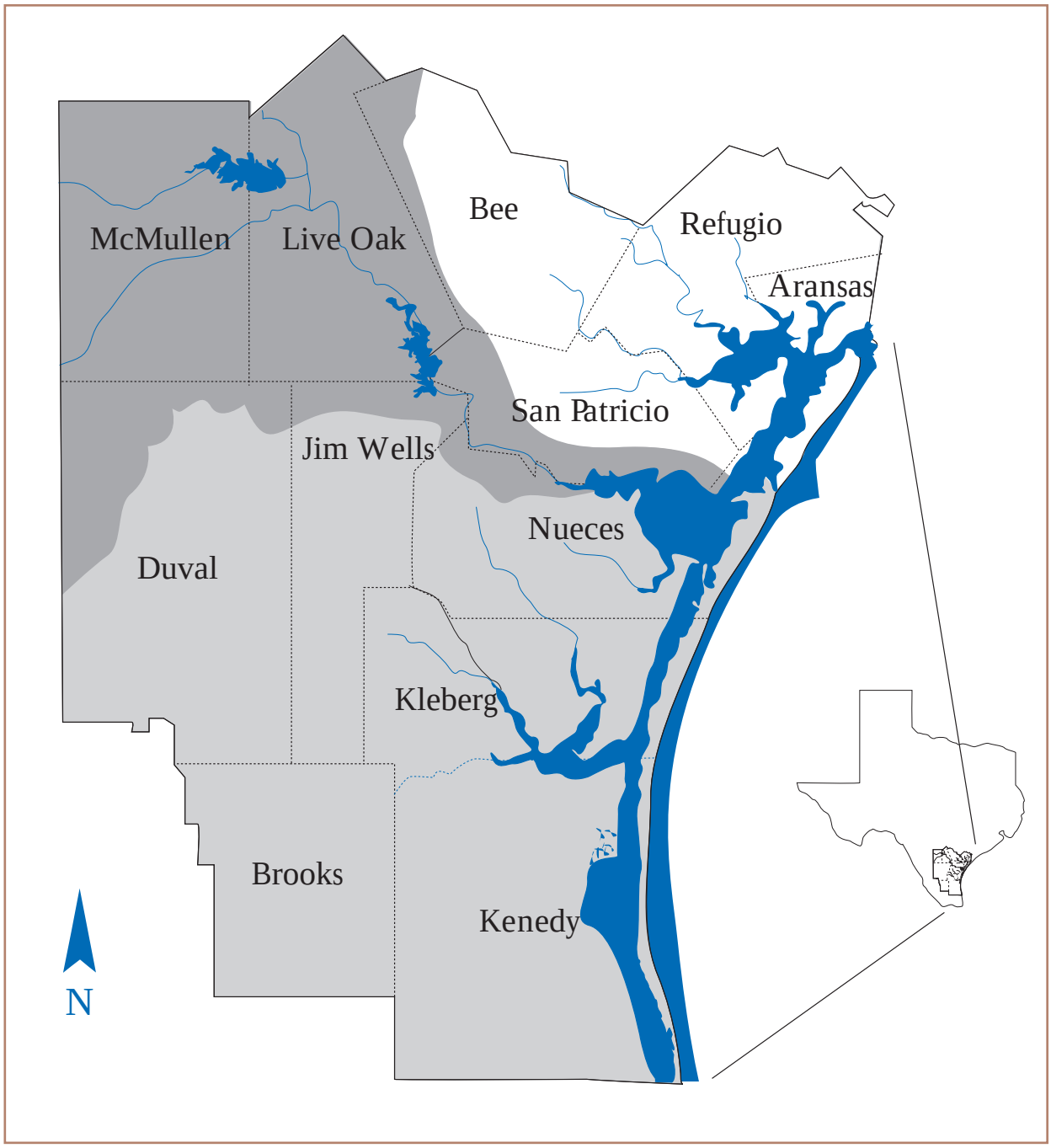
# Coastal Bend Bays Plan

## *August 1998*


*CBBEP-1*

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# Coastal Bend Bays Plan

## *To Conserve and Manage the Coastal Bend Bays of South Texas*

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***August 1998***

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*Color paintings by Victoria Marcellan-Allen*

# Foreword

Resource management in the final decade of the 20th century is fundamentally different than in decades past. It is less about resource managers applying their technical knowledge through mandated regulations and enforcement, and more about local communities broadening their own knowledge base. In the process, local communities are helped to become true stewards of their own resources. It is more about tackling problems such as pervasive habitat loss, diffuse sources of pollution (called nonpoint source pollution), and changes to freshwater inflow, through a coordinated regional approach. These types of problems are complex and interrelated, and involve not only the bays, but also the creeks, rivers, and entire watersheds that drain into our estuaries. As a result, "sustainable development" becomes key to pursuing economic growth compatible with maintaining the natural environment.

With the advent of the National Estuary Program (NEP), Congress gave recognition to the fact that nonpoint sources of pollution and the cumulative impacts associated with development must be managed if we are to enjoy the benefits that result from maintaining high coastal water quality. It was recognized that those residents whose livelihood and leisure are dependent on the health of coastal waters represent our best hope as stewards of these resources. Congress thus established the NEP as a stakeholder participation process. A principal mission of the NEP is to involve local residents at all stages in the development and implementation of a regional plan to protect, restore, or enhance the quality of water, sediments, and living resources.


*Participants at Bay Summit meeting.*

Because of the increasing values, development pressures, and environmental impacts to the Coastal Bend Bays and the need to maintain a healthy economy, area citizens initiated a drive in early 1992 to nominate the bay system for inclusion in the NEP (Texas Water Commission, 1992). Subsequently, the bay system was designated "an estuary of national significance," and the Corpus Christi Bay National Estuary Program (CCBNEP) was established. Over a four year period, the CCBNEP used a community-based, consensus-building approach to identify the problems facing our bays and estuaries, and to develop this long-term comprehensive conservation and management plan, called the Coastal Bend Bays Plan (***Bays Plan***).

Local representatives of industry, commercial shrimping, agriculture, ranching, recreational activities, environmental organizations, municipal and county governments, scientists, and federal and state resource managers, interacting through a Management Conference, have all been volunteers in this effort. To date, these volunteers have invested more than 35,000 hours in the design, review, and discussion of more than 30 technical studies and early-action projects leading up to this Plan.

The ***Bays Plan*** is designed to complement and coordinate existing resource management programs and plans. The CCBNEP is now restructuring and preparing to implement the Plan under the auspices of the Coastal Bend Bays and Estuaries Program (CBBEP). Consensus has emerged on a set of guiding principles for the CBBEP. For example, the CBBEP will not have regulatory or taxing authority, will not have a formal permit review role, and will not affect private property rights nor supersede existing local, state, and federal authority in any way. Rather, the Program will help focus limited technical and financial resources in a goal-directed manner to effect resource management at the regional scale.

Early on, Program participants worked hard to develop a common vision for the Coastal Bend Bays that could be agreed upon by all. That Vision Statement and a set of Operating Principles (see page 5) continue to serve as a reminder of the interdependent roles of the economy and the environment, and thus the ultimate goal to attain a sustainable balance between the needs of the environment and those of the human community.

### *Coastal Bend Bays Priority Issues*

- *Altered Freshwater Inflows into Bays and Estuaries*
- *Condition of Living Resources*
- *Loss of Wetlands and Estuarine Habitats*
- *Degradation of Water Quality*
- *Altered Estuarine Circulation*
- *Bay Debris*
- *Public Health Issues*

The Program's analysis of the existing bay management structure shows that the Priority Issues are, by-and-large, already covered under one or another agency's authority or mission. Missing, however, has been a full understanding of the 'big picture' with respect to the interactive elements of the complex ecosystems that comprise the three estuaries of the Coastal Bend. That big picture is beginning to emerge, but it is clear that there are many data gaps that prevent our completing the picture any time soon. While it is the intent of the ***Bays Plan*** to identify and coordinate efforts and resources to close those data gaps in a prioritized manner, the truth is that we will never have 100 percent complete information. Regardless, today's policy-makers, resource managers, and local governments must effectively manage natural resources based on the best data and science available.

Equally important, however, are answers to these types of questions: What are our management goals and objectives? Have we taken into account the needs or desires of all user groups? Is there a gap between these management goals and the general public's understanding of them that will impede progress toward effective resource management?

Answers to these questions require public involvement and the forging of consensus around previously unasked questions. Like policy-making of any type, resource management policy, to be successful, must be a public process and open to participation by all interested stakeholders. That foundation has been laid with the completion of this initial ***Bays Plan***, which must be seen as a starting point for further discussion and revision.

Creating efficiencies in the way today's public dollars are spent on resource management is at the heart of the ***Bays Plan*** goals. For example, efficiencies in future monitoring and research will be realized as the goal-directed, regional framework of the Plan is utilized by implementing partners to focus their own future work plans. Moreover, as the Plan is endorsed by regional partners, state and federal agencies should be willing to invest more of their own limited resources in the region, knowing that the actions of the ***Bays Plan*** have been developed with a sound, technical basis and are supported by broad-based consensus. This aspect of implementation, leveraging local dollars with state, federal, and private foundation dollars, should bring new opportunities to minimize the cost of remedial measures in the long-term.

The draft ***Bays Plan*** was reviewed at four Town Hall meetings during February and March 1998, with participation by 130 people. Over 185 comments were received and these comments were individually reviewed and considered in the revision to the ***Bays Plan***. Implementation of the Plan will provide a continued forum for interested stakeholders, and an opportunity for conflict resolution and consensus-building among user groups.

The bottom line is that now, for the first time, the Coastal Bend has before it a regional framework for action. Not a blueprint, the ***Bays Plan*** is simply the basis for both action today and a continuing dialogue regarding an incremental approach to achieve regional resource management goals. The 'structured flexibility' of the Plan sets the stage for a bright future for this bay system, one that will find balance in its multiple human uses, regional social development, successful long-term environmental management, and sustainable economic growth.

As the stewards of the bays and estuaries, we acknowledge that our values and actions must reflect our interdependence with the bay. We envision a Coastal Bend which supports a high quality of life for its inhabitants and a thriving bay system which is sustained throughout all generations. We hold ourselves responsible for the management of our precious resource, the bay system.

## *Our guiding principles:*

- Promote healthy and diverse economic, social, and ecological systems.
- Facilitate enlightened public action through education and dialogue with all interested parties.
- Maintain a balance of people and nature.
- Achieve equity among competing uses.
- Seek and implement sustainable solutions.

To achieve this vision, we promise to work cooperatively with all interests to forge lasting relationships, based on mutual respect, which provide for the needs of all inhabitants of the Coastal Bend.

*Corpus Christi Bay National Estuary Program Management Conference*

## *Management Conference Operating Principles:*

- Incorporate into the comprehensive plan a balanced consideration of the interdependence of natural processes and human uses operating within upper watersheds, bays and estuaries, and the Gulf of Mexico.
- Obtain sound data from an adequately funded regional monitoring and applied research program.
- Maintain clean water and sediment, and the diversity of native living resources and habitat.
- Maintain essential freshwater inflows to the estuaries.
- Provide safe waters for swimming, clean beaches for recreation, and sustainable supplies of safe seafood for residents and visitors.
- Preserve open space, with free and easy public access to meet the needs of a growing population.
- Manage the bay system so that it can survive catastrophic events and adapt to changing conditions.


The enormous physical and geological forces that sculpt their shores define coastal regions. Wind and waves, the flow of freshwater from the land, evaporation, and the ebb and flow of tides place these areas at the center of a huge energy transfer. The result is tremendous biological productivity.

Estuaries are the cylinders of this massive engine and the transition zone between fresh and salt water. They are among the most dynamic and robust of nature's ecosystems. With a continual supply of sediments and nutrients, and a salinity gradient to which only certain organisms have adapted, estuaries provide both sustenance and refuge from predators.


Along the Texas coast are seven major estuaries. Together, these 2,100 square miles of sheltered water exhibit a remarkable diversity in geography, resources, climate, and industry. Waters and lands adjacent to this coast are richly endowed with petroleum reserves, agricultural land, wildlife, fisheries resources, recreational opportunity, and expansive, open lands in proximity to major population centers. One-third of the state's population and one-third of its economic resources are concentrated along this narrow width of land, which comprises only six percent of the total area of the state (Brown, *et al*., 1976).

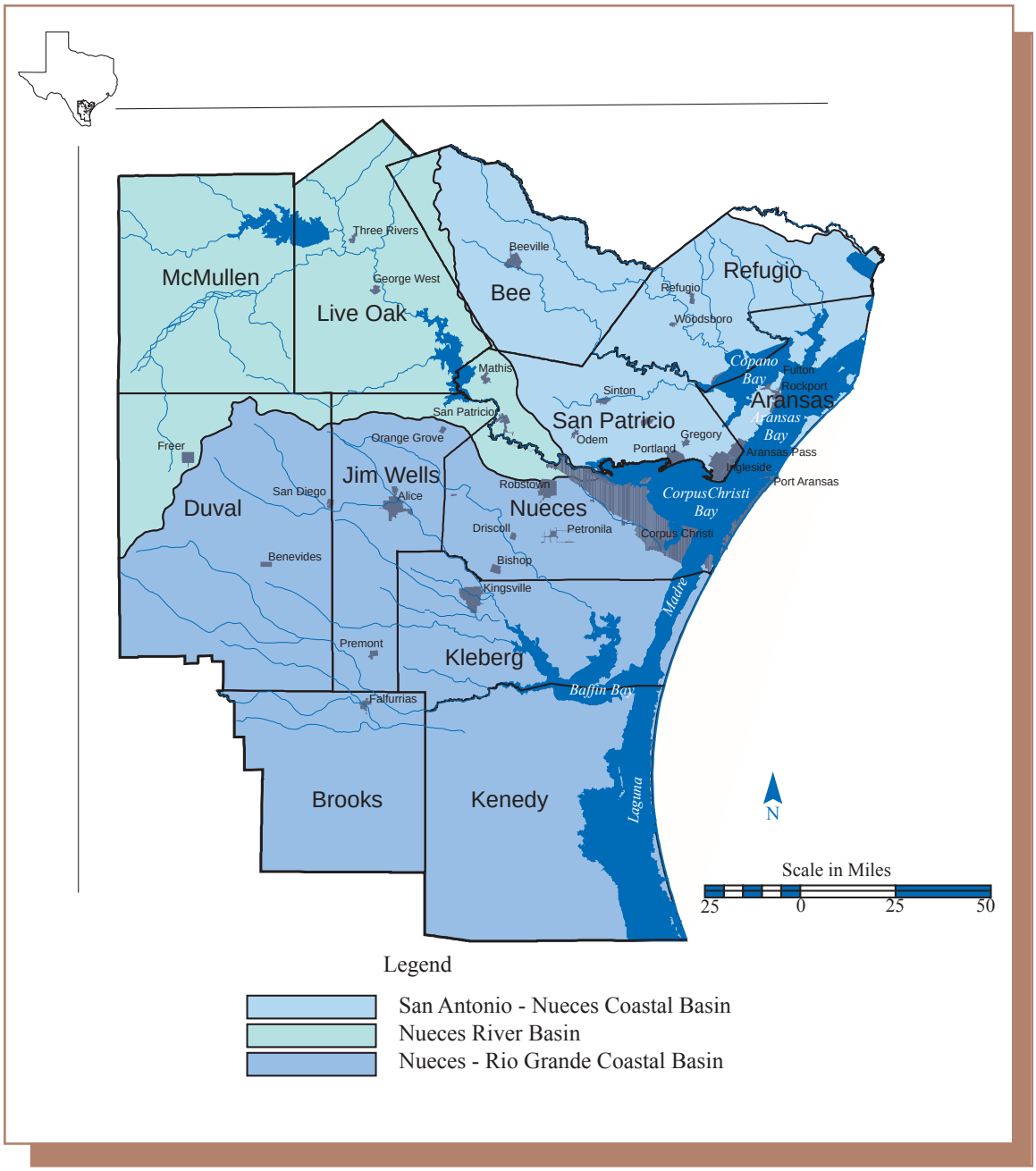

The Coastal Bend is blessed with three of the seven Texas estuaries – the Aransas, Corpus Christi, and upper Laguna Madre estuaries. Broad belts of mostly flat coastal prairies, chaparral pastureland, and farmlands adjacent to expansive bays characterize this transition zone between the mid- and lower-coast. A nearly unbroken string of barrier islands provides definition to the bays, estuaries, and one of only three hypersaline lagoons in the world.

