STATE OF MOBILE BAY

A Status Report on Alabama's Coastline

from the Delta to Our Coastal Waters

Presented by the Mobile Bay National Estuary Program and its Science Advisory Committee
November 2008

Credits, Sources, and Acknowledgements

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Other Partners

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Coastal Alabama Clean Water Partnership (CACWP)
Geological Survey of Alabama (GSA)
Mobile County Soil and Water Conservation District
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National Marine Fisheries Service (NMFS)
National Weather Service (NWS)
National Oceanic and Atmospheric Association, Coastal Services Center (NOAA)
United States Food and Drug Administration (FDA)
United States Geologic Survey (USGS)
University of Southern Mississippi Gulf Coast Research Laboratory (GCRL)

Middle Bay Lighthouse

Introduction

From the Mobile Bay National Estuary Program
Science Advisory Committee ~

When the Mobile Bay National Estuary Program (MBNEP) was established in 1995, Alabama's coastal environment was already changing. Our once abundant and lush wetlands and dense forests were in the process of being converted into urban and suburban developments. This development, coupled with the successful efforts of our elected officials to recruit new jobs to our area, has been largely applauded by our citizens. Still, we should be mindful of the fact that a key reason for our economic prosperity is the high quality of life provided by our natural environment. In 1851, Albert James Pickett noted changes in the Alabama landscape.

> "The heart yearns to behold, once more, such a country as Alabama was the first time we saw it, when a boy. But where can we now go, that we shall not find the busy American, with keen desire to destroy everything which nature has made lovely?"

As we read these words, we were struck by their similarity (in spirit, if not language) to the expressions of concern we hear now as the economy of coastal Alabama grows and diversifies. Using established management practices, and an accumulating body of information about our coastal resources, we believe it is possible for the citizens of lower Alabama to be the wise stewards of our environment. We further believe that educating the citizens of lower Alabama about our environment is key to getting the public to be a part of the stewardship process. To that end, we present you with the MBNEP's report on indicators of our estuary's health.

As you read the information we have compiled for you, it is our hope that you will come to realize that, overall, the environmental health of coastal Alabama is not as bad as one might believe. Still there can be no question that there have been impacts on the environment from our growth, and that we need to increase our efforts to preserve, and restore, where possible, our coastal environment for future generations of Alabamians to enjoy. In reading what follows in this report, we also hope that you will feel compelled to become involved in this noble effort to ensure that the stars will continue to fall on Alabama for the foreseeable future.

Sincerely,

The Mobile Bay National Estuary Science Advisory Committee

Dr. Eldon Blancher
Dr. Scott Douglass
Dr. Kenneth Heck
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Great Blue Heron
Alan Davis

The mission of the ***Mobile Bay National Estuary Program*** *is to lead the wise stewardship of water quality and living resources of Mobile Bay and the Tensaw Delta. Established as a part of the Clean Water Act and funded in part by the US Environmental Protection Agency, MBNEP serves as a catalyst for activities of estuary stakeholders, helping to build community based organizational capacity for sound resource management and leveraging commitment and investment to ensure the estuary's sustainability.*

Indicators of Environmental Change

Mobile Bay

Acronyms

ANS—aquatic nuisance species
As—arsenic
BMPs—best management practices
DIN—dissolved inorganic nitrogen
DIP—dissolved inorganic phosphorus
DISL—Dauphin Island Sea Lab
DO—dissolved oxygen
EPCRA—Emergency Planning and Community Right-to-Know Act
FAMP—Fisheries Assessment and Monitoring Program
Fe—iron
HACCP—Hazard Analysis and Critical Control Point
HABs—harmful algal blooms
Hg—mercury
MDL—method detection limit
MTBE—methyl-tertbutyl ether
N—nutrients
NADP—National Atmospheric Depositional Program
NCA—National Coastal Assessment
NPDES—National Pollutant Discharge Elimination System
NOEP—National Ocean Economics Program
OE/DO—organic enrichment / dissolved oxygen
P—pathogens
PCBs—polychlorinated biphenyls
PCE—tetrachloroethylene
SAV—submerged aquatic vegetation
T—temperature
TCE—trichloroethylene
TOC—total organic carbon
TMDL—total maximum daily load
TRI—Toxic Release Inventory
VOCs—volatile organic compounds

Human Impacts: Changing Our Alabama Coast

Habitats: Maintaining Our Coastal Quality of Life

Living Resources: Ensuring Species Richness

Water Quality: Protecting Our Primary Resource

Community Involvement: Changing the Future

The Mobile Bay Watershed

The **Mobile Bay Watershed** is the sixth largest river basin in the United States and the fourth largest in terms of streamflow. It drains water from three-quarters of the State of Alabama, and portions of Georgia, Tennessee and Mississippi into Mobile Bay, Alabama's only port for ocean-going ships. The Bay is also a point of entry for hundreds of smaller recreational and commercial vessels, many of which cruise the 450-mile trip to the Tennessee River through the inter-basin connector known as the Tennessee-Tombigbee waterway or reach other inland Alabama ports via extensive navigation projects on the Alabama and Warrior River systems.

Mobile Bay is an estuary, a transition zone where the freshwater from the rivers mixes with the tidally-influenced salt water of the Gulf of Mexico. Estuaries are environmentally and economically important because of their exceptional biological diversity and productivity. The outflow of the Mobile River into Mobile Bay has created the second largest intact river delta system in the nation.
It includes a vast network of wetlands and waterways, with over 200 rivers, bays, creeks, bayous, lakes, cutoffs, branches, and sloughs. The Bay is approximately 32 miles long and 23 miles across at its widest point with an average depth of 10 feet. It is fed by two major river systems: the Alabama-Coosa-Tallapoosa system and the Warrior-Tombigbee system. These produce an average total flow out of Mobile Bay of 62,000 cubic feet of water per second. There are many sub-watersheds within the larger Mobile Bay area. The larger sub-watersheds include the Escatawpa River, Magnolia River, Fish River, Three Mile Creek, Dog River, Fowl River, the Lower Tensaw River, Wolf Creek, and the Perdido River.

This report focuses on an area that includes both Mobile and Baldwin Counties, the Mississippi Sound westward to the Alabama-Mississippi State Line, and the Alabama State marine waters in the north central Gulf of Mexico extending three miles south of Dauphin Island and the Fort Morgan Peninsula.

In 2005, MBNEP brought together over 70 scientists, environmental professionals, resource managers, and citizens to assess coastal environmental concerns, resulting in the identification of a set of "indicators" that would provide the data necessary to assess the health of the Mobile Bay estuary. Since that time, MBNEP has been gathering and analyzing time series data on each of these indicators to determine the state of Alabama from the delta to our coastal waters. In this search for data, MBNEP found that research, improvements in monitoring capability, the revolution made possible by satellite remote sensing, and myriad other technological marvels provide new data sets every day, but we still lack data to answer many specific questions about our local environment.

The following pages provide an analysis of 15 indicators selected to provide insights into environmental changes that have occurred over the past five to ten years. Several of the original 51 indicators identified are included as subcategories of the 15 used herein to describe the State of the Bay because data sets were available to support the trends describing human impacts, habitat changes, species richness, and water quality. The analysis of these indicators sheds light on how community growth has impacted coastal Alabama - how we have altered the coastal environment where we live, work and play.

HUMAN IMPACTS: CHANGING OUR ALABAMA COAST

Population & Land Use

HUMAN IMPACTS at-a-glance….

Many or most of the changes occurring along our coast can be described as "anthropogenic." The root of that increasingly-used word is from the Greek "anthropos," which means "human being," and "genos," which means "birth." It is used to describe impacts that are caused or produced by humans or human activities. With so many people choosing to live along the coast, the changes we impose on natural landscapes sometimes compromise the features that make coastal living so desirable.

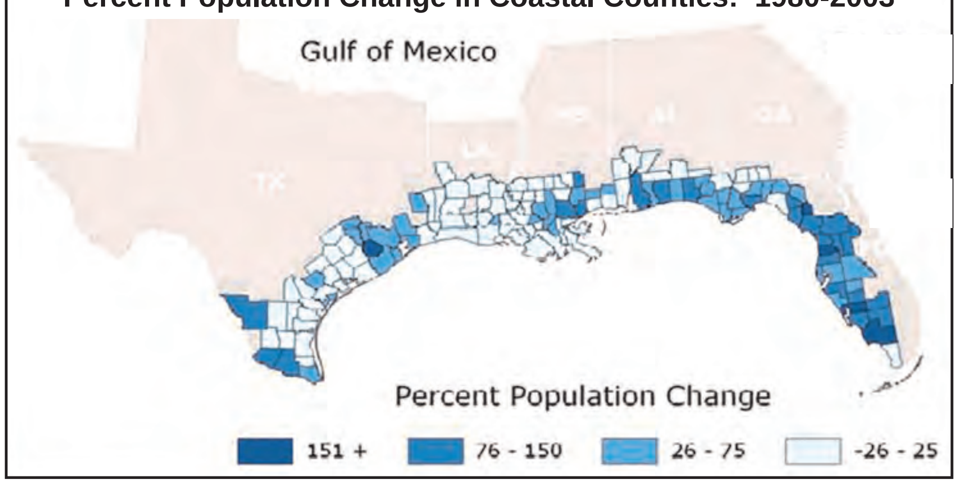
Coastal counties within the United States account for only 17 percent of the nation's land area but currently support over half (53%) of the U.S. population. In the report Population Trends Along the Coastal United States: 1980-2003, *NOAA projected that up to 12 million people would move into our nation's coastal areas by 2015. The coastal communities of Alabama have not escaped this population explosion.*

Gulf Shores

Indicator #1: Population Change

Is it impacting the Alabama coast? Yes.

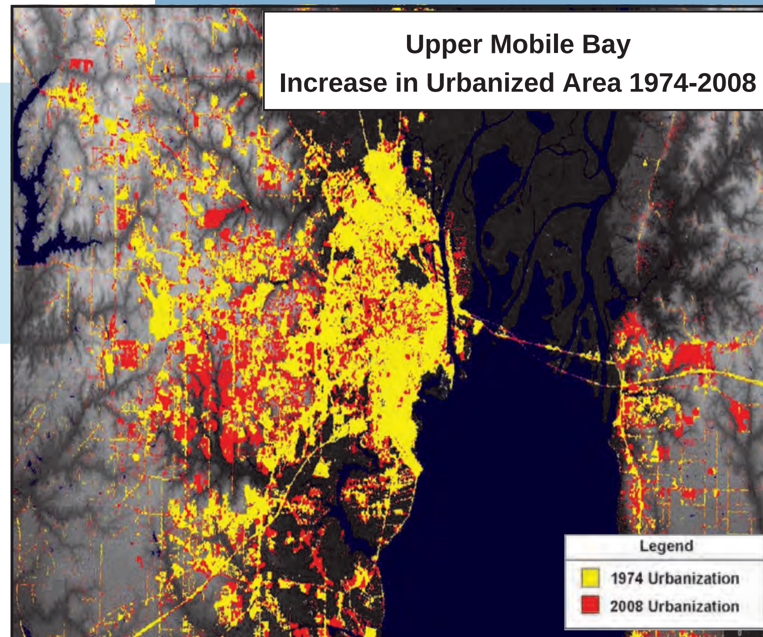
Percent Population Change in Coastal Counties: 1980-2003



NOAA Populations Trends Along the Coastal United States 1980—2003

Economic successes in Mobile and Baldwin Counties and the discovery of coastal Alabama as a sunbelt retirement and vacation destination have resulted in an influx of people along our coasts. According to the U.S. Census, between the years of 1990 and 2007 Baldwin County experienced a 75% increase in its population, from 98,280, to 171,769. In Mobile County there was a smaller increase of seven percent, from 378,643 to 404,406. According to the Center for Business and Economic Research at the University of Alabama, it is estimated that by 2025 the combined coastal population of Alabama will exceed 690,000 people, representing a 76.9% increase for Baldwin County and a 10.9% increase for Mobile County.

Dauphin Island beachgoers



NASA Stennis Space Center

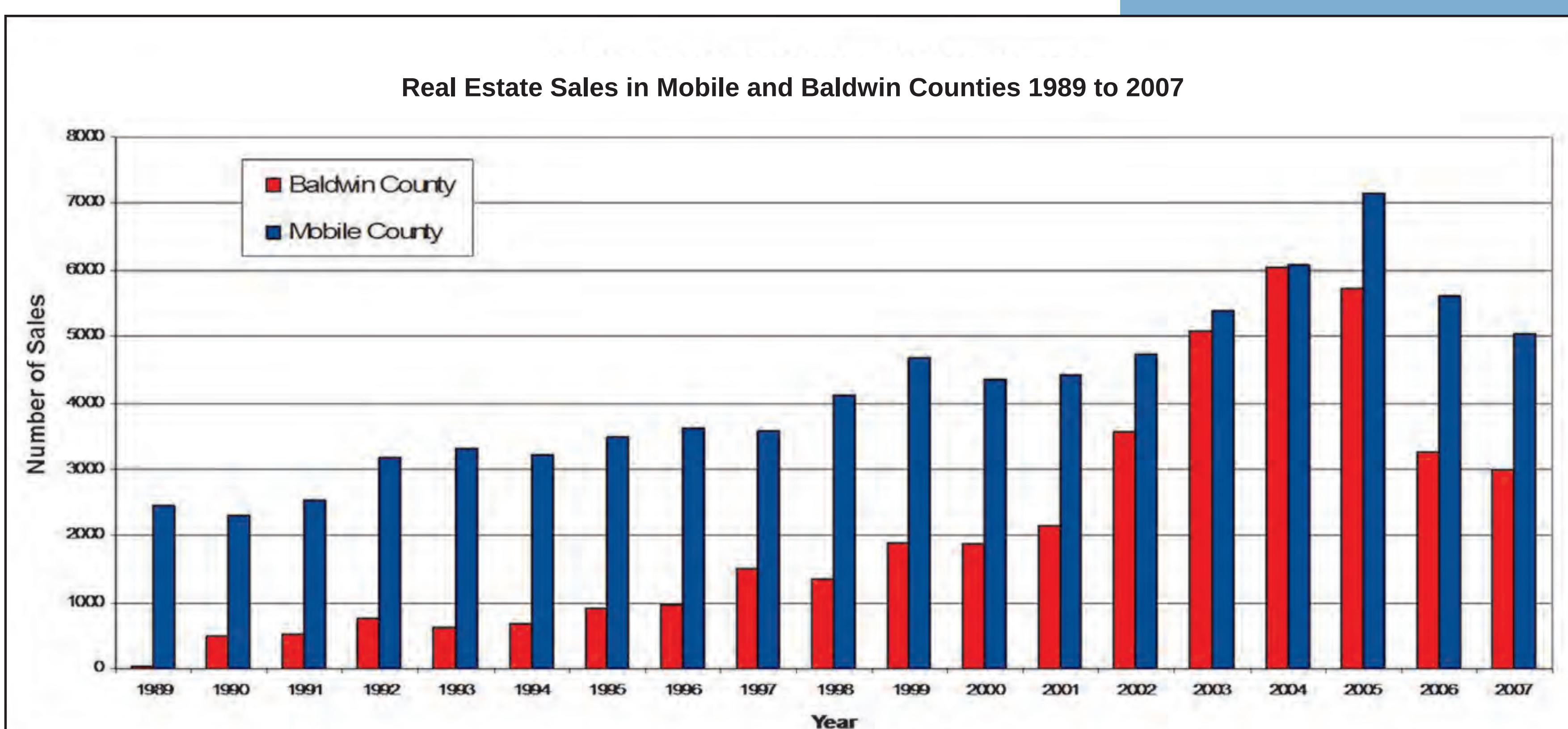
Not only are people coming to live along the coast of Alabama, but they are visiting in greater numbers as well. According to the Alabama Tourism Department, Mobile and Baldwin Counties experienced a slight increase in the number of visitors from 7.2 million in 2006 to 7.3 million in 2007. However, this boost in tourist numbers corresponded to an 18% growth in tourist expenditures within the Gulf Coast region with a total of $3.3 million being spent.

Indicator #2. Land Use Change

Are land use changes impacting the Alabama coast? Yes.

Within a limited land area, population growth impacts natural ecological systems through conversion of land from low intensity use to higher intensity alternate uses. Population increases in our two coastal counties have resulted in greater demands for housing, commercial services, and infrastructure expansions. The graph below presents data from the Alabama Center for Real Estate and depicts the increase in number of real estate sales in coastal Alabama from 1990 to 2007. Between 1990 and 2006, housing units increased in Baldwin County by 89% (50,933 to 96,390) and in Mobile County by 17% (151,220 to 176,664). A review of Mobile County Inspection Department data from the City of Mobile Land Use/ Code Administration indicates that between 2000 and 2007 the permit value of construction activity rose from $136.7 million to $175.9 million, a 28% increase in value over a seven-year period.

Construction in Spanish Fort



Alabama Center for Real Estate

HUMAN IMPACTS: CHANGING OUR ALABAMA COAST

Impervious Surfaces

Alternatives to Impervious Surfaces

Impervious surfaces are everywhere and they smooth the progress of stormwater to the receiving waters that they pollute. These are things that you can do to keep stormwater on your property, where it can infiltrate.

Use Rain Gutters to Channel Water to Porous Areas *Use downspout extensions and splash blocks to channel rainwater to areas where it can soak in.*

Use Rain Barrels to Collect Stormwater Running Off Your Roof *It can be used for watering your plants or garden or even washing your car (hopefully not on paved surfaces).*

Create Rain Gardens. *Natural or "engineered" shallow depressions planted with water-tolerant flowers, grasses, or shrubs collect rainwater and allow it to soak into the ground. Run downspout extensions to the rain garden.*

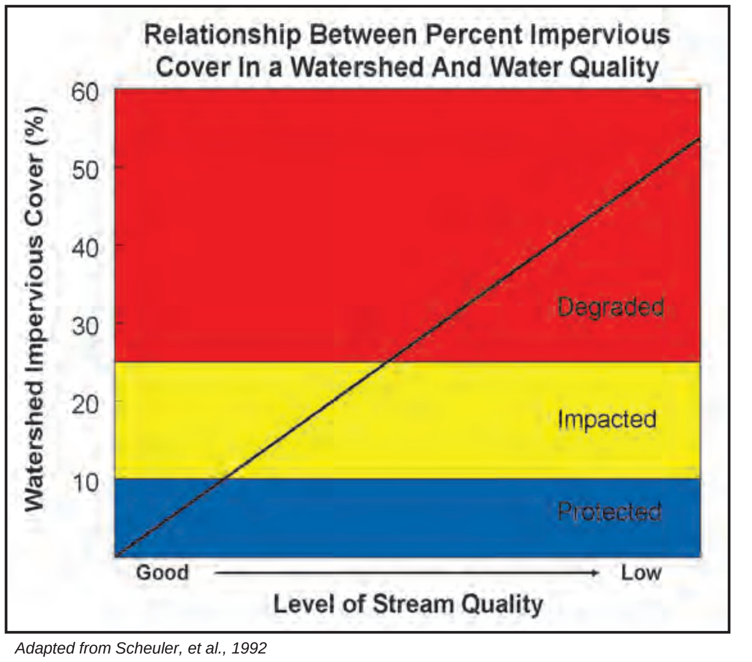
Create Infiltration Swales. *Where water collects on your property, remove the grass or ground cover, dig and replace a couple feet of underlying soil with rock or gravel, then replace some of the soil and ground cover. This swale will allow stormwater to soak quickly into the ground.*

Use Alternatives to Impervious Surfaces *Wherever possible use bricks, gravel, mulch, turf block, or other porous materials for sidewalks, driveways, or patios. These (frequently cheaper) materials allow rainwater to seep into the ground. Pervious concrete is now available and very effective. Use "wheel tracks" instead of full-width paved drives.*

Highway 98 in Daphne

Impervious surfaces, which replace the porous soil of natural landscapes, are of environmental concern because their construction initiates a chain of events that negatively impacts water resources. Land left in its natural state filters, cleanses, and absorbs stormwater; recharges groundwater supplies; and acts as a buffering zone for aquatic communities. One of the main impacts of population growth is the proliferation of roofs, roads, parking lots and other impervious surfaces that keep rainwater from soaking into the ground. These impervious surfaces seal the soil surface, eliminating rainwater infiltration and natural groundwater recharge and increasing saltwater intrusion into aquifers. Stormwater accumulates on and runs directly across impervious surfaces, increasing flow volumes and velocities and resulting in incidents of localized flooding; accelerated streambank erosion; and increasing sediment, nutrient, and pollutant loads. Many of the residues of urban and suburban living flush into streams without treatment, degrading the stream's water quality. Impervious surfaces also deprive tree roots of aeration, eliminating the "urban forest" and the canopy shade that would otherwise moderate our coastal climate. Because impervious surfaces displace living vegetation, they reduce ecological productivity and interrupt the natural removal of carbon dioxide from the atmosphere.

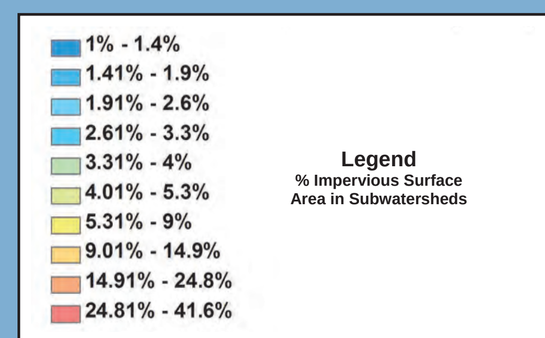
When a watershed's surface is less than 10% impervious, its receiving water has typically good water quality, intact habitats, and diverse biological communities. With 10-25% imperviousness, a watershed's water quality and biological diversity become impacted. As impervious cover increases, exceeding 25%, the water quality degrades significantly due to an increase in pollutants from runoff and consequences of streambank erosion. These factors result in a reduction in species richness where only pollutant-tolerant fish and insects can survive.



