

1 Executive Summary

Introduction

The stakeholder-led Galveston Bay Estuary Program (GBEP), formerly the Galveston Bay National Estuary Program, is a program of the Texas Commission on Environmental Quality (TCEQ). The GBEP was established in 1989 to develop a Comprehensive Conservation Management Plan (CCMP) for the Galveston Bay system. The CCMP for the Galveston Bay area is called *The Galveston Bay Plan (The Plan)*, a consensus-based program to manage bay resources. *The Plan* has many goals that relate to the well-being of the bay. The ability to assess progress toward those goals is constrained by the information that can be extracted through the monitoring of selected parameters.

The Status and Trends Project is primarily focused on data collected by agencies under quality assurance project plans (QAPPs) that are or could be approved by the U.S. EPA. Trends in parameters or groups of parameters, as well as status of indicator parameters, will permit assessment of the health of the bay and its associated resources.

The data used in this report as supportive evidence are the result of various public monitoring programs run by federal, state, and local government agencies. For the most part, these monitoring programs were initiated following the passage of environmental protection laws in the 1960s and early 1970s. Water and sediment quality monitoring programs are the direct result of federal and state clean water legislation (i.e. the 1965 Federal Water Quality Act, the 1967 Texas Water Quality Act, and the 1972 Federal Clean Water Act). Monitoring of living resources is tied to the concern for wildlife embedded in environmental and fish and game legislation.

Most of the monitoring programs upon which Status and Trends analyses depend have been consistently maintained for more than 20 years. Some monitoring programs have been intermittent and contain spatial and temporal gaps, which often make the calculation of trends difficult and at times impossible. While the intent of this report is to inform the reader regarding changes in the bay, the report cannot elucidate changes that have occurred over a longer temporal period than covered by the data, nor in areas not adequately sampled.

Management of Bay resources and implementation of *The Plan* are aided by the elimination of potential gaps in data collection and by implementation of some recent monitoring programs, e.g. wetlands permit and mitigation tracking and Texas Department of State Health Services (DSHS) health consultations.

Water and Sediment Quality

Recent trends in water and sediment quality as evidenced by data collected by the Texas Commission on Environmental Quality (TCEQ) during the period 1999-2005 depict the following.

Nutrients (ammonia, nitrate-nitrite, total phosphorus, and chlorophyll-a/pheophytin-a) in most areas of Galveston Bay rate very good or good (zero to five percent or six to 15 percent of samples above TCEQ screening levels, respectively). Exceptions include Upper and Lower Galveston Bay, Trinity Bay, Houston Ship Channel, and Armand Bayou which rate moderate for nutrients (16-30 percent of samples above TCEQ screening levels). Buffalo Bayou rates poor with more than 30 percent of samples collected being greater than TCEQ screening levels. Maps of sampling station level indicators are included in the report.

Most areas of Galveston Bay rate very good for dissolved oxygen samples collected between 5:00 and 10:00 AM. A number of sampling stations had less than 12 samples collected during the six year period. Of the stations with adequate sample sizes, many rated “good” in terms of morning dissolved oxygen levels meeting a screening level of 2 mg/L. One station along Buffalo Bayou and two stations along Clear Creek rated “poor” and “moderate”, respectively.

The Status and Trends Project tracks three indicators of bacterial pathogens (fecal coliform bacteria, *E. coli*, and Enterococci). Four of the five subbays are rated good with nine percent or less of the samples exceeding the TCEQ bacteria screening levels. Christmas Bay is the only subbay to rate very good with no samples exceeding screening levels for the 1999-2005 time period. Conversely, a number of Galveston Bay tributaries are rated poor for bacterial contamination. They include: Buffalo Bayou, the Houston Ship Channel, Clear Creek, Armand Bayou, and Dickinson Bayou/Bay. Of those tributaries, Buffalo Bayou had an astonishing 90 percent of samples exceeding TCEQ bacteria screening levels. Three additional bay tributaries rate moderate. They are the San Jacinto River, Chocolate Bayou/Bay and Bastrop Bayou. Only one tributary, the Trinity River, rated good for bacterial concentrations.

The Galveston Bay Indicators Project in 2005 developed a methodology comparing concentrations of organic compounds in Galveston Bay sediments to probable effect levels (PELs) established by the TCEQ. While gaps in the sediment data record are evident, the data show that Upper and Lower Galveston Bay, Trinity Bay and East Bay exhibit very good sediment quality. West Bay rates moderate for sediment quality in recent years. However, these observations occurred in one year and have not been observed again. The majority of sediment quality problems occur in the Houston Ship Channel; this is not surprising since the Houston Ship Channel is the industrial center of the Texas Gulf Coast. Greater than 25 percent of samples for twelve organic compounds have exceeded Probable Effect Levels (PELs) since the year 1999. As with organic pesticides and industrial organics, sediments in the subbays of Galveston Bay rate very good for metals. The Houston Ship Channel again has issues with contaminated sediments, particularly mercury, nickel, and zinc.