The ***Bays Plan*** focuses on the CBEP 'project area', which includes all of the open water, submerged habitat, emergent wetland, and upland environments of the 12-county area known as the Coastal Bend (see page 7). The 12 counties — Refugio, Aransas, San Patricio, Nueces, Kleberg, Kenedy, Bee, Live Oak, McMullen, Jim Wells, Duval, and Brooks — comprise more than 11,500 square miles and are home to over 550,000 residents. The term 'bay system' refers specifically to all marine and estuarine waters (saline and

brackish waters) behind the Gulf surf line from the eastern edge of Mesquite Bay (in San Antonio Bay) to the 'land cut' south of Baffin Bay in the upper Laguna Madre.

This delineation of the bay system's boundaries is based on the knowledge that these areas:

- are physically linked,
- share a common connection with the Gulf of Mexico, and
- support living resources that are affected by human activities in all 12 counties.




*CBBEP Project Area*

## *Why Is the Coastal Bend Bay System Important?*

The Coastal Bend bay system is one of only 28 estuaries around the Nation that have been designated as "Estuaries of National Significance." The bay system was so designated because of its many benefits to both Texas and the Nation. Few components of the regional economy are completely detached from the bay system.

➢ The presence of a deepwater port is of strategic economic importance. Corpus Christi Bay is gateway to the nation's sixth largest port and the third largest refinery and petrochemical complex. Coastal Bend refineries have the combined capacity to process more than 700,000 barrels per day of crude oil, accounting for approximately 13 percent of Texas production and 5 percent of the U.S. total. In addition to petroleum refining, there are many industries or activities that use the bays for navigation or transportation. In 1995, these activities generated over $2.4 billion in total output, another $1 billion in value-added* for the region, and nearly 18,800 high-paying local jobs (Jones, *et al.*, 1997).

➢ Bay and Gulf commercial fisheries (shrimp and finfish combined) directly benefit from a productive bay system, and together generate $45 million in total output (sales) plus another $31.5 million in value-added to the region (Jones, *et al.*, 1997).

➢ Fishing for fun, tourism, and other recreational activities are big business. Over 30 percent of the state's saltwater fishing occurs in the region, where anglers spend millions of dollars each year on food, lodging, transportation, and fishing equipment. Meanwhile, nearly five million people visit these shores each year, with ecotourism becoming an increasingly important component of the travel industry (State Task Force on Texas Nature Tourism, 1996).

➢ In 1995, tourism and related industries provided $470 million in output (sales), $286 million in value-added for the region, and generated more than 10,800 local jobs (Jones, *et al.*, 1997).

** Value-added refers to the value of all goods and services produced, and is analogous to Gross Domestic Product as reported at the national level. Hence, value-added within a region may be referred to as Gross Regional Product.*

➢ More than 490 species of birds and 234 species of fish attest to the region's enormous biological diversity. The region is one of the premier bird watching spots in the world (Chaney, *et al*., 1996). Several major habitat types underlie this display of wealth, but seagrass meadows are of special significance and central to the high productivity of these estuaries. The Coastal Bend harbors 40 percent of the state's total seagrass acreage (Pulich, *et al*., 1997).

➢ Thirty-five state listed endangered or threatened species inhabit or use the 12-county area. Of these 35, 20 are also federally listed. Nineteen of the state listed species utilize estuaries, including the whooping crane; Arctic and American peregrine falcons; piping and snowy plovers; brown pelicans; Eskimo curlew; reddish egrets; opossum pipefish; and Kemp's Ridley, green, hawksbill, leatherback, and loggerhead sea turtles (Tunnell, *et al*., 1996).

➢ Agriculture has always been an important part of the Coastal Bend economy despite the highly variable rainfall. Agricultural land is managed as rangeland. This rangeland is used for a variety of purposes, including livestock production, wildlife habitat, and recreation. Rangeland watersheds are a major source of freshwater inflows for the area's bays and estuaries. Row crops include cotton, grain sorghum, and corn. Agriculture accounted for $448 million in value-added to the region in 1995 (Jones, *et al*., 1997).

Altogether, in 1995, bay related economic activities in the Coastal Bend provided over $4.1 billion in output (sales) to the regional economy, $2.3 billion in value-added, and generated more than 53,000 jobs for local residents (approximately one-third of all jobs in the region) (Jones, *et al*., 1997).

***Altogether, in 1995, bay related economic activities in the Coastal Bend provided over $4.1 billion in output (sales) to the regional economy, $2.3 billion in value-added, and generated more than 53,000 jobs for local residents.***

The increasing population and expanding residential, commercial, and industrial developments will be a significant stress on the bay system. The region's population was nearly 550,000 in 1995, with projections of nearly 1 million people by 2050. More than 50,000 new single family homes are projected to be built in the metropolitan area in the next 30 years. By 2050, water demand for residential and business uses is expected to increase by about 50 percent, while industrial water use is projected to double. Proper planning now is essential to sustain the balance between the needs of the environment and those of the human community.

The CCBNEP identified a need for action in six major areas:

- Human uses, including Bay Tourism and Recreation, Bay Debris, Public Health, and Shoreline Management
- Maritime Commerce and Dredging
- Habitat and Living Resources
- Water and Sediment Quality, including Nonpoint Source Runoff
- Freshwater Resources, and
- Public Education and Outreach.

Fifty specific actions have been developed to address these issues. The goals, objectives, and actions for each Action Plan are listed in Appendix A. For a more detailed description of each action, please refer to the ***Implementation Strategy for the Coastal Bend Bays Plan*** (CBBEP-2, August 1998), which is available from the Coastal Bend Bays and Estuaries Program Office.

Dinah Bowman

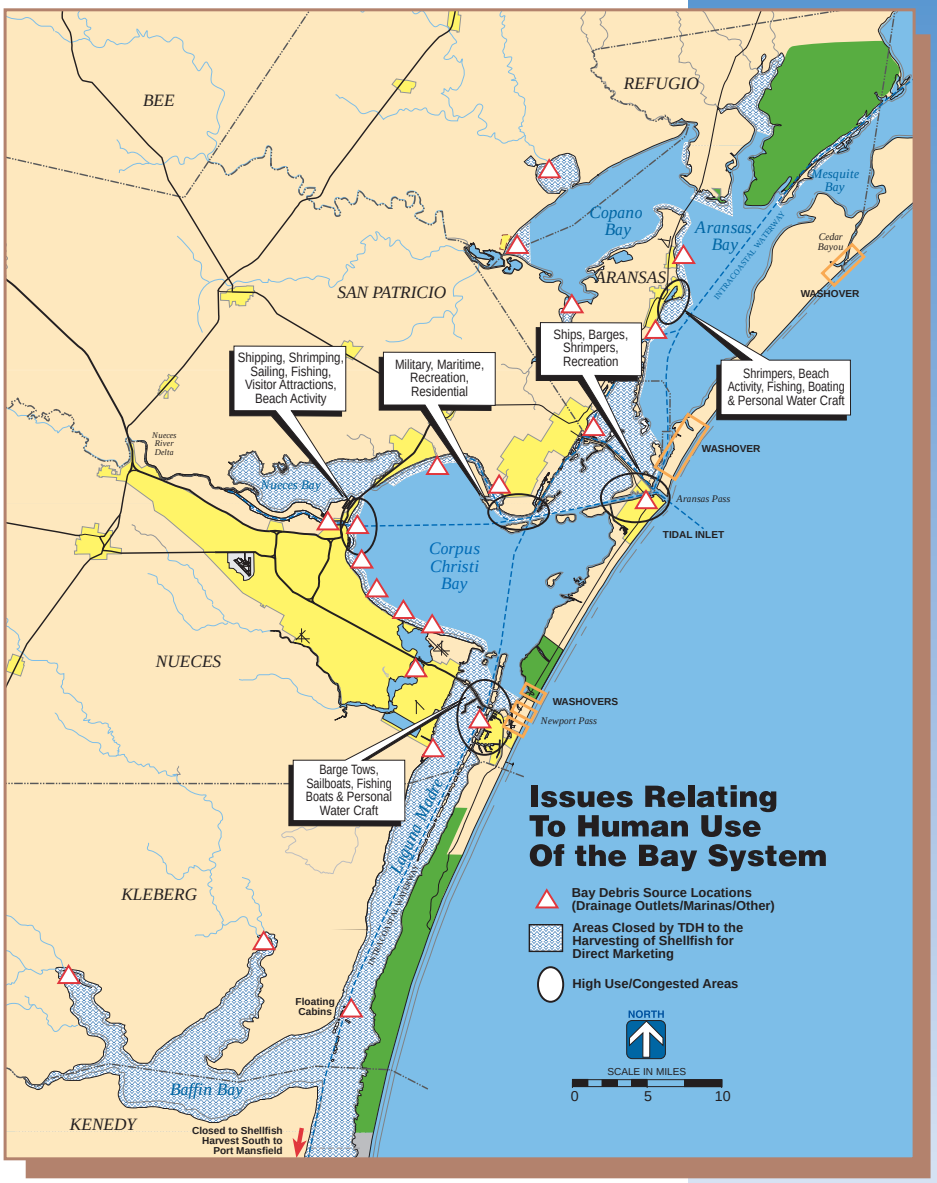
The Action Plans were initially developed at a January 1996 workshop. They have been subsequently refined and further developed through the cumulative efforts of more than 325 individuals representing over 100 organizations within the Management Conference. Management Conference members are listed in Appendix B. The actions reflect a consensus of the Management Conference that they are: justified, based on sound science; technically and economically feasible; a benefit to the environment; and politically acceptable with wide community support.

Each of the issue areas, including goals, key technical findings, and actions is described in the sections that follow.

### Goals

- *Maintain and expand tourism and recreational opportunities in a way that enhances the local economy and protects the natural resources of the bay.*
- *Reduce bay debris in the Coastal Bend to ensure minimal impact to people, aquatic life, and natural resources.*
- *Ensure public health associated with contact recreation and seafood consumption.*
- *Minimize impacts to bay resources from development or activities occurring within the coastal shore area.*

The Coastal Bend bays and estuaries contain a wealth of resources for people to enjoy and appreciate. Indeed, these resources are central to the quality of life for many who live or come to recreate here. But our use of these waters — what we put into them and what we take from them — must be monitored to ensure that the bay system remains healthy and productive (see map at right for issues relating to our use of the bay system).




Principal goals of the Human Uses Action Plans are to ensure that people continue to benefit from a safe, clean bay system environment and to promote stewardship of bay system resources. To do this, it is important to inform the citizens of this community and our millions of visitors with a consistent message about how to enjoy the resources without degrading them. All who use the bays and estuaries have a personal responsibility to maintain their beauty and values.

It is also important to plan for the ever-increasing number of people who visit the region to enjoy its natural resources. Well-planned and well-managed access areas will do much to curtail resource damage while providing enough parks and facilities for the growing numbers of users.

Ensuring that the waters are safe to swim in and that the fish, crabs, and shrimp are safe to eat are important goals. Equally, an efficient method of communication to the public is needed in case problems do arise.

## Enhancing the Economy while Protecting Resources

### Key Findings

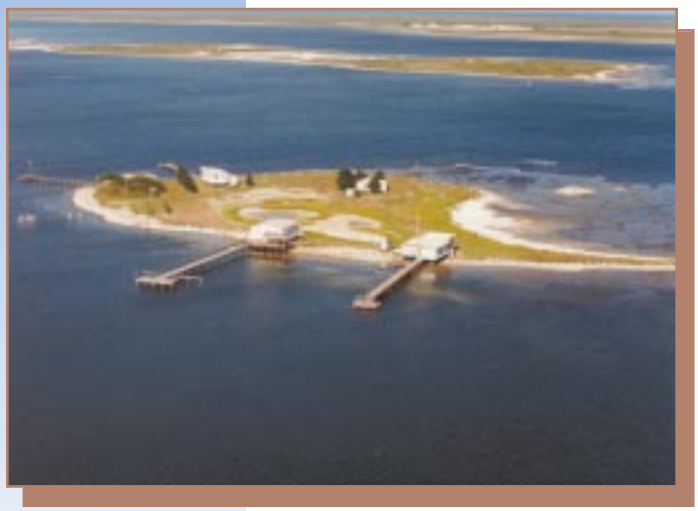
➢ *The natural resources of the Coastal Bend Bays provide for many recreational activities including fishing, windsurfing, birdwatching, waterfowl hunting, camping, jet skiing, kayaking, canoeing, surfing, swimming, sailing, power boating, shelling, beach combing, walking, and running. These recreational activities result in tremendous economic benefits. Even using conservative estimates of participation, sport-boat fishing, bird watching, and windsurfing contribute more than $90 million per year to the economy. The majority of these benefits are from sport-boat fishing (Wellman and Noble, 1997).*

➢ *The total economic impact from tourism and related businesses, including leisure and business travel, is over $950 million and 21,358 jobs. This represents nearly 1/3 of the total of bay-related jobs (Jones,* et al., *1997).*

➢ *The Coastal Bend Bays recreational fishery contributed about 28 percent of the total catch from all Texas bays between 1976 and 1991; however, the success rate (catch per unit effort) of individual fishermen appears to be declining (Tunnell,* et al., *1996). Declines are due mainly to more stringent size and bag limits put in place during the 1976 to 1991 period.*

➢ *The ever-increasing number of bay users has resulted in impacts to natural resources. There is evidence that bay bottoms have been disturbed by recreational boating and other human-related activities (Montagna,* et al., *1998). For example, aerial photography of north Redfish Bay from 1975 and 1994 reveals a network of cuts through seagrass beds, suggesting that boat propellers have contributed to the loss of seagrass in this bay (Pulich,* et al., *1997).*

The bays and estuaries support an enormous segment of the local economy, supplying us with recreation and dollars. To enhance the area's attraction, the Program and the Regional Tourism Council will encourage and assist tourism organizations to adopt a 'theme' of resource protection and stewardship in their promotions of the Coastal Bend. The Program will work to improve existing public access sites and develop the appropriate number of well-managed sites in order to protect the coastal resources and ensure their longevity for future bay users (see page 13 for existing public access sites). This will be done in partnership with other agencies, including the Texas General Land Office which is responsible for preparing a Coastwide Shoreline Access Plan, and local governments that issue beach access and dune protection permits.