Adapted from Scheuler, et al., 1992

Drainage from construction near Halls Mill Creek

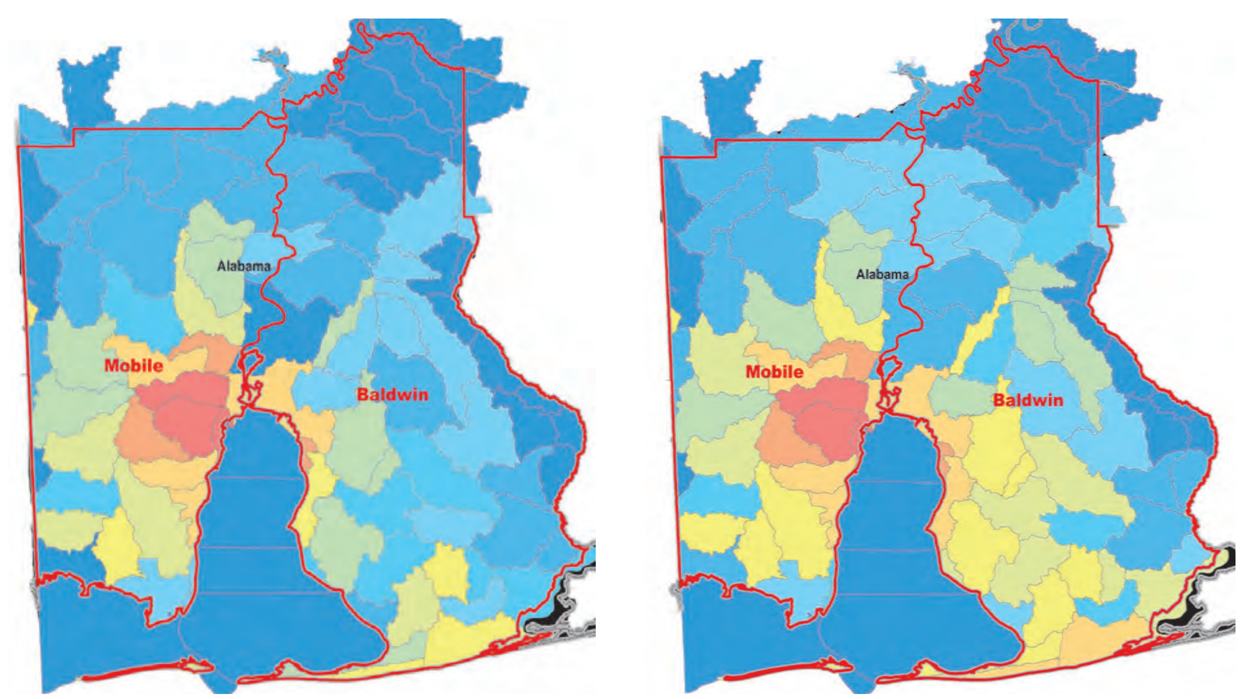
The following figures are depictions of the two-county area broken into 12-digit Hydrologic Unit Codes (the smallest defined/classified watersheds) that illustrate 2000 estimated and 2025 projected impervious cover as a percent of the total watershed area. From these illustrations, one can conclude that water quality in streams in the metropolitan Mobile area are either negatively impacted or degraded. The Chickasaw area, west Mobile, and the Daphne area are also significantly impacted. Areas south and northwest of Mobile as well as the Spanish Fort area are also significantly impacted to a lesser degree. By 2025, impervious surface cover is expected to negatively impact Fairhope as well as the coastal areas between Fort Morgan and Orange Beach.



According to the National Weather Service, coastal Alabama receives an average annual rainfall of over 66 inches per year, the highest in the contiguous U. S. As a result, our communities are particularly susceptible to increased stormwater runoff and decreased water quality in nearby surface waters. This runoff picks up sediments, nutrients, toxins, pathogens, refuse, and other substances usually characterized as *nonpoint source pollutants* and deposits them into local waterways. Nonpoint source pollutants come from scattered or diffuse sources including fertilizers, herbicides, and insecticides from residential areas, agricultural lands, and golf courses; oil, grease, and toxic chemicals from roadways and parking lots; pathogens and nutrients from pet waste, livestock, and faulty septic systems; and organic matter from yard clippings and leaves.

Estimated Impervious Cover by 12-digit HUC in Mobile and Baldwin Counties

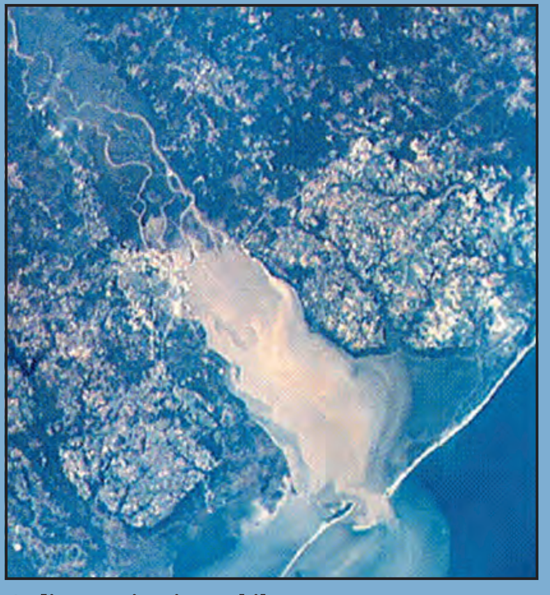
Estimated Year 2000 | **Estimated Year 2025**



EPA Office of Research & Development Analysis

HUMAN IMPACTS: CHANGING OUR ALABAMA COAST

Impervious Surfaces & Sedimentation



Sedimentation in Mobile Bay
Skylab photograph (c. 1974)

"We abuse land because we regard it as a commodity belonging to us. When we see land as a community to which we belong, we may begin to use it with love and respect."

- Aldo Leopold

Typically two-thirds of impervious cover is pavement (streets, sidewalks, parking lots, driveways, etc.). In Alabama, 2005 statistics indicated that 94.8% of the working population travels to work by car, truck or van. Of that number, 84% drive alone. In Mobile and Baldwin Counties, the numbers are similar: 90.9% of workers in Baldwin County and 95.2% in Mobile County use personal vehicles to travel to and from work. Widespread public preference and lack of accepted and alternative public transportation systems translate into a greater demand for more extensive road and bridge systems. According to Public Works Departments in Mobile and Baldwin Counties, both have experienced an approximate five percent increase in the number of miles of new paved road over the last five years. Not surprisingly, in a Loading Budget Analysis for Mobile Bay Modeling (2002) prepared by Tetra Tech to assess pollutant loadings contributing to Mobile Bay by way of the Mobile River basin, there were significant increases in non-point source pollutants for the period from 1970 to 1995.

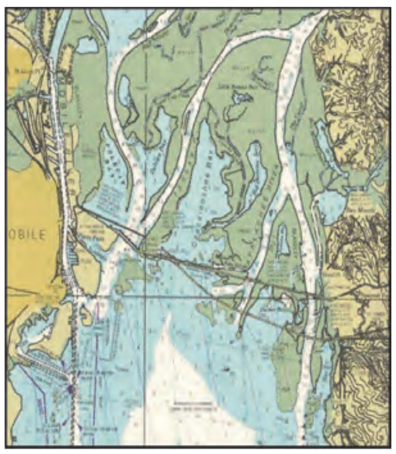
Sedimentation, or increased erosion and sediment delivery and deposition, is a consequence of land conversion. Development and growth produce impervious surfaces that cause stormwater runoff to increase in volume and velocity. These factors accelerate the processes of erosion and sediment deposition, particularly in areas of highly erodible and porous soils. A result of the usually heavy rainfalls in this area is the mud and clay from surfaces cleared for development or silviculture (timber) which easily find their way into storm drains and receiving waters. According to the Geological Survey of Alabama (GSA), the geologic and hydrologic character of Mobile Bay's Eastern Shore makes it particularly vulnerable to erosion and subsequent transport of large volumes of sediment that are eventually deposited in Mobile Bay, especially during natural events like tropical storms and hurricanes that periodically impact our area.

Mobile Bay Causeway

D'Olive and Tiawassee Creeks were studied during the summer of 2007 by GSA in partnership with the Alabama Department of Conservation and Natural Resources, State Lands Division (SLD) to assess the impacts of land-use change in this quickly developing area. This study det- ermined sedimentation rates in streams that receive sediment from construction sites in this watershed. Sediment loads were determined by direct measurement of suspended and bed sediment for a range of discharge events from ten sampling stations. These data revealed from a two- to over 200-fold increase in annual sediment loads in most of these streams when compared to estimated natural geologic erosion rates (without human impact or alteration). However, sediment loads in D'Olive and Tiawassee Creeks were similar to those of 25 other streams with anthropogenic erosional impacts throughout Alabama. Five of the eight streams that drain into Lake Forest carry an estimated 1,977 tons of sediment annually which equates to 180 dump truckloads of dirt.

Indicator #3. Hydrologic and Bathymetric Changes

Has the extent of physical/chemical alteration of the watershed been reduced or managed? Yes.



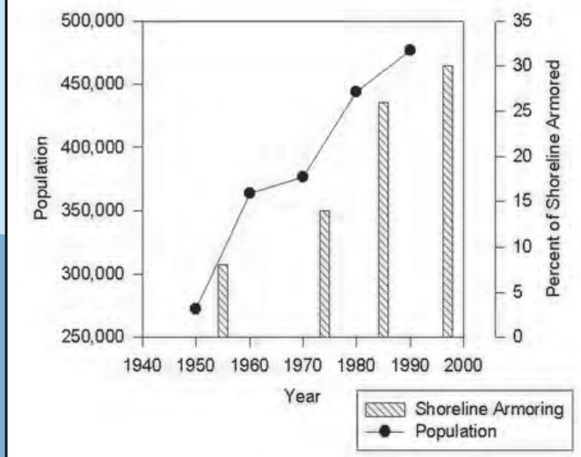
Upper Mobile Bay

Over time, the Mobile Bay watershed has undergone many hydrologic changes as a result of economic forces and development. The most important hydrologic and bathymetric changes have occurred as a result of man-made alterations affecting the flow of water from the Delta's primary feeder streams to the Gulf of Mexico. Since the early 1920s, twenty large dams and water control structures have been built on the Alabama/Coosa/Tallapoosa and the Tombigbee/Black Warrior river systems. In 1926 a large dike-like causeway was constructed across the head of the Bay that sealed off a number of once open bays from immediate contact with the Gulf.

These developments have changed the character of the waters north of the causeway. Since the construction of the causeway and dams, the extent of saltwater into the delta and the extent to which freshwater inflow dominates the area have suffered major alterations. Changes to sedimentation patterns and salinity in the lower Delta and upper Bay may have caused vegetation changes leading to altered wildlife habitats and increased invasive species. The proliferation of hardened shoreline around the Bay has exacerbated erosion of adjacent shorelines, reducing their ability to withstand and recover from unusual wave stresses like those that occur during tropical storms and hurricanes.

With population growth and development along the southern shorelines and coastal areas of the counties, perceived property preservation/erosion prevention needs have resulted in hardening or armoring of the shoreline. In fact, this shoreline modification, involving the use of bulkheads or other rigid materials to "stabilize" the waterfront edge, actually causes accelerated erosion, increased deepening, increased turbidity, loss of intertidal soft bottom habitat, and elimination of wetland vegetation. According to a 1997 investigation by Dr. Scott Douglass at the University of South Alabama, the percentage of Mobile Bay armoring has increased from 8% in 1955 to 30% in 1997, corresponding to the rate of population growth (1997 USA Report). These data suggest that by 2010 approximately half the Mobile Bay shoreline will be bulkheaded or armored — if this trend continues, we will effectively create a bathtub with vertical walls and no intertidal habitat.

Population Trends and the Effects of Bulkheads on Urban Bay Shorelines



Dr. Scott Douglass, University of South Alabama

Alternatives to Hard Armoring

Alternatives to shoreline armoring use natural approaches that can be both environmentally and economically favorable. "Living shorelines" employ bank stabilization techniques that minimize erosion (or even promote accretion), while protecting, restoring, enhancing, or creating natural habitat for aquatic life. A living shoreline is developed by installing wave suppressing "sills" of oyster shell, synthetic reef, or even concrete aggregate just offshore, using sand fill to reduce grade, and planting native vegetation along the shoreline for stabilization and habitat restoration.

Bulkhead/shoreline armoring
watersideconstruction.com

HABITATS: MAINTAINING COASTAL QUALITY OF LIFE

Habitat Diversity

Sand dunes

Pitcher plant bog

Cypress swamp

HABITAT MANAGEMENT at-a-glance...

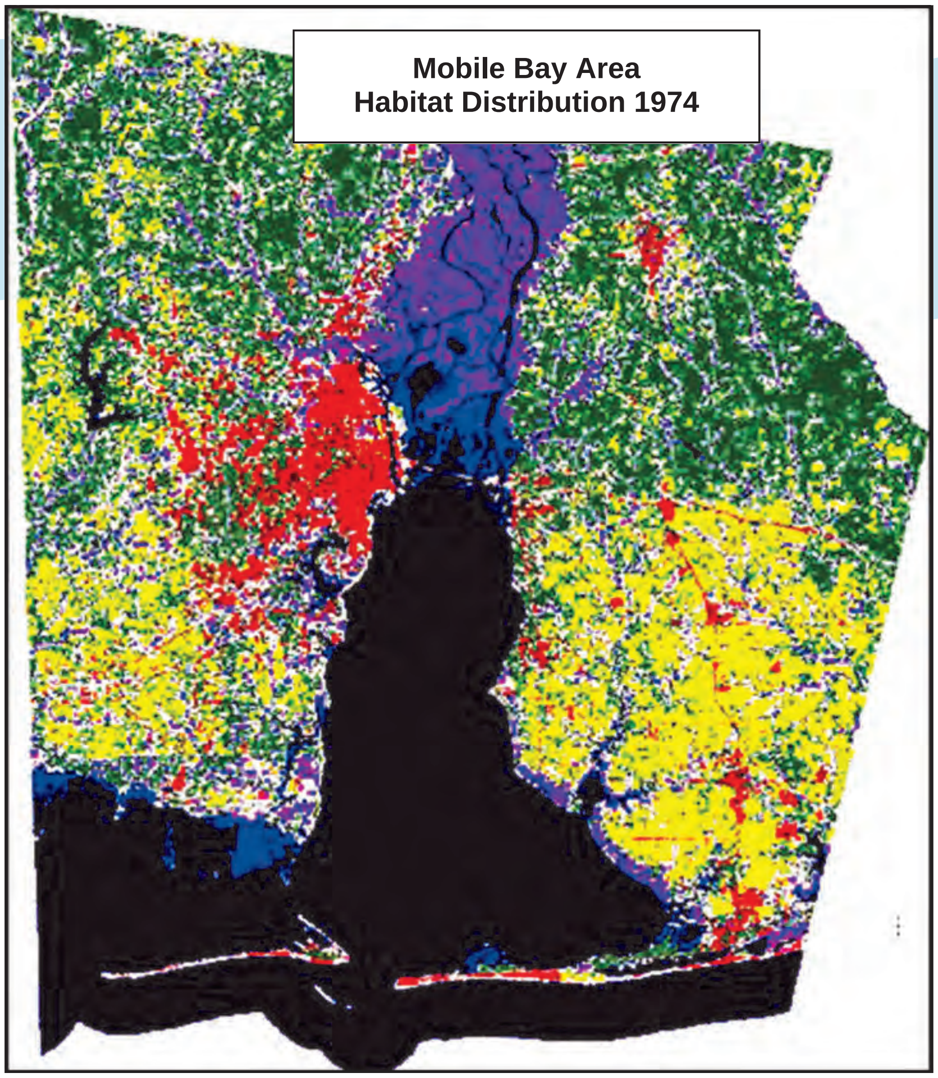
The qualities that attract us to the Mobile Bay area are largely related to the extraordinary variety of habitats found in such a relatively small area. Soft sediments, seagrass beds, barrier island dunes and inter-dune wetland swales, fresh and saltwater marshes, pitcher plant bogs, bottomland hardwood forests, wet pine savannas, and upland pine-oak forests are all found in Mobile and Baldwin Counties. This wealth of habitats has contributed to the rich biodiversity that distinguishes our region and draws residents and visitors to the coast. While some natural occurences are responsible for alterations to habitat, fragmentation and loss of natural habitats is mainly due to population growth, land use conversion, shoreline hardening, and runoff. Just as the natural ecosystems around us are complex and interdependent, so are the social and economic issues related to the use of our surroundings. The goals of the MBNEP are to understand why and how patterns of land-use and land-cover are changing and how they will change in the foreseeable future; the implications of these changes for our environment; and how we can mitigate these impacts.

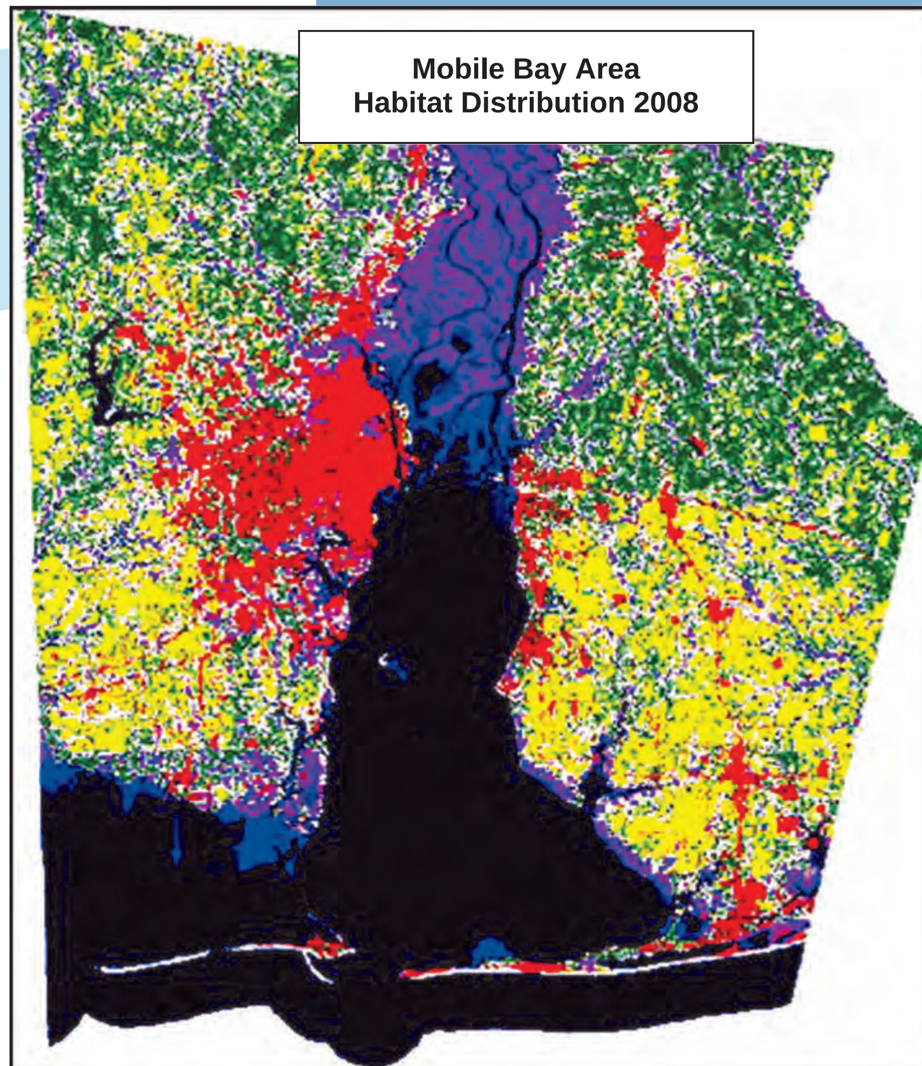
Indicator #4 Acres of Habitat by Type

Are natural habitats being managed to maintain sufficient populations, diversity, distribution, connectivity, and natural functions? Yes and No.

The diversity of species and abundant aquatic ecosystems associated with our coastal lands are the foundation of our community, economic, and recreational qualities of life. Conservation of Alabama's natural habitats is being challenged as coastal habitats are converted and divided into fragments too small to support healthy wildlife populations and vital ecological services. The coastal region from the Florida panhandle to Mobile Bay is among the richest in the U. S. in terms of biodiversity, harboring threatened and/or endangered species like the federally endangered Alabama canebrake pitcher plant, red-cockaded woodpecker, and the Alabama beach mouse. As habitat types are altered by continued human development as well as natural occurrences, this biodiversity will diminish with these endangered species and others will be increasingly threatened.

Land use research seeks to both quantify habitat coverage within the coastal landscape and determine the extent to which habitat coverage has changed over time. In cases where habitat coverage has changed, researchers seek to determine the extent to which these changes are caused by the impacts of natural events or urban development. Among the tools used to conduct such studies are satellite and high





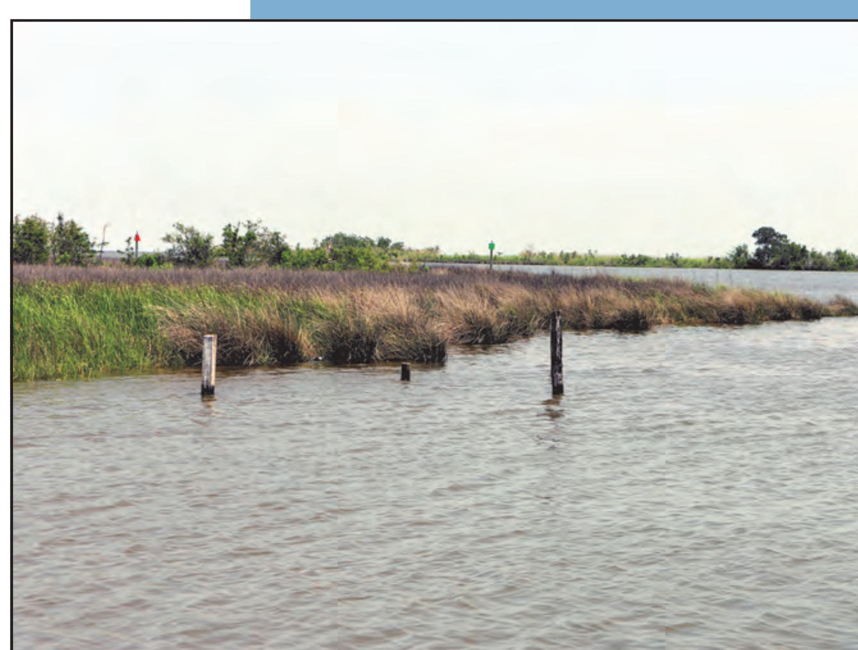
NASA Stennis Space Center

Legend

Water
Barren
Agriculture
Non-Woody Wetlands
Upland Woods
Wetland Woodlands
Urban

definition aerial imagery (photography taken at very low altitudes). The variables associated with this type of research, including time series data, seasonality, and how habitat categorization, among others, have made habitat change analysis challenging and have produced conflicting results. However, one thing is certain: urbanization of our natural habitats is occurring and it is having a negative impact on several different habitat types.

