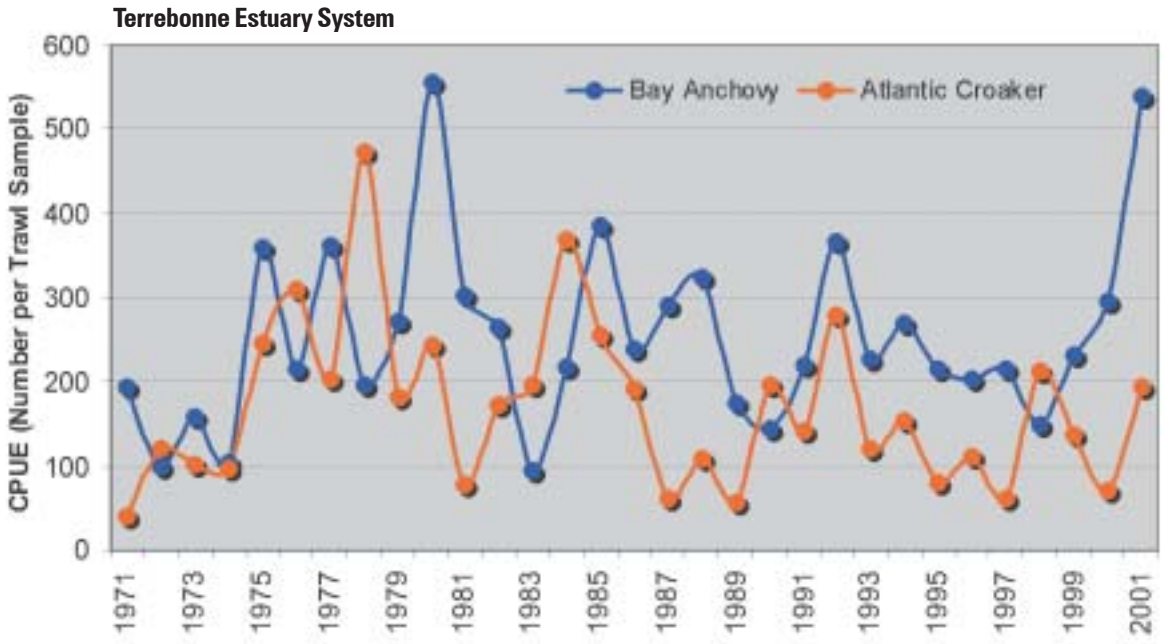
Planting oyster cultch, courtesy of BTNEP.

What is *cultch*?

The Louisiana Department of Wildlife and Fisheries periodically deposits cultch on public seed grounds to serve as substrate for new spat set – the initial attachment of oyster larvae. Cultch is any hard material, most often shell or limestone, placed on water bottoms to enhance oyster habitat or create oyster reefs.

Indicator #7 and #8: Bay anchovy and Atlantic croaker abundance

Average Annual Catch Per Unit Effort (CPUE) for Bay Anchovy and Atlantic Croaker in the Barataria-Terrebonne Estuary System



Source: LDWF Marine Fisheries Division. CPUE determined by sampling with a 16 foot trawl at inshore stations in LDWF Areas 3 (Barataria Bay estuary), 4 (Terrebonne/Timbalier estuary), and 5 (Caillou/Fourleague Bay estuary), in January through April.

The bay anchovy (*Anchoa mitchilli*) is the most abundant fish species in coastal Louisiana, including the BTES. This surface-dwelling species is considered by biologists to be a key component of the estuarine food chain. The Atlantic croaker (*Micropogonias undulatus*) is the second most abundant estuarine fish species in coastal Louisiana, including the BTES. This bottom-dwelling species is considered by biologists to be an important component of the estuarine food chain. Based on available data, both the bay anchovy and Atlantic croaker populations appear to be stable. The high year-to-year variability in abundance of both species probably reflects the natural variability of estuaries (caused by variable rainfall, river flow, and temperature, and extreme weather, like hurricanes).

Atlantic Croaker, courtesy of LDWF Marine Fisheries Division.

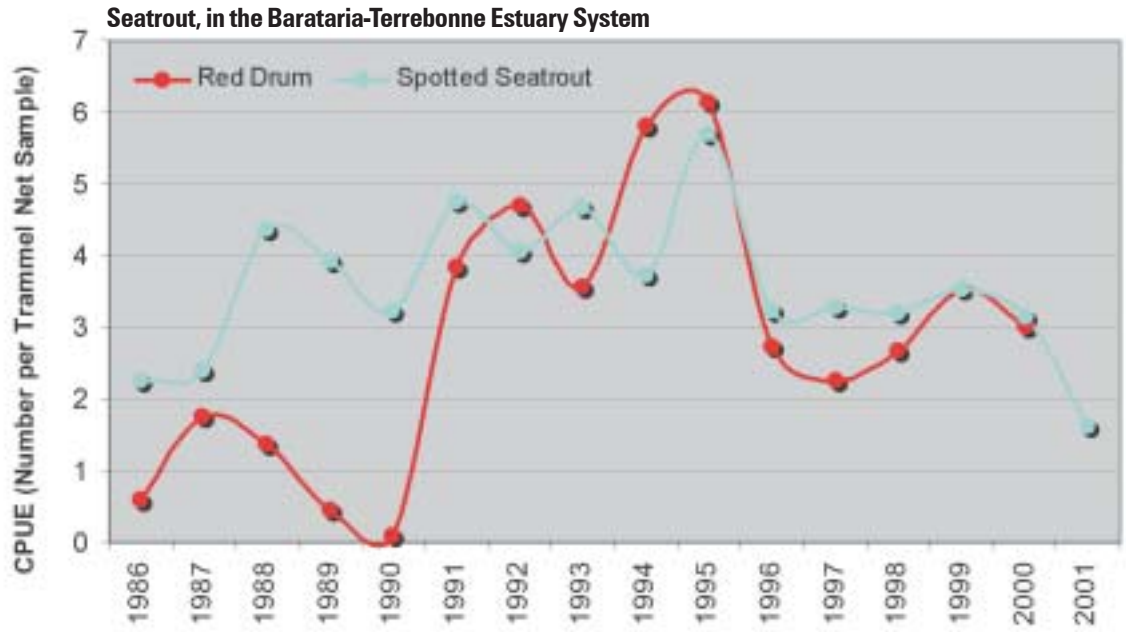
Bay Anchovy, courtesy of LDWF Marine Fisheries Division.

Indicator #9 and #10: Red drum and Spotted seatrout abundance

While the BTES supports over 200 species of finfish, red drum (*Sciaenops ocellatus*), or redfish, is one of the most abundant species, and one of the most popular recreational species. It is a fast-growing fish that remains in estuaries until about four years of age. Red drum can live up to 35 or more years, and is thus one of the more long-lived estuarine-dependent species.

Based on available data, the red drum population in the BTES is probably stable. Low abundance levels recorded in 1990 reflect massive fish kills resulting from the catastrophic freeze of December 1989. The marked increase in population levels from 1990 to 1995 may reflect changes in harvest regulations, and environmental conditions more favorable to the survival of juvenile red drum.

Average Annual Catch Per Unit Effort (CPUE) for Red Drum Less Than 16 Inches, and Spotted Seatrout, in the Barataria-Terrebonne Estuary System



Source: LDWF Marine Fisheries Division. Red drum CPUE determined by sampling with trammel net for Age 1 red drum less than 16 inches at stations in LDWF Areas 3 (Barataria Bay Estuary), 4 (Terrebonne/Timbalier estuary), in October through March. Spotted seatrout CPUE determined by sampling with 2 inch stretch mesh gill net at stations in LDWF Areas 3,4, and 5, in January through December.

Red Drum, courtesy of Duane Raver, USFWS.

Indicator #9 and #10 continued.

The spotted seatrout (*Cynoscion nebulosus*), or speckled trout, is one of the most popular recreational estuarine fish species in the BTES. It is a fast growing fish that remains in estuaries until about four years of age, making the fishery completely dependent on healthy estuaries. Low abundance levels recorded in 1990 reflect massive fish kills resulting from the catastrophic freeze of December 1989. The marked increase in population levels from 1990 to 1995 may reflect changes in harvest regulations and environmental conditions more favorable to the survival of juvenile spotted seatrout. Moderate year-to-year variability is probably associated with environmental factors, such as temperature and salinity. Coastal erosion and land loss could impact critical shallow, vegetated nursery habitat for this species.

Spotted Seatrout, courtesy of Duane Raver, USFWS.

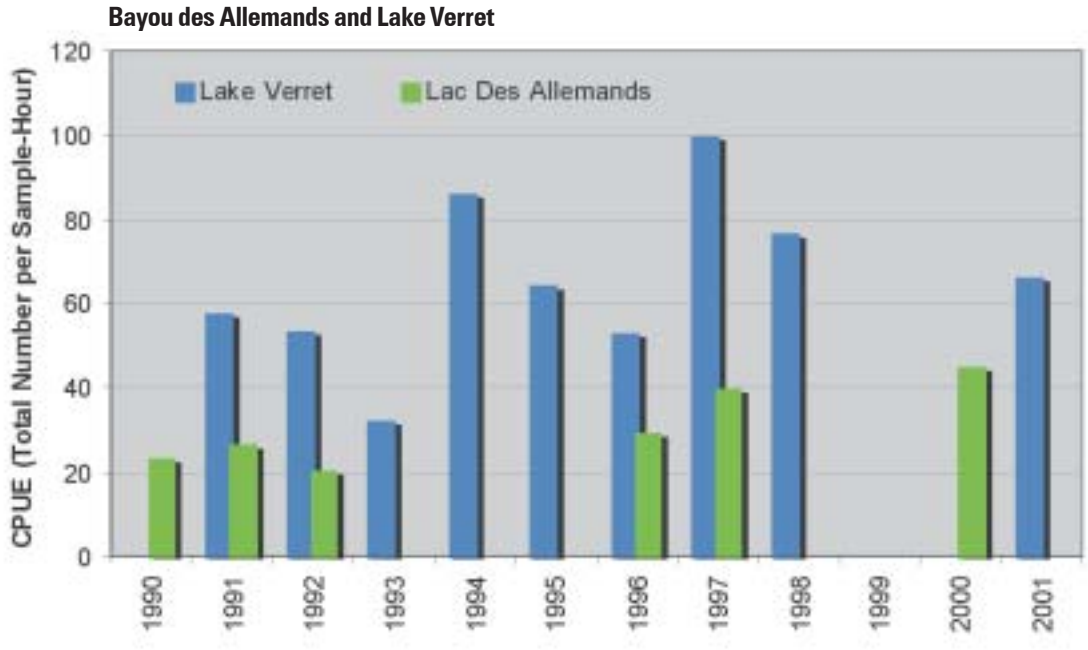
Indicator #11: Largemouth bass abundance

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. This species nests along quiet shorelines in freshwater lakes and bayous, although as adults, largemouth bass can tolerate brackish waters. Populations of largemouth bass are influenced by environmental variables such as water quality, water level, and the availability of spawning habitats, food, and cover.

Long-term population abundance data are available for two BTES lakes – Lac des Allemands in the Barataria Basin and Lake Verret in the Terrebonne Basin. In comparison to Lac des Allemands, largemouth bass abundance in Lake Verret may be generally higher due to more appropriate environmental conditions. For example, Lake Verret has a higher level of water exchange and is impacted less by high salinity events. In addition, since 1993, Lake Verret has had a fourteen-inch minimum size restriction on the take of largemouth bass, which may be contributing to a greater total population of the species. It is suspected that lower production in 1993 is due to a massive fish kill caused by Hurricane Andrew in 1992.

Based on available data, it is difficult to draw definitive conclusions about the health of the largemouth bass population in the BTES, however, the population is generally thought to be stable. 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 Lac des Allemands and Lake Verret.

Average Annual Catch Per Unit Effort (CPUE) for Largemouth Bass in Lac des Allemands/ Bayou des Allemands and Lake Verret



There are no data for years where there is no bar.
Source: LDWF Inland Fisheries Division. CPUE determined by electrofishing from March to December.

Largemouth Bass, courtesy of Duane Raver, USFWS.