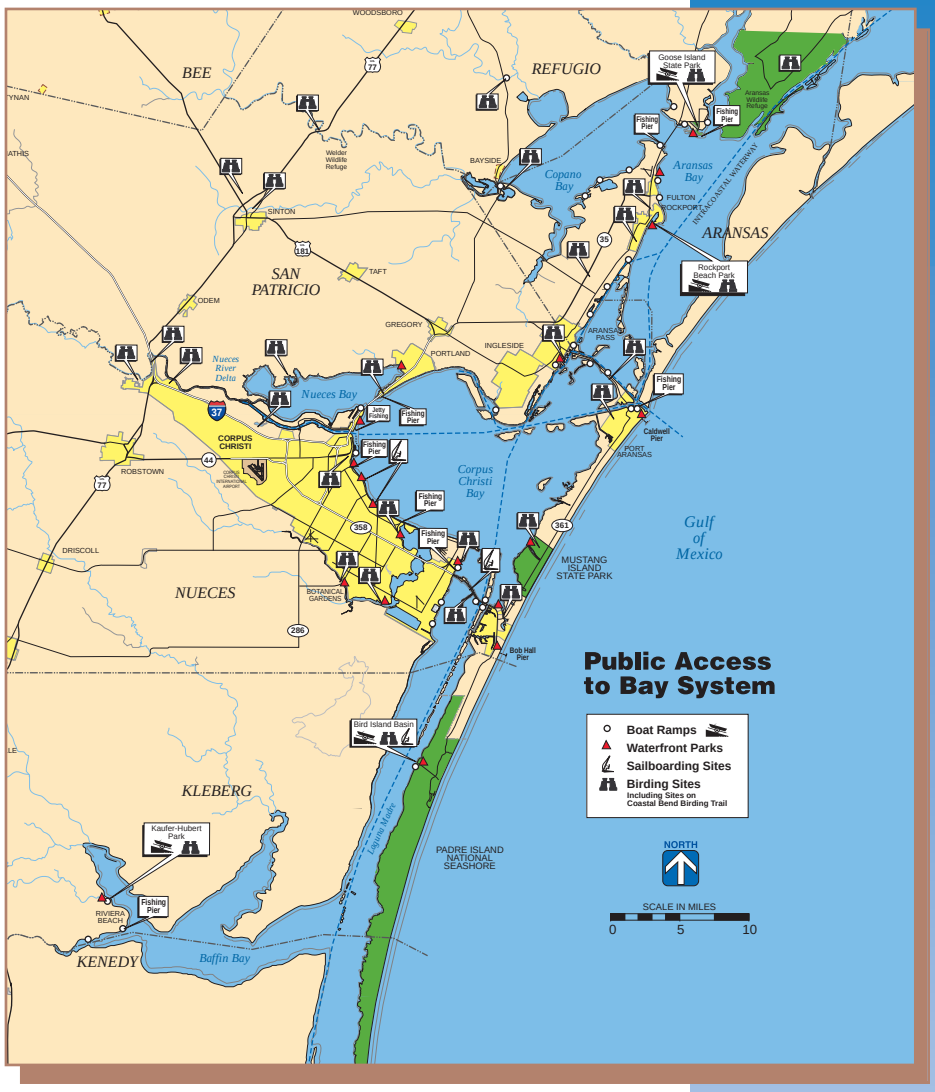


*Hunting and fishing cabins located in Laguna Madre.*

Other actions will include working with state agencies and the private sector to develop educational campaigns for specific user groups. Keeping the public informed is the goal, so that individuals can assist, for example, in preventing disturbance to birds during nesting season and

losses to seagrasses from propeller scarring. In this regard, it is important to ensure that visitors to the area are familiar with the location of seagrass beds and other sensitive habitats. Taking inventories and assessing the environmental impacts of these and other activities will lead to the development of appropriate educational materials for specific audiences.

The increasing number of water craft using the bay system calls for additional attention to the kind and amount of services available to support this use. The Program will work with the owners and operators of marinas to develop plans and funding options to make improvements to solid waste, sanitary pump-out, or fueling facilities. The Program will also work to ensure that commercial haul-out facilities have applied the appropriate controls to minimize the potential for the release of paint scrapings to receiving waters. Likewise, the Program will work with owners of floating cabins (over-water cabins), land-based cabins, and the responsible state agencies to develop management guidelines that are practical and meaningful for the continued enjoyment of all who use the bay system.




## Reducing Harmful Bay Debris

### Key Findings

➢ *Debris is obvious throughout the Coastal Bend Bays, but the amounts and distribution have not been quantified. Most data is related to Gulf beaches. There is also a lack of consistency in the methodologies used to collect data (Amos,* et al., *1997).*

➢ *Although bay debris clearly has an aesthetic impact on visitors to the bays and beaches, other impacts of bay debris in the project area have not been cataloged. (Amos,* et al., *1997).*

Bay debris poses public health risks and reduces the aesthetic appeal of the bay system. It can degrade habitats and ensnare aquatic and wildlife species. These impacts result in costs: to the shrimper who tears his net by hanging up on debris; to the windsurfer who steps on a broken bottle; to the tourism industry when hotel rooms are unfilled because potential visitors would rather visit cleaner beaches; and to agencies and organizations who devote thousands of hours to cleaning up the beaches along the bays.

The debris in our bays comes from many sources — runoff from land, including the debris carried by storm sewers and tributaries; debris discarded or blown from vessels and offshore operations; the trash that blows out of a pick-up truck; the trash that beach goers leave behind; and the debris that washes and blows into the bays from festivals held on the shoreline. Bay debris is a large, multi-faceted, solid waste management problem.


Since prevention is generally more cost-effective than clean-up, the Program will work with local governments to improve solid waste management and to educate citizens on ways they can assist to achieve our goal of a cleaner environment.

## Ensuring Public Health

### Key Findings

➢ *While some diseases can be contracted from eating raw oysters,* Vibrio *infections are of most concern because these infections are potentially lethal. On average, there is only one infection per year in the project area and one death every 8 years.* Vibrio *bacteria occur naturally in bay waters and have no known relation to human uses or wastewater. There is a need for a better indicator of risk from* Vibrios *and other natural pathogens (Jensen and Su, 1996).*

➢ *Water-related accidents (including injuries and fatalities) are a public health and safety concern, averaging almost 12 deaths per year in the project area. Two-thirds of the fatalities are from recreational activities and one-third are from commercial operations. Reliable data are not available for water-related injuries, but these are much more common (Jensen and Su, 1996).*

➢ *Within the bay system, Nueces and Copano Bays have the highest fish tissue concentrations of toxic contaminants. However, the only documented public health threat is from the consumption of oysters from Nueces Bay due to zinc contamination. In addition to zinc, tissue levels of cadmium, copper, and lead are all highest in Nueces Bay. Blue crabs from Redfish and Baffin Bays have elevated levels of several metals (Ward and Armstrong, 1997).*

While significant threats to public health from water contact or seafood consumption are NOT found in the project area, shellfish closures and isolated cases of waterborne illness have occurred. Fortunately, there are already several county, state, and federal agencies working to safeguard public health from bay-related maladies. Better public education on a variety of health issues could avoid unnecessary problems and provide important, positive information about the overall health of the bay system. Such assurance is desired by residents and visitors alike.

Regarding contact recreation (e.g., wading, swimming, windsurfing), professionals debate which type of water quality indicator(s) is most appropriate to gauge water contact safety. A first action will facilitate consensus among health officials throughout the region regarding the most appropriate indicators, sampling and analytical protocol, and risk tolerance level for contact recreation. Through such discussion and review of programs in use elsewhere, participants will decide whether or not it will be feasible to move forward with a regional framework to assess recreational water quality.

***While significant threats to public health from water contact or seafood consumption are NOT found in the project area, shellfish closures and isolated cases of waterborne illness have occurred.***

Another action will focus on the consumption of fish and shellfish. Although the government tightly regulates commercial seafood harvesting, little is known about the safety of consuming recreationally caught seafood. We need analyses of fish and shellfish tissue to determine the presence and concentration of harmful substances, such as polychlorinated biphenyls (PCBs), metals, and pesticides. The data will be submitted to the Texas Department of Health for a risk assessment evaluation.

Because of the need for greater information sharing among health officials, a third action calls for the establishment of a reporting and information retrieval system that will focus on bay-related epidemiological and injury data.

## *Environment-friendly Shoreline Development*

### *Key Findings*

➢ *Approximately 320 km (199 miles) of the Coastal Bend Bays shoreline are hardened or protected by seawalls, solid structures (concrete, wood, or metal), riprap, and piers, and 1,800 km (1,118 miles) of the shoreline are natural (White,* et al.*, 1998).*

➢ *Jetties provide the primary artificial hard substrate habitat in the region. The Aransas Pass jetties extend for 2.55 km (1.58 miles) (north jetty) and 1.89 km (1.17 miles) (south jetty). The Fish Pass jetties are each 30 m (98 ft) wide and 261 m (856 ft) long. In contrast, providing natural hard substrate are 16 km$^2$ (3,954 acres) of serpulid reefs in the project area (Tunnell,* et al.*, 1996). Data has not been provided on the area for groins, breakwaters, and bulkheads.*

➢ *Wetland restoration, enhancement, and creation projects should be incorporated in landscape-level planning for long-term sustainability of the natural resources in the project area (Smith,* et al.*, 1997). Preservation and restoration of the remaining woody areas along waterways and bay shorelines, where possible, should be incorporated into landscape-level planning as well.*

Long-range comprehensive shoreline management is necessary for wise coastal development. Projected development of the Padre and Mustang barrier islands calls for long-range planning to ensure that the natural shore processes are maintained and cost-effective strategies are in place to minimize coastal erosion and loss of life and property. Environmental impacts from poorly planned shoreline development can result in unnecessary habitat loss, reduced public access, altered bay circulation, and degraded water and sediment quality.

The Program will work with local governments, landowners, and key resource management agencies to develop 'Guidelines for Shoreline Management for Use by Local Governments.' A major player in this action will be the Texas General Land Office (TGLO), the designated state lead agency on coastal erosion response. The handbook will be consistent with TGLO's Coastwide Erosion Response Plan and include siting criteria for future development that acknowledges the dynamic nature of bay and barrier island shorelines and sea level rise.

Guidelines will recognize private property owners' needs, as well as the planning, zoning, and permitting authorities of local governments, while promoting a regional approach to shoreline management. The Program will establish a Regional Shoreline Advisory Council that will study 'lessons learned' from other areas of the country so that avoidable mistakes will not be made here.

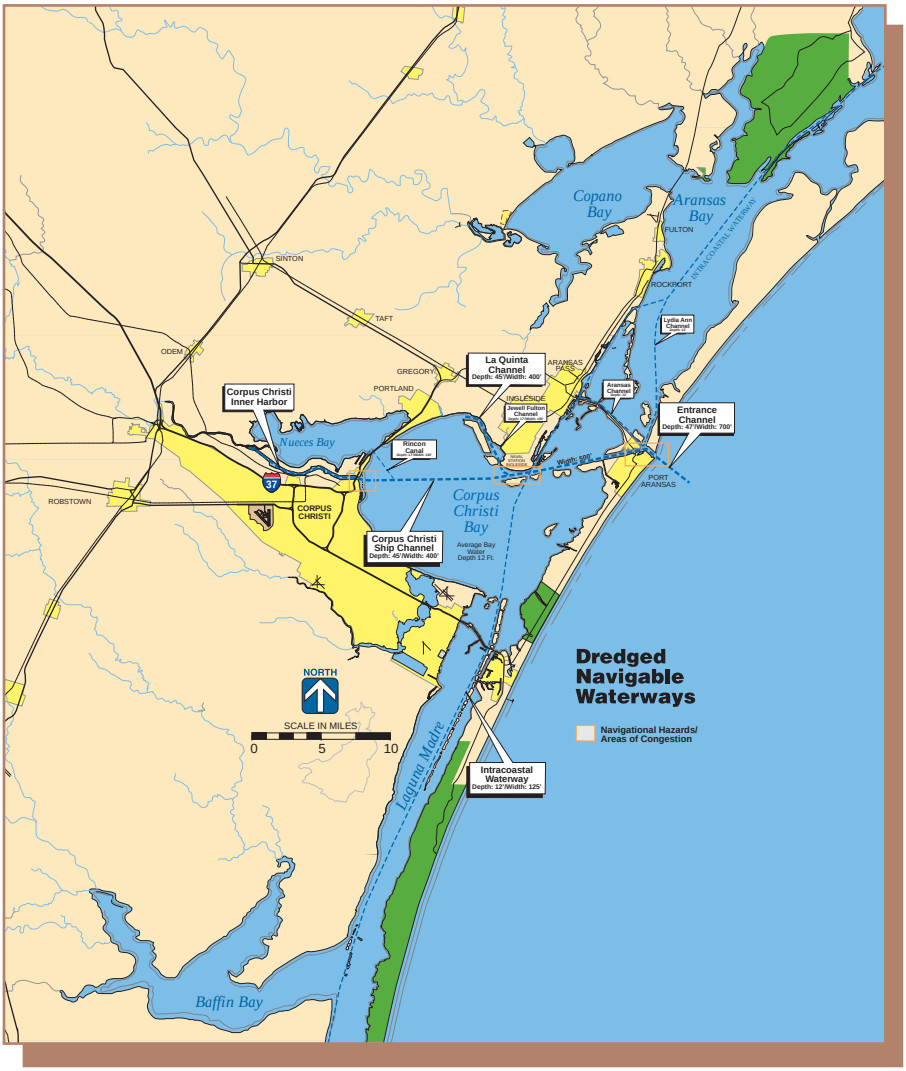
Wherever practical, the preservation of natural shoreline functions and features, at both public and privately owned facilities, will be encouraged to take advantage of natural defenses against wave and wind energy. Tax-paying citizens and users of the bay beaches, as well as private property owners along the shoreline, will benefit from the sound development and use of coastal shore areas.

### Goals

- *Enhance maritime traffic safety while reducing the rate of maritime incidents from shipping, terminal operations, and marine pipelines.*
- *Ensure that all dredging activities are planned and conducted in ways that consider the cost effectiveness of the operation, while minimizing ecological impacts and maximizing the beneficial uses of dredged material.*

Maritime commerce is vital and will continue as the cornerstone of the region's economy. Every year, some 80,000 vessels of all types cross the bays of the Coastal Bend (Jones, *et al*., 1996). The possibility of an accident that could impact the marine environment must be minimized through practical and cost-effective strategies.

Dredging is required to maintain the region's navigation channels and help keep maritime commerce flowing safely (see map at right for dredged navigable waterways). A resolution is needed to the continuing debate about the best way to manage dredging and placement of dredged material. With proper planning, it is possible to minimize negative environmental impacts and maximize benefits to the bays and the regional economy.