In 2008, MBNEP entered into a partnership with NASA Stennis Space Center's Applied Science Program to conduct an analysis of land use and land cover change for Mobile and Baldwin Counties. This analysis included the quantification of geographic change for agriculture, barren (beach) lands, open water, urban, upland forest, woody wetland and non-woody wetland (marsh) landscapes over a thirty-four year period. It revealed that the amount of acreage classified as urban increased by over 50% from 1974 to 2008. Most of this new urban growth was the result of conversion of upland forests, agricultural lands and woody wetlands. Concurrently MBNEP is working with United States Geological Survey (USGS) to better understand the impacts of this urbanization on habitats along the immediate coast. The preliminary results of this study indicate that urbanization is occurring not only along the coastline but is expanding in areas with access to estuarine waters and tributaries, particularly Dog River, Fowl River, Big Creek Lake, Chickasaw Creek, Fish River, Wolf Bay, D'Olive Creek, and Fly Creek.



East Fowl River

Submerged Aquatic Vegetation & Turbidity

Submerged aquatic vegetation (SAV), including our coastal seagrass, is a vital habitat and a component in thriving estuaries. SAV provides shelter for fish and invertebrates, nursery habitat for commercially and recreationally important finfish and shellfish species, a food source for over-wintering waterfowl, and prevention against erosion through sediment stabilization. In 2002, MBNEP partnered with Barry A. Vittor & Assoc., Inc. to conduct a survey of SAV along the Alabama coast. This survey resulted in the identification of sixteen different SAV species throughout Mobile Bay and the surrounding coastal areas, including a previously undocumented bed of turtlegrass (*Thalassia testudinum*) in Little Lagoon.

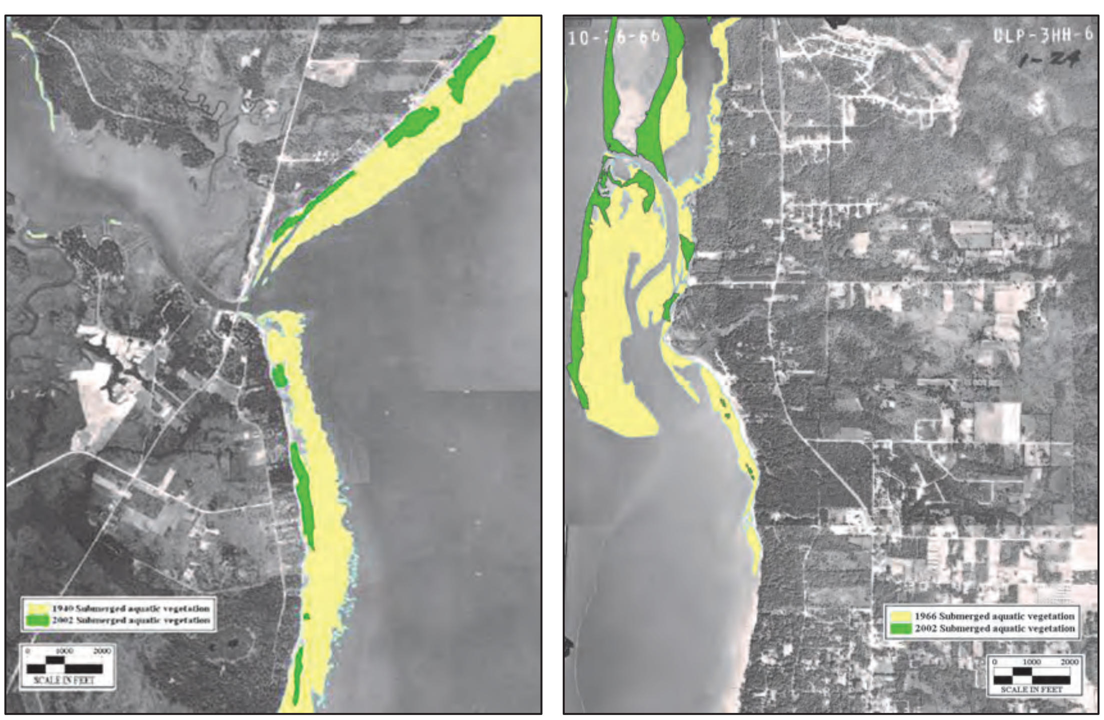
Comparisons between the 2002 survey and historical aerial photographs show a dramatic decline in Mobile Bay SAV over the past 60 years. Since 1940, a loss of 691 acres of SAV has occurred along the western shore of Mobile Bay and 268 acres in the Alabama portion of the Mississippi Sound, representing a 55.5% decrease in coverage within Mobile County. The 1940 photographs documented 109.6 acres of SAV near the mouth of Dog River which was completely absent in 2002. The most dramatic changes in SAV coverage were noted along the Baldwin County shoreline. In 1955 seagrass beds extended from north of Point Clear to south of Bon Secour Bay and within Wolf Bay, Bay La Launch, Arnica Bay, and Perdido Bay. No sign of SAV beds was observed during the 2002 survey, indicating a decrease in SAV habitat of over 88% in Baldwin County. While many SAV species, such as widgeongrass, are ephemeral in nature, appearing and then disappearing with some regularity, the persistent absence of SAV described above indicates a serious negative trend. The disappearance of SAV around the Bay is likely due to consequences of land-use change such as increased turbidity, nutrient over-enrichment, and shoreline armoring along with some natural processes such as drought, salinity change, and tropical weather events. Efforts are currently underway to further monitor trends related to SAV around Mobile Bay.

Tampa Bay experienced similar losses in SAV, from an estimated 40,400 acres of coverage in the 1950's to 21,653 acres by 1982. Since then, Tampa Bay SAV coverage has rebounded to over 27,000 acres, or 67%, of 1950's values. These improvements are attributed to reduction in phytoplankton levels that, in turn, have been linked to imposed reductions in anthropogenic nitrogen loads.

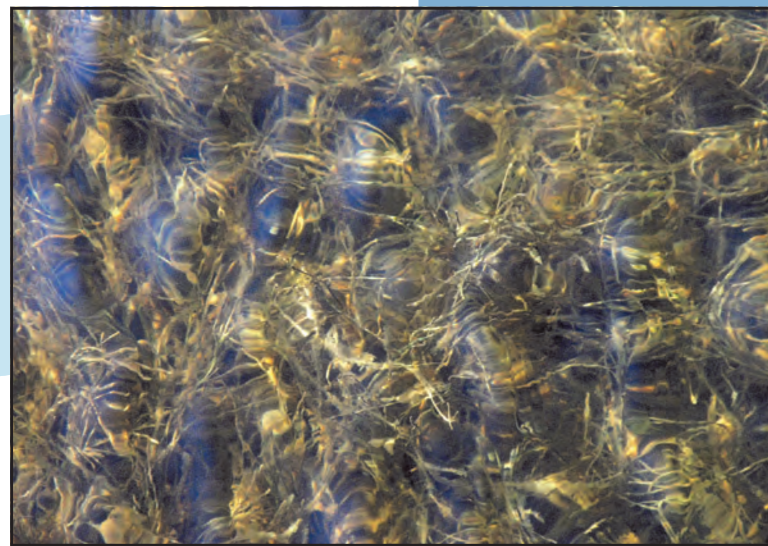
Extent of Submerged Aquatic Vegetation (SAV) 2002

Western Shore of Mobile Bay
1940 compared to 2002

Northeastern Shore of Mobile Bay
1966 compared to 2002

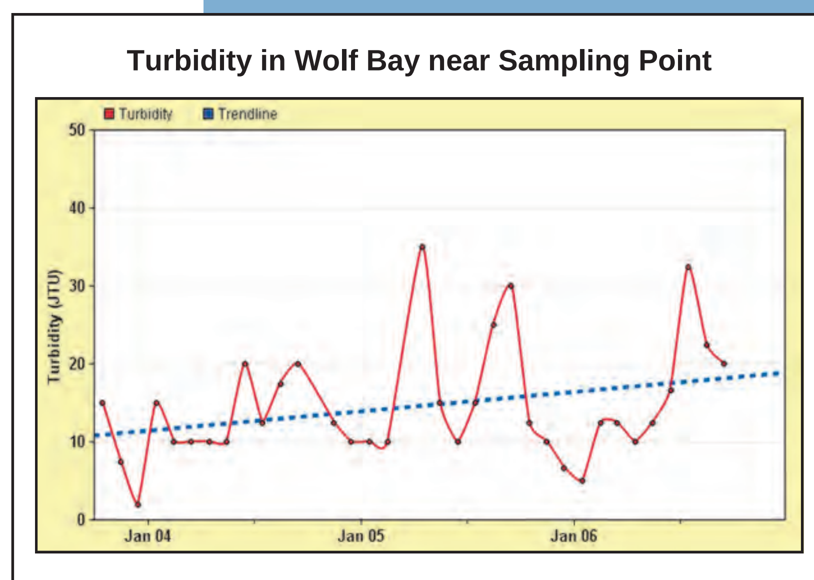


MBNEP SAV Survey, Vittor & Associates 2002



Seagrass bed

Turbidity can be defined as “muddiness created by stirring up sediment or having foreign particles suspended” in the water column. The brown water commonly seen in Mobile Bay due to its shallow depth and high suspended sediment load (4.85 million metric tons per year) represents turbidity caused by both natural and anthropogenic factors. Turbidity negatively affects SAV by reducing light penetration through the water column. This light attenuation is a major cause of the SAV decline.

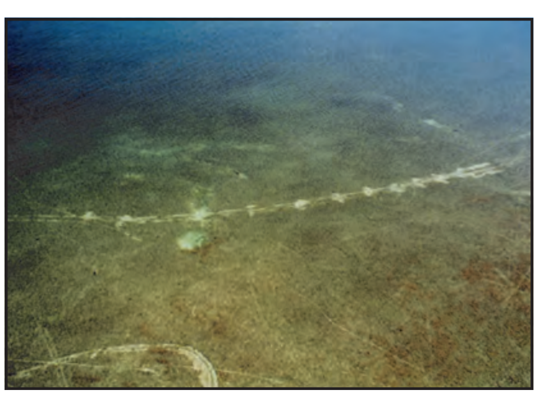


Alabama Water Watch

As noted in the Wolf Bay turbidity sampling graphic, storm events bringing high winds and wave action to the bay cause re-suspension of bottom sediments, but these short term activities do not seem to have lasting impacts on SAV survival. Hurricane Ivan, a Category 3 storm that made landfall on September 16, 2004, caused spikes in turbidity that exceeded the detection limit of monitoring stations within Mobile Bay (Park et al. 2007). However, the increased turbidity, combined with the debris-related damages caused by the storm, only resulted in an SAV decline of 18% when compared to the 2002 survey. A post-Katrina survey of seagrass beds along western Mobile Bay documented the presence of SAV in each of the sites surveyed in 2002. Shoot density was lower following Hurricane Katrina, but the reduction in numbers of plants within the bed could not be specifically attributed to the storm (Heck and Byron 2005).

Stormwater runoff contributes to high turbidity levels by delivering sediments into the water column and providing nutrients which stimulate algae growth. Over-enrichment of nutrients (particularly nitrogen) comes from the use of agricultural and household fertilizers on our fields and lawns as well as waste from animals.

Other human activities detrimental to SAV survival include recreational and commercial boating which causes a re-suspension of sediments from propellers and boat wakes along bay edges. These activities increase turbidity, and grounding of outboard motor props rips seagrass leaves and rhizomes out of the sediments, leaving behind “prop scars” that can take three to five years to recover. Some other human activities impacting SAV growth include commercial and recreational trawling, which disturbs the substrate in which the plants grow and increases turbidity by stirring up sediments, and deposition of dredge material.



Propeller scarring in SAV bed

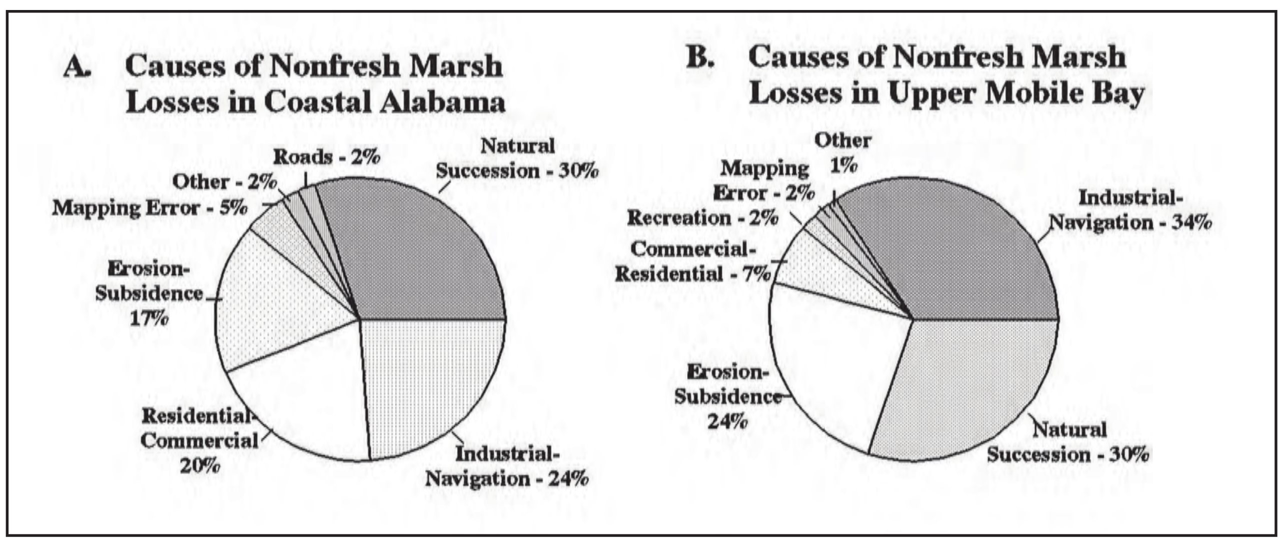
HABITATS: MAINTAINING COASTAL QUALITY OF LIFE

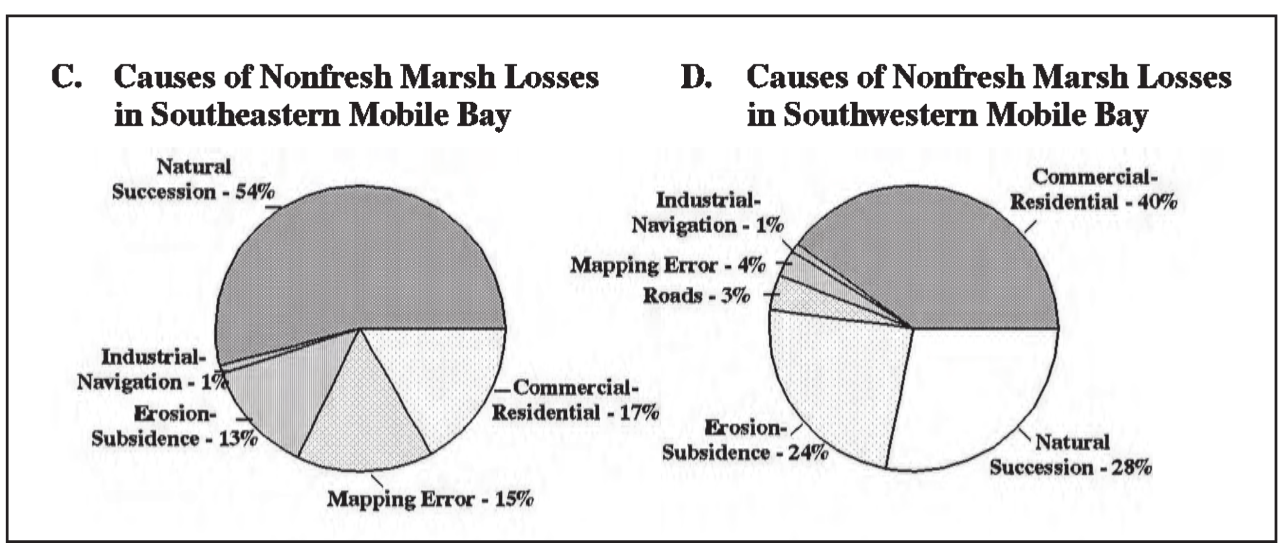
Wetlands

Coastal marsh

Wetlands are the transitional zones between land and water. Mobile Bay wetlands provide shelter and food for a variety of unique and ecologically, commercially, and recreationally important fish and invertebrates including juvenile shrimp, blue crab, and oysters. Freshwater and saltwater wetlands also absorb excess nutrients, sediments, and pollutants from stormwater runoff prior to emptying into Mobile Bay. They provide the benefit of slowing the overflow of river waters and protect against property damage and loss of life from floodwaters and tropical weather events. Research has shown that the more area and available "edges" of emergent wetlands there are in an estuary, the more shrimp the estuary will produce. The monetary value of the ecological functions that wetlands provide, relative to what it would cost for humans to engineer facilities to perform the functions, was evaluated by Mitsch and Gosselink (Wetlands, 2000) and estimated to be up to $36,000 per acre. Critics feel that undervaluation is unavoidable, since even if all provided services – nutrient retention, flood control, storm protection, groundwater recharge, ecosystem support, climatic stabilization, shoreline stabilization, and many others –

Edge Effect is a phenomenon of increased variety of plants and animals at the transition, or ecotone, between two adjacent ecological communities. Ecotones are particularly significant for mobile animals, as they can exploit more than one set of habitats and potential food sources within a short distance.





Roach, et al 1987

Salt marsh with black needle rush

Freshwater marsh
nrcs.usda.gov

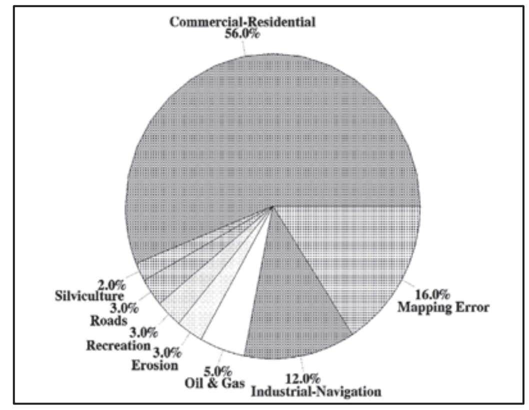
could be valued, these services are provided continuously in perpetuity. Quantifying the additional aesthetic value of a salt-marsh presents an insurmountable challenge to determining the true worth of wetlands.

The transition from a freshwater to a saltwater environment in the Mobile Bay watershed allows for the existence of a variety of wetland ecosystems, including scrub-shrub wetlands, forested wetlands, fresh wetlands, and non-fresh, or saltwater emergent wetlands. The *National Coastal Condition Report II* published in 2004 by the EPA indicated that wetland loss in Alabama over the last 40 years was four times greater than the national average. According to NOAA's Coastal Services Center, over 50% of Alabama's coastal wetlands were lost between 1780 and 1980, largely due to increases in population density and urban development.

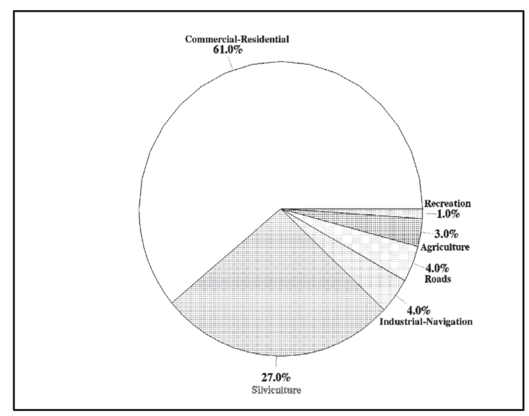
Research from Roach et al. (1987) indicates that freshwater wetland decline in Mobile Bay is largely a result of urban development (61%) and conversion to forest through drainage (27%). The majority of saltwater wetlands loss was due to the natural processes of succession (30%) and erosion or subsidence (17%). Anthropogenic impacts on salt marsh were industrial or navigational development (24%) and commercial or residential development (20%).

Heron in front of the Mobile skyline
Kathy Hicks

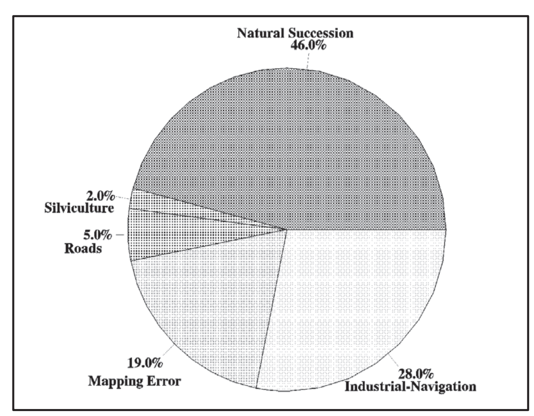
Forested Wetland Losses



Freshwater Marsh Losses



Scrub-shrub Gains



Roach, et al 1987

HABITATS: MAINTAINING COASTAL QUALITY OF LIFE

Conservation, Protection, & Restoration

Indicator #5. Acres of Habitat Protected or Restored

Is progress being made to conserve, protect, and restore our coastal habitats? Yes.