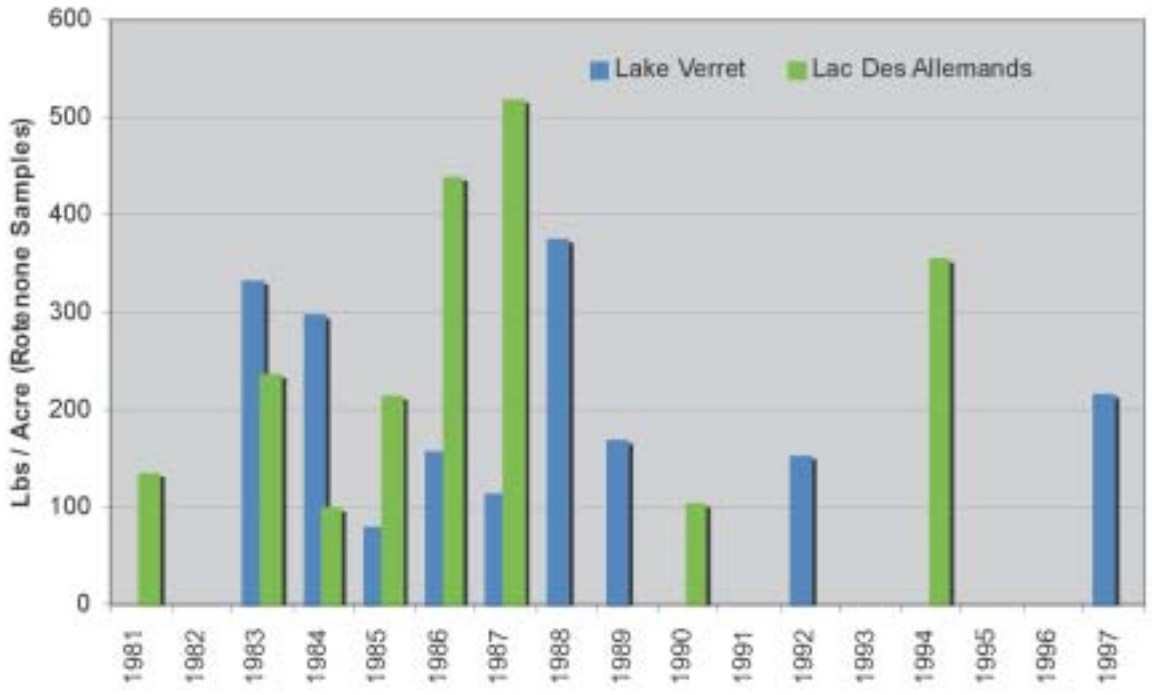
Indicator #12: Freshwater catfish abundance

BTES residents and visitors alike enjoy freshwater catfish as a local delicacy, and therefore, catfish are an important recreational and commercial species. 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. Blue catfish can tolerate low salinity waters (i.e., less than 10 parts per thousand), and are often found in brackish marsh. Channel catfish are somewhat less tolerant of low salinity waters.

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. Existing data indicate that both populations are stable. The variability represented in the graph is not unexpected for a healthy catfish population in an estuarine system. Most variability is probably due to salinity and water flow changes from weather-related effects such as drought. Both lakes are subject to blooms of noxious algae called colonial cyanobacteria, 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.

While existing data indicate that freshwater catfish populations in the BTES are stable, land loss and saltwater intrusion in the BTES could cause catfish populations to decline. For these reasons, BTNEP will continue to track blue and channel catfish abundance in Lac des Allemands and Lake Verret.

Average Annual Abundance of Freshwater Catfish – Blue and Channel Catfish– in Lac des Allemands/ Bayou des Allemands and Lake Verret



There are no data for years where there is no bar.
Source: LDWF Inland Fisheries Division. CPUE is determined by pounds of blue and channel catfish combined, collected on the first day of rotenone application to one acre samples. Sampling is conducted from May to September.

Blue Catfish, courtesy of Duane Raver, USFWS.

Channel Catfish, courtesy of Duane Raver, USFWS.

Fresh
0 ppt

Brackish
5 ppt

Bay
10-15 ppt

Gulf
30-35 ppt

What is salinity?

Salinity refers to the concentration of salts dissolved in water. Estuaries are where freshwater from rivers and saltwater from the ocean mix, resulting in a wide range of salinities, which is measured in parts per thousand (ppt). We can generally associate the following salinities and habitats (see graphic).

Indicator #13: Alligator nest density

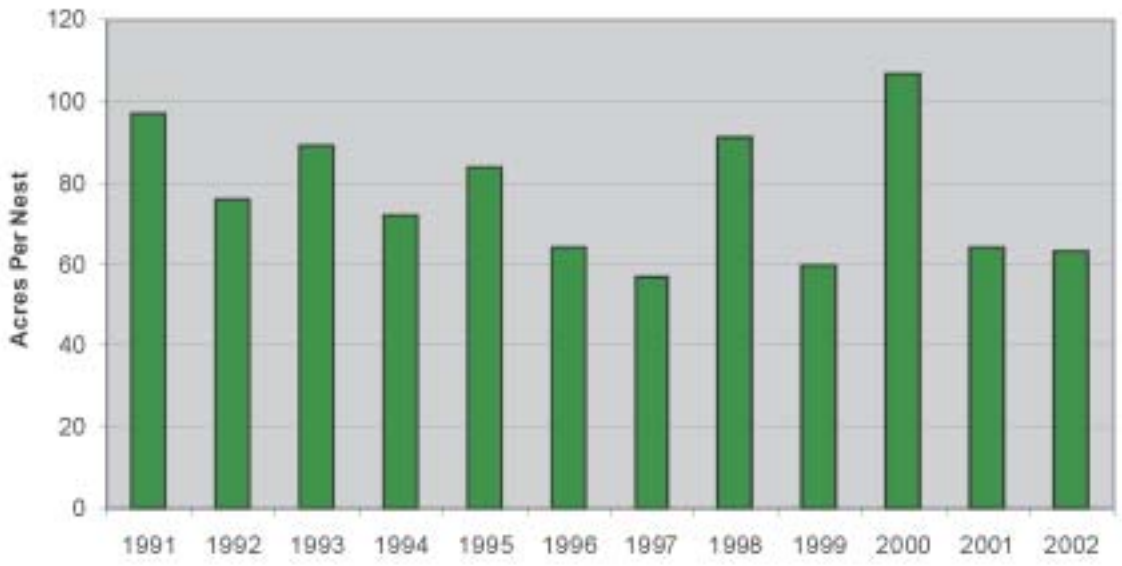
The American alligator (*Alligator mississipiensis*) is the largest resident reptile in the BTES. Alligators eat virtually anything, and can be found from the swamps in the northern part of the BTES to the estuary's brackish marshes in the south. Alligators nest in predominantly freshwater, marshy habitats where the water's salinity is less than 10 parts per thousand. The alligator is sensitive to land loss in the BTES – without healthy coastal wetlands acting as a buffer between land and sea, the inland portions of the BTES will be exposed to water with higher salt content, which will eventually affect the nesting success of our alligator population.

Courtesy of W.L. Berry, LL&E.

Alligators are hunted for their soft belly skin, which produces high quality leather. Past extreme hunting pressures have subsided as a result of new harvesting restrictions. The harvest of wild alligators and collection of alligator eggs, a cultural tradition in the BTES, is generally lucrative. Although hide, meat, and egg prices fluctuate, the long-term outlook for these commodities is positive.

Scientists think that alligator populations in southeast Louisiana are stable to increasing. Nest density data indicate that the BTES provides shelter to a stable number of alligator nests (*note that a lower number – acres per nest – in the graph translates to a larger number of alligator nests in the BTES*). The number of nests in any given year, however, is subject to environmental conditions, such as drought, and probably does not reflect annual population fluctuations. Drought, which generally lowers water levels and increases salinity in the marshes, was the probable cause for relatively lower nesting activity in 1998 and 2000.

American Alligator Nest Density in the Barataria-Terrebonne Estuary System



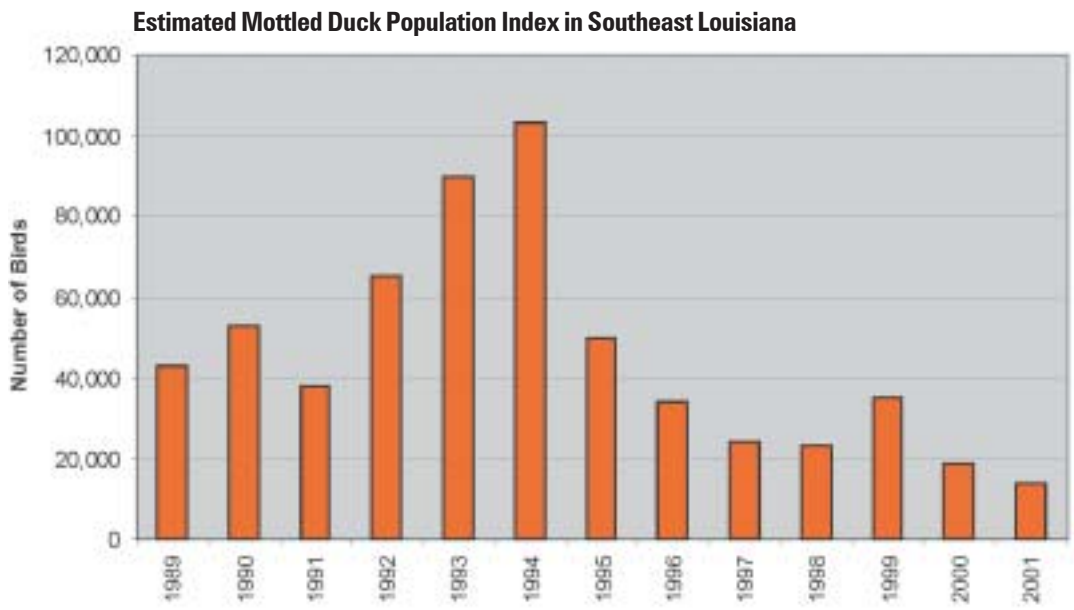
Source: LDWF Fur and Refuge Division, Annual Alligator Nest Survey. Number of nests determined by LDWF personnel flying parallel transects across the BTES (Terrebonne, Lafourche, Jefferson, St. Charles, St. John, Plaquemines [West], and Plaquemines [Delta] Parishes) and counting nests in surveyed areas. 24,004 acres surveyed from 1991 to 1998; 33,798 acres surveyed in 1999; 34,143 acres surveyed from 2000 to 2002.

Indicator #14: Mottled duck abundance in southeast Louisiana

The BTES serves as a refuge to a large number of species of migrating waterfowl in any given year. The mottled duck (*Anas fulvigula*) is the only resident waterfowl species in the marshes of coastal Louisiana, including the BTES. In fact, scientists estimate that over half of the North American mottled duck population resides in Louisiana. This duck resides and nests primarily in fresh and brackish marshes, and adjoining agricultural habitats. Ducklings seem to survive best when raised in water with a salinity of less then 9 parts per thousand.

Mottled duck population indices have varied widely from year to year, and there are many factors that affect the annual population – for example, drought, marsh loss, development, and predation. Degradation of fresh and brackish marshes by erosion, saltwater intrusion, and general land loss might be the most influential factor, while hunting is generally regarded not to have a large impact on the population. Scientists tell us that the mottled duck population in southeastern Louisiana is currently stable, but there is growing concern about an emerging downward trend.

Estimated Mottled Duck Population Index in Southeast Louisiana



Source: LDWF Wildlife Division. Estimates made by flying similar coastal transects each year in November.

Mottled duck, courtesy of BTNEP.

FOCUS QUESTION 4: How are *threatened* and *endangered species* faring?

The purpose of the Endangered Species Act, passed in 1973, is to conserve "the ecosystems upon which endangered and threatened species depend" and to conserve and recover listed species. Under this federal law, species may be listed as either *endangered* or *threatened*. 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. Listings are made on the basis of the species' biological status, and threats to its existence.