## *Ensuring Safety for the Maritime Commerce Industry*

### *Key Findings*

➢ *Analysis of U.S. Army Corps of Engineers data on vessel traffic shows increasing trends for freight transported (about 60 million tons in 1992), increasing numbers of vessel trips (about 80,000 trips from all types of vessels in 1993), and a decreasing average size of shipments (to about 1,800 tons per vessel trip) (Jones,* et al.*, 1996).*

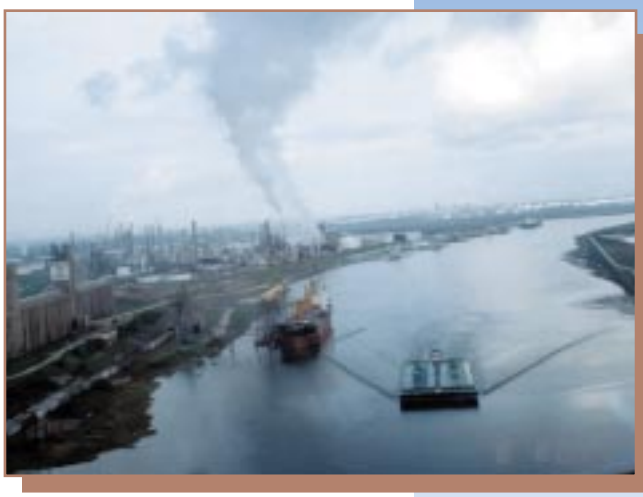
➢ *Oil and petrochemicals make up more than 90 percent of the cargo tonnage moved by ship and barge on the waters of the Coastal Bend Bays. The number of oil and chemical spills has decreased since about 1990, primarily due to the enactment of the Oil Pollution Act of 1990 which imposed new requirements for vessel construction, crew licensing, and financial responsibility for damages. There are about 5.5 oil spills for every chemical spill in the area from the Colorado River to Brownsville (Jones,* et al.*, 1996).*

➢ *Ballast water may be the source of the largest volume of foreign organisms released on a daily basis into American ecosystems. There is a concern that the invasive edible Brown Mussel (*Perna perna*) recently found in the project area could infest and partially sink navigation buoys, thus affecting maritime safety (Tunnell,* et al.*, 1996).*

More than half of the economic activity in the region is linked to waterborne commerce via the use of shipping or pipelines. Given the increase in vessel size and numbers over the years, and the widespread use of marine pipelines, there is a potential for accidents. Accidents could impact the marine environment, threaten human health and safety, and cause economic loss.

***There have been relatively few vessel collisions or major spills in the bay system.***

There have been relatively few vessel collisions or major spills in the bay system. The soft bottoms onshore and offshore are relatively forgiving to ships or barges that run aground. Moreover, accidents have generally been concentrated within the Corpus Christi Inner Harbor where it is relatively easy to contain a spill and minimize damage to wildlife and the marine environment. Nevertheless, accidents involving both ships and pipelines have occurred, and incidents in recent years have increased awareness that we must do everything practical to minimize the potential for additional accidents.



Operators of all waterborne craft including ships, barges, towboats, harbor tugs, shrimp trawlers, passenger vessels, supply boats, ferries, Navy ships, and recreational vessels are part of the mix that is involved in channel traffic safety. Several agencies are involved in maritime safety. The U.S. Coast Guard Marine Safety Office located in Corpus Christi is responsible for enforcing vessel safety and operational rules along the entire South Texas coast. It is assigned specific responsibility for inspection of vessels, crewmembers, bridges, and dock operations to help avoid accidents and prevent pollution. It is also assigned the task of maintaining adequate aids to navigation and issuing safety-warning notices to mariners.

Members of the local harbor pilots association, tug operators, line handlers, the Harbormaster, and even operators of the Tule Lake Lift Bridge play a role in preventing accidents. The Coast Guard, the Port Authority, and the Pilots Association have historically ensured that traffic safety in the ship channel is a high priority. For instance, when tankers above a certain size are underway, only one-way traffic is allowed in the channel. The Port of Corpus Christi Authority operates the Harbormaster's Office round-the-clock to assist mariners with traffic management.

Participants in developing the ***Bays Plan*** recognize that additional safety improvements can be achieved. The actions call for the Pilots Association to provide continuing education and training for its members. Another action calls for the pilots, the Port of Corpus Christi, the Coast Guard, and others to collaborate on improvements to navigational ranges and the area's Vessel Traffic System. In addition, the Plan calls for support of a Port of Corpus Christi Authority initiative to create a 'barge shelf' that will significantly reduce the potential for vessel collision along that route.

The Coast Guard serves as the federal on-scene coordinator responding to petroleum or chemical spills into the marine environment. The Texas General Land Office has responsibility as the state oil spill response coordinator and has been instrumental to ensure that substantial resources are pre-positioned to reduce spill response times. Established in 1970 by the Port Authority and local industries, the Corpus Christi Area Oil Spill Control Association was a pioneer in oil spill response, active well before the advent of specialty private cleanup contractors. The association responds to accidents in the Inner Harbor with equipment and trained personnel.

With respect to spill response, the Plan calls for continued refinement of the area's oil spill contingency plan, improved response technologies, and enhanced public awareness of response plans and notification networks. There are, of course, many partners to these actions, including the Texas Railroad Commission which has jurisdiction for certain spills of 240 barrels or less. The Texas General Land Office and the Coast Guard share the lead on actions related to oil spill response. The Texas Natural Resource Conservation Commission (TNRCC) is the state chemical spill response coordinator. This responsibility is shared with the Coast Guard. The Local Emergency Planning Committee works with TNRCC to improve hazardous material spill response planning.

Meanwhile, the Texas Railroad Commission will lead efforts to establish an interagency forum to coordinate pipeline mapping and contingency planning. Information on marine pipelines, such as ownership, condition, and content, is not readily available in a consolidated source for use by response agencies. The ***Bays Plan*** will work to integrate pipeline information sources, and develop a Geographic Information System that will facilitate planning and response.

Finally, minimizing the potential for the introduction of non-native species through ship ballast water will be the target of another set of actions.

## *Maximizing Benefits from Dredging*

### *Key Findings*

➢ *Dredging is an ongoing activity necessary to maintain navigable waterways in the Coastal Bend Bays. There are 284 km (176 miles) of transportation canals within the bays and estuaries of the project area (Tunnell,* et al.*, 1996).*

➢ *There is a lack of consensus about the beneficial and adverse effects, both economic and ecological, of new dredging projects and maintenance dredging, and the handling and placement of dredged material. Program studies have documented some impacts.*

- ➢ *The Redfish Bay area lost 795 ha (1,964 acres) of seagrass between 1958 and 1994, attributed to dredged material deposition and channel impacts. An additional 407 ha (1,006 acres) were gained during the same time period for a net loss of 388 ha (958 acres). These losses were primarily related to construction of the Gulf Intracoastal Waterway through the Redfish Bay area and the resulting discharge of dredged material directly onto seagrass beds (Pulich,* et al.*, 1997).*
- ➢ *Marshes have been lost in the project area, although these are limited in extent and have been offset by large gains due to localized sea level rise. Marshes have been converted to agricultural and urban land or lost as a result of dredging, excavating, filling, draining, and leveeing (White,* et al.*, 1998).*
- ➢ *Bay bottoms have been affected by human-related activities, including dredging and commercial tug and barge operations (Montagna,* et al.*, 1998).*

Until the 1970s, almost all of the dredged material excavated in channel construction and maintenance was placed in unconfined areas, generally a short distance from the channel. This created 'spoil' islands (now referred to as dredged material placement areas) and covered large areas of shallow bay bottoms, creating either short-term or permanent disruption of biological productivity in these areas. Such material created much of the land on the north side of the Inner Harbor and on the west end of Harbor Island. Dozens of islands created by dredged material placement exist along the ship channel west of Port Aransas, on the west side of La Quinta Channel, and along the Intracoastal Waterway, especially in the Laguna Madre.

Despite losses of bay bottom habitat (largely due to the burial of seagrasses during dredging), dredged material placement has produced notable environmental enhancements, including the creation of nesting habitat on material placement islands. One such island, Pelican Island, is the largest brown pelican nesting area in Texas.

During the 1970s, minimizing wetland losses became an important public policy goal. The outcome was increased coordination between state and federal agencies regarding dredged material placement practices (i.e., levee-confined areas). Concern about the release of potentially harmful contaminants trapped in bottom silts in the Inner Harbor was also a factor in the design of material placement areas. However, dredged material must be tested using nationally approved methods to ensure sediment quality is adequate for in-bay or Gulf placement. Not all dredged materials must be confined; for example, material excavated during channel maintenance across Corpus Christi Bay and in the Gulf entrance channel is placed in designated open water areas.

*Aerial view of historical open bay dredged material placement.*

Dredge and fill activities not specifically authorized by the United States Congress cannot be conducted without an approved federal permit under Section 10 of the Rivers and Harbors Act and, in most cases, a permit under Section 404 of the Clean Water Act. A permit is needed whether the job is a ship channel or a shallow residential canal planned by a single landowner. These and other permitting requirements provide the current management framework for dredging. Project sponsors must apply to the U.S. Army Corps of Engineers, which seeks review and comment from federal and state natural resource agencies and the public. If it appears that a project will have significant impacts, an environmental assessment or an environmental impact statement is required. Each project is viewed individually in this management system; however, assessing the long-term cumulative impacts of multiple and interrelated dredging projects has been difficult.

One action of the ***Bays Plan*** calls for the creation of an interagency and public stakeholder committee that will examine the 'big picture' for maintenance dredging and give special attention to the possible beneficial use of dredged material. This 'Beneficial Uses Group' will identify opportunities to increase the volume of clean dredged material that is put toward beneficial uses. Such uses might include habitat creation or renourishment with suitable dredged material, or shore protection against erosive wave energy. The group will work to identify potential funding sources to achieve these goals.

The Port of Corpus Christi Authority is the local sponsor of the Corpus Christi Ship Channel and the branch La Quinta Channel. The Program will support the Port, in conjunction with the Corps of Engineers and other stakeholders, to achieve consensus on a long-term dredged material management plan that will make use of sound dredging practices and maximize the beneficial use of dredged material.

Working in parallel fashion, the Program will assist the Texas Department of Transportation to achieve consensus among stakeholders on a long-term dredged material management plan for the Gulf Intracoastal Waterway (GIWW). Both the Corpus Christi Ship Channel and the GIWW are federal projects authorized by Congress, administered by the U.S. Army Corps of Engineers, and funded primarily through federal appropriations. Local sponsors of the dredging projects are responsible for development of long-term plans to manage dredged material and provide upland sites for dredged material placement when practical. The ***Bays Plan*** will assist to achieve consensus on the best overall plan for these and other future dredging projects.

The largest private dredge and fill project in the region is the waterfront residential subdivision on North Padre Island. More than 10 miles of canals have already been built and more are allowed under an existing permit. The Padre Island Property Owners Association is responsible for maintenance dredging of most of these canals. However, no areas for placement of maintenance dredging material have been designated or permitted. Residential subdivisions with dredged canals are also located in Ingleside, Aransas Pass, Port Aransas, and Rockport.

***The Program will support the Port, in conjunction with the Corps of Engineers and other stakeholders, to achieve consensus on a long-term dredged material management plan that will make use of sound dredging practices and maximize the beneficial use of dredged material.***

### Goal

✦ *Increase and preserve the quantity, quality, and diversity of habitats and living resources.*

A diversity of tidally-influenced habitats is found within and adjacent to Coastal Bend bays and estuaries. These habitats and their populations of fauna and flora comprise ecosystems that are unique to South Texas. Recognizing that high quality, functional habitat is the foundation for a healthy bay system, the ***Bays Plan*** adopts an 'ecosystems approach' to evaluate and implement the various conservation and management measures necessary to ensure long-term productivity of these resources.

The Program has worked to assess the status and trends of selected habitats and living resources, and to evaluate strategies to ensure continued productivity for the three estuaries.

Although results indicate that the bay system is in moderate to good overall health, there is a considerable lack of data with respect to many of the ecosystem components. Despite this lack of certain data on the ecological functioning of parts of the estuarine system, participants have identified several actions that can and should be undertaken in order to ensure long-term resource sustainability.

## Ensuring a Diversity of Functional Habitat

### Key Findings

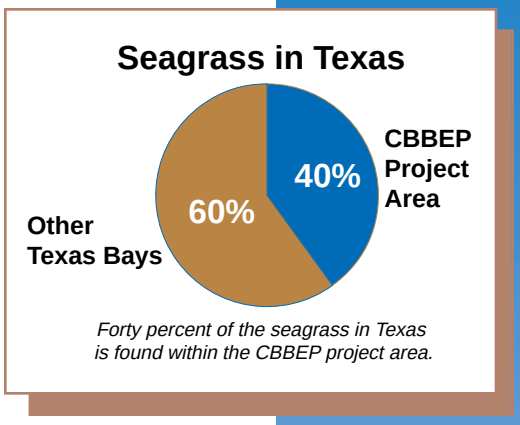
➢ *Extensive changes in intertidal flats occurred between the 1950s and 1979, during which time more than 10,000 ha (24,710 acres) were converted to other habitat classes. Almost 55 percent of the change was due to permanent inundation of the flats and their replacement by either open water or seagrass beds attributed to a rise in sea level. About 20 percent of the intertidal flats were converted to marshes, and another 20 percent were converted to uplands (White,* et al.*, 1998).*

➢ *Marshes have been lost in the project area, although these are limited in extent and have been offset by large gains. Among the notable losses were pothole wetlands on the coastal prairie and on the barrier strandplain ridge, Live Oak Peninsula/Ridge. Palustrine marshes had their largest gains on the barrier islands. Marshes have been converted to agricultural and urban land or lost as a result of dredging, excavating, filling, draining, and leveeing (White,* et al.*, 1998).*

The Coastal Bend is comprised of eight major tidally-influenced habitat types essential to native living resources and a productive estuarine ecosystem. These habitats are coastal marshes, wind tidal flats, seagrass meadows, open bays, oyster and serpulid worm reefs, barrier islands, and freshwater marshes. Although losses have been incurred by every type of habitat, offsetting gains have also taken place in some cases. Wind tidal flats have suffered the most significant losses, but habitat acreage is, in general, fairly stable over the long-term.

The quality and functionality of habitat is, however, a different and perhaps more important indicator of overall health and productivity. And while much additional monitoring and assessment is needed to make accurate, quantifiable statements regarding habitat function,

evidence suggests that certain habitat types are stressed and at risk. Changes in circulation patterns from freshwater inflow alteration, dredging and filling, shoreline alteration, and road construction have altered the hydrology of some areas. In addition, point and nonpoint source discharges can degrade habitat, as can activities associated with seismic exploration for oil and gas. For example, past (point source) brine discharges have degraded habitat at White's Point in Nueces Bay, and nonpoint source pollution from some urban stormwater outfalls has altered the chemistry of bay sediments and may have affected their biological communities (Carr, *et al*., In review).



*Forty percent of the seagrass in Texas is found within the CBBEP project area.*

The ***Bays Plan*** calls for efforts to identify habitat types that are most at risk and to work with landowners and local and state governments on ways to preserve sufficient, functional acreage of those habitats. Various tools can be employed to attain this goal, including the use of conservation easements, tax abatements, or land acquisition. Once set aside, habitat management plans will be developed and implemented.