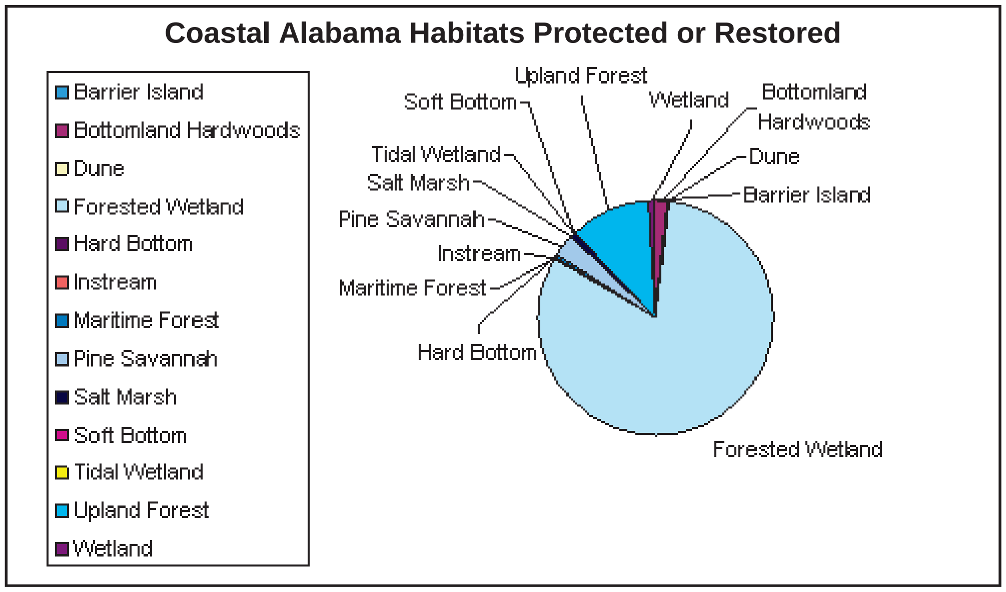
Mobile-Tensaw Delta
John McShane

Decades of growth and development have led to habitat losses in many estuaries, causing various plant and animal species to struggle for survival. In coastal Alabama, recent conservation efforts are attempting to reverse this pattern. In fact, Alabama's Forever Wild Program has made a substantial commitment to the protection of coastal wetlands with the purchase of large portions of the Mobile-Tensaw River Delta. The Forever Wild Program has acquired over 100,000 acres in both Mobile and Baldwin Counties by combining federal funds with state funding from oil and gas lease revenues in the following areas: Bayou Sara, Perdido River- Longleaf Hills, Bayou Canot, Freedom Hills, Grand Bay Savanna, Jacinto Port Upland and Wetlands, Lillian Swamp, Caney Bayou, Middle River West, Mobile-Tensaw Delta, Bayou Jessamine, Salco and Middle River, Splinter Hill Bog, Weeks Bay, and Blakeley Addition.

In 1995, Baldwin County also initiated significant conservation efforts led by the Baldwin County Commission's Wetland Conservation Plan. The Plan assessed fresh and saltwater wetland habitat areas that comprise 25% of the county's land area. From the assessments, Baldwin County has determined that 88% of its wetlands (260,000 acres) are suitable for conservation, 10% (30,000 acres) suitable for enhancement, and 2% suitable for restoration.

"For in the end, we will conserve only what we love, we will love only what we understand, and we will understand only what we are taught."

- Baba Dioum



Mississippi-Alabama Habitat Database

SAV restoration

Alonzo Landing shoreline stabilization

Key projects in the habitat database:

Mon Luis Island – 5 acre salt marsh restoration by the Alabama Coastal Foundation

Bon Secour Dunes – 180 acres of protection for the Alabama beach mouse habitat by the U.S. Fish and Wildlife Service

Bohemian Park Stream Restoration – 1 acre stream flow modification by Baldwin County Planning and Zoning Department

Dauphin Island Bird Habitat – 7.4 acres of upland maritime and wetland forest acquired for conservation by Dauphin Island Bird Sanctuaries, Inc.

Alonzo Landing – 3 acres of shoreline stabilization by Gulf of Mexico Foundation, AUMERC, MASGC, and the Town of Dauphin Island

In order to track habitat restoration activities like these and others in coastal Alabama and Mississippi, a database has been developed by the MS-AL Sea Grant Consortium, the Dauphin Island Sea Lab (DISL) and the MBNEP to improve coordination and restoration methods. The database, located at http://restoration.disl.org/www, provides information on over 92,000 acres of habitat restoration projects and maps them for natural resource planning use.

Mon Luis Island restoration

The 83 different projects included in the database are either currently being planned, are in progress, or are completed, and conserve or restore habitat types including: Barrier islands (1); bottom land hardwoods (3); dunes, forested wetlands (4), hard bottoms (7), maritime forests (3), pine savannas (6), salt marshes (10), soft bottoms (1), tidal wetlands (9), uplands (16), and wetlands (7). The conservation methods used included: placement of dredge material (3), removal of invasive species (9), land acquisition (47), prescribed burns (4), reef construction using natural materials (3), shell or cultch plantings (2), stream channel restorations (2), and installation of wave attenuation devices (2).

HABITATS: MAINTAINING COASTAL QUALITY OF LIFE

Nesting & Migrating Birds

Terns on Dauphin Island

Critical Habitats for Nesting and Migrating Birds - Bird surveys continue to be conducted by ADCNR Wildlife and Freshwater Fisheries Division (WFFD) to assess populations of both migratory and colonial nesting birds as an indicator of suitable quality and quantity of the critical habitats that support them. Colonial Nesting birds were surveyed in 2006 at sites throughout coastal Alabama by Dr. John Dindo, DISL, in partnership with the MBNEP. This survey highlighted a disturbing relationship between the sequence of storms recently experienced, including Georges, Ivan, and Katrina, and the quantity of suitable habitats for bird nesting. Sites where populations had been particularly depleted include the west end of Dauphin Island, Sand/Pelican Island, Cat Island, and the islands of Perdido Bay. In 2003-2004, 1,000 Royal and Sandwich Tern chicks were counted running along the beach front on the west end of Dauphin Island. In 2006, following Hurricanes Ivan and Katrina, no Royal Tern colonies were observed. These two storms flattened the Sand/Pelican Island complex, which previously supported at least three colonies of Black Skimmers and Common Terns along with Blacknecked Stilts. Cat Island has been a noted coastal heronry for over 70 years with remarkable success rates for hatching and fledgling for species including Tricolor Herons and Reddish Egrets. Following Hurricane Georges, which devastated the island's habitats, a restoration effort returned it to its pre-storm level of vegetation, but Katrina again devastated the island. Prior to the purchase of Robinson Island in Perdido Bay by the Town of Orange Beach, its owner cut 85% of the slash pines on the island, which were used for nests by Great Blue Herons and Great Egrets. Katrina's salt over-wash killed the remaining trees, and only ten nests were counted in 2006.

Coastal Alabama also has some success stories. Least Terns are successfully nesting in the oyster shell hash on the edges of the runway at the Dauphin Island landing strip. Fifteen nesting pairs of Great Blue Herons were observed in trees of eastern Dauphin Island in 2006, compared to five or six nests in other years. Gaillard Island, a man-made island owned and maintained by the Alabama State Port Authority, was built to store and de-water dredge material from Mobile Bay and provides a protected wildlife refuge. It is located two miles east of the mouth of Dog River and is the area's only local nesting site for Brown Pelicans, with 5,000 breeding pairs and 3,000 non-breeding juveniles. In addition, over 4,000 Laughing Gulls and 2,000 Royal Terns, Sandwich Terns, and Caspian Terns nest on the open flat areas of the island. In the last five years, approximately 1,500 herons and egrets, including Cattle Egrets, Snowy Egrets, and Black Crowned Night Herons, and Tricolored Herons have nested in the upper vegetation of Gaillard Island. A relatively new mixed colony, including approximately 200 nesting pairs of Glossy Ibis, White Ibis, Little Blue Herons, Snowy Egrets, Yellow Crowned Night Herons, and Great Egrets, formed at the former site of the International Paper Company after Hurricane Ivan and grew after Katrina, probably as a consequence of habitat loss on Cat, Coffee, and Gaillard Islands.

Birdfest

Since its founding in 2004, the Alabama Coastal BirdFest has raised more than $40,000 that has been donated toward the purchase and protection of bird and wildlife habitat in Baldwin and Mobile Counties.

Reddish egret

"It's essential to protect the natural habitat along the Gulf Coast to give migrating birds, as well as our local species, a place to nest, to feed, and to rest on their journeys," said John Borom, president of Mobile Bay Audubon and chairman of the BirdFest steering committee.

Snowy Plover
Margo Zdravkovic, Audubon CBCP

Beach nesting breeding birds were counted along the coast of Alabama in 2007 by the National Audubon Society through its Audubon Coastal Bird Conservation Program (CBCP) funded by MBNEP and ADCNR. The CBCP surveyed all beach-nesting bird habitat or potential habitat on coastal sites that included Bon Secour National Wildlife Refuge, Dauphin Island, West Dauphin Island, Isle Aux Herbs, Sand/Pelican Island, Cat Island, Gulf State Park, and Barton Island Peninsula. The total number of breeding birds located for each species are as follows: Snowy Plover - 10 pairs; Wilson's Plover - 13 pairs; American Oystercatcher - 12 pairs; Least Tern - 63 pairs; Gull-billed Tern - 30 pairs; Common Tern - 9 pairs; and Black Skimmer - 56 pairs. In 2008 the CBCP conducted a second season of surveying and began monitoring and protective signage programs. The CBCP is currently engaged in discussions to implement protective measures with the cooperation of local, state, and federal agencies to preserve and enhance Alabama's small beach-nesting bird population (Zdravkovic, 2008).

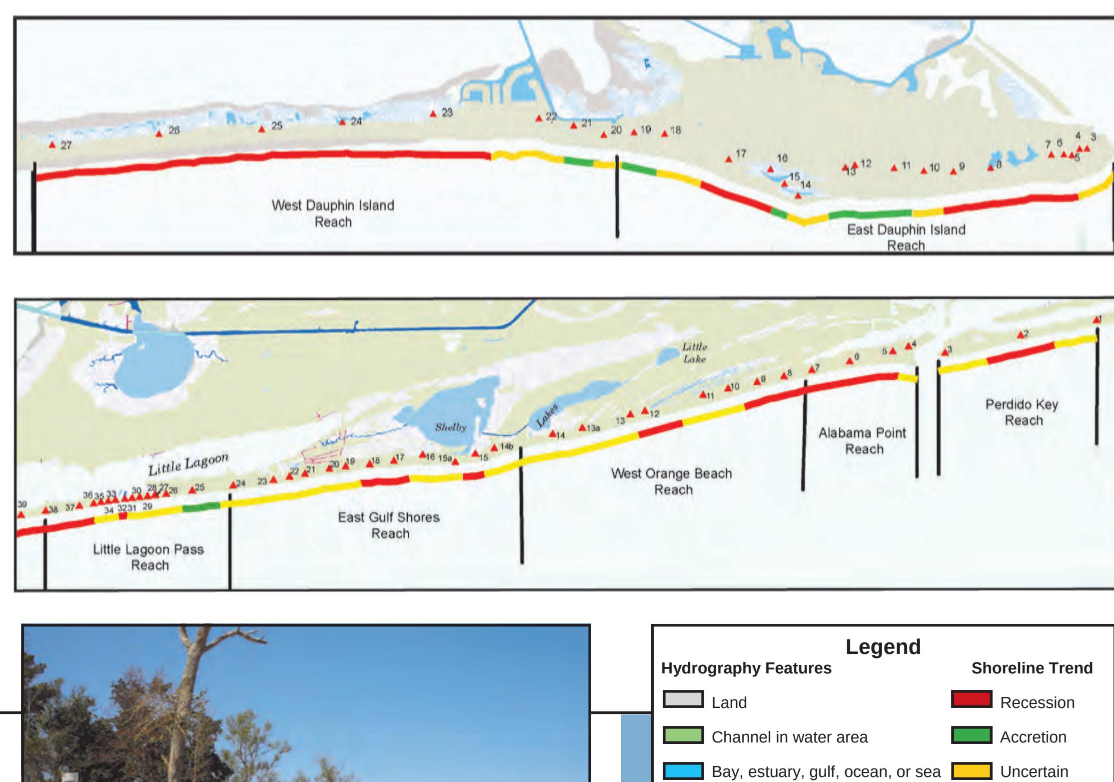
Indicator #6. Shoreline Change

Has the extent of physical/chemical alteration of the watershed been reduced or managed? Uncertain.

In recent years, the Alabama coastline has undergone substantial modifications due to beachfront development, existing hard shoreline defense structures, beach nourishment, and tropical weather events. As part of the "Gulf-fronting Shoreline Monitoring Program," an assessment project was conducted by SLD and the GSA. Based on available data, shoreline changes from 1979 to 2005 were evaluated for 98 reference points along the coast. The project noted the following shoreline recession rates along the Alabama coastline:

- Perdido Pass - 2 ft .per year
- Little Lagoon Pass - 6 ft. per year
- West end of Morgan Peninsula - 10 to 44 ft. per year
- Eastern Dauphin Island - 7 to 14 ft. per year
- West Dauphin Island - 6 ft. per year

Shoreline Trends



Geological Survey of Alabama

Dauphin Island beach erosion

LIVING RESOURCES: ENSURING SPECIES RICHNESS

Fishery Populations

LIVING RESOURCES at-a-glance...
Our two-county area contains four broad natural ecosysems - terrestrial, freshwater, estuarine, and marine/continental shelf - which support an extremely diverse assemblage of plants and animals. In terms of "biodiversity" - the number of distinct species in a given area - Alabama ranks fifth among states in the U. S. and first among those east of the Mississippi River. Of primary concern are understanding the history, habitat requirements, life cycles, strengths, and weaknesses of endemic flora and fauna; the problems associated with the introduction of exotic species; and the health of commercial and recreational fisheries.

Increasing our knowledge of the status and trends of estuarine populations is important and challenging. Our knowledge about any given species seems directly proportionate to both the physical size of the species and its perceived economic importance. While some species are naturally rare, others become rare, at least in part, because of habitat loss and fragmentation, pollution, and over-harvest. We must determine why certain species become rare and develop management strategies to minimize species loss.

The Alabama coast is recognized for its recreational fishing opportunities and commercial fishing industry. Many of the species that support these fishing opportunities have complex life histories. They usually exhibit onshore/offshore migrations and a dependence on estuarine habitats during juvenile stages. Monitoring of estuarine-dependent organisms provides insight into the status of fishery resources, the effectiveness of habitat restoration programs, the consequences of habitat degradation, and the impacts of invasive species.

Stock assessments are used to determine the health of a particular fishery. Although harvests/landings data are a component of stock assessments, numerous factors that affect landings potentially misrepresent the health of a stock. According to the ADCNR Marine Resources Division (MRD) landings data do not necessarily represent stock strength because of factors like weather events, technological developments, or even imposed regulations which all affect harvest efforts. While harvest/landings data provide an indication of trends, more careful analysis is necessary to make decisions affecting management.

Spanish Mackerel

Indicator #7. Sustaining Fishery Populations

Are fish populations stable? Yes.

Even though our state is ranked as the 25th in land area, The Nature Conservancy report, *States of the Union: Ranking America's Biodiversity* (2002), lists Alabama as fifth in terms of biodiversity with a total of 4,533 different species. This distinction is mainly a result of the relatively high number of species of freshwater fish (297), marine animals (250), reptiles (85), amphibians (68), and vascular plants (2,902). This incredible species richness includes 144 *endemic* species, or organisms found only in the state of Alabama. The coastal ecosystems of the Mobile-Tensaw River Delta, Mobile Bay, and Mississippi Sound are unique to the state of Alabama and provide valuable habitat to a large percentage of our diverse floral and faunal populations.

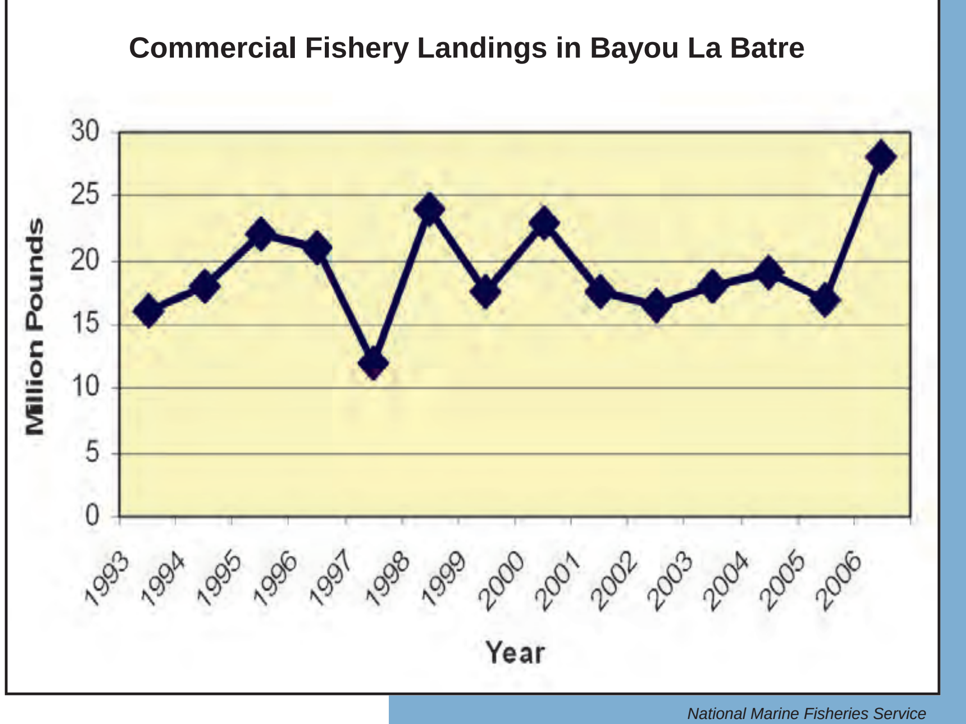
Shrimp boat fleet in Bayou La Batre

Two recent analyses of more than twenty years of sampling from the Fisheries Assessment and Monitoring Program (FAMP) of the MRD were undertaken to determine status and trends in stocks that included commercially and recreationally important fish and shellfish in our coastal waters. Monitoring abundance of estuarine-dependent species provides data that can be used to assess fisheries status, determine consequences of habitat degradation, evaluate effectiveness of habitat restoration programs, and ascertain impacts of invasive species. Changes in species abundance must be interpreted using long-term data because of intrinsic time lags of cause-effect processes and high year-to-year "expected" variations due to annual changes in the environmental conditions that characterize coastal waters.

In an MBNEP-funded study completed in 2006, Dr. John Valentine of the DISL evaluated data on selected species (brown shrimp, white shrimp, pink shrimp, blue crab, lesser blue crab, hardhead catfish, Gulf butterfish, white trout, Gulf menhaden, spot, and Atlantic croaker) from 1981 to 2003. Field samples from shrimp trawls, plankton nets, and seines, were used to summarize status, identify species requiring additional management, and make recommendations to increase their abundance. In 2008, Harriet Perry's team from the Center for Fisheries Research at the University of Southern Mississippi Gulf Coast Research Laboratory completed another statistical analysis, funded by MASGC, of long-term FAMP data sets from 1981 through 2007 for Alabama and Mississippi (with comparisons to data in Louisiana). Both studies were in agreement that for most species no significant changes in status were revealed over this time frame. Notable exceptions were brown shrimp and blue crabs.

Commercial Species Harvests

Commercial species harvests provide a valuable source of revenue for the state. The dockside value from the 2006 harvest was $48.5 million, with 85%, or $41 million, coming from landings in Bayou La Batre alone. While dockside values of the 2006 harvest did not exceed the $63 million recorded for the year 2000, the biomass of 2006 annual landings of all species was the highest ever at 34 million pounds, according to the National Marine Fisheries Service (NMFS). The increase in 2006 landings was likely related to port unavailability in Mississippi and Louisiana as a consequence of Hurricane Katrina. An estimated 75% of the nation's commercial fish and shellfish depend on estuaries at some stage in their life cycle, and 98% of commercial fishery landings in the Gulf of Mexico are dependent on estuaries and wetlands. The most common commercial species obtained from Alabama waters are shrimp, blue crabs, striped mullet, oysters, and ladyfish - all of which spend juvenile stages in Estuarine waters (National Ocean Economics Program, NOEP).



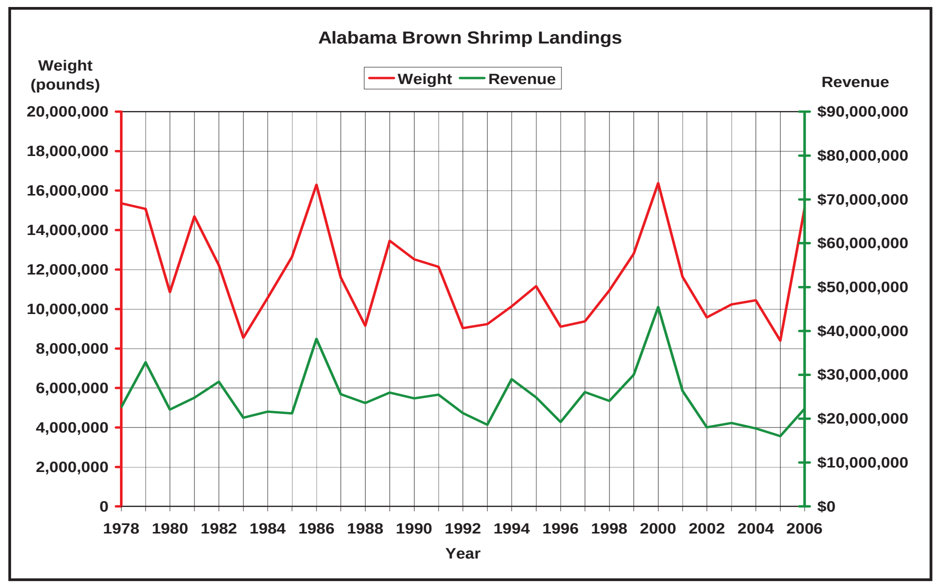
National Marine Fisheries Service

LIVING RESOURCES: ENSURING SPECIES RICHNESS

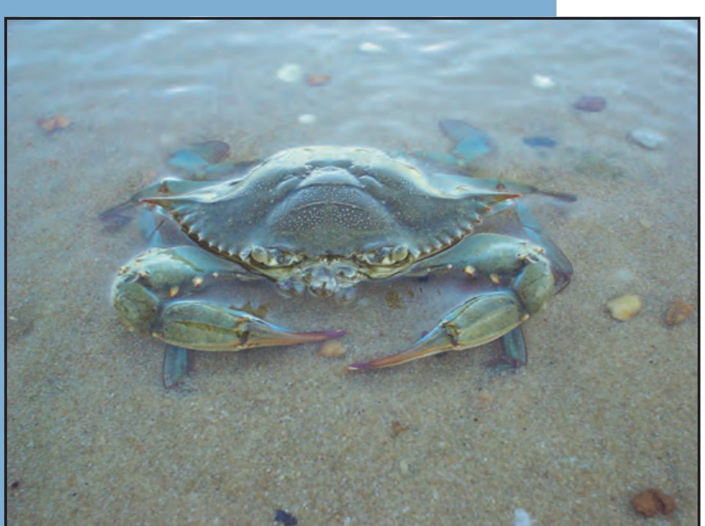
Shrimp, Crabs, & Oysters

Common shrimp
Mote Marine Laboratory

Commercial landings of brown and white shrimp contribute approximately 80% of the Alabama commercial fisheries revenue (NOEP). An assessment of long-term fisheries data collected by the MRD from 1981 to 2003 shows a decrease in brown shrimp populations between 1999 and 2003 that correlates with a drop in commercial harvests over the same period (Valentine, 2006 and Perry, 2008). However, the data from the 2006 brown shrimp catch, supported by Perry's 1921-2001 analysis, reveals a rebound in production with over six million more pounds harvested than in the 2005 season (NOEP).