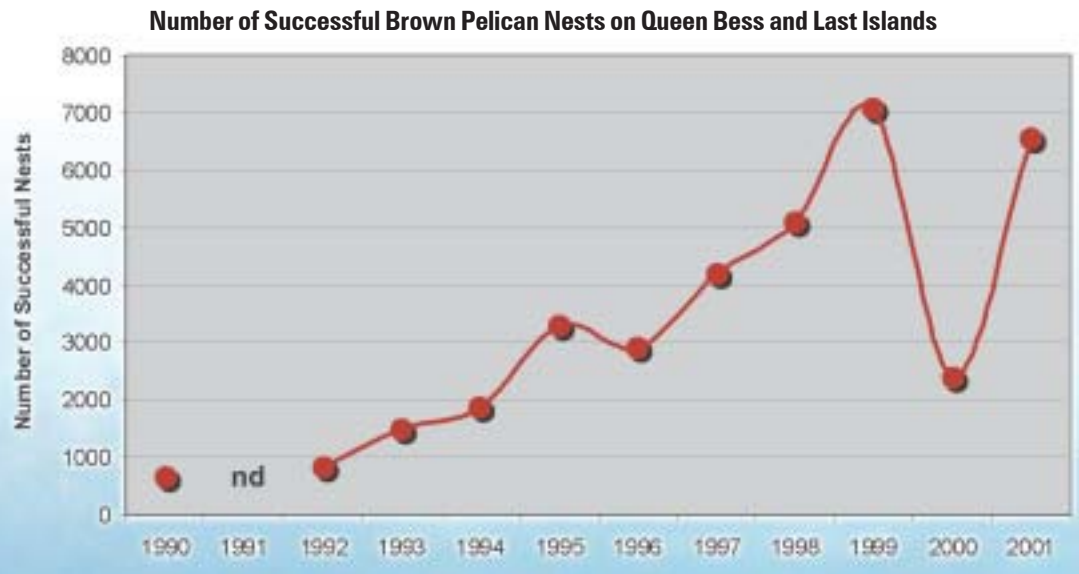
Indicator #15: Bald eagle nesting success

The bald eagle (*Haliaeetus leucocephalus*) population in Louisiana has been impacted historically by pesticides, hunting, and habitat changes, causing it to be listed as an endangered species under the federal Endangered Species Act. The principal factor causing population declines was related to persistent toxic substances. As top carnivores in the estuary food chain, bald eagles can accumulate persistent toxic substances, such as the pesticide DDT and the manufacturing product, polychlorinated biphenyls (PCBs), at concentrations that can impair their ability to reproduce. The nesting success of the bald eagle is an important indicator of recovery efforts for this species.

The number of successful bald eagle nests in the BTES has risen from well below 50 in the early 1990s to over 125 in 2000 and 2001. In 2001, over 200 fledglings (young eagles that successfully reach flight stage, normally at 10 to 12 weeks of age) were produced in the BTES. This recovery has allowed the downlisting of bald eagles in Louisiana from endangered to threatened in 1995. Banning the use of DDT is the major cause of population recovery, as well as habitat protection and increased public awareness and education. The population in the BTES appears stable, and probably is expanding.

Bald Eagle, courtesy of U.S. Fish and Wildlife Service.

Indicator #16: Brown pelican nest abundance



Source: LDWF Fur and Refuge Division. Number of successful nests determined by LDWF personnel conducting annual aerial surveys of Queen Bess and Last Islands.
nd = no data

The brown pelican (*Pelecanus occidentalis*) is a long-time inhabitant of coastal Louisiana. In the BTES, the brown pelican nests on dune habitat on Queen Bess and Last Islands. Unfortunately the presence of persistent toxic pesticides, particularly Endrin, reduced nesting of the native pelican population to zero in the early 1960s. The species was consequently 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 – the placement of rock breakwaters at the east end of Last Island and the placement of rock breakwaters around Queen Bess Island – have reduced wave erosion of critical nesting habitat.

The number of successful nests in the BTES has risen from 675 in 1990 to over 6,500 in 2001. The population appears stable. The dramatic decrease in nests in 2000 was due to high tides that inundated nests in April of that year. A second nesting attempt produced both nests and young, but at considerably lower levels than the year before. Nesting activity increased to expected levels again in 2001.

An ecological success story...

The number of successful brown pelican nests in the BTES has risen from less than 1,000 in 1990 to over 6,000 in 2001. Because of this population rebound, the U.S. Fish and Wildlife Service removed the brown pelican from the List of Endangered and Threatened Wildlife, under the Endangered Species Act, in July 1998.

Juvenile Pelicans, courtesy of U.S. Fish and Wildlife Service.

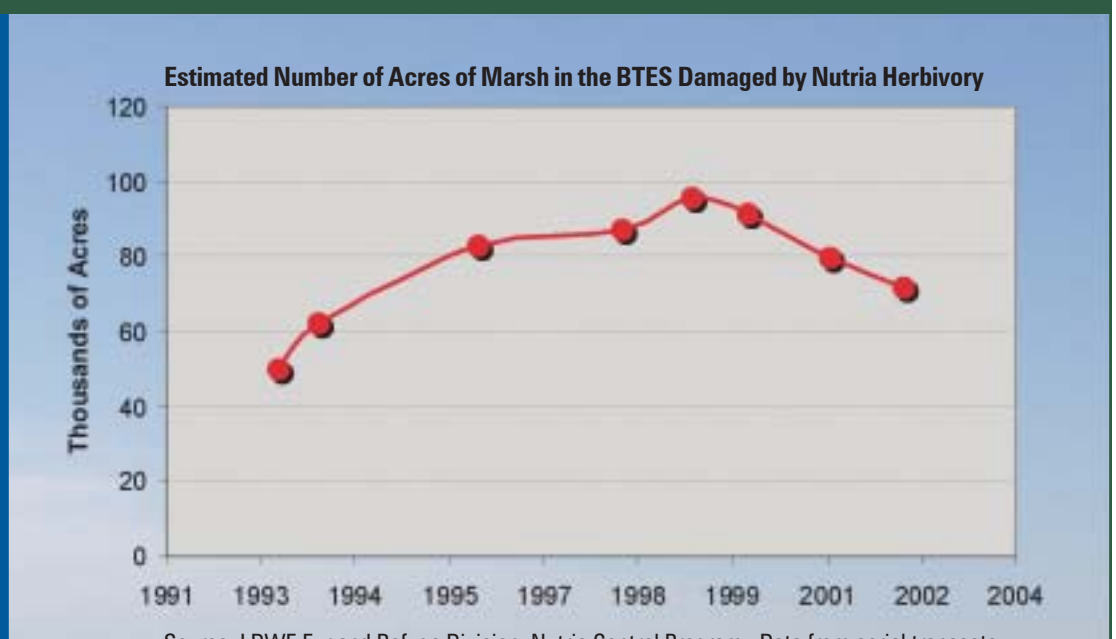
FOCUS QUESTION 5: Are non-native species *a problem*?

Many plants and animals that are native to other states and countries are now living and multiplying in the BTES. A wide range of human activities has brought, and continues to bring, untold numbers of these **non-native species** to the BTES. This can happen in obscure ways, for example, recreational boaters can unintentionally pick-up pieces of non-native aquatic plants on their boat trailers and deposit these into Louisiana waters. Large ships can cause similar introductions of non-native plants and animals when they discharge ballast water in Louisiana that was taken in at foreign ports. Other introductions can be intentional, for example, when local residents release non-native plants and animals purchased at nurseries and pet stores. While only a few of these introduced species ever become new residents of the BTES and cause problems by invading native ecosystems, the consequences of these few invasions are usually very costly – both ecologically and economically. Scientists tell us that preventing uncontrolled introductions of non-native species is the best way to avoid harmful impacts to the health of the BTES and our regional economy.

Indicator #17: Acres of marsh damaged by nutria

The nutria (*Myocastor coypus*), a large semi-aquatic rodent native to South America, was brought to Louisiana in the 1930s to create a fur-farming industry. After escapes from captivity and possibly several intentional introductions, a large nutria population is now well established in the marshes of coastal Louisiana. Without natural predators in the BTES, except for the alligator, the population continues to grow, outcompeting the native muskrat. Nutria are herbivores (i.e., animals that feed on plants) and feed on marsh plants, but because they eat the roots of these plants, the areas they damage often do not recover. This serious damage to marsh areas contributes to erosion and land loss. Nutria also eat agricultural crops, including sugar cane, and have damaged rice field irrigation dikes. As the size of the nutria population increases, so does their damage to BTES marshes, harm to native species, and impact on regional agricultural productivity.

Surveys by Louisiana Department of Wildlife and Fisheries scientists tell us that over 72,000 acres of marsh in the BTES were damaged by nutria herbivory in 2002. Data collected (see graph) appear to indicate that nutria damage is steady. Nutria herbivory is one more contributor to the land loss problem in the BTES. State agencies are currently trying to develop a viable nutria meat market, for example through an incentive program, as a means to reduce their population to a level that might inflict less damage on Louisiana's marshes. The agencies included in the Coastal Wetlands Planning, Protection, and Restoration Act (CWPPRA), have approved funding for the Coastwide Nutria Control Program which will provide an incentive payment to registered participants for each nutria taken during the open trapping season. The area in which the program takes place is south of Interstate 12 from Baton Rouge to Slidell, and south of Interstate 10 from Slidell to the Mississippi State line. The BTES falls within this program area and will potentially benefit from the removal of nutria.



Source: LDWF Fur and Refuge Division, Nutria Control Program. Data from aerial transects of the BTES; transect total is extrapolated to the entire BTES.

Nutria, courtesy of BTNEP.

 Wetland, courtesy of Guy Fanguy.

What are the **costs** to *control non-native species*?

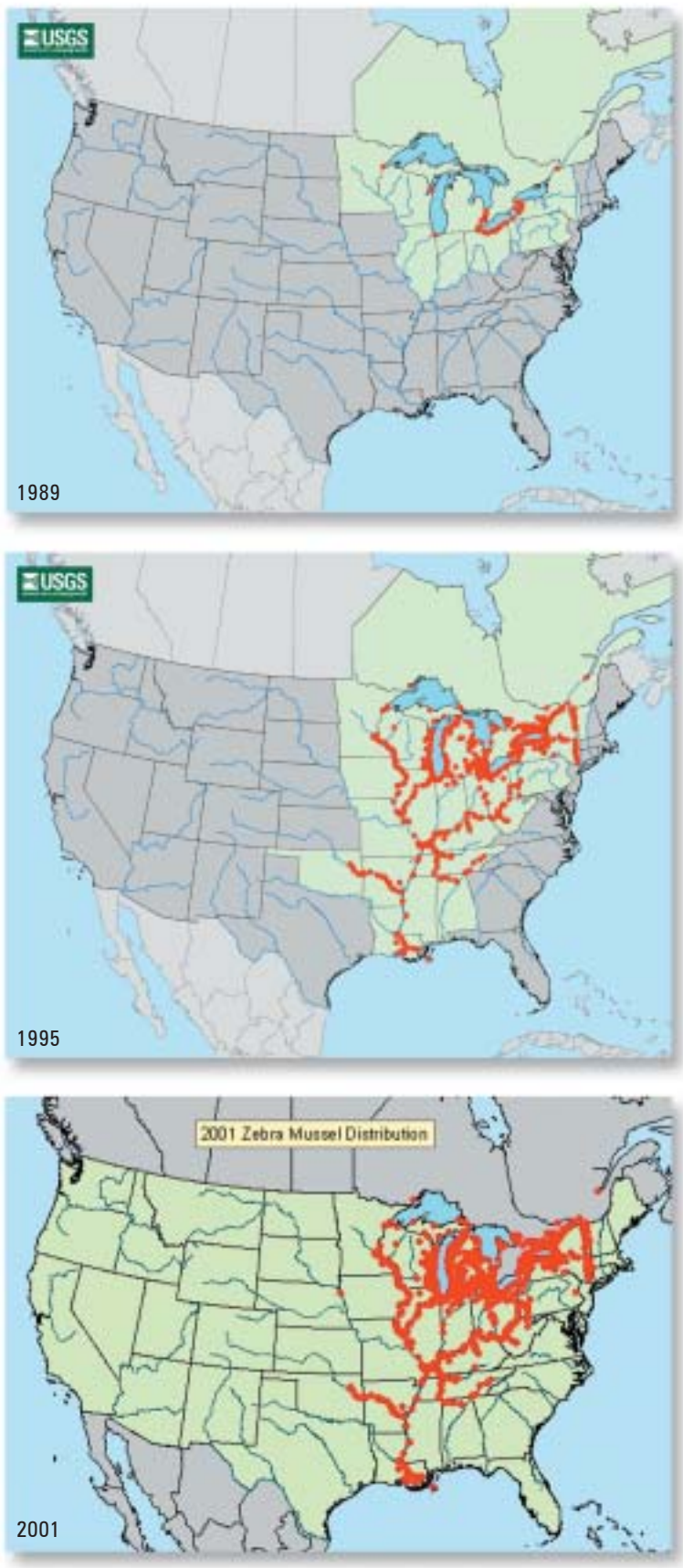
A **non-native** species is one that is intentionally or unintentionally **introduced** (i.e., moved) beyond its natural range, for example when a species is moved from one continent, country, or state into another. Often used synonyms include nonindigenous, foreign, and alien species. Only a few non-native species become **established** in a breeding population in the new area. Fewer still become **invasive species**, threatening native species or agricultural or recreational activities. The ecological and economic impact of these few invasive species, however, has proven to be enormous.