Habitat destruction, degradation, and fragmentation have been documented by various Program studies. Factors contributing to the loss of habitats include conversion to other land uses, dredge and fill activities, natural erosion, altered freshwater inflow, and degraded water quality. Declines in living resource populations are related to the loss, degradation, or fragmentation of essential habitats, and, at times, over-exploitation. The development and implementation of site-specific plans for habitat creation or restoration will be pursued, again through cooperative efforts of landowners, local governments, and resource agencies with available technical and/or financial assistance. The following species of concern have been identified that would potentially benefit from the restoration, enhancement, creation, or better management of habitats: whooping cranes, neotropical migratory birds, colonial waterbirds including the brown pelican and snowy and piping plovers, shrimp, blue crabs, larval fish, and many others.


*Coastal marsh grass provides a habitat for many estuarine organisms.*


*The largest nesting population of the endangered brown pelican in Texas can be found within the CBBEP project area at Pelican Island in Corpus Christi Bay.*

## Survivability for Species of Concern

### Key Findings

➢ *A review of state listed species in 1994 documented 39 threatened or endangered species, 19 of which utilize estuaries. The only natural population of the endangered Whooping Crane winters in the marshes in the Aransas National Wildlife Refuge. Over 20 species of shorebirds have been recorded on wind-tidal flats, including several endangered species. Causes for decline include over-exploitation or habitat degradation and loss (Tunnell,* et al.*, 1996). (Note: At the time the* **Bays Plan** *went to press, the number of state listed species was 35.)*

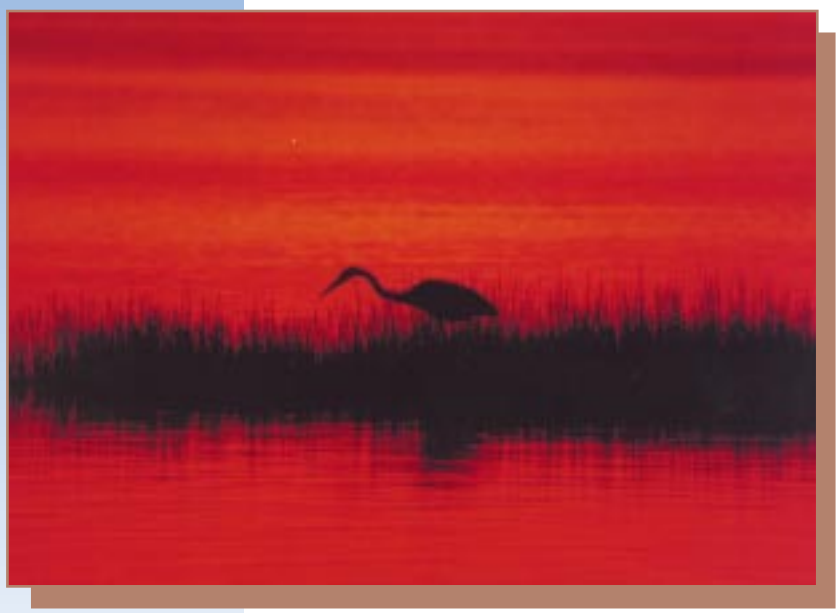
➢ *The project area is one of the richest fisheries resources in Texas. An average of 8.4 million pounds per year of finfish, shrimp, crab, and other aquatic species were harvested between 1972 and 1992 (Tunnell,* et al.*, 1996). Data suggest, however, some population declines in Atlantic croaker, southern flounder, Gulf menhaden, white shrimp, and adult blue crab (Lacson and Lee, 1997).*

➢ *There are 494 known bird species inhabiting or migrating through the project area. This enormous diversity is attributed to the numerous food and habitat types, key geographical location for migration, and multiple nesting areas. However, except for the brown pelican, nesting populations of colonial waterbirds have decreased. The U.S. Fish and Wildlife Service is concerned about two issues that impact neotropical migrant birds: 1) rapid habitat loss in other countries, and 2) the need to preserve wooded riparian corridors and coastal prairies along the Gulf coast (Tunnell,* et al.*, 1996).*

➢ *There is some evidence of an increasing trend in dolphin strandings, particularly the bottlenose dolphin (Tunnell,* et al.*, 1996).*

➢ *The benthic communities of Corpus Christi, Baffin, and Nueces Bays are characterized by low diversity, dominance by pioneer species, and high variance of community and physical variables (Montagna,* et al.*, 1998).*

There are some cases where providing sufficient, high-quality habitat is not enough to ensure the survivability of a species. Other impacts, such as over-harvesting, invasion by non-native species, or decreased reproductive rates due to the persistence of a certain chemical in the environment, can be equally or more threatening to a given species. In such cases, a targeted species recovery or management plan is needed, and its actions put into full implementation throughout the species' range.



The ***Bays Plan*** calls for a vigilant and continuing look at such species of concern, and the development and implementation of management plans as necessary. Thus, coordinated with the habitat workgroup that will oversee essential habitat plans, stakeholders will address species of concern and develop management plans for birds, aquatic species (including marine mammals and reptiles), and plants on an as-needed basis. Coupled with this action, stakeholders will work to improve the existing network of animal rescue and rehabilitation programs, and secure stable funding and human resources to fulfill their missions.

Other potential management actions address shrimping, harmful algal blooms, and non-native species.

## *Collaborative Management of the Shrimp Fishery*

### *Key Findings*

➢ *Shrimp is currently the dominant catch in the project area (primarily Aransas and Corpus Christi Bays), representing between 60 and 90 percent of the commercial harvest between 1988 and 1993. Bycatch as a result of shrimp trawling may comprise 1.5 to 7 times the weight of shrimp caught in these bays (Tunnell,* et al.*, 1996).*

➢ *Preliminary findings suggest that various designs of Bycatch Reduction Devices (BRDs) have potential conservation benefits to bay ecosystems without undue loss of shrimp or commercial revenues (Fuls,* et al.*, In review). Three BRDs are currently being evaluated for their potential to reduce bycatch.*

➢ *Bay bottoms have been affected by human-related activities, including shrimp trawling (Montagna,* et al.*, 1998).*

Few intensively utilized fishery resources in the world exist without conflict among competing users. The shrimp fishery in South Texas is no exception. Bay, bait, and Gulf shrimpers all have their own ways of doing business and views on existing regulations. Environmental groups, recreational fishermen, and even the maritime transport industry also have something to say about how the present management regime could be improved. Although the Texas Parks and Wildlife Department (TPWD) has worked very hard to stay abreast of the ever-evolving dynamics of the fishery, the fact remains that few stakeholders are satisfied with the present management system.

The ***Bays Plan*** will work to facilitate consensus among all stakeholders on a regional approach to effectively manage bay and bait shrimping. To accomplish this, relevant stakeholders will be invited to participate in a series of workshops and meetings, the goal of which will be to develop a regional framework and recommendations for presentation to the TPWD and existing state shrimp fishery advisory boards.

*Shrimp are the most important commercial seafood in Texas.*

There are many issues to be dealt with, one of which is the question of how best to minimize the incidental catch of non-shrimp species while trawling. This 'bycatch', as it is called, can result in environmental and economic losses of considerable dimension. The Program has worked with TPWD and members of the Texas Seafood Producers Association to test alternative designs for an effective Bycatch Reduction Device (BRD). The ***Bays Plan*** calls for continued assessment of the optimal BRD design and its eventual voluntary use by bay shrimpers.

## Other Management Issues and Needs

### Key Findings: Harmful Algal Blooms

➢ *The Brown Tide has caused a recent loss of 10 km² (2,471 acres) of seagrass coverage in upper Laguna Madre and other impacts such as decreased abundance, biomass, and diversity of benthic fauna, and reduced larval fish populations (Buskey,* et al.*, 1996).*

➢ *There is a lack of consistent data on red tide conditions before, during, and after a bloom (i.e.,* in situ *water sampling of temperature, salinity, winds and currents, nutrients, cell counts, and biologically active organic compounds), both offshore and inshore (Buskey,* et al.*, 1996).*

### Key Findings: Non-Native Species

➢ *The introduced edible brown mussel expanded a distance of 1,300 km (808 miles) south between its first observation in 1990 and 1994. Its invasive nature has raised concern that it may have the potential to overcome native species inhabiting the limited artificial hard substrate found within the project area (Tunnell,* et al.*, 1996). To date, no significant adverse effects have been recorded.*

➢ *The nutria, an exotic herbivore, appears to be extending its range into the project area, and could impact marsh vegetation (Tunnell,* et al.*, 1996).*

➢ *Data is lacking on the effects of invasive non-native fire ants on reproduction of brown pelicans, sea turtles, and other species (Tunnell,* et al.*, 1996).*

Additional issues affect living resource populations and/or habitats that have been partly addressed by resource managers or industry. These issues deserve at least some continued assessment and possible management action: impingement or entrainment of organisms by cooling water intakes; harmful algal blooms; and the introduction of non-native species.

Aquatic organisms are lost when they are drawn through the cooling water apparatus of power generating plants or other industrial operations. The most significant user of marine cooling water in the project area is Central Power and Light (CPL), and the company has already employed state-of-the-art technology at its Barney-Davis Power Plant to minimize losses due to impingement or entrainment. Similar equipment is not employed at its Nueces Bay plant. Cooling water for that plant is drawn from the Inner Harbor. It is not known how (if at all) significant the issue may be for that bay segment. The Plan simply calls for CPL to take the lead on further evaluation of impacts as a result of its operations within the project area, and to determine if any additional, cost-effective technologies can be employed.

*Fishkills may occur because of natural events, such as algal blooms.*

Algal blooms are considered harmful if they threaten human health, cause economic loss, or result in detrimental changes to an ecosystem. Environmental mechanisms that trigger and sustain these blooms are not fully understood, preventing effective forecasting and/or management of harmful algal blooms (HABs). Research and monitoring programs are necessary to assess both short- and long-term effects of blooms, and to seek management practices that could reduce their severity or prevent their occurrence.

Since 1980, four well-documented harmful algal blooms have occurred in the Coastal Bend. Red tide blooms occurred in 1986, 1996, and 1997, and killed millions of marine organisms. During these blooms, the Texas Department of Health prohibited the harvest of oysters from area bays, which resulted in economic loss to oyster fishermen. Local processing houses and many area beaches were also closed. From 1990 through late 1997, the upper Laguna Madre experienced a persistent bloom of a microscopic phytoplankton species generally referred to as the Brown Tide. The turbid, brown-colored water resulted in environmental impacts to the underlying seagrass meadows. Laboratory and field studies have also shown that high concentrations of the Brown Tide organism are toxic to the eggs and larvae of at least some finfish species. To date, however, no statistically significant declines in finfish stocks have been observed.

***Since 1980, four well-documented harmful algal blooms have occurred in the Coastal Bend.***

Unfortunately, scientists and resource managers have not, as yet, solved all the mysteries of algal blooms. Knowing with certainty their cause and reasons for perpetuation is a pre-requisite to developing effective management strategies. The ***Bays Plan*** recognizes this need for continued research (including demonstration projects on possible mitigation measures), and calls for ongoing attention to the issue in the hope of reducing the occurrence and impacts of future blooms.

***The invasion of non-native species into native habitats can alter both habitat structure and function, and disrupt or displace native species.***

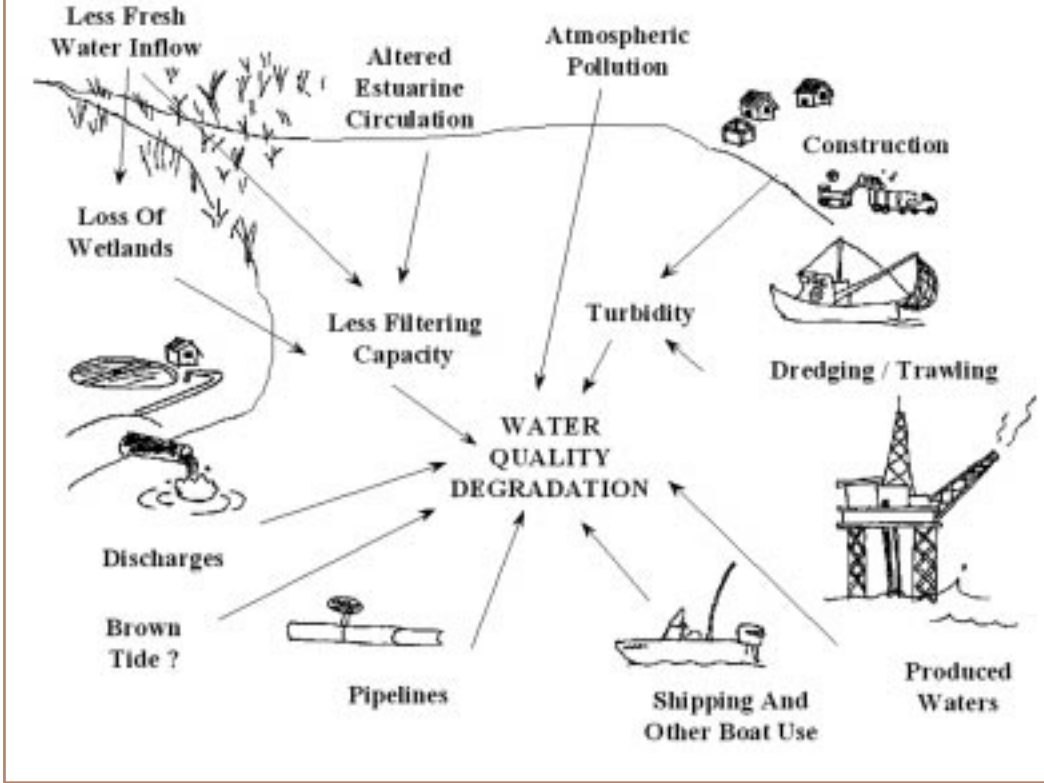
Finally, the invasion of non-native species into native habitats can alter both habitat structure and function, and disrupt or displace native species. Heightened concern over the increased introduction of non-native species, which are causing multi-million dollar control problems in some areas of the country, led to the passage of the Invasive Species Act of 1996. The only local aquatic invasive species of concern identified to date, the edible brown mussel, has fluctuated greatly in population numbers since its introduction in 1989, but no significant adverse impacts have been recorded. The ***Bays Plan*** calls for the identification of techniques and practices to control the new introductions of non-native species.