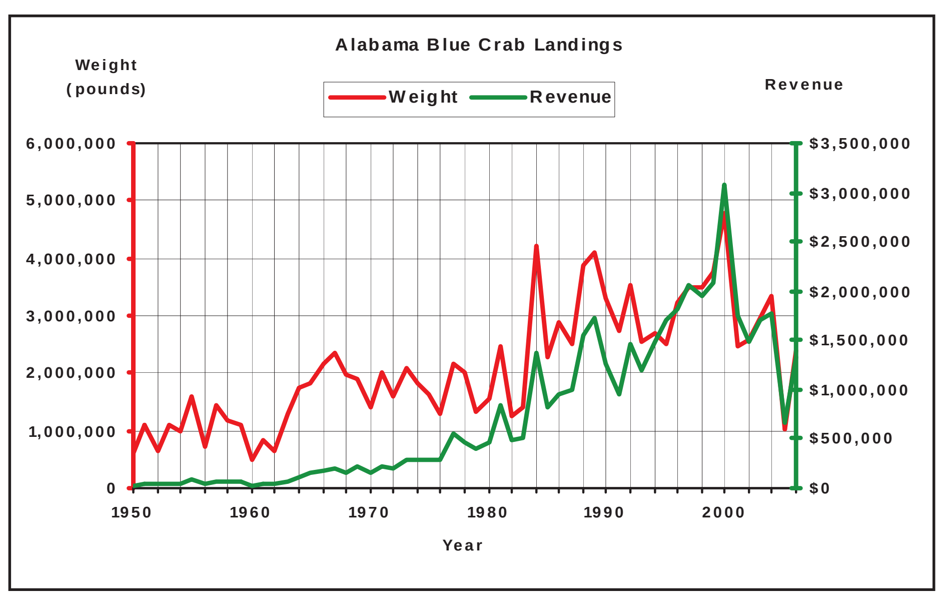


National Ocean Economics Program



Blue crab

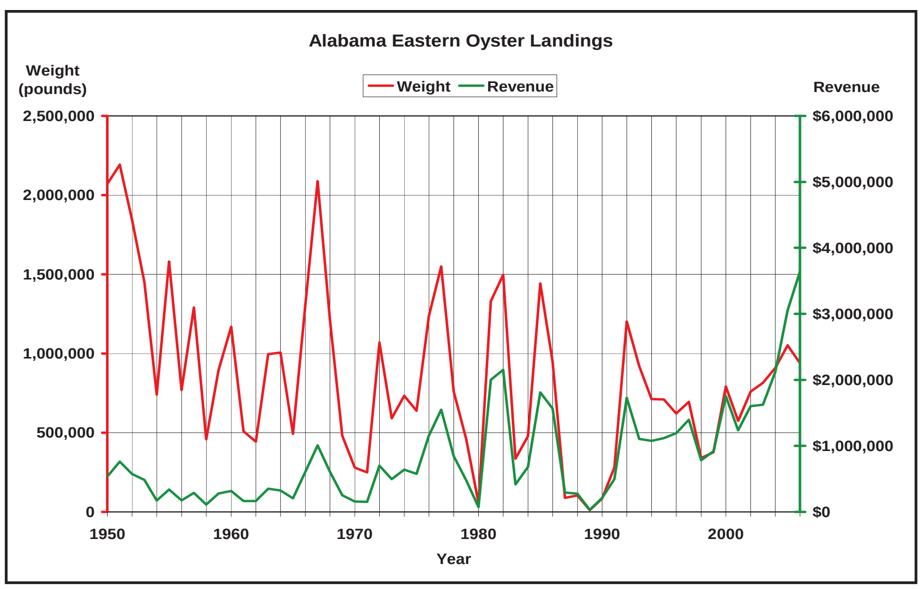
Reductions of blue crab populations were revealed in an analysis of the long-term data obtained from MRD during the 1999 to 2003 (Valentine, 2006) and 2007 (Perry, 2007) time frames. NOEP reports the same drop in harvest numbers starting in 1999 and continuing through 2005, with a small increase in 2006.



National Ocean Economics Program

Placing oysters on a reef in Mobile Bay

Oyster harvests within the Alabama coastal environment**,** in contrast to recent brown shrimp and blue crab landings, were in an increasing trend from the lowest point in 1989 until hurricanes in 2004 and 2005 and the onset of drought conditions in 2006. Without sustained input from upstream freshwater sources and perhaps exacerbated by the opening of the "Katrina Cut" through the west end of Dauphin Island, salinity in coastal waters has increased and moved upstream, providing ideal conditions for oyster drills, the primary predator of oysters. Reduced catches in 2006 and 2007 reflected this salinity shift. Populations of oysters remain sufficient to produce strong spat sets (i.e., settling juveniles), but the drills consume developing adults before they reach harvestable size. With increased rainfall and modification in restoration practices, this condition could be reversed.



National Ocean Economics Program

Oyster reefs are not only important in the Mobile Bay ecosystem for their commercial value as food; they also remove excess nutrients and suspended particles from the water column. One adult oyster is capable of filtering five gallons of water per hour while also providing hard-bottom habitat for a variety of other marine species. Because of the high ecological value of estuarine oyster populations, oyster gardening has been undertaken as a joint effort between the MBNEP, the MASGC, and AUMERC since 2001. In November 2006 and 2007, around 60,000 oysters raised by volunteers and 100,000 raised by AUMERC were placed on Boykin Reef off Dauphin Island and Shellbank Reef in Bon Secour Bay. The oyster gardening program is specifically intended for habitat and ecological restoration, not consumption, but more importantly, its educational component teaches citizens that oyster reefs are the estuarine equivalent of coral reefs.

Oyster Gardening

Modeled after a successful program in the Chesapeake Bay, the AUMERC/ MBNEP Oyster Gardening Program is the first of its kind on the Gulf Coast. Each year, volunteers conduct water quality and oyster growth research, maintain reef habitats, and release young oysters. The oysters are not grown for consumption, but to rebuild the wild oyster population in the Mobile Bay area.

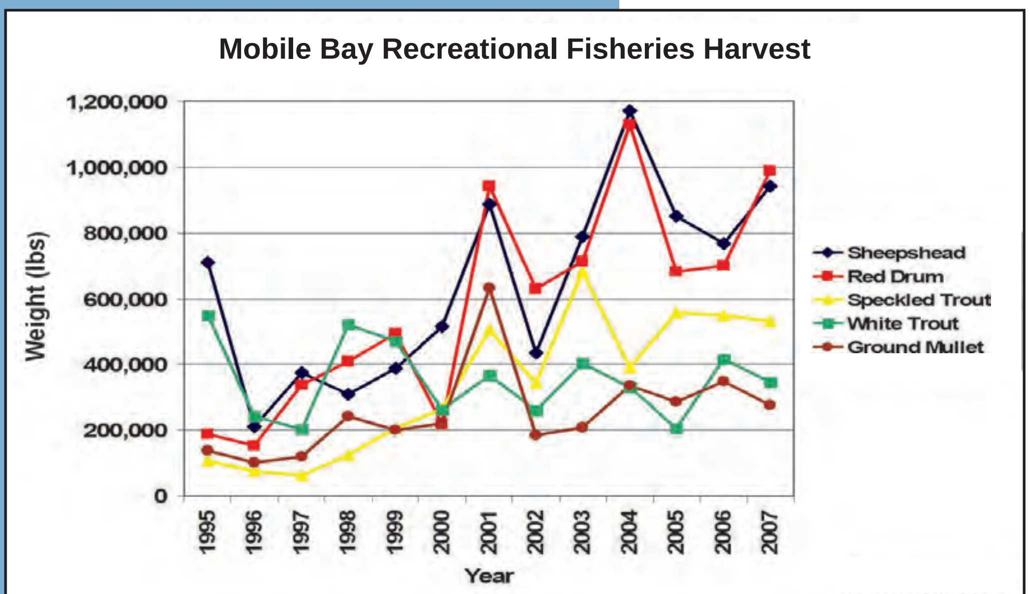
The 2004- 2005 storm season wiped out nearly 75% of the oysters meant for reef restoration. However, in November 2005, over 11,000 oysters were placed at the Kings Bayou Reef as part of the oyster gardening program.

Although oysters take up to two years to mature, because of efforts like these, it is anticipated that a strong recovery is on the horizon for the Alabama oyster.

Oyster gardening

LIVING RESOURCES: ENSURING SPECIES RICHNESS

Recreational Species Harvest



NOAA/NMFS

<u>Recreational Species Harvests</u>

Saltwater species provide the vast majority of fish caught recreationally in the Mobile Bay system, which encompasses both fresh and saltwater habitats. In 2007, over 1.1 million trips were made by anglers to Alabama coastal waters, resulting in a recreational harvest of 4.4 million pounds of marine fish. Between 1995 and 2007, sheepshead, red drum, speckled trout, white trout, and ground mullet accounted for 28.2 million pounds (64%) of the total 43.8 million pounds harvested in Alabama state waters (NOAA/NMFS). The NMFS Gulf of Mexico Fisheries Management Council has identified the entirety of Mobile Bay and the Mississippi Sound as Essential Fish Habitat, or habitat which is "essential to a species' long-term survival and health," for red drum. Since 2001, more red drum and sheepshead have been harvested than any recreational fish with a peak harvest of around 1.2 million pounds of both species in 2004. Speckled trout harvests have also experienced more than a five-fold increase within State waters since 1995. In recent MRD angler surveys, greater than one-third of the fishermen interviewed were targeting speckled trout as their primary or secondary species with an average of two "specks" caught per fishing trip.

Recreational Harvests of Saltwater Species from Alabama Waters 1995-2007

Rank	Species	Pounds Harvested	Percent of Total Harvest
1	Sheepshead	8,347,810	19.1
2	Red Drum	7,593,213	17.2
3	White Trout	4,581,480	10.5
4	Speckled Trout	4,401,268	10.1
5	Ground Mullet	3,296,564	7.5

NMFS

Sheepshead catch

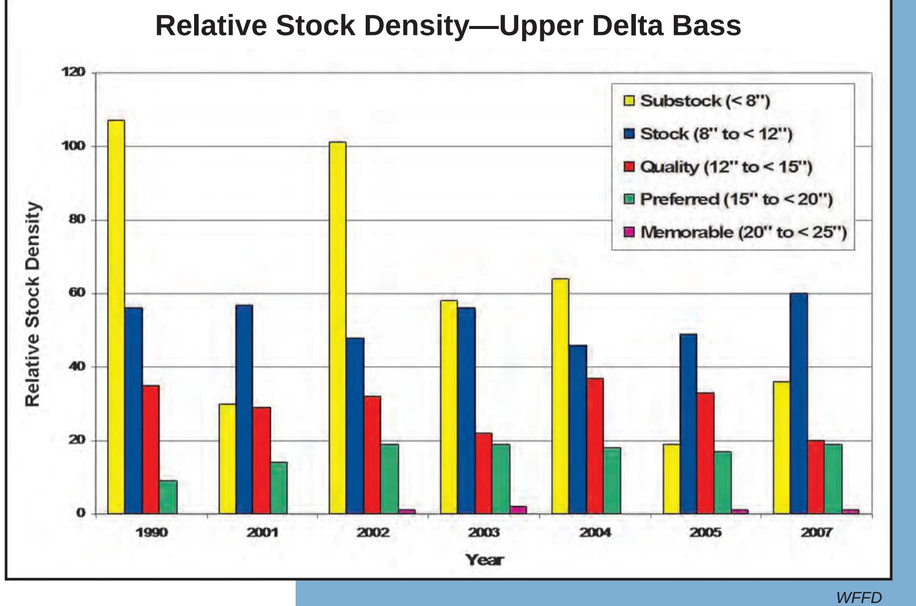
Freshwater species are the predominant target for recreational anglers in the Mobile-Tensaw Delta, which also has limited fisheries for seasonal marine and estuarine species such as red drum, speckled trout, and southern flounder. The principal freshwater species in the Delta include largemouth bass, crappie, bluegill, and redear sunfish. Prior to the construction of dams on the Mobile River, striped bass and Alabama shad were also popular sport species.

Tournament angling has increased in popularity over the last 20 years for several species of fishes in the Delta. While largemouth bass tournaments are the most common, there are now tournaments for crappie, bream (bluegill and redear sunfish), and bowfin. Largemouth bass tournaments include small local events hosting a few anglers from area fishing clubs to regional and national tournaments involving hundreds of anglers. The Mobile Delta is recognized as one of the stops on the Alabama Bass Fishing Trail by the WFFD (www.outdooralabama.com).

Flounder

WFFD maintains a long-term sampling program in the Delta to monitor the status of important game species, such as largemouth bass, and make management recommendations for conservation issues. Largemouth bass population structure is assessed using relative stock densities - the percentage of fish of any designated length-group in a sample of fish greater than or equal to “stock” size (less than eight inches). The spring 2007 WFFD survey revealed an adequate spawn of largemouth bass in 2006, and catch rates of 2007 spawned bass were higher than the 2006 sample, despite the drought. Anglers may currently find reduced numbers of “quality”-sized bass (12 inches to less than 15 inches) due to abnormally high mortality rates in the 2004-year class related to drought conditions and the effects of Hurricane Ivan. However, good recruitment of “stock”-size bass should result in improvement in this size class in 2008. Data collected by WFFD from voluntary reports during largemouth bass tournaments in the Delta and published in the *2007 B.A.I.T. Annual Report* indicate no long term trends in catch rates over the last 20 years.

An ongoing project from Auburn University has focused on the unique biology of the largemouth bass in the Delta. This work suggests that fish in this geographic area are proving to be different from the largemouth bass that have been studied comprehensively in inland fresh waters. Delta bass appear to reproduce and die at an earlier age when compared with their better-studied inland populations, complicating management decisions concerning these fishes. These biological differences may explain why relatively few largemouth bass in the Delta exceed five pounds body weight.



WFFD

The greatest threats to the fresh and saltwater fish populations and the fisheries they support would most likely be non-point source pollution and habitat loss associated with the development of the watershed. Continued fisheries monitoring and conservation management should ensure the future success and sustainability of this important component of the Delta and Mobile Bay regions.

Threatened & Endangered Species

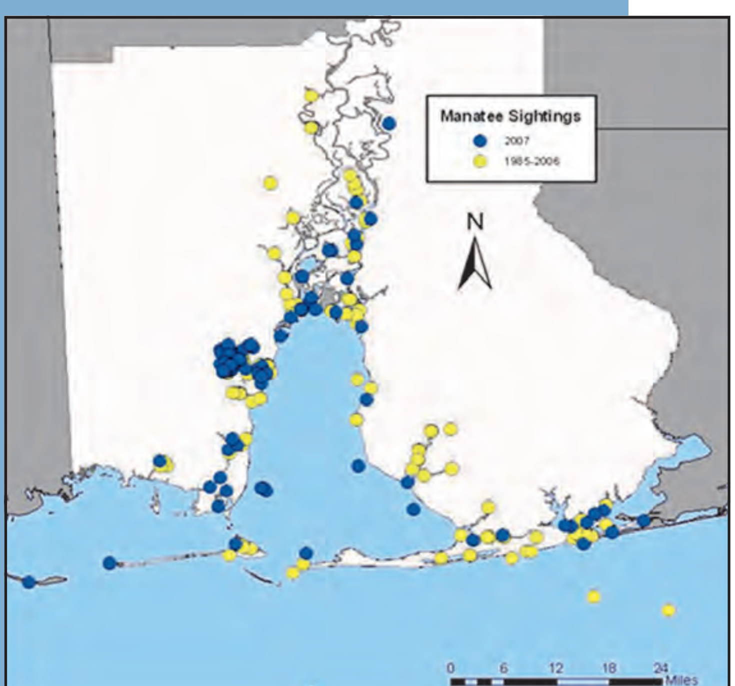
Gopher tortoise

Indicator #8. Threatened / Endangered Species

Are threatened and endangered species rebounding? Yes.

Among the 50 states, Alabama is ranked second in number of extinctions, with a total of 90 species presumed or possibly extinct, and fourth in terms of species considered at risk of extinction, with 14.8% of its 4,533 species in peril (NatureServe and The Nature Conservancy, 2002). The Mobile Bay area is home to 21 of these threatened and endangered species, including:

- fish (Alabama sturgeon and Gulf sturgeon);
- shellfish (heavy pigtoe mussel and inflated heel splitter mussel);
- mammals (West Indian manatee, Alabama beach mouse, and Perdido beach mouse);
- turtles/tortoises (Alabama red-bellied turtle, gopher tortoise, Kemp's ridley sea turtle, green sea turtle, and loggerhead sea turtle);
- other reptiles and amphibians (eastern indigo snake and flatwoods salamander); and
- birds (piping plover, red-cockaded woodpecker, and wood stork).



Carmichael—Mobile Manatee Sightings Network

According to the Daphne Field Office of the U.S. Fish and Wildlife Service (USFWS), the only species added to the list of threatened or endangered species in Mobile or Baldwin Counties in the last ten years were the flatwoods salamander in 1999 and the Alabama sturgeon in 2000. Due to their remarkable recoveries, the brown pelican was de-listed in the state of Alabama in 1985 and the American alligator was de-listed for the entire United States in 1987. The USFWS is currently moving forward with efforts to de-list the brown pelican across the lower 48 states.

Manatee sightings have recently increased in Alabama coastal waters. In 2007, the DISL, in collaboration with Wildlife Trust in Florida, started the Mobile Manatees Sighting Network (http://manatee.disl.org), the first formal network to receive and track manatee sightings in Alabama waters. Only 158 sightings were recorded in the Mobile Bay area over the preceding 20 prior years, but the sighting network processed 102 manatee sightings in 2007, (perhaps reflecting increased attention stimulated by the Network rather than increases in manatee populations). Researchers rely heavily on public participation to report any manatee sightings as soon as possible. These data are important to manatee management and conservation efforts coast wide and have contributed to the AL Natural Heritage Program's recent decision to reclassify manatees in Alabama waters from accidental to priority.

Manatees
Monica Ross, Wildlife Trust

Brown pelican

The brown pelican is a success story for the Mobile Bay area. In 1970, it was listed as endangered as a result of breeding failure. High levels of DDT, a broad range pesticide, were accumulating in the pelican population through consumption of tainted fish and causing production of eggs with extremely thin shells resulting in high rates of egg breakage, moisture loss, and extensive hatchling mortality. In 1983 Alabama wildlife biologists observed four pairs of nesting brown pelicans on Gaillard Island, a man-made island constructed from dredge product from the Theodore Ship Channel. Within two years the pelican population had increased dramatically, and they were removed from the Endangered Species list in Alabama and Florida. Current estimates of brown pelicans residing on Gaillard Island have topped 12,000.

Piping plover

The piping plover and the beach mouse are frequently highlighted for having critical habitats in Baldwin County. The critical habitat designation indicates that a specific geographic area contains essential features for the conservation of the species and requires special management and protection (FWS). FWS-designated critical habitat areas for the piping plover include Isle Aux Herbs (a.k.a. Coffee Island), Dauphin Island, Pelican Island, and portions of Bon Secour National Wildlife Refuge (including Little Dauphin Island). FWS-designated critical habitat areas for the beach mouse encompass approximately 1,200 acres along the Alabama coast and include land in the following areas: Fort Morgan State Historic Site, Fort Morgan Parkway, land south of ADEM's Coastal Construction Control Line, Gulf Highlands, and Gulf State Park. Most of the frontal dune habitat for the beach mouse was destroyed by recent storm activity, but FWS officials have planted sea oats, morning glory, and seashore elder across Bon Secour Wildlife Refuge to experiment with re-growth of surfside dunes and restoration of habitat.

Bald Eagle
Weeks Bay NERR

Bald eagles historically nested along the Gulf coast, but the population dwindled in the 1950's and 1960's as a consequence of DDT pesticide poisoning. The wintering population plummeted, and the breeding population died out completely. After DDT was banned in 1972, the population began to increase, but the birds continued to migrate north to nest. In the early 1980's, the Nongame Wildlife Program of the ADCNR initiated the Bald Eagle Restoration Program. From 1985-91, in a process known as "hacking," 91 juvenile eagles were released and forced to take their first flight in Alabama to become imprinted to that geographic area. The first nesting attempt in Alabama since 1949 was confirmed in 1987, and more unsuccessful attempts followed in subsequent years. The first successful nests were documented in 1991. By 2006, in the nearly twenty-year period since nesting behavior was initiated, 493 documented nesting attempts resulted in 557 young eagles successfully fledging these nests. In 1999 a proposal was made to de-list the bald eagle from the Endangered and Threatened Species List, and on June 28, 2007 it was removed from the federal list during a ceremony at the Jefferson Memorial. With 4,500 pairs currently nesting, the future appears to be bright for the bald eagle, and the sight of our national symbol flying or perched along Alabama coastal waters is not uncommon.

LIVING RESOURCES: ENSURING SPECIES RICHNESS

Invasive Species

Aquatic Nuisance Species

Aquatic Nuisance Species (ANS) pose a significant problem to the State of Alabama. The vast amount of water resources acts as a conduit for the invasion of these species. ANS are aquatic plants and animals introduced outside of their native ranges that can have harmful effects on the local economy, human health and/or ecology. For example, Eurasian milfoil is a native of Europe, Asia, and northern Africa. It was introduced to coastal Alabama in the 1940's presumably attached to commercial or private vessels. Eurasian milfoil forms large, floating mats of vegetation on water bodies, crippling boat traffic and blocking light penetration to native plants.

Take Action: Boaters should check boat hulls and motors closely when transporting craft from one body of water to another, to minimize spreading.

For more information log on to www.anstaskforce.gov.

Indicator #9. Invasive Species

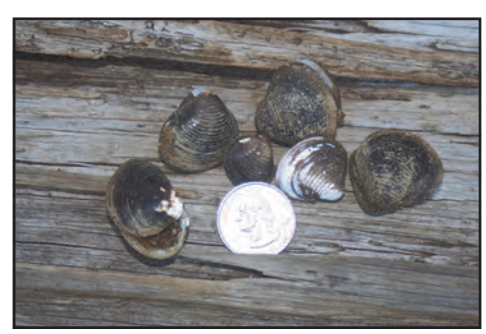
Are introduced, non-native species a problem? Yes.