Three seafood consumption advisories for Galveston Bay and its tributaries have been issued by the Texas Department of State Health Services (DSHS) since 1990. While the majority of bay and tributary surface waters are not included in seafood consumption advisories, the DSHS advises that consumption of seafood taken from the Houston Ship Channel and portions of Upper Galveston Bay poses an increased risk of adverse human health effects.

The Status and Trends Project conducted an in depth analysis of water quality and sediment quality gradients in the Clear Creek watershed. One parameter, 5-day biochemical oxygen demand, exhibited an increasing trend from upstream to down stream stations. Nitrate-nitrite exhibited a decreasing trend from upstream to downstream stations. Chlorophyll-a/pheophytin-a, fecal coliform bacteria, E. coli, and Enterococci did not exhibit gradient trends. However, samples of these parameters were consistently above TCEQ screening levels throughout the Clear Creek watershed. Many gaps exist in the sediment quality data record for the Clear Creek watershed. However, all samples of organic or inorganic contaminants were below PELs.

Coastal Fisheries

A statistical examination of the relationship between water quality variables and length of estuarine species as sampled by Texas Parks and Wildlife (TPWD) bag seine and shrimp trawls was conducted by researchers at the University of Houston-Clear Lake. Perhaps the most interesting relationships described by this analysis are the correlations of length to salinity and length to turbidity. Atlantic croaker, brown shrimp, Gulf menhaden, and spot all show relationships between size and salinity and turbidity. All sizes of Atlantic croaker and Gulf menhaden show a positive effect of salinity on size in the samples. Smaller individuals captured in bag seines also showed a negative correlation with turbidity. Brown shrimp exhibit a positive correlation between size and turbidity at smaller sizes and a negative correlation at larger sizes. Spot captured by shrimp trawl tended to be larger in high salinity conditions and smaller in high turbidity conditions. None of these patterns are counterintuitive because they are consistent with variation in water quality that would be encountered as the animals move around and out of the estuary according to their life cycle. The developmental stages encounter different water quality conditions, according to the type of bay habitat or the time of year, as they mature or migrate and are sampled under those conditions.

Three species of finfish captured in TPWD Coastal Fisheries gill net samples exhibited increasing trends in length over the period of record: red drum, sheepshead, and Southern flounder. The gill net samples represent large predatory fish at or near the top of the Galveston Bay food web. Two species in shrimp trawl samples exhibited declines in length of fish: Atlantic croaker and white shrimp. Atlantic croaker is an important benthic predator in Gulf of Mexico estuaries. It is not as popular as red drum, spotted seatrout, or Southern flounder in terms of recreational catch, but is landed by anglers. Croaker is a commercial species harvested in the Eastern Gulf of Mexico. White shrimp also exhibited declining trends in length.

Habitat

Wetlands are tremendously important habitats to the Galveston Bay Estuary. Wetlands provide important nursery, shelter, and foraging areas for many species of fish and wildlife; stabilize bay sediments; improve water quality; reduce shoreline erosion; and alleviate coastal flooding. The Status and Trends Project conducted two sets of analyses looking at the quantity and quality of this habitat type.

An assessment of wetland losses and gains utilized data from the National Oceanic and Atmospheric Administration (NOAA) Coastal Change Analysis Program (C-CAP). Of the six wetland classes analyzed at the subwatershed and county level, palustrine emergent, palustrine forested, and palustrine scrub/shrub wetland classes exhibited the greatest losses from 1996 to 2001. According to the NOAA C-CAP data set, more than 10,000 acres of these habitats were lost during the five year time period, the majority (7,043 acres) in Liberty County. A simple projection of wetland losses using the NOAA C-CAP data finds that more than 40,000 acres of palustrine wetland habitat could be lost between the years 1996 and 2016 in the five counties surrounding Galveston Bay (Brazoria, Chambers, Galveston, Harris, and Liberty).

An examination of habitat fragmentation in the Galveston Bay watershed provides a useful view of the distribution of wetland and forested habitat types. In general, the less fragmented wetland habitats are found east and south of Houston in the Lower Galveston Bay watershed. For woody habitats, there are less fragmented areas for conservation around Clear Creek and Dickinson Bayou, as well as east and south of Houston along tributaries of the bay. It is clear that the development of Houston has been a major factor in fragmenting these habitats. As Houston and surrounding municipalities grow, information such as this should be used to inform land use planning.