*The non-native edible brown mussel was first discovered in the Coastal Bend in 1989.*

### Goals

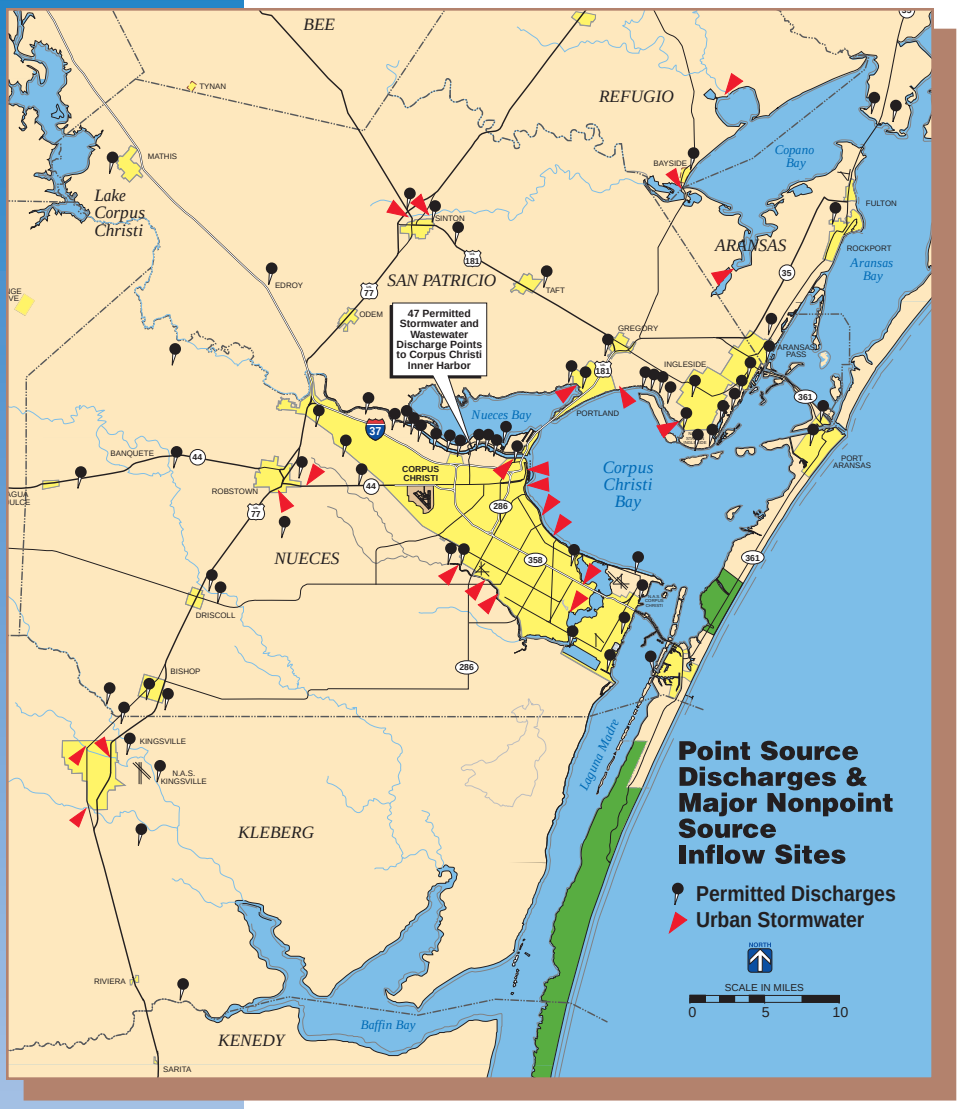
- *Maintain and/or enhance water and sediment quality.*
- *Understand total loadings and the transport pathways and biological effects of loadings to the bay system.*
- *Improve management of all loadings to the bay system.*

Maintaining the quality of water and sediment in the face of expanding population is important to human health, aquatic life, and the economic vitality of the region (see diagram at right for factors contributing to water quality degradation).




*The most productive marine ecosystems thrive in areas with clean water and an optimal level of suspended solids. Increasing the amount of contaminants or turbidity in the water can decrease productivity, or even human health. Human activities, such as agriculture, dredging, and trawling can increase water turbidity, which limits photosynthesis. Limiting the flow of water in an estuary or limiting freshwater inflow can inhibit the natural properties that wetlands have to filter contaminants from water. Many human activities have the potential to contaminate water, from oil spills to runoff from streets following a storm.*

Fortunately, overall bay water quality has significantly improved during the past 25 years. The advent of the Clean Water Act in 1972, and the subsequent control of point source discharges, has brought steady improvement to several conventional water quality parameters in certain, previously impaired segments. Despite a 42 percent increase in municipal and industrial discharge volumes between 1980 and 1995 for the region, there has been a 60 percent decrease in Biochemical Oxygen Demand ($BOD^5$) loadings and a 47 percent decrease in Total Suspended Solids (TSS) over that period (Armstrong and Ward, 1997). Industries and municipalities have invested and worked hard to do their part to achieve coastal water quality standards. Today, point source discharges are frequently reused to offset freshwater supply demands, including beneficial return flows to the estuaries.




Many factors contribute to water and sediment quality. In addition to discharges from municipal and industrial wastewater treatment plants (point sources), we must also consider the diffuse runoff from urban and rural areas (nonpoint sources) (see map at left for locations of point source discharges and major nonpoint source inflow sites). Point sources and some nonpoint sources already fall under a regulatory management framework, and the state is obligated to develop a coastal nonpoint source pollution control program under the Texas Coastal Management Program. Successful management practices must be continued and extended to a wider area in order to maintain or enhance water and sediment quality in the future.

Sediment quality is important because sediments are a 'sink' or repository for pollutants such as metals and pesticides. Sediments accumulate and concentrate pollutants over a long period of time. When activities such as dredging disturb contaminated sediments the result can be a reintroduction of pollutants into the water column.

Water and sediment quality is important to estuarine productivity, wildlife habitats, and the aesthetic appeal of bays and shorelines. Maintaining the water quality improvements made during the past 25 years will be a challenge in the years ahead as the regional population increases. While there are larger natural forces at work that impact the bay system, it is possible to enhance water and sediment quality through pollution prevention and other Best Management Practices.

*A typical drainage way found in the Coastal Bend designed to drain rain water. These systems not only move the water quickly but pick up pollutants from surrounding property.*

### *Key Findings*

*The quality of water and sediment within the project area is generally good to moderate. Program reports and state agencies, however, have identified areas that exhibit poor quality and may benefit from source reduction activities, although specific sources of loadings affecting water and sediment quality have not yet been identified.*

➢ *Water does not move quickly through the Corpus Christi Bay system and, therefore, has a greater tendency to concentrate waterborne substances, including pollutants (Ward, 1997).*

➢ *The central bays (Nueces and Corpus Christi Bays) receive the majority of point source loads of most constituents; the lower bays (Baffin Bay and Laguna Madre) receive the next highest amount, while the upper bays (Redfish and Copano/Aransas Bays) receive the least (Armstrong and Ward, 1997). Nonpoint source loadings are not as well understood, but a 'total loadings' model under development will assist to identify the relative contributions from both point and nonpoint sources, including those from atmospheric deposition.*

➢ *More specifically, the Corpus Christi Inner Harbor (CCIH) and Oso Bay receive the greatest point source loads (Armstrong and Ward, 1997). The Inner Harbor generally exhibits the highest levels of pollutants including sediment metals (especially sediment zinc and copper), sediment PCBs, sediment organics, and fecal coliforms. Oso Bay has elevated fecal coliforms and low dissolved oxygen (DO) levels (Ward and Armstrong, 1997). Some of these constituents may also come from nonpoint sources.*

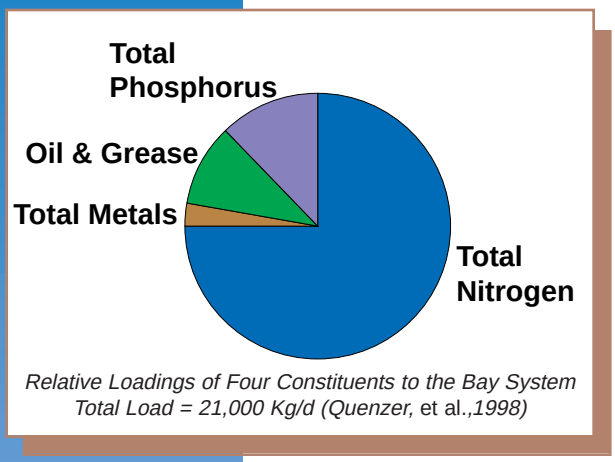
➢ *The highest sediment PCB levels are in Redfish Bay. Sediment PCBs and PAHs exhibit very high levels in the Inner Harbor (Ward and Armstrong, 1997).*

➢ *Nueces Bay is consistently elevated in metals in both the water column and sediments. Elevated metal concentrations are also found in Baffin and Copano Bays, around the Bird Islands in the Laguna Madre, the La Quinta channel, and in Redfish Bay near Aransas Pass. However, data are generally insufficient to determine whether or not these metals concentrations pose a threat to aquatic life or whether violations of water quality standards are more frequent than what current data have revealed. Reliable trends in water phase metals concentrations (either increasing or decreasing) have not been established (Ward and Armstrong, 1997).*

➢ *A possible increase in zinc concentrations is noted in large portions of Corpus Christi Bay and Baffin Bay. Sediment zinc levels in the Inner Harbor are an order of magnitude higher than those found in the Houston Ship Channel (Ward and Armstrong, 1997).*

➢ *Because some Coastal Bend bays are naturally warm and highly saline, natural dissolved oxygen saturation values in the project area are only slightly above the state water quality standard of 5 ppm, which has been established to avoid biological stress to living resources. This implies that the bay system has little assimilative capacity to handle additional waste-loads. Statewide dissolved oxygen standards may not be appropriate for some shallow, saline Coastal Bend bays. (Ward and Armstrong, 1997).*

Urbanization and industrial development came relatively late to the Coastal Bend, and concerns about water quality did not surface until the 1950s. Collection of water quality data began around that time and intensified after 1965; data collection on sediments started in the 1970s. These historical data are limited, thus making it difficult to draw a detailed picture of water and sediment quality trends or to quantify 'total loadings' to the bay system.




*Relative Loadings of Four Constituents to the Bay System*
*Total Load = 21,000 Kg/d (Quenzer,* et al.*,1998)*

Although there are many gaps in the historical record of water and sediment quality, the available data indicate at least a few specific areas that deserve further investigation. The ***Bays Plan*** calls for a closer investigation of the sources of water and sediment quality problems found in several areas and the design of strategies to reverse negative trends. In particular, elevated concentrations of zinc, copper, nickel, chromium, and fecal coliforms, and depressed concentrations of dissolved oxygen have been reported for several segments. Working with various local governments, industries, agencies, and stakeholder groups, the Program will facilitate a focused assessment for these priority areas of concern.

A relatively new industry to Texas, shrimp farming has until recently not been subject to controls on discharges to receiving waters. This has caused concerns for water quality and the possible introduction of non-native shrimp or disease to the bay system. Whether such concerns are real or perceived, such discharges should be subject to the same high standards as the permitting process for other point sources. The ***Bays Plan*** supports the implementation of the existing aquaculture regulations and more local input on the siting and discharge requirements for future operations.

Understanding the contribution of 'total loadings' to the bay system and the transport pathways and biological effects of those loadings is a fundamental goal of the Water and Sediment Quality Action Plan. To accomplish this, the Program will continue to refine the 'total loadings model', working with partner agencies, local governments, and the private sector to obtain more data for that purpose. The effort will involve new data collection projects designed to determine relative contributions from various land use types and sources. Once areas of concern are identified – if any – additional investigation will be carried out to determine the biological effects (including biotoxicity) of those pollutants of greatest concern.

The approach of the ***Bays Plan*** is to develop ways to get ahead and stay ahead of water and sediment quality problems before they pose risk to people or the environment. Knowing more about the quality, volume, and biological effects of loadings will allow stakeholders to provide educated input during the state's triennial review of water quality standards. Such knowledge may also drive the development of sediment quality and/or biological criteria guidelines as additional tools to assess ecosystem health. It will also allow stakeholders to participate in a variety of important water quality management programs, including the development of basin watershed management plans, identification of priority water bodies, and the development and implementation of Total Maximum Daily Load (TMDL) allocations for impaired water segments.

Although the ***Bays Plan*** does not indicate a specific action related to brine discharges, the Management Conference calls for support of efforts already underway by the U. S. Environmental Protection Agency and the Texas Railroad Commission to eliminate harm from surface discharges into coastal waters of brine water from oil and gas production wells. These hypersaline discharges are an unavoidable product of oil and gas well operations, and are known to have negative impacts on the coastal environment. Recognizing this, the U.S. Environmental Protection Agency and the Texas Railroad Commission are working together with industry on subsurface re-injection of these coastal brine discharges. Recent actions by the U.S. Environmental Protection Agency require all coastal discharges of produced brine water in Texas to cease on or before December 31, 1998.

## *Managing Nonpoint Source Runoff*

### *Key Findings*

*Based on preliminary information from the project area and evidence from other estuary programs, urban nonpoint source runoff can have detrimental effects on rivers, lakes, bays, and estuaries. Urban nonpoint source pollutants may include oil and grease, pathogenic microorganisms, pesticides, nutrients, trash, and heavy metals. These pollutant loadings will increase as urban areas expand and the population increases unless prudent management actions are taken.*

➢ *Localized declines in seagrass are related to increased amounts of algae, perhaps due to increased nutrient loading from adjacent mainland developments (Pulich,* et al.*, 1997).*

➢ *Atmospheric deposition on land contributes significantly to loadings found in nonpoint source runoff (Baird,* et al.*, 1996).*

➢ *Preliminary data suggest that some storm drain outfall sites have elevated concentrations of contaminants which can be toxic to sensitive life stages of organisms, and may result in localized decreases in species diversity. Some sites adjacent to industrial and municipal outfalls and dredged material placement operations may also have elevated levels of contaminants (Carr,* et al.*, In review).*

➢ *The most impacted sites in the project area are the storm drain sites in the Corpus Christi marina near the L-head, Cole Park, and the Padre Island outfall (Carr,* et al.*, In review).*

➢ *Septic tank systems are the most common on-site sewage facilities (OSSFs) in the project area. Problems associated with septic tank systems include the following: soils that are unsuited for conventional septic systems; lot sizes that are too small, resulting in soil saturation; and sites that are located in floodplain areas where the water table is too shallow to allow for proper drainage (Michael,* et al.*,1998).*

➢ *The most common public complaints received by all project area counties are raw sewage bypasses and inadequate or non-existent on-site sewage facilities.*

➢ *Agricultural production significantly influences the economy and environment of the project area. Agricultural runoff can have either good or bad effects on receiving waters. Preliminary studies indicate, however, that edge-of-field concentrations of both nutrients and most pesticides may, in fact, be relatively low (Baird,* et al.*, 1996).*

*Inlet stencilled with a message to prevent debris from being improperly discarded.*

When chemicals in rainwater runoff exceed certain concentrations they become pollutants and result in reduced water and sediment quality. Stormwater runoff picks up and carries not only pollutants (e.g., oil and grease from vehicles, lawn and garden chemicals, animal wastes, and street litter), but also ecologically important nutrients, sediments, and freshwater. Excessive nutrients or other chemicals not fully utilized by the ecosystem become pollutants.

## Urban Runoff

Urban runoff is an important factor in bay water and sediment quality. In addition to the populated areas within city limits, urban runoff is generated by rural subdivisions, highways, industrial activities, and construction sites throughout the region. Urbanized areas have impervious surfaces and drainage systems that increase the volume of runoff and deliver loads faster to the bays. Stormwater drainage ditches can create linear freshwater wetlands, vegetated with marsh plants that can function to help slow water movement, trapping sediment and contaminants, and filtering some of the constituents before they reach the bays, while providing habitat for some wildlife species.

On-site sewage facilities (OSSFs), or septic systems as they are more commonly known, can contribute to fecal coliform contamination and nutrient enrichment of receiving waters. Many septic systems are improperly installed or maintained and the clay and sand soils in a large part of the project area are not well-suited to efficient septic system operation.