One negative aspect of our rich habitat diversity is that some exotic species, when introduced through various human activities, become too comfortable in the Bay area. While most introduced species are fairly harmless with only minor impacts on the ecosystem, others go unchecked, having no natural predators to control their population growth, and out-compete native populations without contributing in all of the roles of the native species.

The Alabama Aquatic Nuisance Species Task Force (ALANSTF), a collaboration of state and federal agencies, academia, research institutes, government and industry entities, port authorities, and environmental enthusiasts, has developed a *State Management Plan for Aquatic Nuisance Species in Alabama*. Development of the Plan was led and funded (along with the MBNEP) by WFFD in response to an Executive Order by Governor Riley in 2005. The plan was developed as 1) a guideline for prevention and educational awareness regarding the impacts of introduced non-native organisms and 2) a practical management plan for rapid identification, management, and eradication of aquatic nuisance species in Alabama. It is presently under final review by all ALANSTF members before submission to the Governor

Parrotfeather
Andre' Karwath

Hydrilla
Marilyn O'Leary



Corbicula
Rusty Wright

for final review and approval. Alabama is home to more species of plants and animals than any other state east of the Mississippi River. However, increasing pressures associated with biological invasion imperil 10 to 20% of these species. With a hospitable, subtropical climate and countless ongoing shipping, industrial and recreational activities, ALANSTF estimates that more than 80 nuisance organisms, most introduced by such activities, have established themselves along the state's waterways and coastlines.

Water hyacinth
Rusty Wright

Economically, species invasions carry significant "price tags." Non-native aquatic weeds, such as hydrilla (*Hydrilla verticillata*), water hyacinths (*Eichhornia crassipes*), and water lettuce (*Pistia straiotes*), alter population demographics of fish and other aquatic animals, choke waterways, affect nutrient cycles, and reduce the recreational value of state waters. Management and control of nuisance species has become an expensive necessity. Invading non-indigenous species in the United States cause major environmental damages and losses adding up to more than $138 billion per year (Pimental et. al, 2000).

Kudzu

Aquatic nuisance species (ANS) stress aquatic ecosystems and cause massive changes to their structure. Nuisance species frequently out-compete natives, replacing rich assemblages of native species with single-species populations of invaders. They disrupt native habitats and deplete commercially and recreationally important fish and shellfish stocks. Of species currently classified as "endangered," 42% are significantly impacted by these invaders (ANS Task Force).

Another consequence of aquatic nuisance species invasions are human health risks. In 1991, a strain of human cholera bacteria was found in ballast tanks in the Alabama State Port in Mobile (Dickey, FDA). A similar strain of cholera was also found in oyster and fish samples in Mobile Bay, which resulted in a public health advisory to avoid handling or eating raw oysters or seafood. At the time, cholera was epidemic in some central and South American ports and the source has been attributed to local dumping of ballast water taken on in such a port (ANS Task Force).

" The ultimate test of man's conscience may be his willingness to sacrifice something today for future generations whose words of thanks will not be heard."

- Gaylord Nelson

The *State Management Plan* defines the problems related to aquatic nuisance species and outlines actions prescribed toward the following objectives:

- Coordination of local, state, regional, federal, and international activities and programs pertaining to ANS.
- Control and management of the introduction and spread of new and existing ANS through educational outreach and accepted management techniques.
- Prevention of the introduction and spread of ANS through legislative and regulatory efforts.

WATER QUALITY: PROTECTING OUR PRIMARY RESOURCE

Toxicity

WATER QUALITY at-a-glance…

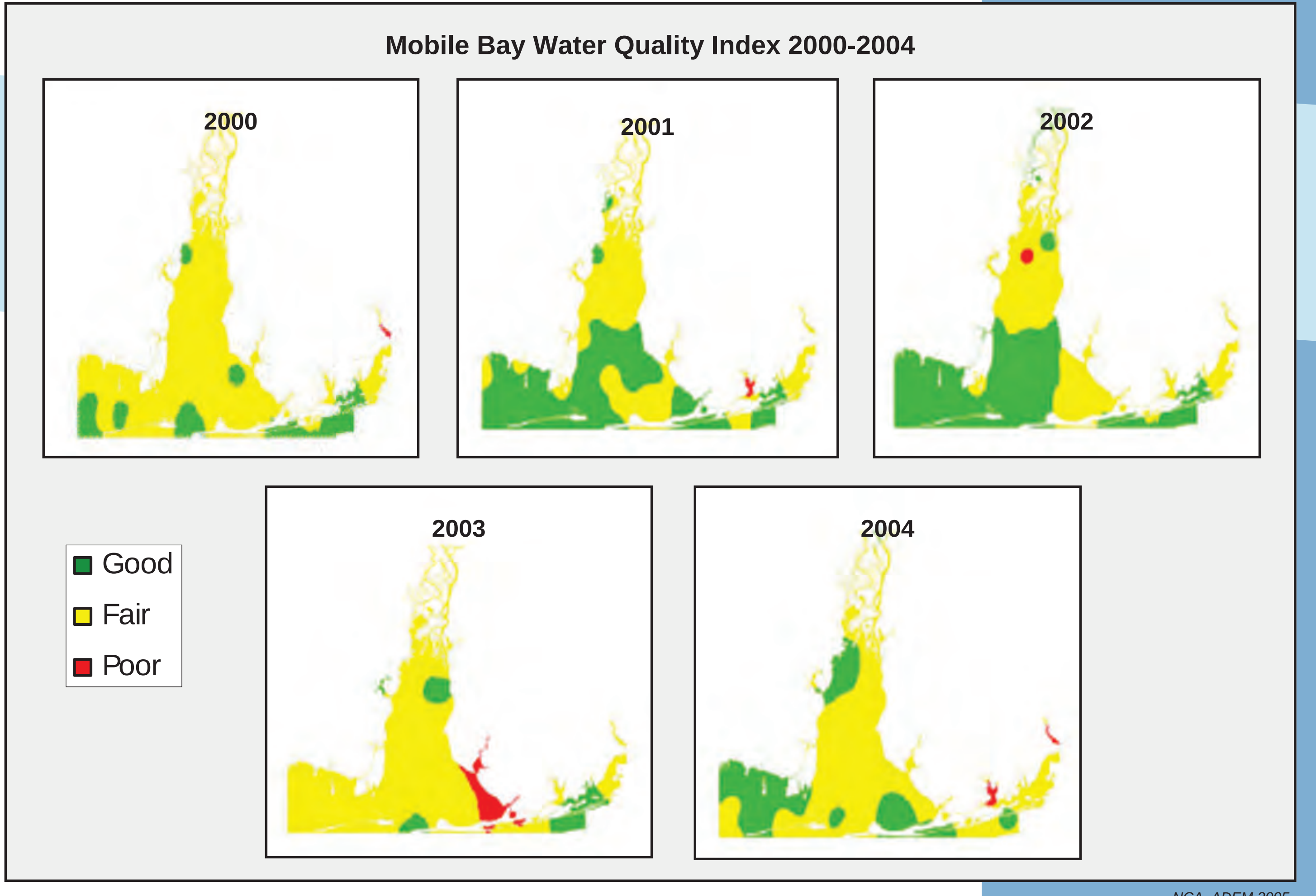
The main source of information about the quality of our water comes from the Alabama Department of Environmental Management (ADEM). Although ADEM has conducted long term monitoring of our bay waters, in 2000 Alabama entered the U. S. Environmental Protection Agency's (EPA's) National Coastal Assessment (NCA) program. This program employs a common set of environmental indicators and sampling protocols across the nation's estuaries to assess conditions at local, regional and national levels.

Under this program, ADEM prepared an NCA for the years 2000-2004. This report included an overall water quality index that captured information on five indicators: dissolved inorganic nitrogen (DIN), dissolved inorganic phosphorus (DIP), chlorophyll-a, water clarity, and dissolved oxygen (DO). ADEM conducted sampling at 50 locations, where indicators were ranked good, fair, or poor. For the water quality index, each sampling site was ranked and then those were combined for an overall index.

The water quality index for Alabama coastal waters was fair to good for each the five years sampled. The following figures are schematic maps showing sampled areas that were ranked fair to good, including Mississippi Sound, Gulf waters, and the lower Bay. Areas ranked poor varied and included Perdido Bay near the river mouth (2000 and 2004), Wolf Bay (2001 and 2004), the open Bay northeast of Dog River (2002), and Weeks Bay and Bon Secour Bay (2003). Dissolved oxygen (DO) levels consistently contributed to the index being ranked fair to poor. Mobile Bay is noted for its occurrence of Jubilees which coincide with low DO episodes, and low DO levels at Perdido Bay have been attributed to its small bay mouth and limited flushing. However, even where favored by natural conditions, land use changes cannot be discounted for contributing to increases in frequency, duration, and/or intensity of low DO episodes. Perdido Bay also has historically high levels of chlorophyll-a, a trend that continued through this NCA.

Playing in the surf at Dauphin Island
Tiffany England

Low tide on western shore of Mobile Bay

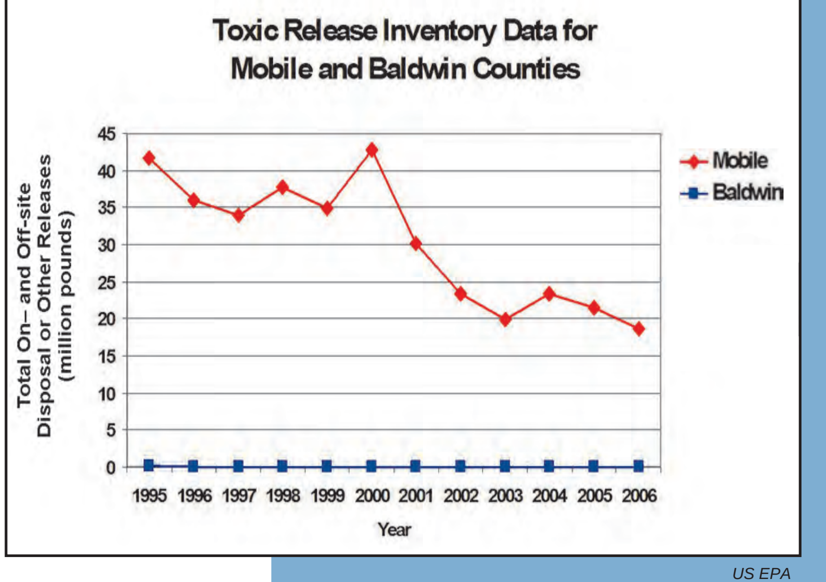


NCA, ADEM 2005

Indicator #10. Toxicity

Are concentrations of toxic substances a cause for concern? Yes and No.

Diverse and productive aquatic environments in the Mobile Bay estuary are threatened by changes in the normal balance of chemical concentrations. Toxic or poisonous chemicals, however generated, are introduced into our waters through sources including stormwater runoff, atmospheric deposition, exhaust from cars and boats, industrial discharges, and illegal disposals. In 2004, a National Sediment Quality Survey was conducted to identify probable areas of concern for sediment contamination from over 19,000 sampling stations located in water-bodies throughout the nation. Results of this survey indicated that certain portions of Mobile Bay are "areas of probable concern" due to the presence of mercury and hydrocarbons (EPA, 2004). Hydrocarbons are compounds made of chains of carbon atoms bonded to hydrogen atoms that include most fuels, solvents, and pesticides.



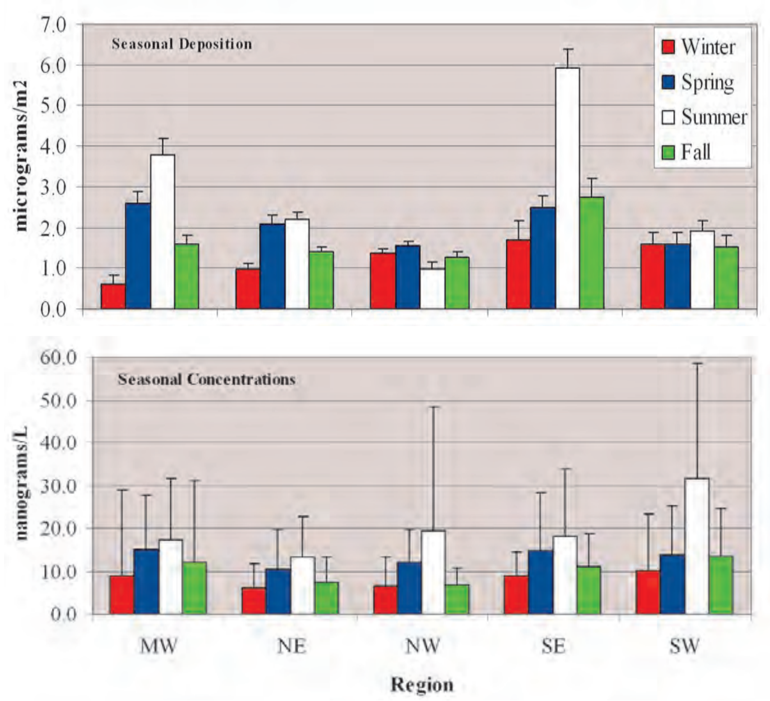
US EPA

Toxic Release Inventory

Section 13 of the Emergency Planning and Community Right-to-Know Act (EPCRA) of 1986 requires the EPA and States to annually collect data on releases and transfers of certain toxic chemicals from industrial facilities and make the data available to the public in the Toxic Release Inventory (TRI). The TRI data for Mobile County shows a general trend of decrease from 41.7 million pounds in 1995 to 18.7 million pounds in 2006. In comparison, the levels of toxic emissions in Baldwin County are negligible with the highest levels recorded in 1995 at 98,815 pounds, falling to 13,998 pounds in 1996 and slowly increasing to more than 33,000 pounds in 2006.

Mercury & Hydrocarbons

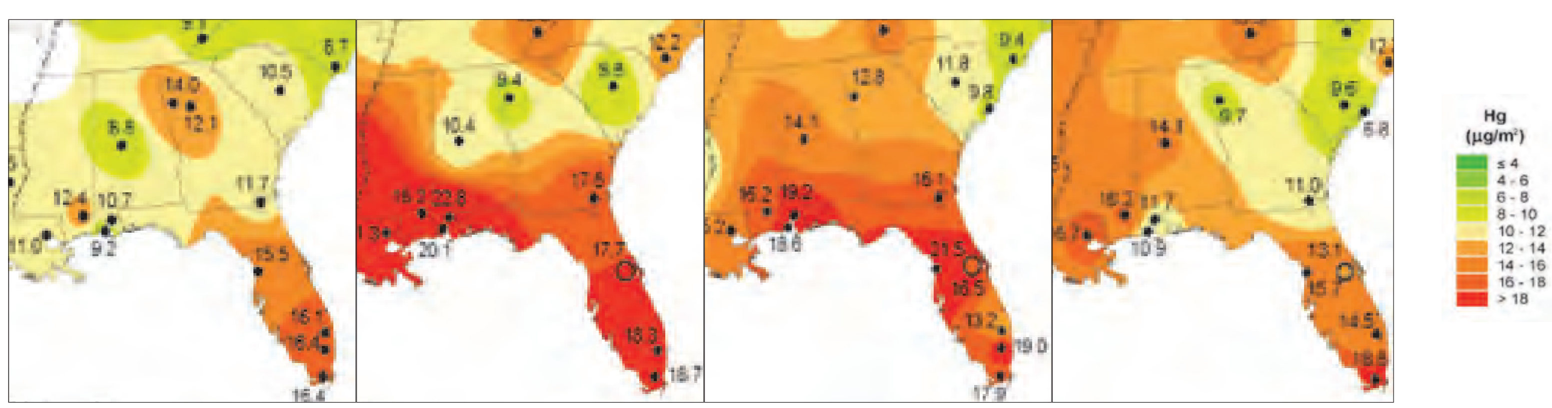
Concentrations of Wet Deposition Mercury by Region



NADP Brochure 2005-01, 2005

Atmospheric deposition data for mercury and certain other substances have been collected at two sites in Baldwin and Mobile Counties since 2001. These sites were established and funded by the MBNEP in partnership with ADEM to measure mercury, ions, and other substances deposited in our area through rainfall. Samples are collected by ADEM and analyzed and reported through the National Air Deposition Program at the University of Illinois. After six years of sampling in Bay Minette and Coden, total annual wet depositions of mercury were found to range between 10.9 and 26.8 $\mu g/m^2$, with an average daily deposition of 0.337 $\mu g/m^2$. Wet deposition is a product of the amount of rainfall an area receives and the value of its air concentration of mercury. The highest U.S. wet deposition rates occur along the Gulf Coast during the usually rainy summers. As the data indicate, there are areas of the country where air concentrations of mercury are much higher than our location, but those areas receive little rainfall and therefore less mercury deposition. The major sources of atmospheric mercury according to the EPA are world-wide industrial releases from coal-fired combustion and municipal and medical incineration.

Total Mercury Wet Deposition, 2003-2006



NADP/Mercury

An estimated 50-90% of mercury loading into inland water bodies is attributed to wet deposition. According to the NADP, elemental mercury has an atmospheric lifetime of approximately one year after release. However, once atmospheric mercury enters the water column through rainwater deposition, it can settle into the bottom sediments and remain for much longer periods of time. Within Mobile and Baldwin Counties, 44 streams, river segments, and water bodies are currently on the ADEM 2006 303(d) list, a collection of impaired water bodies (that do not support their designated uses by meeting state water quality standards). Of those 44 water bodies, 23 have been placed on the 303(d) list due to mercury contamination.

Sediment samples analyzed for mercury from a recent report compiling 30 government studies (Tew et al., 2007) included 576 fresh and saltwater samples from Mobile, Baldwin, Clarke, Monroe, and Washington Counties. Of those 576 samples, 40.3% of the freshwater samples and 53.6% of the saltwater samples were found to contain mercury concentrations at levels exceeding thresholds where adverse effects occur only infrequently. Nineteen percent of the freshwater sediment samples and 11.5% of the saltwater samples were at or above mercury levels where adverse environmental effects are probable. Once deposited into the aquatic environment, biological processes convert inorganic mercury into methylmercury, a form that is readily assimilated into the tissue of living organisms.

Yellowfin tuna fishing
Buzz Sierke (both photos)

Mercury tissue concentrations in fish are routinely monitored in the fall by ADEM. ADEM then provides the mercury data to the Alabama Department of Public Health (ADPH) for assessment. The ADPH then issues annual fish consumption advisories, where appropriate, based on its assessment. The long-term retention of mercury in fish tissue is worth noting. Modeled scenarios predict that if mercury emissions could be reduced by five percent, it would take eight years before any change in fish concentrations would be observed, and the decrease would be small. (USGS, FS-216-95). Since mercury levels cannot be easily reduced or eliminated in living tissue, mercury is passed along from the lowest levels of the food chain (bacteria and plankton) to accumulate (a process called *biomagnification*) in the tissues of higher level predators, such as bass, catfish, and king mackerel.

Alabama and Mississippi issue consumption advisories when mercury tissue concentrations in a given species of fish are determined to be greater than one part per million (ppm); Florida and Louisiana have set advisory levels at 0.5 ppm or greater. A recent review of nine Mobile Bay government studies determined that 19.8% of collected fish fillet samples contained mercury levels of 0.47-0.94 ppm and 19.2% had levels greater than 0.94 ppm (EPA, 2007). The 2000-2004 ADEM National Coastal Assessment (NCA) reported that 79% of fish tissue samples with detectable levels of mercury (greater than 0.05 ppm) came from the Mobile Bay Delta, with largemouth bass and bluegill representing the highest percentages. Research from Auburn University has also shown that largemouth bass bioacculumate high levels of mercury. This biomagnification is dependent on the largemouth bass' diet, size, and growth rate, and whether it is from the upper or lower portions of the Delta. Largemouth bass in the Delta larger than 15 inches in length typically have tissue mercury greater than the limited consumption threshold set by the ADPH.

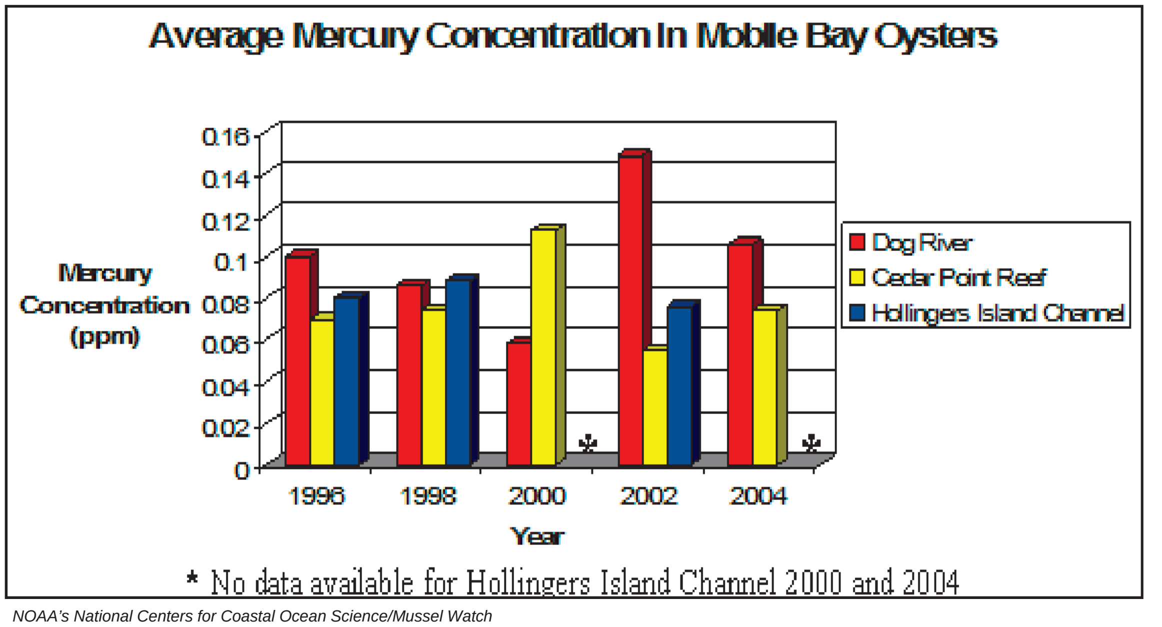
Largemouth bass
USGS

WATER QUALITY : PROTECTING OUR PRIMARY RESOURCE

Mercury & Hydrocarbons

Oysters on the half shell
MASGC

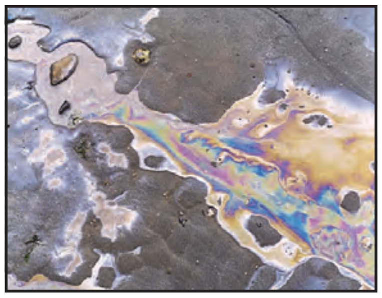
Mercury tissue concentrations in shellfish, also a product of bioaccumulation, are monitored by the federal government. NOAA's Mussel Watch collects oyster samples biannually from Dog River, Cedar Point, and Hollinger's Island Channel. Since 1996, the oyster samples have consistently had average mercury concentrations greater than 0.05 ppm (NOAA's Mussel Watch). These levels are considerably higher than the FDA's reported average mercury concentration of 0.013 ppm from U.S. commercial oyster samples (FDA 1990).