Both state and federal agencies now spend considerable amounts of public money to control the spread of invasive aquatic plant species, particularly water hyacinth (*Eichhornia crassipes*), hydrilla (*Hydrilla verticillata*), and common salvinia (*Salvinia minima*). The Louisiana Department of Wildlife and Fisheries reports spending nearly $1.5 million annually on non-native aquatic plant control. Similarly, the New Orleans District of the U.S. Army Corps of Engineers spent approximately $1.5 million on aquatic plant control in Louisiana's coastal region in Fiscal Year 2001. Similar cost figures to control other nuisance non-native plants and animals are not available, but would likely add up to a considerable expenditure of public funds.

Hydrilla, courtesy of David Spencer, WRIC.

Indicator #18: Zebra mussels in the Mississippi River watershed

Distribution of the Zebra Mussel in the Mississippi River Watershed in 1989, 1995, and 2001



Source: U.S. Geological Survey. Red dots denote locations where zebra mussels were collected.

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. Since that time, this species has spread rapidly to freshwater lakes, streams, and rivers throughout the United States, using the Mississippi River as a conduit to spread south toward Louisiana. The zebra mussel is a well-documented nuisance species, which competes with native mussels for food and substrate, and fouls water intakes, filtration systems, and other infrastructure.

In 1995, just seven years after their introduction, zebra mussels were reported in over 15 states in the Mississippi River watershed. In Louisiana that same year, zebra mussels were reported in both the Mississippi and Atchafalaya Rivers. By 2001, there were several reports of zebra mussels within the BTES. It is assumed that the zebra mussel is now a permanent resident of the BTES, and its full impacts are yet to be seen.

Zebra mussel, courtesy of Rob Ray.

Experts agree that preventing new introductions of non-native species is the best and most cost effective way to control the impacts of invasive species, such as the zebra mussel.

FOCUS QUESTION 6:

Are *concentrations* of *toxic substances* increasing or decreasing?

The use of chemicals is a necessary part of our economy and community, and provides great benefit to our daily lives by, for example, protecting crops from insects, helping us clean our homes, and providing fuel for our cars and boats. There are specific chemical substances, however, that when released to our lakes, bayous, and bays, can be toxic to both wildlife and humans. Chemical substances of concern are usually (1) persistent, that is, they do not break down quickly in the natural environment, and (2) bioaccumulative, that is, they are passed up the food-web concentrating in larger animals such as fish and birds. The presence of such persistent toxic substances in the environment is suspected of causing great declines in populations of both the bald eagle and the brown pelican (see Indicators 15 and 16). In addition, humans must be careful to avoid eating fish that has high levels of mercury (see Indicator 21).

It is therefore important to monitor the concentrations of chemical substances in the BTES – specifically in surface waters, in sediments, and in the tissues of fish, shellfish, and aquatic wildlife – and to understand the ecological and human health risks associated with toxic substances found in these different media.

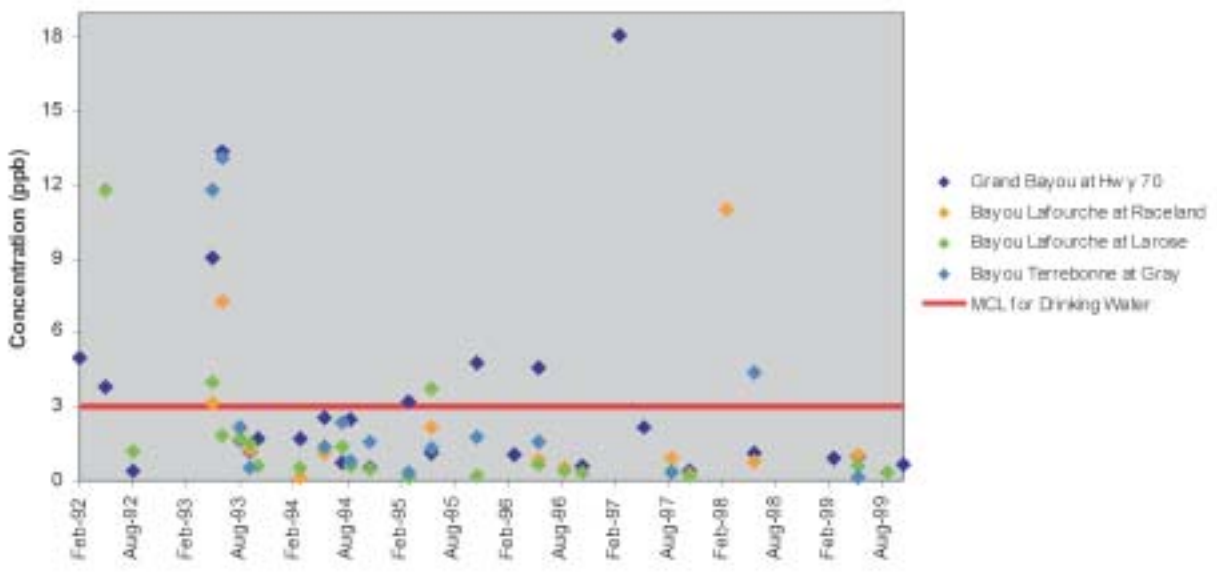
Indicator #19: Atrazine concentrations in northern BTES surface waters

Atrazine is an agricultural herbicide that does not readily break down in the natural environment. It is used extensively to treat sugarcane and corn fields within the BTES. There is concern that runoff from fields treated with atrazine could contaminate lakes and bayous that are 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) 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 pesticides/herbicides throughout the state. Project results indicated that atrazine concentrations in the surface waters of the Upper Terrebonne Basin were reaching levels in excess of the 3 ppb MCL. Because the Upper Terrebonne Basin includes bayous that are the sole source for drinking water supplies for over 250,000 people, LDAF continues the monitoring program (in cooperation with the Department of Environmental Quality).

Review of the available data shows that, through 1999, atrazine entered the waters of the Upper Terrebonne Basin in concentrations that are, in a minor number of instances, several times greater than the atrazine MCL of 3 ppb. Elevated levels generally occur in conjunction with application of atrazine in the spring and correspond to rainfall events.

Atrazine Concentrations at Four Sampling Stations in the Upper Terrebonne Basin, as Compared to the U.S. EPA 3 parts per billion (ppb) Maximum Contaminant Level (MCL) for Drinking Water.



Source: Louisiana Dept. of Agriculture and Forestry

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

Based on the MCLG, 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, considering the ability of public water systems to detect and remove contaminants using suitable treatment technologies. Current regulations require water suppliers to periodically monitor atrazine levels, and in cases where these levels are consistently above the MCL, the supplier must take steps to reduce atrazine levels so that they are consistently below the MCL. Treatment with granular activated charcoal has been approved by U.S. EPA for removing atrazine from drinking source waters.

Courtesy of Photodisc.

Indicator #20: Number of petroleum and chemical spill reports

Number of Oil and Chemical Spill Notifications to the U.S. Coast Guard National Response Center from Two U.S. Coast Guard Marine Safety Offices Adjacent to the BTES

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

The State of Louisiana supports a large oil and gas industry, which supplies a considerable portion of the nation's energy needs. A sizable share of the state's exploration, transport, and production activities occur in our own BTES, and accidental spills to the estuary do occur. While the oil and gas industry constantly works to limit such events, petroleum spills release toxic substances to the estuary's surface waters and sediments. Monitoring the number of spills is important because spills often cause negative impacts to the estuary. Monitoring spills also allows us to track the success of spill reduction efforts.

Of 56 United States Coast Guard (USCG) Marine Safety Offices (MSO), the two representing most of the area of the BTES – MSO New Orleans and MSO Morgan City – consistently rank at the top of the list based on number of oil and chemical spill notifications received. In fact, on an annual basis, these two MSOs report more than double the number of spills from other MSOs in the United States. Since 1991, the number of spill notifications to MSO New Orleans and MSO Morgan City appears relatively consistent. Industry and industry/government partnership efforts to reduce spills will hopefully decrease the number of spills.

Oil platform, courtesy of Getty Images.

FOCUS QUESTION 7: Are Seafoods *Safe* to Eat ?

Seafood is plentiful in the BTES and is an important part of our culinary history and culture. In general the quality of Louisiana seafood, including fish and shellfish caught in the BTES, is excellent. To ensure that these seafoods continue to be safe to eat, several state agencies spend significant resources monitoring both the tissues of the 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, such as pesticides and heavy metals, released into our estuary can accumulate in the fish and shellfish that we love to 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 in the assessment of scientific information to determine human health risks from eating locally-caught fish and shellfish. When a problem is found for a particular toxic substance in a fish species at a specific location, these agencies (along with the Louisiana Department of Wildlife and Fisheries) jointly issue a fish consumption advisory. At present, there is only one fish consumption advisory applicable to the BTES, the statewide king mackerel advisory due to mercury contamination.

2002 statewide king mackerel advisories:

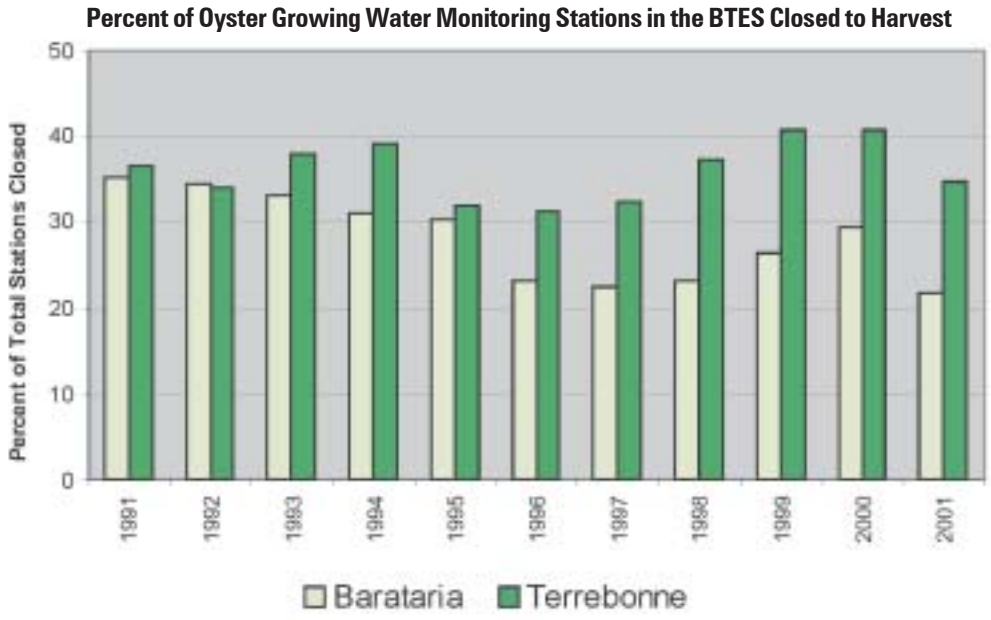
- For king mackerel 39 inches or less in total length, pregnant/breast-feeding women and children less than 7 years of age should eat no more than ONE MEAL PER MONTH. Non-pregnant women, men, and children greater than 7 years of age should limit consumption to TWO MEALS PER MONTH.
- King mackerel greater than 39 inches in total length should not be consumed by any individuals.

Check the Louisiana Department of Environmental Quality website for active fish consumption advisories in the state: http://www.deq.state.la.us/surveillance/mercury/fishadvi.htm. These advisories are also posted in the annual Louisiana Department of Wildlife and Fisheries fishing regulations.

Crab and shrimp, courtesy of Guy Fanguy.

Indicator #22: Bacteriological water quality of oyster harvesting waters

Percent of Oyster Growing Water Monitoring Stations in the BTES Closed to Harvest



Source: LDHH Molluscan Shellfish Program. September to October classification. The total number of stations monitored in the Barataria Basin decreased from 142 to 129 beginning in 1999. The total number of stations monitored in the Terrebonne Basin increased from 197 to 201 beginning in 1995.

Oyster Growing Water Monitoring Stations in the BTES and an Example Closure Line

Source: Map adapted from NOAA and USEPA GMP. 1997. *Gulf of Mexico Oyster Data, Arcview Projects* CD-ROM.

Dredging for oysters, courtesy of BTNEP.