*Debris from urban runoff accumulated at the edge of Corpus Christi Bay after a heavy rain.*

The City of Corpus Christi has moved ahead of other Texas cities with populations of greater than 100,000 with implementation of its National Pollutant Discharge Elimination System (NPDES) stormwater permit. Under the permit, the City implements programs to monitor discharges, identify sources of contamination, establish and enforce ordinances aimed at reducing pollution, and educate residents, construction site managers, and others on how to improve stormwater quality. Additional programs – such as street sweeping, maintenance of marsh vegetation and erosion control in drainage ditches, cleaning of catch basins and storm sewers, litter abatement, household hazardous waste collection, and curbside recycling – assist in the management of urban runoff.

The ***Bays Plan*** calls for the development of a regional handbook to assist local governments to implement urban nonpoint source control programs. The handbook will likely contain many examples from the City of Corpus Christi's stormwater program. Stakeholders will also work to provide compliance assistance to small businesses and industries on ways to help achieve urban runoff objectives. Finally, a program will be established to assist local governments to more effectively manage on-site sewage facilities. One obvious starting point for all of these activities is public education, to help people understand that they can improve environmental quality by simple changes in the way they manage their homes and businesses.

## *Agricultural Runoff*

Agricultural uses, ranging from cattle grazing to rowcrop farming, are found on 88 percent of the land in the Coastal Bend. Nutrients, pesticides, organic matter, and animal wastes can be carried to the bays by stormwater. Preliminary studies indicate that the edge-of-field concentrations and loads of such pollutants may in fact be relatively low. A combination of flat terrain and the use of improved chemicals and application techniques are already at work to minimize the amount of material carried away by stormwater.

Management programs implemented for many years in the region include erosion control and integrated crop management. These and other programs have helped to improve agricultural runoff water quality. While many of these practices were developed for economic reasons, they have had the effect of reducing the amount of sediment, organic material, and chemicals that are washed into the bay system.

The ***Bays Plan*** calls for the continued and expanded implementation of agricultural conservation assistance programs as authorized and funded by state and federal law. Implementing partners will provide technical assistance, seek additional funding, and encourage landowners to continue or expand upon their use of Best Management Practices to minimize and improve the quality of agricultural runoff.

**Goal**

- *Develop a regional water management plan that will meet both human and environmental needs of freshwater for the long-term.*

Freshwater was in short supply in South Texas even before people established ranches, towns, railroads, and industries in the semi-arid region. In the face of increasing population and more industry, this scarcity of locally available freshwater means there will always be competing demands on this limited resource.

Freshwater that flows into Coastal Bend bays comes from rivers, creeks, drainage structures, and wastewater treatment plants. These inflows create a salinity gradient that is important to the productivity of the bay system. Adding to this beneficial effect, they also contribute nutrients and sediments. However, construction of two reservoirs and other smaller impoundments have altered the volume and timing of freshwater inflows and diminished nutrient and sediment supplies to the bay system.

***Substantial concern has been expressed about whether the public understands the water supply situation and the need to balance the human and environmental needs of available freshwater.***

Municipal and industrial water demand in the region will continue to grow. Competing needs for finite water resources have prompted stakeholders to develop management strategies to balance the human and environmental needs of freshwater. Many citizens do not understand the environmental needs and that continued demand for freshwater for human use makes such a balance an expensive challenge. This makes it difficult for elected decision-makers and regulators to develop acceptable strategies that meet household and business needs while maintaining the vitality of the bay system during periods of drought.

## Importance of Freshwater Inflows

Freshwater inflows perform three major functions that are essential for sustaining a productive estuary. First, they blend with the Gulf's seawater to provide a range of salt concentrations. Many of the animals that live in the estuary need water with different levels of salt concentrations during the various stages of their life cycles. As many as 95 percent of important marine species depend on estuaries during at least part of their life cycles. Some can live nowhere else. Without estuaries, for example, there would be no oysters.

Second, freshwater inflows bring nutrients essential to the total productivity of estuarine ecosystems. Nutrients (nitrogen, phosphorus, and decomposing organic matter) are carried by surface runoff into the bays and estuaries. Microscopic phytoplankton, plants upon which the entire food web depend, need dissolved nutrients to survive and multiply. Larger plants that live in the bays and estuaries also need nutrients to grow. Those plants then provide food and breeding, hatching, resting, and protective areas for many forms of aquatic and terrestrial animals. Ultimately, the nutrients are converted to foods and other products that are useful to people.

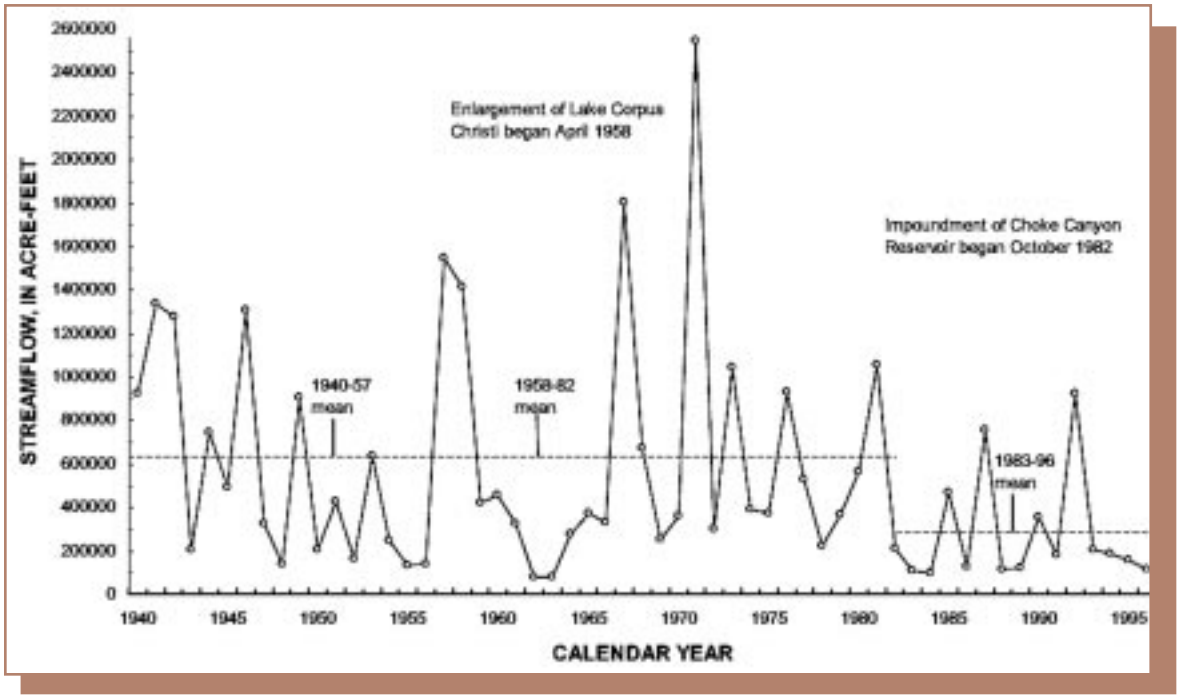
Third, rivers and streams bring in sediments to the estuaries. They deposit sand, silt, and clay as their waters slow down upon entering bays, lagoons, and the Gulf. The muddy deltas and sandy barrier islands formed by these deposits help create and maintain back bays and coastal marshes. Without the replenishment of sediments, wave action eventually would wash away the existing wetlands and begin to erode coastal uplands.

## Regional Demand for Water

Several significant processes have been at work in the past 65 years that have increased demand for water from the Nueces River and decreased the amount flowing to the Nueces Estuary. First among these has been the shift from an economy based on agriculture to one based on oil and gas related activity, manufacturing, transportation, and government services. This has helped to encourage population growth both internally and from other areas. The percentage of the region's population depending on the Nueces River has increased as towns have converted from the use of groundwater to surface water.

***Several significant processes have been at work in the past 65 years that have increased demand for water from the Nueces River: a shifting economy, population growth, and conversions from groundwater to surface water.***

Development of the petroleum and chemical process industries in Nueces and San Patricio Counties would not have been possible without adequate high quality water. Moreover, the population of counties served by the Nueces River water supply system grew from less than 100,000 in 1930 to more than 400,000 by 1990. In the first half of the century, the majority of growth was from newcomers. In recent decades, internal growth based on high birth rates and migration from rural to urban areas of South Texas has been a major factor. Forecasts by the Texas Water Development Board indicate that growth rates in the Coastal Bend are likely to be below the statewide




*Time series of annual streamflow for streamflow-gauging station at the Nueces River near Mathis (Asquith* et al., *1997).*

average in the next several decades, but will still result in a doubling of population by the year 2050. The Trans-Texas Water Program projects that residential and business use of water will increase by about 50 percent while industrial water use will double in that time.

## Toward a Comprehensive Regional Water Management Plan

Local governments are working to ensure that there will be adequate water resources in the project area to meet anticipated long-term demand. The challenge is to strike an appropriate balance between the human and environmental needs for freshwater.

### Key Findings

➢ *Annual streamflow for the Nueces River near the Mathis gauging station shows a dowward trend over the past 57 years (1940-1996). This trend is more of a 'step' trend than a linear one. The step occurred approximately in 1982 and is associated with the completion of Choke Canyon Reservoir. The post-Choke Canyon mean streamflow (279,000 acre-ft.yr.) at the Mathis gauging station represents a 55 percent reduction from the pre-Choke Canyon mean streamflow (616,000 acre-ft.yr.) (Asquith,* et al.*, 1997). However, further analysis of annual streamflow in the Nueces River basin not involving Choke Canyon Reservoir indicated significant downward trends in streamflow for approximately the same time period. Consequently, the downward trend for the Nueces River near the Mathis gauging station is a combination of several factors, including completion of Choke Canyon Reservoir, increased consumptive water use in the basin (Green and Slade, 1995), a decrease in rainfall, and other complex hydrologic issues.*

➢ *Water-budget and streamflow analyses show that storage in and evaporation from Choke Canyon Reservoir account for an annual streamflow reduction of about 28 percent of the total post-Choke Canyon (1983-1996) decrease in annual streamflow (Asquith,* et al.*, 1997).*

➢ *For all bay systems combined, there has been a 19 percent reduction in total annual inflow. The difference between total return and diversion flow is negative (-51,000 acre-ft.), which amounts to a loss of about 4 percent (Asquith,* et al.*, 1997).*

➢ *The available data for estimating inflows are adequate but not optimum. The addition of seven gauges would increase the gauged inflows from about 23 percent of the total to about 70 percent of the total (Asquith,* et al.*, 1997).*

➢ *Freshwater replacement time for the bay system is about 50 months - quite long relative to most other estuarine systems (Ward, 1997).*

The ***Bays Plan*** provides a means for taking a 'holistic' view in developing a regional water management plan that will meet both human and environmental needs well into the future. Through the ongoing efforts of state agencies, the Coastal Bend Regional Water Planning Group, the City of Corpus Christi, and other stakeholders, participants in this process will refine their understanding of the environmental and human needs of freshwater. An evaluation of demonstration projects and an ongoing monitoring and modeling program will be principal tools in this effort. As scientific understanding progresses, so will refinements to the reservoir system operating plan. The result will be to maximize both the firm yield of reservoir storage or other supplies, and the biological productivity of bays and estuaries.

A second component of this strategy is to maximize the beneficial use of treated wastewater by moving such 'return flows' to strategic discharge points that will provide for environmental enhancements. While part of the regional supply of water is consumed as it is used, an estimated 47 percent of the original volume is treated and discharged to the bay system. These return flows help satisfy part of the freshwater needs of the Nueces Estuary.

In taking the lead to develop a regional water management plan, as required under 1997 state legislation for all areas of the state, the Coastal Bend Regional Water Planning Group and implementing partners will investigate ways to maximize beneficial uses of treated wastewater. The City of Corpus Christi has undertaken a demonstration project that diverts two million gallons per day of wastewater from its Allison Wastewater Treatment Plant to a point in the Nueces Delta. Additional proposals have been advanced for substituting much larger quantities of wastewater effluents in place of pass-through requirements that will also serve to enhance estuarine productivity. This concept has been supported by several studies indicating that primary productivity will increase because of the nutrient content of the wastewater effluent. Examples of already successful return flow projects are the Hans Suter Wildlife Refuge on Oso Bay and the Port Aransas Wildlife Viewing Area.

***Freshwater inflow into bays and estuaries is not wasted water: it supports bay and estuary ecosystems so they can continue to provide the abundant resources that our fishing industry and wildlife need.***

Finally, the ***Bays Plan*** calls for continued and expanded efforts to conserve the region's valuable freshwater supply. Already the most successful region in the state at water conservation, there are of course additional ways to conserve water and achieve greater public awareness of the part we can all play. Equally important, every effort will be made to increase the public's understanding of the issues, plans, and programs to meet both human and environmental needs for freshwater. The 'bottom line' is that, by definition, an estuary must have freshwater inflows. With additional water supply available from Lake Texana in 1998, there is a new opportunity to develop a truly comprehensive regional freshwater management plan that will absolutely minimize the economic and environmental impacts of future low-flow years.

**Goal**

- *Implement an innovative and measurable education and outreach strategy to improve public understanding and support for effective management of bay resources.*

One of the most important goals of the ***Bays Plan*** is to educate citizens about the ecology of the bay system, its many environmental and economic values, and how an individual can make a positive difference to ensure its long-term health. To accomplish this, the Public Education and Outreach Action Plan is designed to:

- Raise the public's environmental awareness;
- Foster community stewardship of bay resources; and
- Increase individual involvement in bay resource management issues.

Helping residents and visitors to understand the complex issues concerning bay resource management will be a priority. In addition to understanding how the bay system functions, it is important that citizens develop a sound appreciation for the significant value and economic impact derived from the renewable resources of the bays.

## A Regional Approach to Public Outreach

Before the Program begins this outreach mission it will be necessary to identify and evaluate the effectiveness of existing public education efforts. After gaps are identified, Program partners will develop a comprehensive regional strategy that will utilize and coordinate existing programs to reach people of all ages. Community stewardship through a sense of individual responsibility will be the goal.

***In addition to understanding how the bay system functions, it is important that citizens develop a sound appreciation for the significant value and economic impact derived from the renewable resources of the bays.***

Several techniques will be used to achieve the goals of the regional strategy, including effective use of the media, the development of user-friendly educational materials, and the establishment of an electronic clearinghouse on bay-related resource information. These and other tools will be developed and refined with strong emphasis given to the science which supports the actions of the ***Bays Plan***.

Bringing family fun into play, partners will work to establish an annual 'Bay Day' celebration that will exhibit the appropriate mix of education, seafood, and bay-related, hands-on fun.