NOAA's National Centers for Coastal Ocean Science/Mussel Watch

Biomagnification of methylmercury in human populations occurs through consumption of tainted fish and shellfish and can cause a range of serious health problems at sufficient concentrations, especially during development. There are special concerns for children under the age of 14, pregnant women, and women of child-bearing age. In 2006, the ADPH issued a total of 23 consumption advisories for Mobile and Baldwin Counties. Recommendations ranged from limited consumption of two meals of the designated species per month to no consumption, with 17 of the 23 advisories listing largemouth bass as the affected species, but significantly lower than the FDA's action level of 1.0 ppm for consumption advisories.

Fried fish
PDphotos.org



Oily sheen
USEPA

Hydrocarbons in surface water were among the pollutants detected in the USGS Assessment (USGS Circular 1231, 2001). The most frequently detected pollutants included trichloromethane (a.k.a., chloroform – a common byproduct of water chlorination), tetrachloroethylene (PCE), trichloroethylene (TCE), 1,2-dichloroethylene (used extensively as degreasers), methyl tetra-butyl ether (MTBE – a gasoline additive), and benzene and toluene (components of gasoline-range fuels). One or more of these volatile organic compounds (VOCs) were present in 98% of the stream samples collected in urban streams in the Mobile River Basin. PCE was detected at concentrations above the EPA drinking water standard of 0.005 ug/L.

Hydrocarbons in sediments of streambeds, unlike local surface water, are most commonly not volatile organic compounds, but instead polychlorinated biphenyls (PCBs) and pesticides (USGS Report). While studies for the area confirm that contaminant concentrations in sediments are at low to moderate levels, the 2004 ADEM NCA report documents several local sites with a poor sediment quality index. For a site to be ranked as poor, the sediment total organic carbon (TOC), sediment contaminant levels, and/or sediment toxicity had to be ranked as poor. During the five-year time period, 2000 through 2004, poor sediment quality indices were noted for 8% of the samples, with the majority occurring in the Delta and upper regions of the Bay.

Hydrocarbon concentrations in fish represent the highest concentrations of these pollutants within a watershed (as compared to surface water or sediment samples) because of biomagnification. The most commonly detected compounds in fish tissues include p,p-DDE, chlordane, DDT, dieldrin, heptachlor expoxide, nonaclor, and PCBs (USGS Water Quality Assessment). The 2004 ADEM NCA reported that 38% of fish sampled from Mobile Bay contained PCBs at levels above the Minimum Detection Limit (MDL) and 68% contained DDT at concentrations greater than the MDL. The highest percentages of affected samples were obtained from the Mobile Delta (57% of the PCBs and 47% of the DDT samples) with numbers decreasing as the sites moved toward the mouth of the Bay and the Mississippi Sound.

Mobile Docks

Tips for Clean Boating

Gas or diesel may be spilled during fueling: as backsplash out the fuel intake or as overflow out the vent fitting. Petroleum in or on the water is harmful and, in some cases, fatal to aquatic life.

Follow these tips to avoid problems:

- *Fill tanks to no more than 90 percent capacity--gas that is drawn from cool storage tanks will expand as it warms up onboard your vessel.*
- *To determine when the tank is 90 percent full, listen to the filler pipe, use a sounding stick (if possible), and be aware of your tank's volume.*
- *Rather than filling your tank upon your return to port, wait and fill it just before leaving on your next trip. This practice will reduce spills due to thermal expansion because the fuel will be used before it has a chance to warm up.*
- *Fill portable tanks ashore where spills are less likely to occur and easier to clean up.*
- *Use oil absorbent pads to catch* all drips.
- *Slow down at the beginning and end of fueling.*

WATER QUALITY: PROTECTING OUR PRIMARY RESOURCE

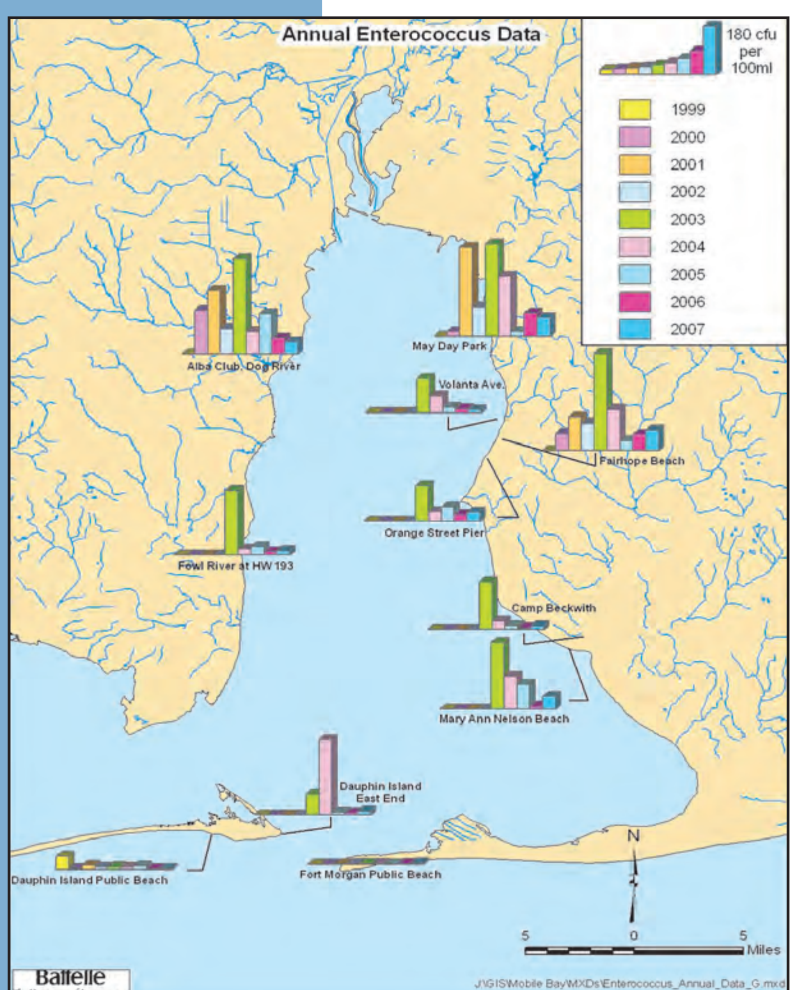
Fecal Coliform

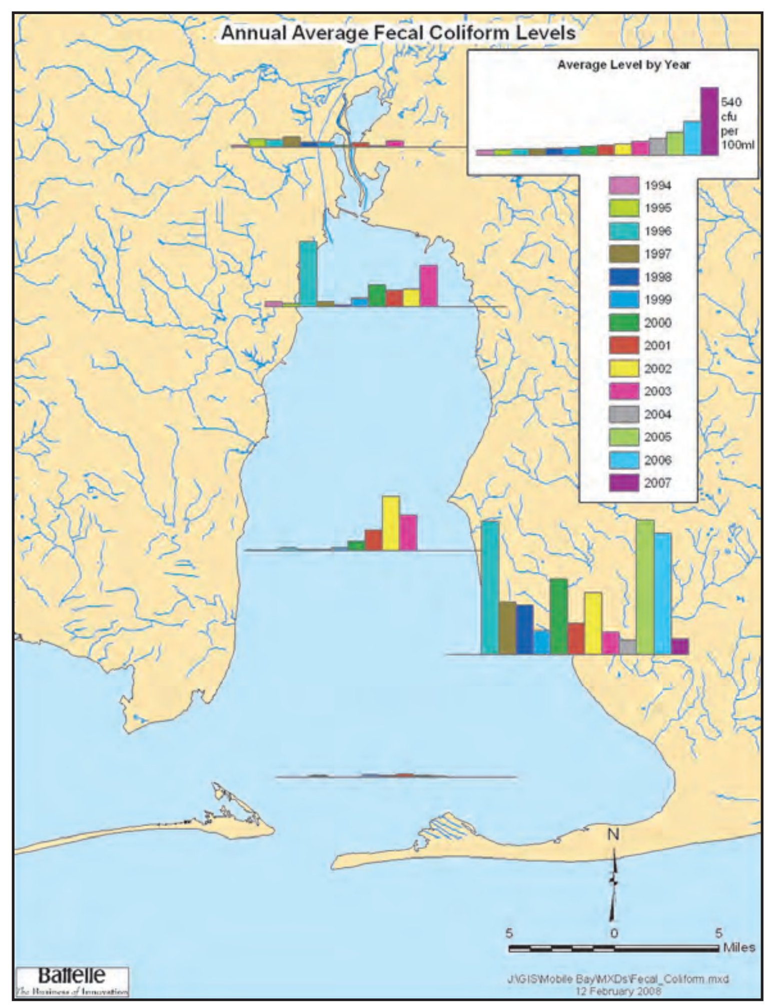
Chasing the waves at Orange Beach

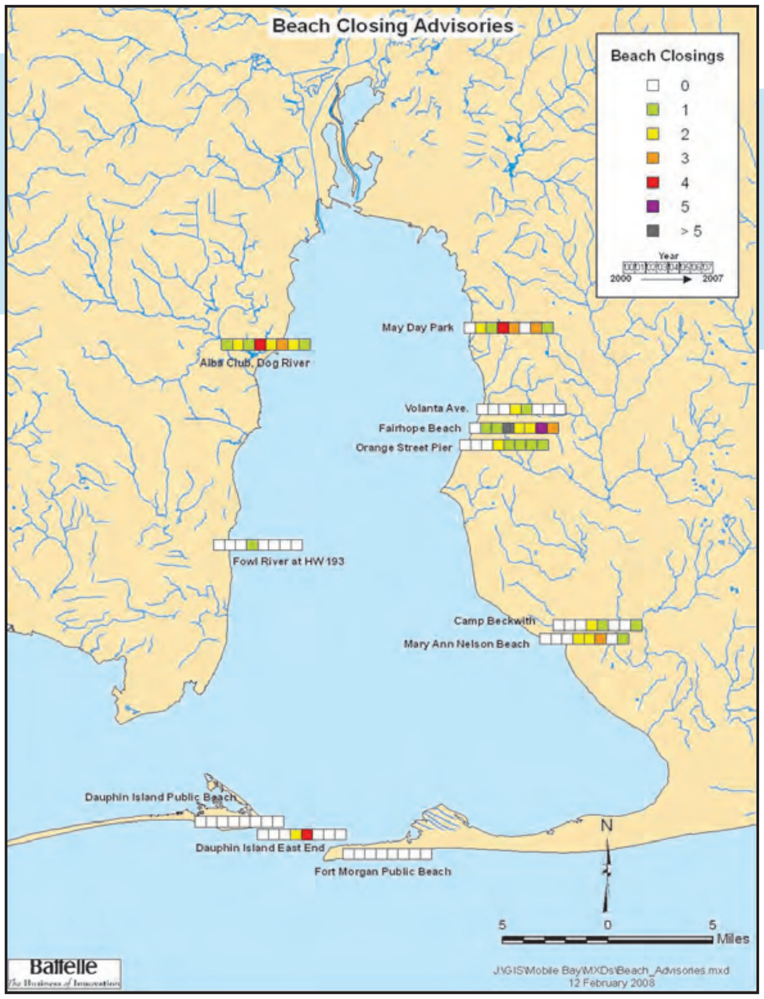
Indicator #11. Pathogens: Fecal Coliform and *Enterococcus* Bacteria

Is the water safe for bodily contact? Yes and No.

Concentrations of fecal coliform and *enterococcus* bacteria found in human and animal waste, are typically monitored to assess bacterial contamination within an estuary and the potential for human infection from bodily contact. Although these bacteria, in and of themselves, are not bacteria that would cause human sickness, they are indicators used to signal the likely presence of other, more harmful bacteria and pathogens that could cause harm to humans. ADEM has been monitoring *enterococcus* at recreational beaches around Mobile Bay and the Alabama coastal waters since 1999. Fecal coliform data were collected for Mobile Bay from 1994 to 2003 (ADEM's ALAMAP and NCA) and Weeks Bay from 1996 to 2007 (Weeks Bay Water Watch).







Typically, areas in the northern portion of Mobile Bay have exhibited higher concentrations of *enterococcus* and fecal coliform. This latitudinal difference may be due to the close proximity of the Mobile and Tensaw Rivers' drainage to the northern monitoring sites and lower levels of tidal flushing from the Gulf of Mexico. Weeks Bay, a partially protected sub-estuary of the Mobile Bay, repeatedly displayed the highest concentrations of fecal coliform. Monthly averages for *enterococcus* and fecal coliform were typically at the lowest levels during the winter and increased throughout summer months, coinciding with monthly precipitation averages and increased runoff. Most stations recorded maximum annual *enterococcus* averages in 2003, possibly as a result of high rainfall levels from Tropical Storm Bob (Battelle 2007).

Beach closures/public health advisories are issued for a particular site if two consecutive tests exceed the EPA *enterococcus* threshold level of 104 colonies per 100 milliliters of water, a concentration associated with increased risk of illness from bodily contact. From 2000 to 2007, beach advisories were most often reported for Fairhope Beach (23 advisories), the Alba Club at Dog River (16 advisories), and May Day Park in Daphne (14 advisories). The beaches at Volanta Avenue (Fairhope), Fowl River, and the east end of Dauphin Island have had no advisories in the last three to four years, while the Dauphin Island and Fort Morgan Public Beaches have never have had an advisory issued (Battelle 2007).

Shellfish bed closures are initiated automatically by the ADPH when the stage of the Mobile River reaches eight feet at the Barry Steam Plant in Bucks, Alabama or conditionally based on events such as hurricanes, harmful algal blooms, or accidental industrial or wastewater discharges. That water level has been correlated to high upstream inputs of water and high levels of fecal coliform indicates the presence of other bacteria and pathogens, which are filtered by oysters in harvested beds.

Local sewage overflow

Septic Tank Maintenance

Failing septic systems are not only bad for your pocketbook, but also pollute the environment.

Signs of signs potential system problems:

- *Wet spots in the yard*
- *Slow draining toilets or drains*
- *Gurgling sounds in drains*
- *Sewage odors*

Failing septic tank systems can endanger your family's health, pollute the environment, reduce your property value, and be expensive to repair. Proper maintenance of your septic tank system begins by installing an effluent filter in your septic tank. The filter will warn you when the system needs to be serviced. Failing to maintain your system will cause your system to fail.

Using an effluent filter and pumping your septic tank every 3-5 years will increase the life span of your system, prevent expensive repairs, and protect groundwater from harmful contamination.

Fertilizer—Too Much of a Good Thing

Fertilizers used to promote plant growth and lush, green lawns have the potential to harm our waterways if applied incorrectly. The principle components of fertilizer are nitrogen and phosphorus and excessive amounts of these nutrients adversely affect water quality.

What Can You Do?

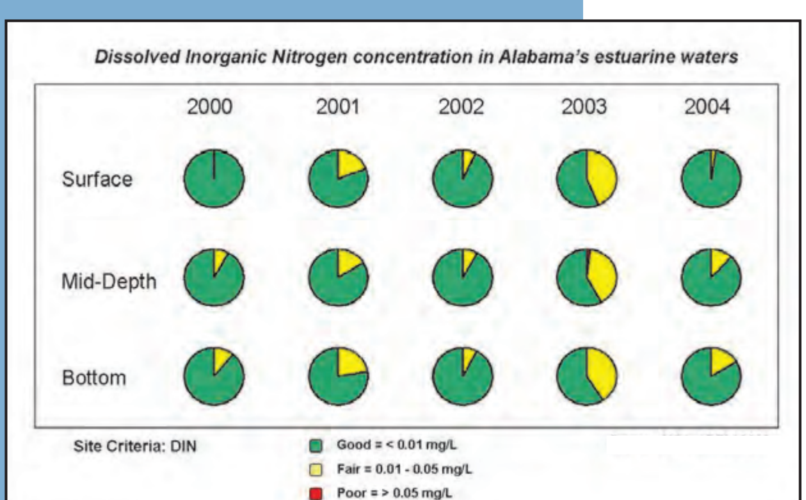
- *Test your soil to determine the appropriate nutrient ratio for your lawn.*
- *Use slow release fertilizer limiting the amount of nitrogen leaching to groundwater.*
- *Use iron as a substitute for or supplement to nitrogen.*
- *Choose the proper spreader and calibrate it to your yard.*

Indicator #12. Nutrients

Is water quality sufficient to sustain aquatic life? Yes.
Is water clarity changing over time? Yes.

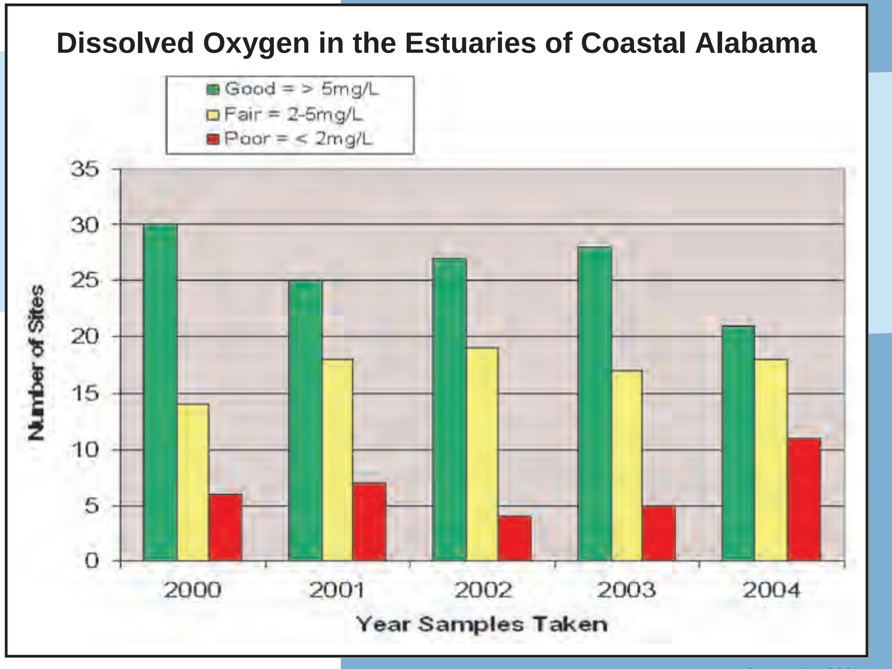
Estuarine and coastal waters are impacted by nutrients from local and upstream natural sources, like animal waste and the breakdown of vegetation, or anthropogenic point and non-point sources. Point sources include sewage or industrial plants, and non-point sources include fertilizers, wastes from pets or confined feeding operations, and organic matter carried by stormwater runoff, atmospheric deposition, failed septic systems, and groundwater. An overabundance of nutrients causes *eutrophication*, or excessive algae growth, which depletes dissolved oxygen in the water. At night, when photosynthesis "shuts down" but respiration continues, the oxygen demands of living algae leave little available for other aquatic organisms. When algae deplete nutrient supplies, they die, settle to the bottom, and decompose, causing further depletion of DO. The condition of low DO, called *hypoxia*, forces fish or other aquatic life to leave the area, become stressed, or die.

Excess nitrogen and phosphorus loading from coastal watersheds are primarily responsible for eutrophication. Because dissolved inorganic nitrogen (DIN) and dissolved inorganic phosphorus (DIP) are the primary nutrient forms used by algae, the loading of these forms are the most worrisome. A study in Mobile and Baldwin counties indicated that agricultural and urbanized watersheds were the primary sources of DIN and DIP (Lehrter, 2006). Ultimately, runoff from these coastal watersheds is delivered to the Bay where the eutrophication is expressed. The NCA measured DIN and DIP in the water-column from 2000-2003. DIN and DIP concentrations were generally rated "good" or "fair." However, some stations were rated "poor," and other studies have shown that DIN and DIP concentrations are high where heavily urbanized or agricultural watersheds enter the estuary (Lehrter, in press).



NCA, ADEM 2005

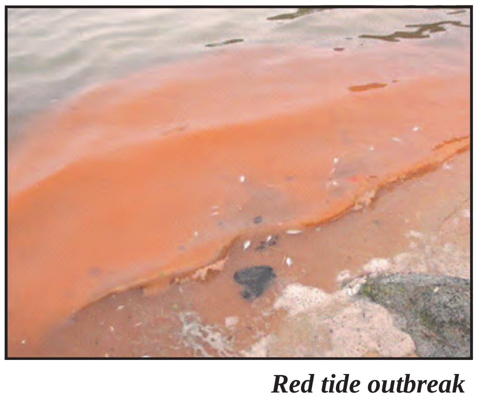
Low dissolved oxygen levels underlie a famous Mobile Bay natural occurrence: the Jubilee. Along the Bay's eastern shore, a combination of summer conditions drives oxygen depleted waters toward the shoreline, trapping fleeing fish and shellfish in shallow water. In the NCA, bottom DO was assessed with the following criteria: over 5 mg/L is considered "good," from 2 to 5 mg/L is considered "fair," and less than 2 mg/L is considered "poor." Alabama coastal water DO was rated as "fair" for the first four years of NCA (2000-2003) and "poor" for 2004. The graph above depicts a comparison of dissolved oxygen levels found during the NCA.



NCA, ADEM 2005

Chlorophyll-a is used as a proxy for algal biomass and is an indicator of nutrient enrichment and eutrophication. Based on NCA chlorophyll-a data from 2000-20004, Mobile Bay was "fair." In the upper reaches of the Dog River estuary which is primarily urbanized and in the upper reaches of Weeks Bay, which has primarily agricultural watersheds, chlorphyll-a concentrations are high (Lehrter, in press). Chlorophyll-a in these regions are associated with high nutrient concentrations and in the case of Dog River poor flushing of the upper portion of the estuary.