Pathogens are organisms such as bacteria and viruses that cause disease. **Fecal coliform bacteria** come from human sewage, from pasture land runoff, and from marsh animals such as nutria and waterfowl. **Human sewage pollution** can come from improper sewage treatment, failing septic systems, faulty aerobic treatment plants, and direct discharges of untreated sewage from camps and boats.

Although the dynamic nature of the fecal coliform bacteria indicator makes it difficult to draw definitive conclusions about trends in oyster growing water quality, it appears that the number of closed stations in both the Barataria and Terrebonne basins has remained relatively constant over the last decade. While there has not been an occurrence within the BTES, blooms of the toxic "red-tide" algae, *Karenia brevis*, have also caused emergency mass closures of oyster growing waters in Louisiana. Other toxic algal species occur in the BTES, but have never reached proportions that cause contamination of shellfish.

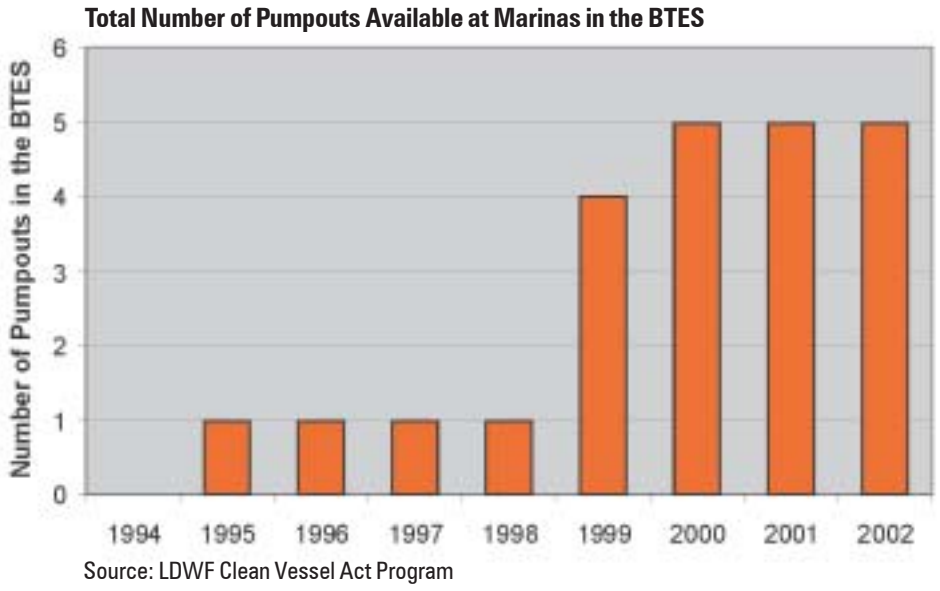
Harvesting oysters, courtesy of Earl Melancon, Jr.

Oysters are a multi-million dollar industry in Louisiana, and 80 percent of Louisiana's oysters are harvested from the waters of the BTES. To live and grow, oysters filter small organisms, including bacteria and viruses from the water. Pathogens from untreated human sewage discharges, filtered from the water by oysters, can cause illness in healthy individuals who eat these oysters raw. In addition, oysters 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 who are 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 a sewage pathogen indicator – fecal coliform bacteria – in oyster growing waters throughout the BTES (sampling stations are pink dots in the map to the left). Based on the results of this monitoring and on the time of year, the state classifies oyster growing waters as "open" or "closed" to harvest. In the example map to the left, waters above the orange closure line are closed to harvest, and those below are open to harvest. The conservative nature of this program has been quite effective in preventing illness from the consumption of sewage contaminated oysters, and the bad press that accompanies an associated illness outbreak. A strong emphasis on proper handling, labeling, and refrigeration by Louisiana's oyster industry has also greatly reduced the risk of contaminated oysters entering the commercial market.

Indicator #23: Number of boat sewage pumpout facilities

In large part, it is Louisiana's waters that make it a *Sportsman's Paradise*. Consequently, there are over 160,000 recreational vessels registered in coastal Louisiana, in addition to thousands of commercial vessels. Pumpouts are facilities provided at marinas that remove sewage from holding tanks in recreational and commercial vessels, so that it may be properly treated. The availability and use of pumpouts is critical to reducing overboard discharges of untreated sewage, especially to oyster growing waters and swimming areas, where sewage contamination can cause human illness. It is suspected that overboard sewage discharges in coastal Louisiana have been responsible for sewage-contaminated oysters, making people ill on at least two occasions in the 1990s. The number of pumpout stations has risen considerably, at both commercial and recreational marinas in the BTES, due to efforts of Louisiana Department of Wildlife and Fisheries. Given the extremely large number of boaters in the BTES, however, many more pumpout facilities need to be installed.



Source: LDWF Clean Vessel Act Program

Some results of overboard sewage discharge...

Outbreaks of gastroenteritis associated with the sewage-related Norwalk (or Norwalk-like) virus have caused five significant emergency spot-closures in Louisiana since 1982. All five outbreaks were linked to illnesses associated with the consumption of raw oysters, and caused significant areas of public oyster seed grounds and private oyster leases to be closed to harvest. Although the exact mechanism by which the suspect oysters became contaminated will remain unknown, there is general agreement that overboard discharges of sewage were a principal contributor to at least two of the five closure events – the 1993 closure at Cabbage Reef and the 1997 closure at Black Bay. Scientists have estimated that the Cabbage Reef closure, which lasted 29 days, resulted in approximately $1.3 million in lost harvest (1993 dollars). The Black Bay closure, which lasted 21 days, is estimated to have cost approximately $1.2 million in lost harvest (1997 dollars). Each event was linked to more than 100 illnesses in multiple states, causing significant negative press about the quality of Louisiana oysters.


A typical pumpout system, courtesy of LDWF Clean Vessel Act Program.

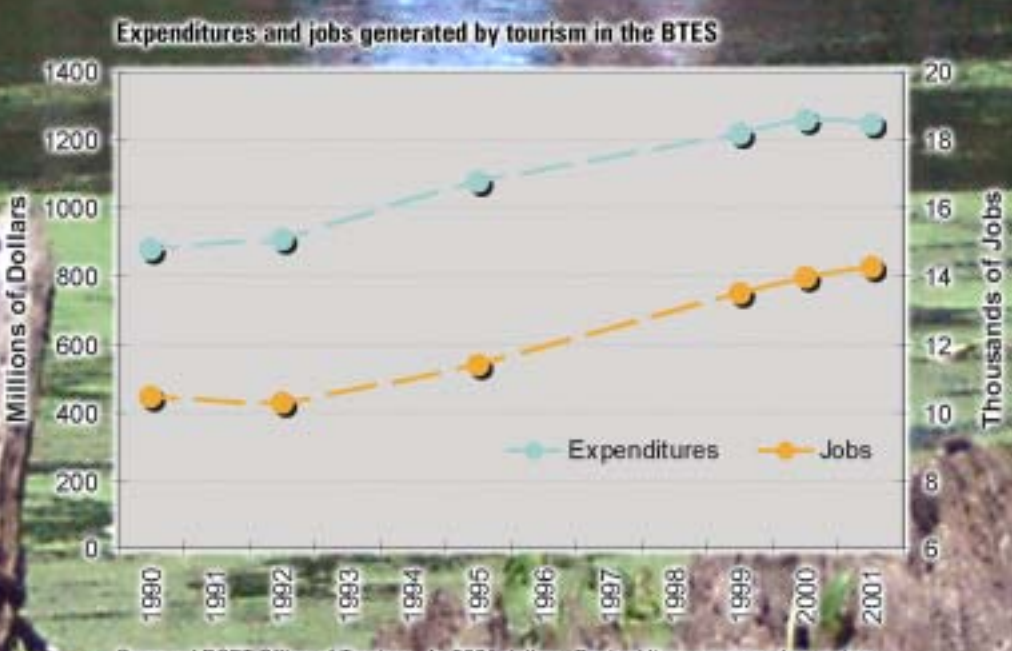
Men on boat, courtesy of Guy Fanguy.

FOCUS QUESTION 8: How are *natural resource-based business patterns* changing?

The BTES supports a wealth of natural resources, and many residents rely on associated businesses for their livelihoods. The major components of this natural resource-based business include tourism, agricultural production, oil and gas production, and recreational and commercial fishing. The supply of many renewable natural resources – particularly the abundance of fishery stocks and the abundance and diversity of wildlife – is dependent upon the health of the BTES marshes and waters. Because a considerable portion of our regional economy is dependent on natural resource-based businesses, it pays – literally – for all of us to support the restoration of the BTES. In the BTES, it can be argued that ecological health and economic health are one in the same.

Indicator #24: Revenues and jobs generated by tourism

Tourism in the BTES makes a considerable contribution to the region's economy, most significantly through the number of businesses and jobs that the industry supports. In 2000, tourists spent over $1.2 billion within the BTES. This spending supported over 14,000 jobs. Both tourism related spending and jobs have grown over the last 10 years. With increasing national interest in nature-based tourism, such as bird-watching, swamp touring, sightseeing, and guided fishing, tourism officials see this positive trend continuing for the BTES.



Source: LDCRT Office of Tourism. In 2001 dollars. Dashed lines connect data points across multiple years.

Supporting Ecotourism: The Grand Isle Bird Day Partnership

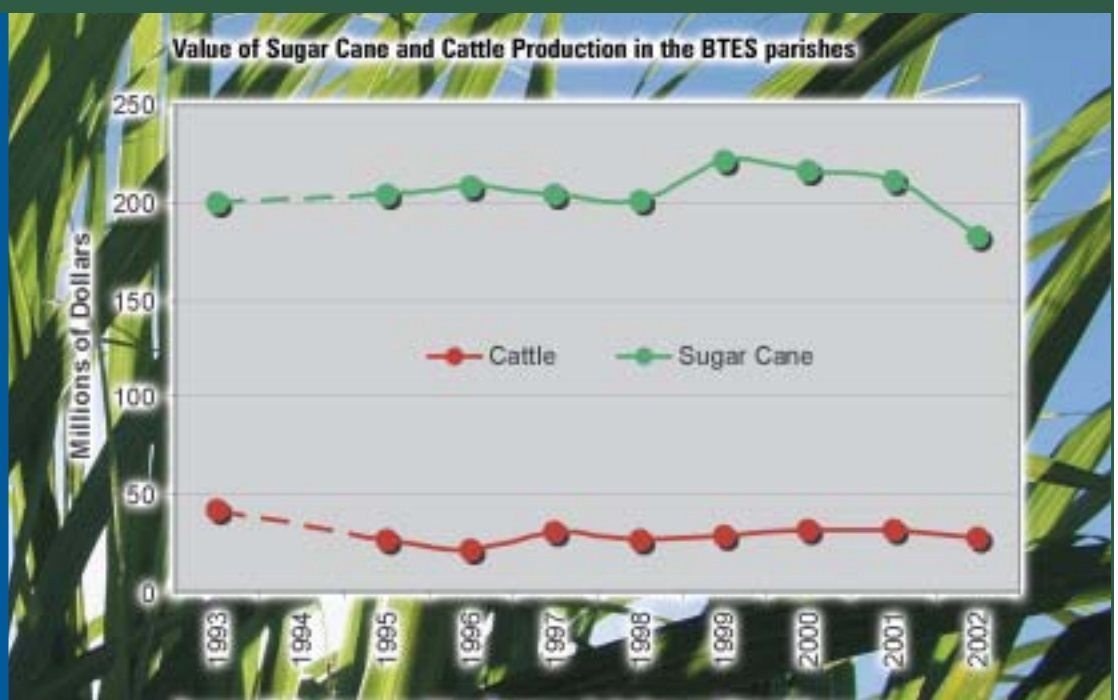
Grand Isle, Louisiana, has held a Migratory Bird Celebration Day for the last four years in order to promote the importance of migratory bird habitat. The event provides eco-tourists the opportunity to witness fall out, when thousands of birds land on the first ground they encounter after crossing the Gulf of Mexico, in the spring on their annual migration north.

Courtesy of Guy Fanguy.

Indicator #25: Value of sugarcane and cattle agriculture

Sugarcane, soybeans, and rice are the dominant agricultural crops in Louisiana's coastal zone. In the BTES, sugarcane and cattle are the two principal agricultural commodities, and these industries are essential to the livelihoods of many BTES residents. In general, crops account for around 90 percent of agricultural sales from the BTES, while livestock make up the remaining 10 percent of sales. While 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, at around $200 million and $30 million, respectively, in the 1990s.