Data Gaps Assessment

The Status and Trends Project conducted a data gaps assessment of water and sediment quality data, living resources data, and habitat data. Of the water and sediment parameters analyzed, the greatest spatial and temporal gaps occur for organic and inorganic toxics in the water column. Very little data exist describing concentrations of these contaminants in the waters of Galveston Bay.

Living resources data sets that are available and meet the criteria of the Status and Trends Quality Assurance Project Plan (QAPP) do not provide a complete assessment of the status and trends of living resources in the Galveston Bay system. The data permits the study of aquatic animals that are larger than several centimeters in length and occupy the top of the sediment or the water column. Most of the information on smaller animals is based on daytime sampling, but the data provide good information about the abundance of adult fish and some adult crustaceans at night in spring and fall. Added to this information about aquatic animals is an annual estimate of the number of breeding pairs in nesting water bird colonies. While these data are very useful, they provide an incomplete picture of the ecosystems in the Galveston Bay system.

Most efforts to follow the change in land cover have been focused on wetlands. It would be easier to follow the change of more recognizable habitats, like forests, but they do not have the same direct significance for the bay. Data describing wetland habitat are available, but the analyses are conducted infrequently and often using varying methodologies. It is also nearly as difficult to classify grassland habitats as it is to classify wetlands. Most classifications can not differentiate golf course fairways and improved pasture from natural prairies. In any case, the change in methodology over classifications obviates a long term trend analysis for habitat acreage. The scientific and resource management community will continue to be limited by the episodic nature of land cover change analysis until an organization makes a commitment to continued, standardized image collection and analysis.

Colonial Waterbirds

The Status and Trends Project analyzed data compiled by the US Fish and Wildlife Service (USFWS) for trends in colonial waterbird populations. The database reported nesting pair abundance for 30 species of colonial waterbirds observed at 131 nesting colonies in Galveston Bay during the years 1973-2005. The indicator shows the twenty year trends in population abundance for 15 species of colonial waterbirds (eight marsh feeding and seven open water feeding species). Of the 15 species, declining trends in nesting pairs were found for black-crowned night heron, great blue heron, tri-colored heron, white-faced ibis, laughing gull, and neotropic cormorant. An increasing trend continues for brown pelican nesting pairs.

Shoreline

The Status and Trends Project analyzed shoreline data compiled by the University of Texas Bureau Of Economic Geology (BEG) in 1995. The shoreline data set, also known as the Environmental Sensitivity Index (ESI), classifies shoreline habitat into a set of 17 shoreline classes. These classes were grouped into two major classes (developed and undeveloped shoreline) and analyzed using ArcGIS software. Of the 1,497 miles of Galveston Bay shoreline classified by the BEG, 22 percent (326 miles) were classified as developed shoreline and 78 percent (1,171 miles) were classified as undeveloped shoreline in 1995. It must be noted that while this data set represents the most recent version of the ESI available for Galveston Bay, the data are now more than ten years old and provide only a baseline for this indicator. An updated data set is needed if change in shoreline development is to be calculated in the future.

Public Outreach

The Status and Trends Project was tasked to write a volume of topic based and geographically focused issue papers for use by GBEP's Charting the Course (CtC) project. This task was completed in the Summer of 2005 when the Status and Trends Project submitted six topic-based issue papers and seven geographically focused watershed papers to the CtC PIs at the University of Texas-Austin. The issue papers are available online at <http://www.galvbaydata.org/projects/reports/Viewreport1.html>.

To facilitate dissemination of data, two web portals using SQL and ASP.net database/web technologies were developed for the Status and Trends website. The [Water and Sediment Quality Data Portal](http://www.galvbaydata.org/projects/wq/water1.html) (<http://www.galvbaydata.org/projects/wq/water1.html>) allows users to query the water and sediment quality database for sampling years 1969-2004 by geographic area (subbay and tributary level) and parameter.

The [Fisheries Data Portal](http://www.galvbaydata.org/projects/fisheries/Fisheries1.html) (<http://www.galvbaydata.org/projects/fisheries/Fisheries1.html>) allows users to query the coastal fisheries Catch per Unit Effort (CPUE) data of 190 fisheries species captured in three gear types (bag seine, gill net, and shrimp trawl) by TPWD. Data for Eastern oyster captured in oyster dredge are also available for sampling years 1969-2004 by geographic area (subbay and tributary level) and parameter. Both portals include dynamic trend graphs with drill down capability (allows for finer temporal resolution by clicking on a year, month, or day) and raw data download capabilities.