Harmful Algal Blooms (HABs) produce many different chemical classes of toxins. These natural hazards are managed through seafood industry Hazard Analysis and Critical Control Point (HACCP) assessments and the National Shellfish Sanitation Program (NSSP), which is implemented by the National Shellfish Sanitation Conference. Seafood HACCP and NSSP are cooperative endeavors that include the U.S. Food and Drug Administration (FDA), state agencies, and industry entities. Traditional methods in use today for detecting HAB toxins in seafood rely on HAB field observations and assays of seafood products using mice. The FDA Gulf Coast Seafood Laboratory (GCSL), Office of Food Safety at Dauphin Island and counterparts at the Office of Regulatory Science (ORS) at College Park, MD, develop and implement non-animal detection methods to improve sensitivity, specificity and speed of analyses. These research centers also serve as informational and analytical resources for federal, state and industry counterparts ensuring that the nation's seafood supply is safe, wholesome, sanitary and secure (Dickey, USFDA).



Red tide outbreak

Locally, HABs kill fish, irritate the lungs and eyes of beachgoers, and negatively impact local/regional tourism and service related industries. According to the DISL (MacIntyre), potential HAB species, such as *Karenia*, *Karlodinium*, *Prorocentrum*, and *Cylindrotheca*, are most common near Weeks Bay, which receives nutrient input from tributaries, runoff, and groundwater.

During June and July 2007, fish kills of menhaden and violet gobies were observed by Weeks Bay National Estuarine Research Reserve (NERR) staff and were attributed to population explosions of the dinoflagellate, *Karlodinium*. Weeks Bay experienced several other recent blooms with the largest in January 2008 (concentrations of 2.4 billion *Prorocentrum* cells/liter). While high numbers of algae have been observed during several events in Weeks Bay, algal populations have not been sampled in previous years making it difficult to determine if 2007 was an anomalous year or if these conditions represent a baseline that is just now being realized.

Red Tide

"Red tide" *is a colloquial term for harmful algal blooms (HABs) and it means different things in different regions. Along the Gulf coast, red tide refers most often to blooms of a single-celled organism,* Karenia brevis, *that produces brevetoxins which can cause large fish kills, human respiratory irritation from sea-spray aerosols, and consumer illness (neurotoxic shellfish poisoning) when it accumulates in shellfish. It is notable, however, that not all harmful algal blooms are red and not all red tides are harmful. In fact, less than 1% of all phytoplankton species are known to be toxic. Toxic phytoplankton species cannot be eliminated from our coastal oceans. Management of the hazards relies primarily upon prohibition of seafood harvest where and when toxic phytoplankton are observed or when toxins are detected in seafood samples.*

Wastewater Permits & Impaired Streams

Outstanding Alabama Waters

***Outstanding Alabama Waters** (OAW) designation is the highest use classification for water quality defined by ADEM. At present there are two local water bodies that boast this designation. In 1998, portions of the Tensaw River were designated as OAWs, giving it one of the strongest water quality protections in the state.*

In 2007, nearly 10 years of effort by Wolf Bay Watershed Watch and ADEM were validated when Wolf Bay was designated Alabama's first estuarine OAW. The Town of Magnolia Springs is in the process of applying for OAW designation for the Magnolia River. Weeks Bay in Baldwin County has received a national designation by the EPA of Outstanding Natural Resource Water.

Indicator #13. Municipal wastewater permit violations

Does the quality of our coastal waters impact its use? Yes.

Municipal wastewater treatment plants are responsible for treating residential and commercial sewage before discharging it into local waters that flow into the bay. According to state and federal databases, Mobile County has 16 wastewater treatment plants and Baldwin County has 21, most of which have reported violations over the past three years. Nearly 75% in Mobile County and 57% in Baldwin County have incurred enforcement actions from the state, generally applied in response to chronic violations. Ninety-eight percent of the actions were for effluent violations associated with the release of raw sewage (indicated by fecal coliform or an *enterococci* colony count). These violations have resulted in restrictions on recreation and commercial uses of the water resources in the bay area.

Indicator #14. 303(d) Listed Streams

Are our coastal waters impaired? Yes.

Section 303(d) of the Clean Water Act requires states to list waters that fail to meet water quality standards for seven established use classifications: Agricultural and Industrial Water Supply, Limited Warm Water Fishery, Fish and Wildlife, Shellfish Harvesting, Swimming and Other Whole Body Water Contact Sports, Public Water Supply, and Outstanding Alabama Water. Alabama's first 303(d) list was released in 1992 and contained 20 creek, river, stream, and bay segments in Mobile and Baldwin Counties, and new lists are compiled and published every two years. More water bodies or stream segments are added based on monitoring data from ADEM, as well as other agencies whose sampling and testing protocols meet ADEM's procedural requirements. Waterbodies are removed from the 303(d) list if new data indicates that it is not impaired or an EPA-approved total maximum daily load (TMDL) has been established for it. A TMDL represents the maximum daily amount of a pollutant that can be discharged into the waterbody before it no longer supports its designated uses. Removal of a water body from the list following the development of a TMDL does not necessarily indicate that it is not impaired. It simply means that the waterbody enters an "implementation phase," the next step after EPA approval. This consists of incorporating effluent limitations into National Pollutant Discharge Elimination System permits for all point sources affected by the TMDL, as well as best management practice implementation for nonpoint sources. After completion of the implementation phase, further sampling is undertaken to determine the effectiveness of implementation. If implementation is effective, the waterbody is no longer considered impaired but capable of supporting its designated uses. Three waterbodies have been restored through the application of TMDLs and best management practices. The waterbodies removed from the list are Caney Branch, Magnolia River, and the un-named tributary to Magnolia River. The following table identifies all water bodies in the coastal area that have been listed since 1992.

303(d)-Listed (Impaired) Waterbodies in Mobile and Baldwin Counties 1996-2006				
Waterbody	***County***	***Cause***	***Date Listed***	***Date Removed***
Baker Branch	Baldwin	OE/DO	2006	
Bay Minette Creek	Baldwin	Hg	2000	
Bayou La Batre River	Mobile	N, pH, OE/DO, O&G, P	1996	
Blackwater River	Baldwin	Hg	1998	
Boggy Branch	Mobile	Fe, P	1998	
Bolton Branch (1st seg)	Mobile	P	2004	
Bolton Branch (2nd seg)	Mobile	P	2006	
Bon Secour Bay	Baldwin	P	1998	
Bon Secour River (1st seg)	Baldwin	Hg	2006	
Bon Secour River (2nd seg)	Baldwin	Hg	2006	
Caney Branch	Baldwin	P	1998	2000
Chickasaw Creek (1st seg)	Mobile	pH, Hg	1998	
Chickasaw Creek (2nd seg)	Mobile	Hg	2004	
Chickasaw Creek (3rd seg)	Mobile	Hg	2004	
Cold Creek Swamp	Mobile	Hg	1996	
Collins Creek	Mobile	P, As	2000	
Dog River (1st seg)	Mobile	N, pH, OE/DO^{TMDL}, P^{TMDL}	1994	
Dog River (2nd seg)	Mobile	OE/DO^{TMDL}, P^{TMDL}	2004	
E. Fowl River/Fowl River	Mobile	Hg	1996	
Eight Mile Creek	Mobile	P^{TMDL}	1998	
Escatawpa River	Mobile	Hg	2000	
Eslava Creek	Mobile	P	2004	
Fish River	Baldwin	pH, Hg, P	1996	
Grand Bay	Mobile	P	2006	
Gulf of Mexico	Mobile	P, Hg	1998	
Gum Tree Branch	Mobile	P^{TMDL}	1998	
Juniper Creek	Mobile	P^{TMDL}	1996	
Little Lagoon	Baldwin	P	2006	
Magnolia River	Baldwin	OE/DO	1998	2000
Middle Fork Deer River	Mobile	OE/DO	2006	
Middle River	Baldwin/Mobile	Hg	2004	
Mississippi Sound	Mobile	P	1998	
Mobile Bay	Mobile	P	1998	
Mobile River (1st seg)	Mobile	Hg	2000	
Mobile River (2nd seg)	Mobile	Hg	2004	
Oyster Bay	Baldwin	P	2006	
Perdido Bay	Baldwin	Hg	2006	
Perdido River	Baldwin	Hg	2006	
Polecat Creek	Baldwin	Hg	2006	
Portersville Bay	Mobile	P	1998	
Puppy Creek	Mobile	N, P^{TMDL}, **OE/DO**^{TMDL}	1996	
Rabbit Creek	Mobile	P^{TMDL}, **OE/DO**^{TMDL}	1996	
Styx River (1st seg)	Baldwin	Hg	2002	
Styx River (2nd seg)	Baldwin	Hg	2004	
Tensaw River (1st seg)	Baldwin	Hg	2004	
Tensaw River (2nd seg)	Baldwin	Hg	2004	
Tensaw River (3rd seg)	Baldwin	Hg	2004	
Tensaw River (4th seg)	Baldwin	Hg	2004	
Three Mile Creek (1st seg)	Mobile	N, pH, OE/DO, P, Chlordane	1996	
Three Mile Creek (2nd seg)	Mobile	OE/DO, P	2000	
Three Mile Creek (3rd seg)	Mobile	OE/DO, P	2004	
Toulmins Spring Branch	Mobile	P	2004	
UT to Bon Secour River	Baldwin	P	1998	
UT to Magnolia River	Baldwin	P	1998	2000
UT to Three Mile Creek	Mobile	P	2004	

ADEM

Dog River (Luscher) Park

Abbreviations for Causes
As – Arsenic
Fe – Iron
Hg – Mercury
N – Nutrients
OE/DO - Organic enrichment/dissolved oxygen
P - Pathogens (fecal coliform bacteria or enterococci)
T - temperature
^{TMDL} - Total Maximum Daily Load determined

"The nation behaves well if it treats the natural resources as assets which it must turn over to the next generation, increased, and not impaired, in value."

- Theodore Roosevelt

COMMUNITY INVOLVEMENT: CHANGING THE FUTURE

Outreach & Education

COMMUNITY INVOLVEMENT at-a-glance…

Outreach, education and recent accomplishment data gathered from local organizations indicate that public support for the estuary is strong. Of the numerous organizations queried, five federal and state agencies, two chambers of commerce, and seven environmental organizations responded to a series of questions about outreach and education activity growth. Over ten of the fourteen organizations responding have been established since 1990, including Smart Coast, Little Lagoon Preservation Society, Dog River Clearwater Revival, Mobile BayKeeper and MBNEP. About 79% of the groups assessed indicated that the number of environmental opportunities for public/volunteer participation has increased since 2000, 21% reported that it has remained unchanged, and none reported decreases. All but one group reported the maximum annual number of volunteers in 2007. Similarly, the total number of volunteer hours supported by these organizations for environmental activities since 2000 has increased by 77%, with 15 percent unchanged, and only eight percent reporting decreases.

Indicator #15. Outreach and Education

Are there opportunities for citizens to take action to help restore and/or protect the bay? Yes.

Media: Most organizations produce newsletters or publications that are mailed to subscribers on a monthly to quarterly basis highlighting recent environmental activities and accomplishments. Most also employ web pages to report news and activities in real time, and links to these web pages can be accessed at http://ww.mobilebaynep.com/site/links.htm.

Technical Information: Brochures and fact sheets on environmental issues are routinely produced by agencies, including MASGC/AUMERC, US Fish and Wildlife Service, Alabama Gulf Coast Convention and Visitors Bureau, Eastern Shore Chamber of Commerce, Little Lagoon Preservation Society, Dog River Clearwater Revival, Weeks Bay Foundation, Mobile BayKeeper, Fairhope Environmental Advisory Board and MBNEP. Each year, MRD produces a popular calendar that includes a tide chart and information on environmental issues of concern.

Little Dauphin Island tree planting

Speaking engagements and workshops: Grassroots organizations, including Dog River Clearwater Revival, Wolf Bay Watershed Watch, and Little Lagoon Preservation Society frequently enlist speakers from agencies, academic institutions, or government entities to speak on topics that affect their watershed. The Bays and Bayous Symposium is hosted biannually by a partnership of the MBNEP and MASGC/AUMERC and provides community members, resource managers, scientists, and others an opportunity to share research and ideas on coastal resources. The Weeks Bay National Estuarine Research Reserve, the Coastal Alabama Clean Water Partnership, and grassroots, inc., among others, hold workshops on issues such as streambank restoration and innovative low impact development. In addition, Smart Coast hosts periodic community conferences that address issues of smart growth.

Clean-ups: The Alabama Coastal Cleanup, conducted annually in the early fall and co-hosted by SLD and People Against a Littered State, is the most comprehensive of many cleanup events in the Bay area. Dog River Clearwater Revival, who participates in Coastal Cleanup, hosts an annual summer event to clean up Luscher/Dog River Park.

Baldwin County Grasses in Classes program

Coastal Cleanup

Special events: Special events are frequently held around the Bay to promote stewardship. Weekend events like DISL's Discovery Day, Dog River Clearwater Revival's Dog Paddle, and Kid's Fishing Tournaments hosted by Weeks Bay Foundation and Wolf Bay Watershed Watch give families activities that provide a connection to our waters. The Mobile Bay Kayak Fishing Association's tournament has grown since its inception in 2007 from 31 participants to over 100 in 2008 with a further doubling-to tripling projected in 2009. Educational activities like the Coastal Kids' Quiz and Water Festival, both sponsored by the Alabama Coastal Foundation, stimulate the curiosity of students who learn about the Bay, its living resources, and impacts affecting them.

Water Monitoring: Volunteer water monitoring is conducted by many of the grassroots organizations that participate in the MBNEP's Community Action Committee. Groups like the Dog River Clearwater Revival, Little Lagoon Preservation Society, and Wolf Bay Watershed Watch train and utilize volunteers to sample water quality and store data with Alabama Water Watch. Other groups, like the Fowl River Area Community Association and the Portersville Bay Revival, are currently working towards establishing Alabama Water Watch volunteer monitoring programs.

Community Organization: In 2005, the Fairhope Environmental Advisory Board took on an arduous task of addressing problems associated with stormwater runoff on a regional basis. The Board, established to provide policy advice on environmental matters to the Fairhope City Council, was fundamental to the establishment of the Baldwin County Stormwater Working Group. Partnering with MBNEP, this group, which included twelve municipalities and Baldwin County, worked diligently for over two years to outline how a regional agency could address the problem of stormwater runoff on a watershed basis. Their actions culminated in the passage of enabling legislation by the Alabama Legislature in 2008 that will allow this group to move forward on the formation of a regional stormwater utility aimed at managing stormwater runoff education and capital projects throughout the region.

Habitat Restoration: Many governmental agencies have partnered with citizens and schools to undertake habitat restoration activities including tree and emergent grass plantings. Both Baldwin and Mobile County School systems have initiated seagrass restoration programs in which students grow plants for local restoration projects.

"The activist is not the man
who says the river is dirty.
The activist is the man
who cleans up the river."

- Ross Perot

Glossary of Terms

Anthropogenic – Refers to anything caused or produced by humans or human activities.

Bathymetric – Pertaining to measurement of the depths or bottoms of oceans, seas, or other large bodies of water.

Biomagnification –Substances occurring in low concentrations in the smaller organisms near "the base" of the food chain are concentrated in the tissues of the organisms that consume them. As substances, like toxins, are tracked through higher levels of the food chain, they are biomagnified, and their concentrations increase. The highest concentrations would be expected in animals at the top of a food chain or pyramid.

Chlorophyll-a – This green pigment is found in plants and plays an important role in photosynthesis, or the production of chemical energy by plants from light energy from the sun. The concentration of chlorophyll-a increases in the water column when nutrient enrichment causes explosive growth, or blooms, of algae.

Concentration – The concentration of a substance is the amount that is dissolved in another substance, like water or tissue. Since the density of water is exactly one thousand grams (describing mass) per liter (describing volume), concentrations of substances in water can be measured conveniently in mass per unit volume, or mass per unit mass, or parts of solute per parts of solvent interchangeably. The concentration of salt in seawater is about 35 grams per liter, grams per kilogram, or parts per thousand. The concentration of mercury found in the tissues of oysters in Mobile Bay is measured in milligrams per liter or parts per million.

Dissolved Inorganic Nitrogen (DIN) – DIN is a measure of the concentration of nitrogen in the water available to aquatic plants in different nutrient compounds like nitrates, nitrites, or ammonia. Typically, DIN is measured in milligrams per liter or parts per million.

Dissolved Inorganic Phosphorus (DIP) – DIP is a measure of the concentration of phosphorus in the water available to aquatic plants in different nutrient compounds like phosphate. Typically, DIP is measured in milligrams per liter (or parts per million).

Dissolved Oxygen (DO) – The measure of the concentration of oxygen in the water is a very important measure of water quality, since most aquatic organisms, like fish or shellfish, require oxygen to survive. DO is the concentration of oxygen dissolved in the water measured in milligrams per liter (or part per million).

Endemic—describes a species exclusively native to one particular place.

Estuary – A place where the river meets the sea, defined formally as "a partially enclosed, coastal body of water, having an open connection with the ocean, where freshwater from inland is mixed with saltwater from the sea." Estuaries are among the richest ecosystems on earth both in terms of production and biodiversity.

Eutrophication – This is a condition of excess nutrient enrichment in waters that causes abnormally high algae growth which depletes dissolved oxygen concentrations in water.

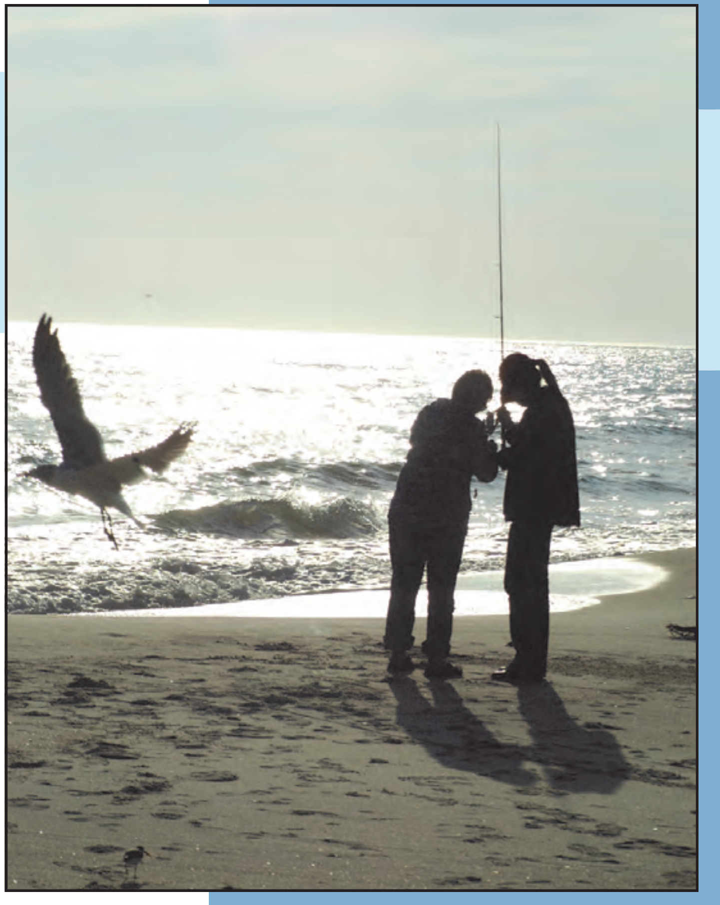
Hydrocarbons – Also called "organic molecules/compounds," hydrocarbons are often large molecules made of skeletons or chains of carbon atoms bonded to hydrogen atoms (and some atoms of other elements) that include most fuels, solvents, and pesticides.

Hydrologic – Pertaining to the occurrence, circulation, distribution, and properties of the waters of the earth and its atmosphere.

Hydrologic Unit Code (HUC) – A HUC is a series of numbers used to define watersheds or drainage basins. A two-digit code defines one of 21 regions, the largest geographical area defined. To describe watersheds of smaller area, more digits are added. A 12-digit code is used to define or catalog the smallest watersheds classified.

Impervious – This describes surfaces which prevent penetration, absorption, or infiltration of water into the soil subsurface, (i.e., streets, sidewalks, parking lots, roofs).

Indigenous—This describes a species native to a particular place or ecosystem.



Fishing on Dauphin Island
Buzz Sierke

Infiltration – The seepage or absorption of rain water into the soil or ground.

Non-Point Source Pollution – Pollution picked up and carried by runoff from diffuse or scattered sources into the receiving waters of a watershed.

Nutrients – Chemical compounds needed by plants for growth and used for fertilizer, (i. e., nitrates and phosphates). Nutrients are generally present and available in coastal waters, so nutrients carried into waters by runoff generally cause over-enrichment and problems related to eutrophication.

Pathogens – Any disease-causing, generally single-celled microorganism, such as bacteria, viruses, or protists (including fecal coliform and *enterococcus* bacteria), that enter receiving waters from sewage overflows; faulty septic systems; or waste from animal feeding operations, pets, or wildlife.

pH – A measure of the “acidity or alkalinity” of water. A pH of 7 indicates neutrality (equal concentrations of H^+ and OH^- ions). As pH values decrease, they indicate increasing acidity (and concentration of H^+ ions). As pH values increase, they indicate increasing alkalinity (and concentration of OH^- ions). As pH values vary from neutral, aquatic organisms can become stressed. Higher salinity waters tend to “buffer” pH between pH scales of 7 and 8.

Salinity – The concentration of salt occurring in waters described in units parts per thousand (ppt or grams/liter). The salinity of seawater is about 35 ppt. The salinity of freshwater is 0 ppt. Estuarine waters range between these two values, with higher values near the ocean and lower values upstream in rivers and tributaries. Salinity levels are important to aquatic organisms, as many are adapted to certain conditions, whether salt, brackish, or fresh water, and become stressed when salinities change.

Species Richness/Diversity (Biodiversity) – A value strongly correlated to the health of an ecosystem, it describes the number of different species of organisms that occur in a given area at a particular time.

Turbidity – Cloudiness or muddiness; a decrease in water clarity caused by suspended particles or waterborne sediments. Events that stir up or sediments or increase runoff such as storms increase the turbidity of water. Dense algae blooms also cause increased turbidity. Growth and survival of submerged aquatic vegetation (SAV) depends upon relatively low turbidity/clear.

"When we heal the earth, we heal ourselves."

- David Orr

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