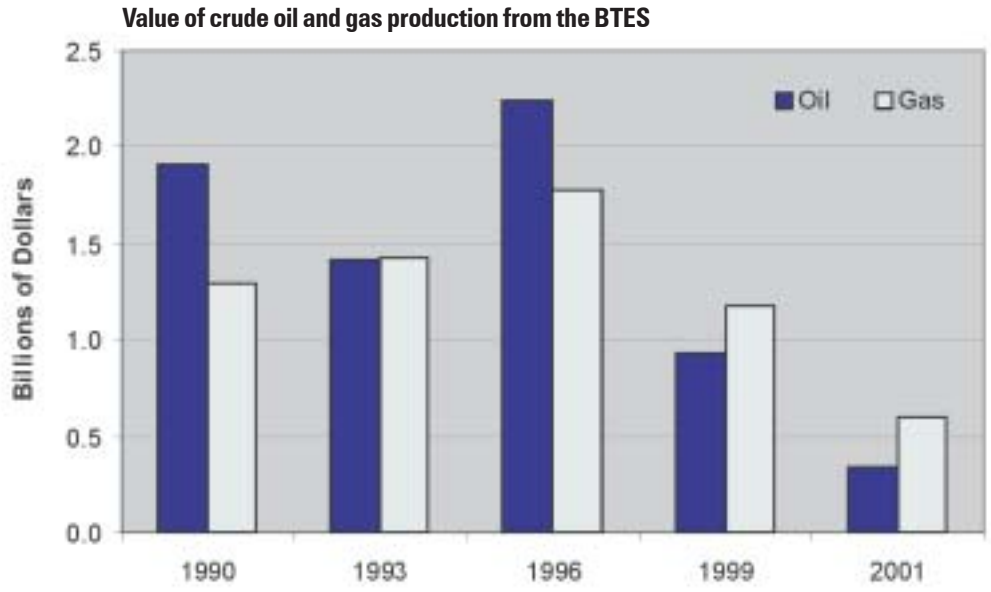
Courtesy of Guy Fanguy.



Courtesy of Guy Fanguy.

Indicator #26: Value of crude oil and natural gas production

Value of crude oil and gas production from the BTES



Source: Louisiana Mid-Continent Oil and Gas Association. Does not account for oil transported through the BTES via pipelines from foreign or offshore sources. In 2001 dollars.

Environmental responsibilities of the **oil** and **gas industry** …

Courtesy of BTNEP.

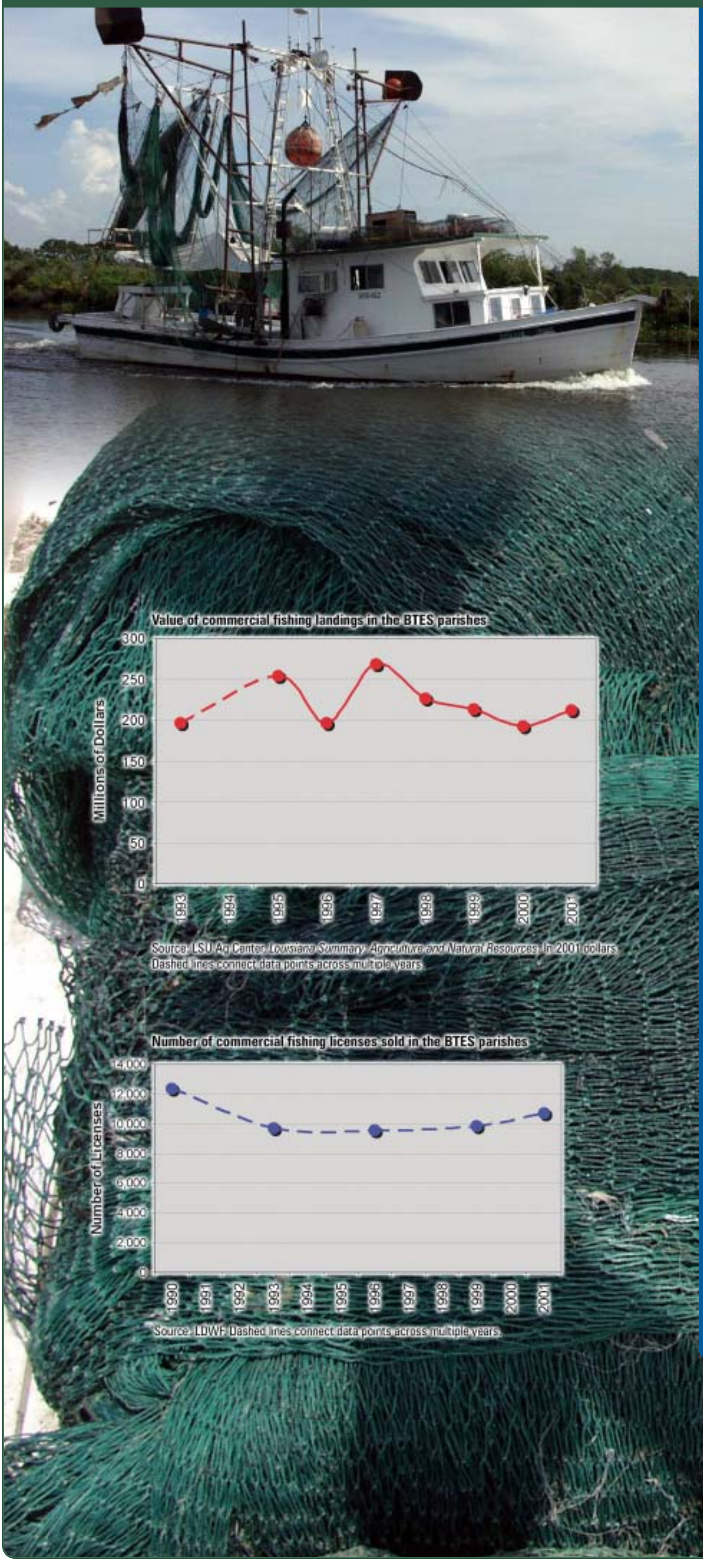
The Shell Pipeline Company LLC's Release Prevention Program functions as both a philosophy and a training tool to impress upon employees the importance of protecting the environment *and* protecting the corporate bottom line by preventing hydrocarbon releases. The program teaches employees more than 70 real-world, 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.

Louisiana has an enormous concentration of crude oil refineries, natural gas processing plants, and petrochemical production facilities. Direct economic benefits to the State of Louisiana from the oil and gas production industry include severance taxes and lease royalties (except for those resources extracted from federal waters). Indirect benefits include employment and income (including those resources extracted from federal waters). 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 has certainly impacted the BTES economy; we all remember the dramatic price drop in the 1980s that caused considerable unemployment and numerous citizens to move 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, south Louisiana. The population of the BTES, however, remains below 1980 levels.

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 canal building for exploration purposes has detrimentally altered the hydrology of the BTES marshes, facilitating saltwater intrusion and contributing to land loss.

Indicator #27 and #28: The value of commercial fishing landings, and the number of commercial fishing licenses in the BTES



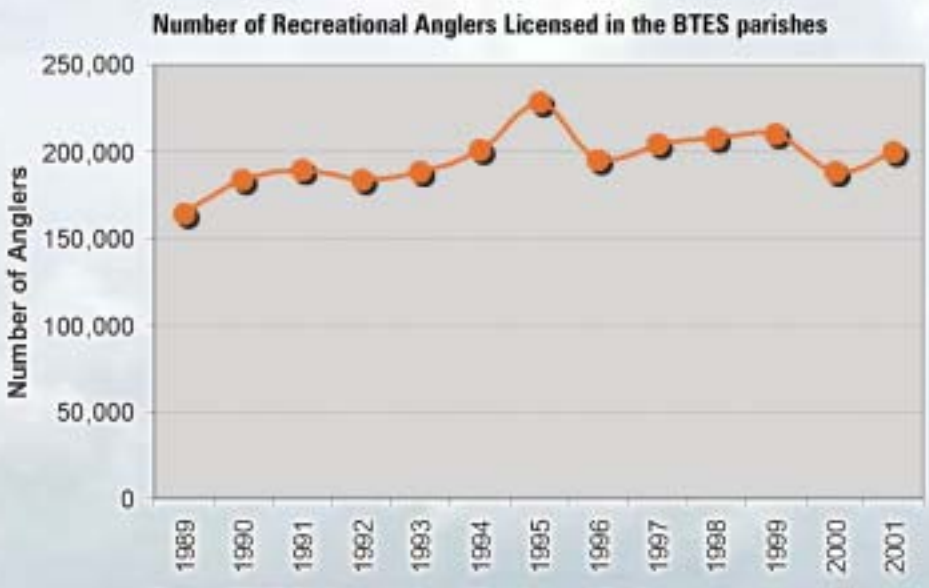
The State of Louisiana ranks second in the nation for overall production of seafood, and commercial landings and associated revenues in the BTES parishes normally represent at least half of the state's totals. The importance of the BTES to commercial fishing in Louisiana, and the nation, is tremendous. As BTES residents know well, commercial fishing is a cornerstone of our economy, and generations of fishermen have shaped our regional culture. The value of commercial landings from the BTES has remained relatively steady at $200 million over the past decade.

The large majority of landings in the BTES and Louisiana are of estuarine-dependent animals, such as shrimp, blue crabs, oysters, and several fishes. Scientists say that most evidence indicates that land loss – the break up of healthy marsh that ultimately converts to open water – actually increases the more productive marsh edge habitat in the short term. This phenomenon may explain why we are not seeing declines in landings, even though we are losing massive areas of healthy marsh. Most scientists agree that there will be some threshold 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 1990s, the total number of commercial licenses sold in the BTES parishes has averaged just over 10,000. State fisheries managers suspect that part-time commercial fisherman are being attracted to renewed opportunities in the oil and gas industry, causing a possible decline in the number of commercial licenses sold in the BTES and statewide. Other reasons for this possible decline may be increased regulations or increased costs.

Shrimp boat and nets, courtesy of Guy Fanguy.

Indicator #29 and #30: Number of recreational fishing licenses, and estimated economic impact of recreational fishing in the BTES



Source: LDWF, Socioeconomic and Development Section

Estimated Sport Fishing Economic Output in the BTES in 1996

	Louisiana*	BTES**
Angler Expenditures	$824,339,739	$269,559,095
Total Economic Output	$1,546,264,215	$505,628,398
Earnings from Employment	$406,206,498	$132,829,525
Number of Jobs	21,507	7,033

* Source: Maharaj, V. and J. Carpenter. 2001. *The 1996 Economic Impact of Sport Fishing in Louisiana.* American Sport Fishing Association.** Louisiana totals multiplied by percentage of licenses in BTES parishes (Pointe Coupee, West Baton Rouge, Iberville, Ascension, Assumption, St. James, St. Mary, St. John the Baptist, Jefferson, St. Charles, Plaquemines, Lafourche, and Terrebonne) versus total state licenses [~32.7 percent] (1996-97 LDWF license data)

Recreational fishing – both freshwater and saltwater – is an activity enjoyed by BTES residents and tourists alike, bringing a significant economic impact to the region. The number of recreational fishing licenses sold in the BTES parishes to both residents and nonresidents remains fairly constant at 200,000 over the last decade. In 2001, this represented about 32 percent of the total recreational fishing licenses sold in Louisiana.

A 1996 study conducted by the U.S. Fish and Wildlife Service and the American Sportfishing Association found recreational fishing activities in Louisiana generated a total economic impact in excess of $1.5 billion. Using the percentage of recreational fishing licenses sold in the BTES versus the total sold in Louisiana as a proxy for the level of recreational fishing activity in the BTES, the total economic impact of recreational fishing in the BTES is estimated at $500 million. It is estimated that this regional activity supports over 7,000 jobs.

Scientists say that most evidence indicates that land loss – the break up of healthy marsh that ultimately converts to open water – actually increases the more productive marsh edge habitat in the short term. This phenomenon may explain why we are not yet seeing declines in fish and wildlife populations, even though we are losing massive areas of healthy marsh. Most scientists agree that there will be some threshold of marsh loss after which rapid population declines of our most valued fisheries species will occur.

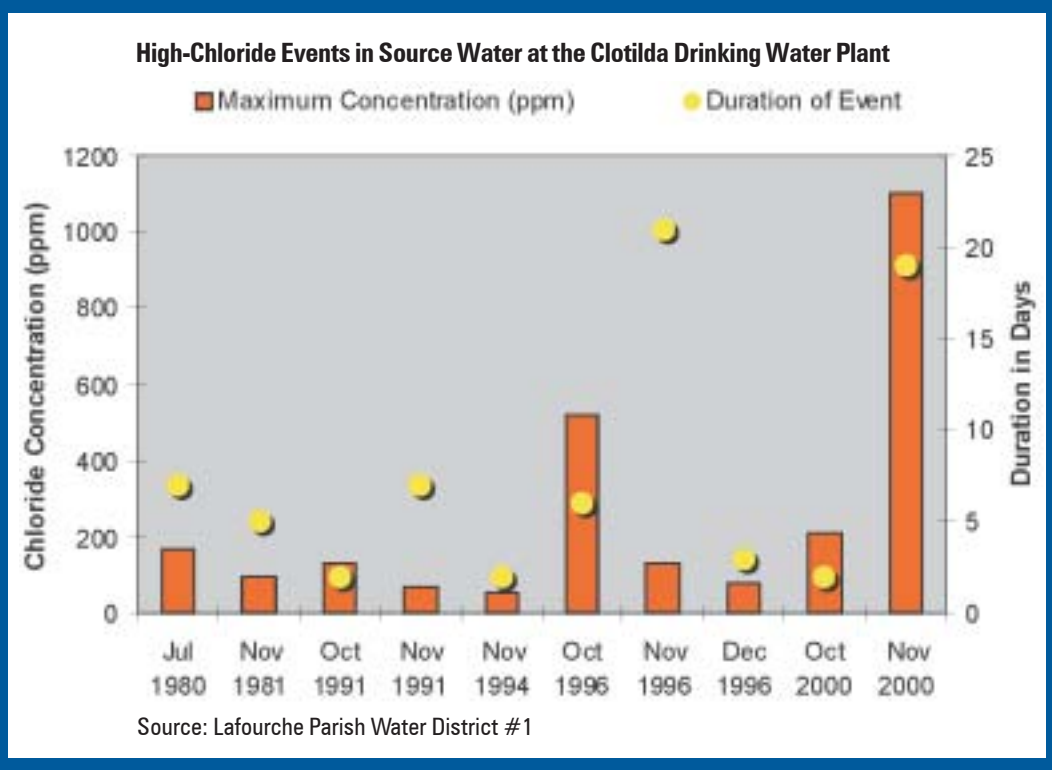
Coastline, courtesy of Guy Fanguy. Boy fishing, courtesy Photo Disc.

FOCUS QUESTION 9: How are *environmental changes* affecting our *quality of life*?

We, the residents of the BTES, are surrounded by water. The bays, bayous, and marshes of the BTES have provided our livelihoods, shaped our regional culture, and given us a home that is truly unique in the United States. We all know, however, that we live in a sometimes precarious balance with these waters. Hurricanes, floods, land loss, saltwater intrusion … these are events that have impacted our lives and livelihoods on numerous occasions. It is important to recognize how large-scale environmental changes in the BTES are currently affecting, and will continue to affect, our families, jobs, and homes.

Indicator #31: Number and duration of high-chloride events in source water to the Clotilda Drinking Water Plant

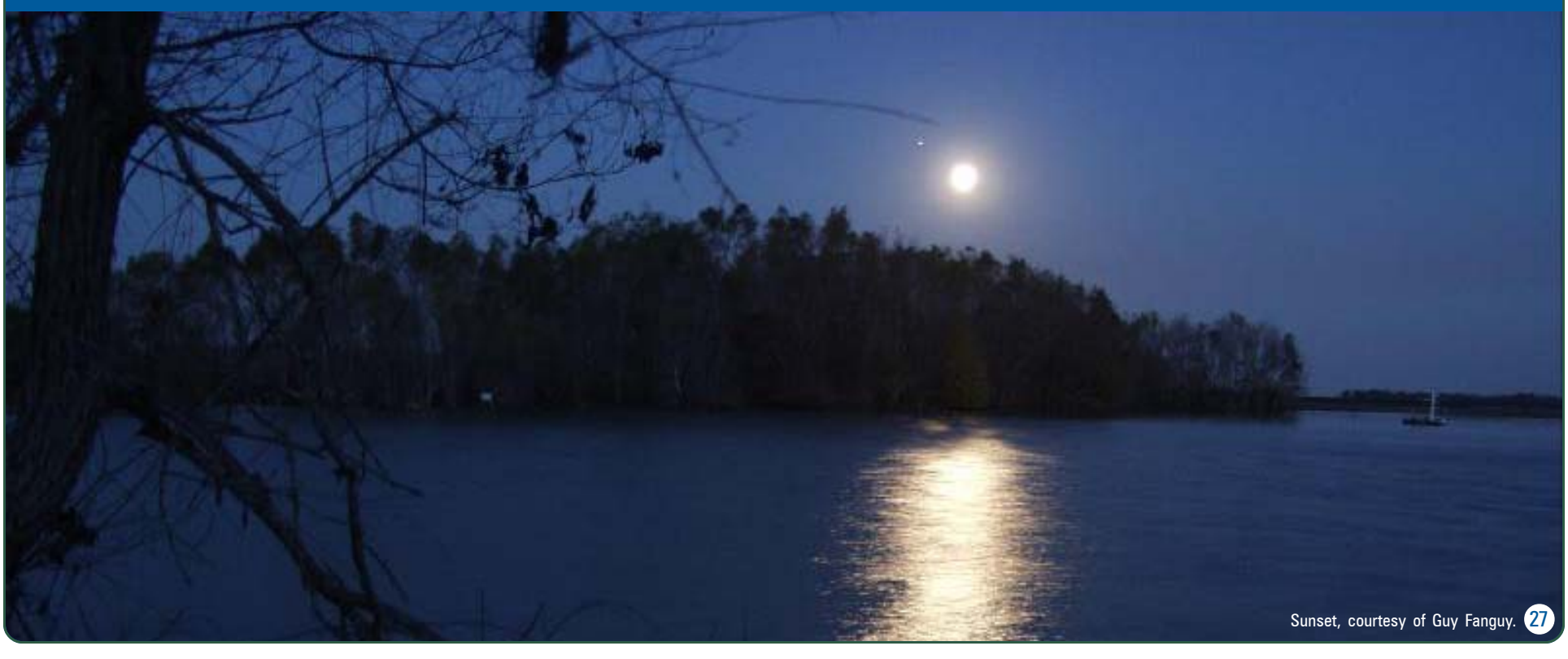
Bayou Lafourche is the source for drinking water for approximately 340,000 residents in the BTES. The Clotilda Drinking Water Plant, the southernmost drinking water plant in Lafourche Parish, draws water from Bayou Lafourche just north of Lockport, and provides treated water to numerous surrounding communities. Normal chloride – or salt – concentrations at this water intake are generally around 35 parts per million (ppm). For reference, full strength seawater from the Gulf of Mexico is usually 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. This concentration will cause unpleasant tastes, odors, or colors, but will not cause adverse health risks.



Source: Lafourche Parish Water District #1

High chloride events, times when source water had a chloride concentration greater than 35 ppm, have been reported at the Lafourche Parish plant approximately ten times since 1980. Since 1996 there have been two occasions where chloride concentrations have been above the SMCL threshold of 250 ppm. In fact, in 2000, a high-chloride event lasted more than 20 days and chloride concentrations rose to as high as 1100 ppm. While water extracted from Bayou Lafourche is always treated before human consumption, the treatment process is ineffective at removing high levels of chlorides. As many residents will recall, unpleasant salty drinking water was delivered to our taps during the high chloride event in 2000.

Salty Gulf of Mexico water entering Bayou Lafourche is caused by many factors, often working together in complicated ways. A simple contributor could be a sustained south wind, but in the long-term, these high chloride events are indicative of land loss and the degrading health of our marshes. One mechanism to combat this major threat to our quality of life is to increase the flow of Mississippi River water down Bayou Lafourche. Of course this would have to happen in a manner that does not increase the risk of flooding in our communities.


Sunset, courtesy of Guy Fanguy.

Courtesy of Photodisc.

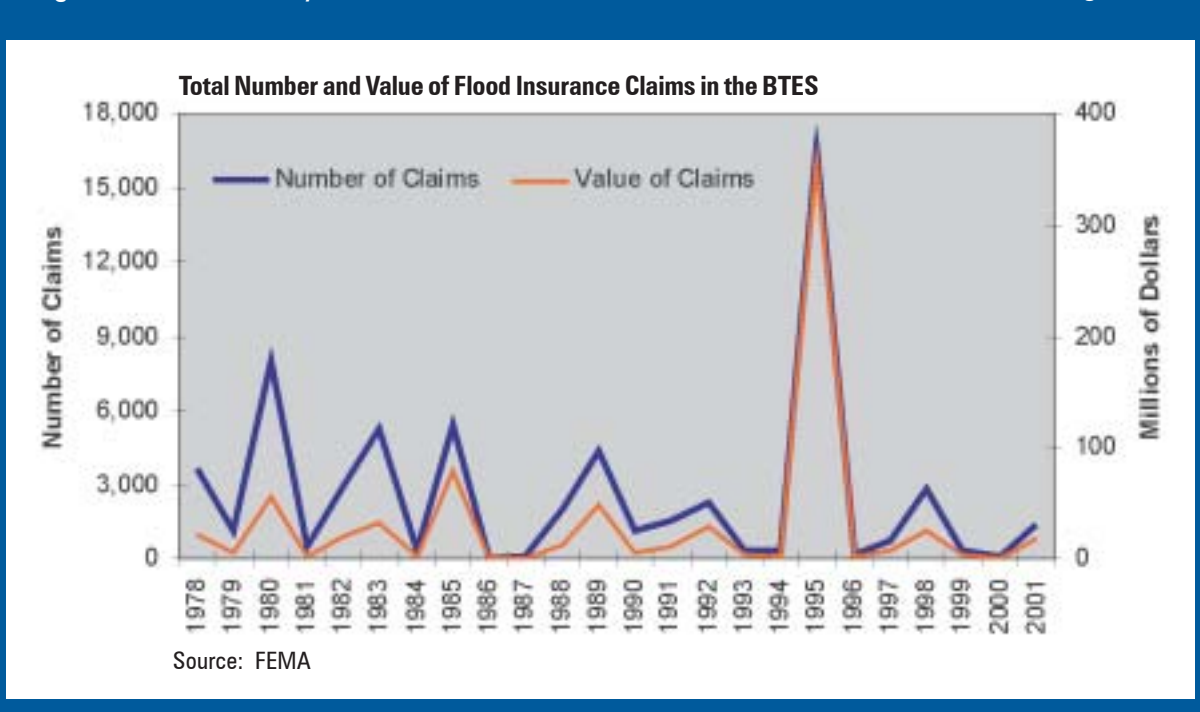
Indicator #32: Number and value of flood insurance claims

Bayou Decade after Hurricane Lili, October 2002, courtesy of Guy Fanguy.

Pump station in Terrebonne Parish,courtesy of Gulf of Mexico Program.

Pump station on the hurricane levee, courtesy of BTNEP.

Most communities within the BTES are located on low-lying land, and 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 5 feet below sea level. In some "higher" areas within the BTES, like Thibodaux and the West Bank of New Orleans, ground floors are only 15 feet above sea level. Because many communities are built on such low-lying land, an extensive system of levees has been constructed in the BTES. These levees, however, can prevent water from draining naturally back into the marsh, so over 250 pump stations located throughout the BTES must work to keep leveed areas dry. In fact, some 400,000 acres – about 10 percent of the land area of the entire BTES – are under pump. These pumps have limits though, and in general they cannot keep up with rains that fall at a rate of more than one inch per hour. Consequently, from 1978 to present, there have been more than 61,000 damage claims to the National Flood Insurance Program from the BTES, valued at nearly $750 million. The May flood in 1995, with considerable damage in Jefferson Parish, was a significant contributor to the 1995 spike in claims.



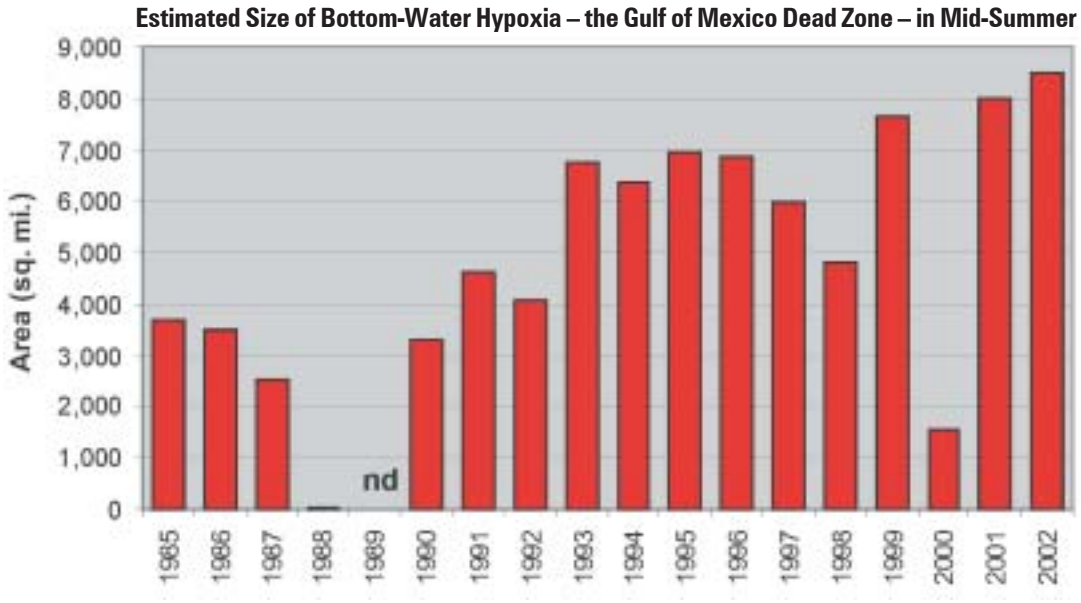
Source: FEMA

The expansive BTES marshes provide a valuable buffer to hurricanes, storms, and associated storm surges. Unfortunately the BTES is losing emergent marsh at an alarming rate, due to erosion, subsidence, and saltwater intrusion (see Indicator 1), which only increases the potential for flooding especially in communities outside of the levee system, such as Grand Isle and Golden Meadow. It seems that flooding will only continue to make history in the BTES.

Indicator #33: Area of hypoxia, or Dead Zone, off the Louisiana coast

The Mississippi River basin drains an area that covers 41 percent of the lower United States (see map). With the rainwater that flows across this land into streams, to small rivers, and then to large rivers, comes loose sediment, waste from wildlife and domestic animals, excess fertilizer and pesticides on lawns and crop fields, and oil and other substances from city streets and parking lots. Even discharges to the air, for example directly through power plant smokestacks and indirectly through the volatilization of manure, result in a considerable level of potentially harmful substances settling on the lands and waters within the basin. The delivery of sediment, fertilizers, and other substances via rainwater runoff is generally termed *nonpoint source pollution*. Other human activities, such as factories and sewage treatment plants, discharge directly to the streams and rivers via pipes. These sources are termed *point sources*.

Estimated Size of Bottom-Water Hypoxia – the Gulf of Mexico Dead Zone – in Mid-Summer



Source: Rabalais, Turner, and Wiseman, LUMCON/LSU, nd = no data

Courtesy of EPA.

While some of these substances, like pesticides and oil products, can be toxic in small amounts, others like sediments and nutrients (e.g., nitrogen and phosphorus) are often only problematic in excessive amounts. Swamps, wetlands, and riparian vegetation all along the Mississippi River and its tributaries, play a beneficial role in filtering rainwater runoff and removing these pollutants. Unfortunately, much of these wetland areas in the Mississippi River basin have been destroyed or by-passed.

Nutrient pollution – nutrients at levels that the ecosystem cannot use or remove naturally – is associated with massive hypoxic events in the plume of the Mississippi River as it enters the Gulf of Mexico. Hypoxia is a condition in which a portion of the water column becomes so low in oxygen concentrations that animals are not able to survive in the area if they are unable to escape. The large Gulf of Mexico hypoxic area is referred to as the Dead Zone.

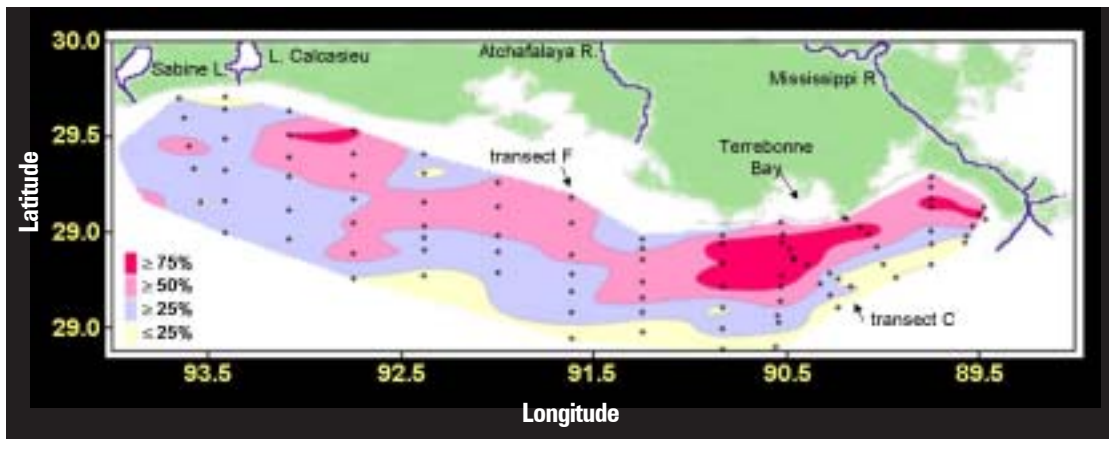
Since 1985, Louisiana scientists have monitored a large area off the coasts of Louisiana and Texas, quantifying the size and location of hypoxia that occurs each summer. In addition, these scientists have monitored, on a monthly basis throughout the year, selected transects across the continental shelf from the Atchafalaya River to offshore areas, and from Terrebonne Bay to offshore areas. The size of the 2002 Dead Zone off Louisiana and Texas – 8,500 square miles – is the area of the State of Massachusetts. The regular occurrence and massive extent of hypoxia off of coastal Louisiana indicates that Mississippi River water carries large loads of nutrient pollution, which scientists say comes primarily from agricultural sources.

The effect of the Dead Zone on Louisiana fisheries, and specifically on communities in the BTES, has yet to be quantified. Onshore movement of these hypoxic waters as a result of wind have caused massive fish kills in the BTES. Another issue residents of the BTES must address is how nutrient pollution in the Mississippi River will affect coastal restoration using river water diversions, such as Davis Pond in the BTES.

What is hypoxia?

Dissolved oxygen concentrations in water are often used to gauge the overall health of the aquatic environment. **Eutrophication** is the increased rate of carbon production in a waterbody, often caused by increased nutrient – nitrogen and phosphorus – loads to the waterbody. Eutrophication is often expressed as a phytoplankton (single celled algae) bloom(s) in the water column. The ensuing death and decomposition of the phytoplankton, and fecal pellets from zooplankton, consumes great quantities of oxygen, leaving the water column low in oxygen needed by other organisms, sometimes resulting in fish kills or a mass exodus of swimming fish and shrimp from the area. An area is considered **hypoxic** if dissolved oxygen concentrations are below 2.0 mg/L. Large areas of low dissolved oxygen are commonly termed **dead zones**, since fish and invertebrates cannot survive if trapped within them. Hypoxic events have been correlated with the magnitude of nutrient pollution inputs.

Frequency of occurrence of bottom-water hypoxia from 1985 to 2002. Source: Rabalais, LUMCON

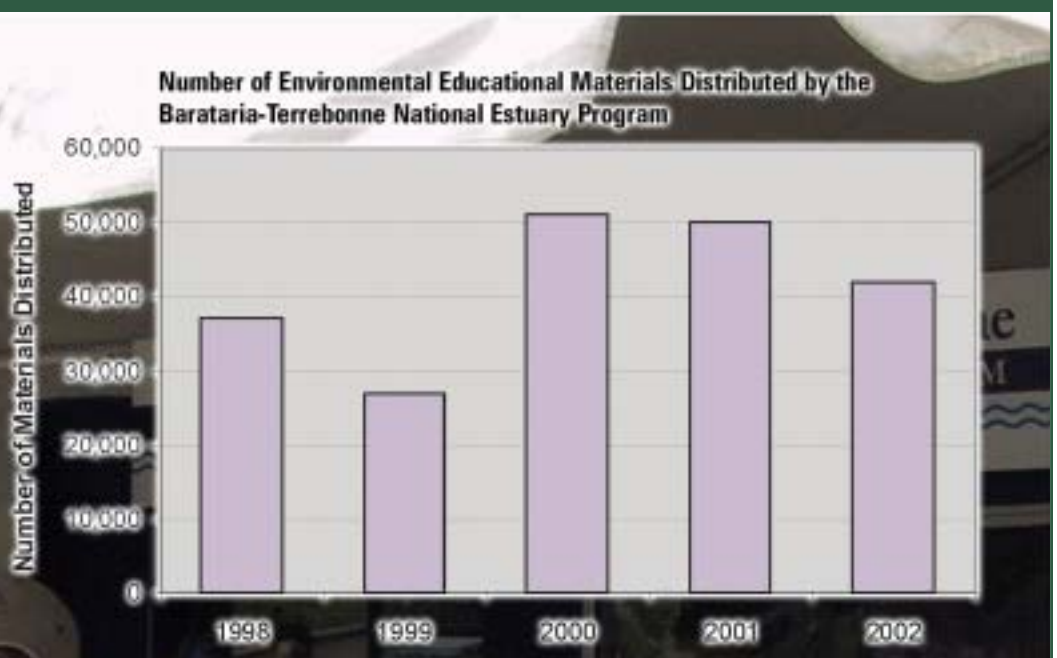


FOCUS QUESTION 10: How **strong** is *public support* for a **healthy estuary**?

Positive environmental change in the BTES ultimately comes from public awareness of the estuary's problems. Awareness stimulates personal responsibility and public support for programs to solve these problems. There are several environmental awareness programs in the BTES that work with residents and tourists to increase awareness and interest in the future of this ecologically important region.

Indicator #34: Number of educational materials distributed by BTNEP

The BTNEP sponsors and implements a major environmental awareness program in the BTES community. BTNEP has developed and distributes a large suite of education and outreach materials – posters, videos, scientific summaries, project summaries, and school curriculum-development materials – targeted towards a public audience. One measure of the success of this program is the number of educational materials distributed. The number of brochures distributed by BTNEP has been stable at over 40,000 for the last three years.



Please contact BTNEP at 1-800-259-0869 to get copies of any educational posters, videos, technical documents, or school curriculum-development materials.

30 BTNEP information booth at the annual La Fête d' Ecologie celebration, courtesy of BTNEP.

More in-depth scientific information on the indicators presented in this report can be found in the BTNEP's four status and trends documents:

- *Status and Trends of Hydrological Modification, Reduction in Sediment Availability, and Habitat Loss/Modification in the Barataria-Terrebonne Estuarine System*. BTNEP Publication No. 20. 1995.
- *Status, Trends, and Probable Causes for Change in Living Resources in the Barataria and Terrebonne Estuarine Systems*. BTNEP Publication No. 21. 1995.
- *Status and Trends of Eutrophication, Pathogen Contamination, and Toxic Substances in the Barataria-Terrebonne Estuarine System*. BTNEP Publication No. 22. 1995.
- *Land Use and Socioeconomic Status and Trends in the Barataria-Terrebonne Estuarine System*. BTNEP Publication No. 23. 1995.

Courtesy of Guy Fanguy.

What can I do to help?

Restoring and enhancing 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. At the same time, there are a number of activities that residents can undertake individually and collectively to enhance the health of the BTES.

- ***Above all, educate yourself about the BTES and its resources, and cherish it as the national treasure that it is.***
- Write or call your local, state, and federal officials and voice your support for implementing the BTNEP CCMP.
- 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.
- When boating in the estuary, don't dump sewage overboard – use marina pumpouts (map available at http://www.wlf.state.la.us/apps/netgear/index.asp?cn=lawlf&pid=1096).
- Observe fish and shellfish regulations.
- Teach your children about the BTES, our land loss problem, the fish and wildlife that inhabits our marshes and swamps, and their role in the ecosystem.

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

Contacting BTNEP

If you are interested in receiving a monthly newsletter, finding information on a specific BTES issue, or volunteering in any capacity to help restore the BTES, please contact the Barataria-Terrebonne National Estuary Program Office at:

1-800-259-0869
Physical Address:
BTNEP
320 Audubon Drive
North Babington Hall Room 105
Nicholls State University Campus
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P.O. Box 2663
Thibodaux, LA 70310

Or by email at: sandra@btnep.org Web site: www.btnep.org

Barataria-Terrebonne
NATIONAL ESTUARY PROGRAM

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Gibson in Terrebonne Parish, courtesy of Guy Fanguy.

Barataria-Terrebonne
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