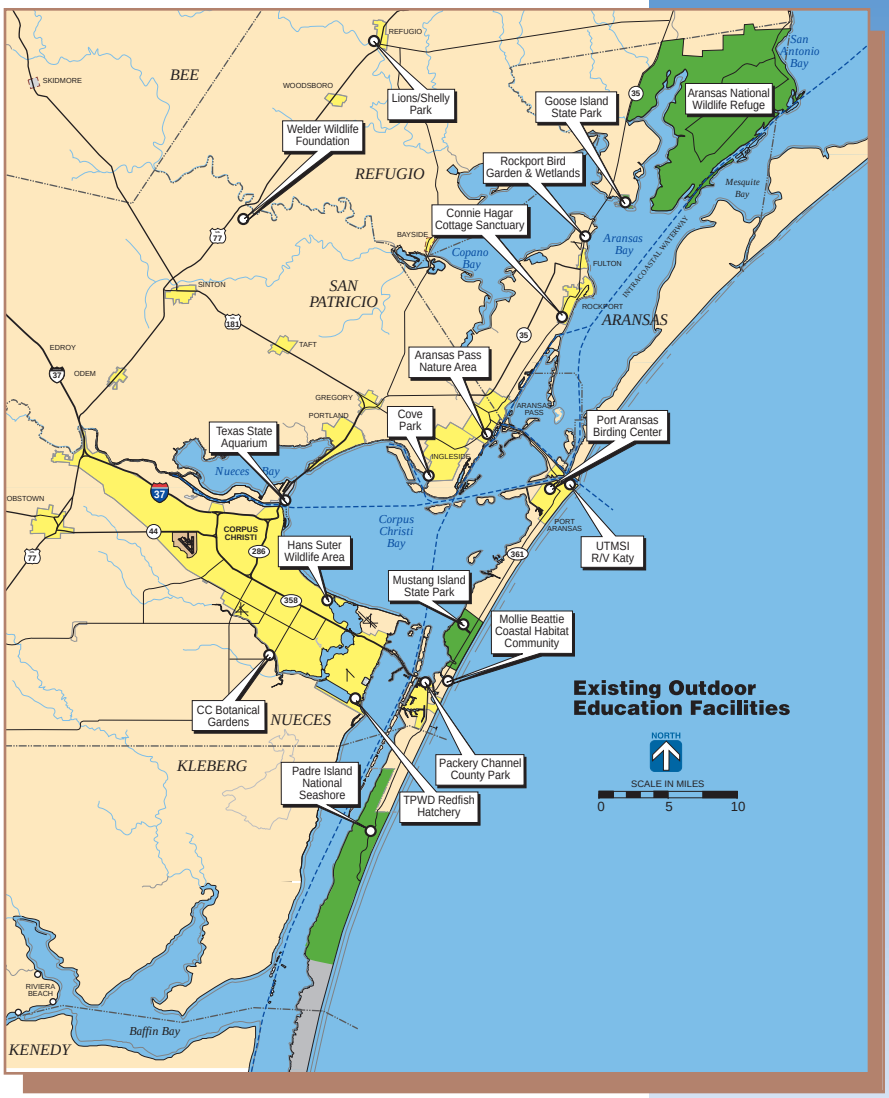
## Educating Tomorrow's Leaders

One of the strongest messages the public has put forth in the development of the ***Bays Plan*** is that efforts to educate tomorrow's leaders must begin today. The Plan thus calls for the design and implementation through school districts of environmental curricula on bay resource issues. Other actions will expand upon and promote the use of outdoor educational facilities that exist throughout the region (see below), as well as identify new sites or opportunities to build or develop additional 'outdoor laboratories.'

These 'outdoor laboratories', together with the necessary supporting resources and teacher training, can result in considerable 'return on investment' for our next generation of leaders.

## Achieving Stewardship

Other actions of the ***Bays Plan*** will focus on how best to achieve stewardship through individual involvement and responsibility for sound environmental practices. A 'Coastal Bend Environmental Citizen's Guide' will be developed that will provide practical information on the many positive actions that any individual can do to help. Coupled with this will be an environmental stewardship recognition program, with appropriate awards and public recognition given to those individuals and groups who have demonstrated environmental leadership. By working to promote public/private partnerships in this fashion, the ***Bays Plan*** will achieve its educational goals more quickly and with more lasting success.




But there will always be the need for continued dialogue between competing user groups, and thus the need for a relaxed, public forum to allow for individual input into the public policy debate. The Coastal Bend Bays Foundation, a local nonprofit organization dedicated to the health and productivity of these bays and estuaries, has served such a function for several years. The Plan calls for continued involvement in this regard from the Bays Foundation, as the region prepares itself for ever-increasing numbers of people wanting to make use of the bays and

estuaries. Minimizing conflict through informed discussion will help achieve the overall objective of ensuring the public's safety, health, and enjoyment of our bays and estuaries.

## Target Audiences and Subjects

The development of the Public Education and Outreach Action Plan has occurred on many parallel levels. The Action Plan reflects Management Conference consensus on educational issues that need attention. The Action Plan provides a framework and a process for developing a Regional Outreach Strategy. Most of the Action Plan focuses on how to accomplish that goal.

The tables below and on the next page provide a summary of educational subjects and targeted audiences that can serve as a starting point for implementing this component of the ***Bays Plan***. The list can and should be revised with other issues and audiences as they are identified.

### Public Education and Outreach: Issues and Audiences

| Issue | General Public | Recreational Users | Gov't Officials | Schools/ Youth Groups | Commerce/ Industry |
|---|---|---|---|---|---|
| **HUMAN USES** | | | | | |
| Pollution and environmental damage reporting | X | | | | |
| Littering and illegal dumping | X[3, 2], and pickup & boat owners | | X | | |
| Marina pollution abatement | | X | X | | X |
| Angler education | | X | | | |
| Public health issues | X[1] | X[1, 2, 7] | X | X[1] | |
| Shoreline management | X | | X | | X |
| **MARITIME COMMERCE AND DREDGING** | | | | | |
| Boating safety | | X | | | |
| Maritime/port value | X | | | | |
| Dredging | X[1] | | | | |
| **HABITAT AND LIVING RESOURCES** | | | | | |
| Exotic species | X[1, 2, 6] | | X[1] | X[1] | |
| Algal blooms | | | | X[1, 8] | |
| Fisheries management | | X | | | |
| Estuarine ecology and health | X | | | | |
| **WATER AND SEDIMENT QUALITY** | | | | | |
| Point source discharges | X[9] | | | | |
| Nonpoint source runoff | X | | | | |
| Water/sediment quality | X[1, 2, 7] | | | X[1] | |
| Urban runoff | X | | X | | |
| **FRESHWATER RESOURCES** | | | | | |
| Freshwater inflows | X[1] | | X | X[1] | |
| Water conservation/efficiency and demand activities | X[6, 9] | | | X | |
| Xeriscape | X[6] | | | | |
| Summary of regional forums, conferences, and workshops | | | X[1, 4, 5] | | |

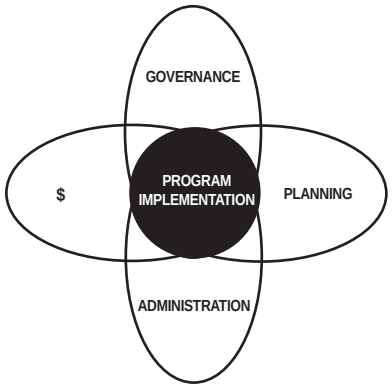
[1]Print Material [2]Public Service Announcement [3]Speakers Bureau [4]Newsletter
[5]Fact Sheet [6]Display [7]News Release [8]Internet [9]Multimedia

## Public Education and Outreach: Messages

| SUBJECT | MESSAGE |
|---|---|
| **HUMAN USES** | |
| Pollution and environmental damage reporting | Encourage public reporting of pollution and other resource damaging activities. Educate the public about spill prevention and reporting. |
| Littering and illegal dumping | Discourage littering and illegal dumping. Educate on adverse impacts of bay debris. Encourage the 3R's: Reduce, Reuse, and Recycle. Recycling information clearinghouse. |
| Marina pollution abatement boating operations | Promote use of pump-out stations and operational measures to control release of pollutants during boat bottom cleaning/ painting. Promote the proper disposal of hazardous materials. Promote seagrass awareness and reduce prop scarring. |
| Angler education | Promote stewardship of fisheries resource and fisheries management practices. |
| Public health issues | Provide the general public with accurate information regarding health concerns associated with utilization of bay resources (e.g., contact recreation & seafood consumption). |
| Shoreline management | Provide private sector assistance/understanding for shoreline management goal. |
| **MARITIME COMMERCE AND DREDGING** | |
| Boating safety | Increase recreational boat operator awareness of Rules of the Road, especially in regard to deep draft vessels. |
| Maritime/port value | Increase public understanding of the Port and marine channel industries. |
| Dredging | Increase public understanding of the dredging process, funding alternatives, beneficial uses of dredged material, benefits, alternate dredged material disposal areas, and cost/benefit of channel operation. |
| **HABITAT AND LIVING RESOURCES** | |
| Exotic species | Educate the public about negative impacts of exotic species in the coastal ecosystems. |
| Algal blooms | Educate the public about algal blooms and their impact on the public. |
| Estuarine ecology and health | Provide information about the economic and environmental importance of a healthy bay system. Increase basic understanding of the function of an estuary. |
| **WATER AND SEDIMENT QUALITY** | |
| Point source discharges | Educate the public about the quality and status of point source discharges, their beneficial effects, and the public's contribution to pollution discharged from Municipal Wastewater Treatment plants and what can be done to minimize them. |
| Nonpoint source (urban) runoff | Develop a public awareness program about the need to contain and reduce polluted nonpoint source (urban) runoff. |
| Water/sediment quality | Provide information to the public regarding water and sediment quality issues. Rapidly respond to media events with accurate information. |
| **FRESHWATER RESOURCES** | |
| Freshwater inflows | Stress protection of the bay system and identify the need for freshwater inflow. |
| Water conservation, efficiency, supply, and demand | Educate the public on regional water supply issues and the need for continuous water conservation. |
| Xeriscape | Encourage use of xeriscapes and natural vegetation to reduce water consumption, pesticides, and herbicides. |

## Implementation Structure

The long term success of the ***Coastal Bend Bays Plan*** is dependent on an effective implementation organization. There are four basic functions for any proposed implementation structure: governance, identifying and securing resources to implement the ***Bays Plan***, ongoing planning, and overall administration.




**Functions: Program Implementation Structure**

Results of a Program study indicate that the current management framework is fairly effective at managing area resources. Federal and state institutions have the strongest presence, while regional and local entities are somewhat less involved in problem resolution related to the Program's priority issues. This study recommends that the Program seek increased involvement from regional and local entities, obtain commitments from active institutions to maintain efforts and continue beneficial programs and activities, and make full use of local educational and research institutions (Richard, *et al.*, 1996).

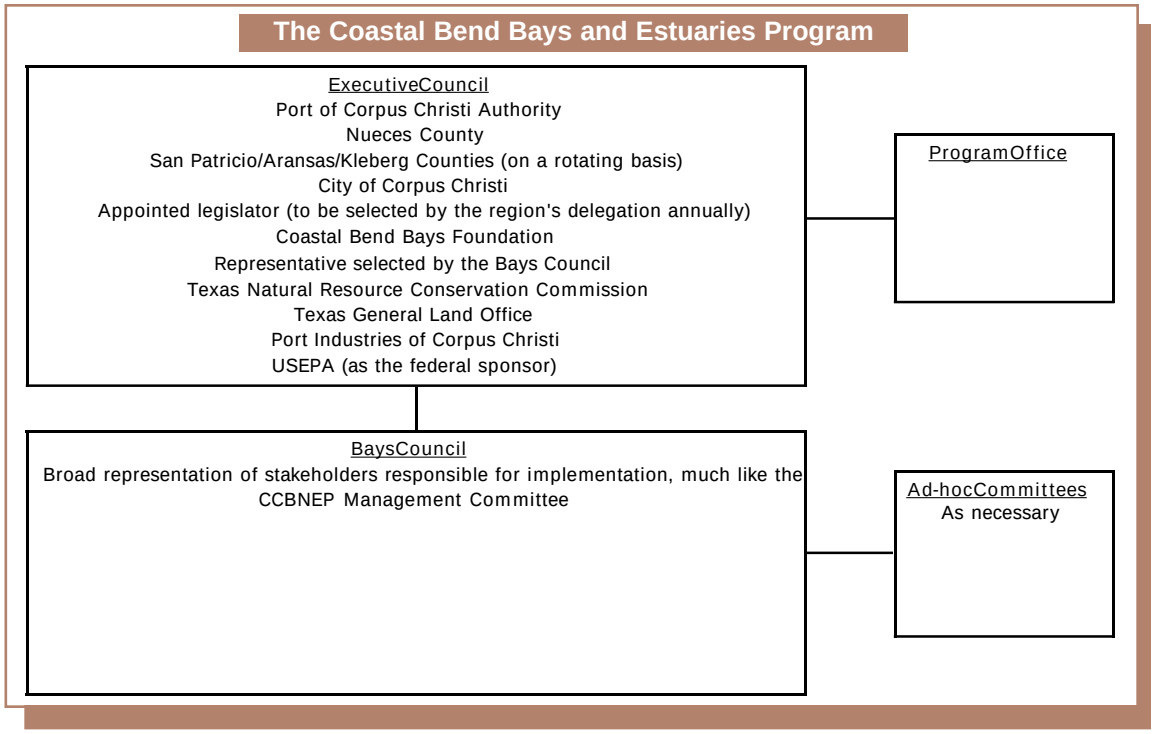
Fifteen basic implementation principles have been adopted. Foremost among these, there is agreement that the structure will not have taxing authority, regulatory authority, or a formal permit review role.

### Fifteen Basic Program Implementation Principles

- No taxing authority
- No regulatory authority
- No formal permit review role
- Continue oversight by stakeholders, including local governments
- Voluntary participation by stakeholders, with right to withdraw at any time subject to current year financial commitments
- Conduct biennial priority goal setting
- Minimize overhead
- Receive/administer state/federal funds
- Receive/administer tax-exempt contributions
- Administer interagency agreements
- No communications/publications policy constraints
- Comment authority for consistency determinations
- Close coordination with Coastal Coordination Council
- Ensure ***Coastal Bend Bays Plan*** is consistent with Texas Coastal Management Plan
- Ensure ***Bays Plan*** continues to be a consensus-based framework approved by the Governor of Texas and the U. S. Environmental Protection Agency

The new implementation structure, called the Coastal Bend Bays and Estuaries Program, will be run by an Estuary Council that includes all units of local general government that financially contribute to the program, as well as state and federal agencies and other key stakeholders. It will ensure accountability and maintain a strong coordination/catalyst function.

The Estuary Council includes two tiers: an Executive Council and a Bays Council. The Executive Council has the ultimate decision-making authority and responsibility for the ongoing support of a Program Office. The Bays Council is designed to bring in active stakeholder participation as well as sound technical advice.




In general, overall tracking and coordination for implementing the ***Bays Plan*** is the responsibility of the Program Office. Implementation of individual actions is the responsibility of designated lead and partner agencies as identified in the ***Implementation Strategy.***

## *Funding the Plan*

The National Estuary Program provides funding for the development of management plans, but it does not provide full funding for the implementation of the plans. It is anticipated that federal funding will drop to $300,000 per year for the first four years of implementation.

There are two types of costs associated with ***Bays Plan*** implementation. The first cost is associated with maintaining a small Program Office staff. The cost to maintain this staff function is estimated to be $400,000 to $450,000 per year for a six-person staff. The second type of cost is the cost to implement actions in the ***Bays Plan***. The Management Conference has developed a funding strategy that includes an assessment of existing revenue sources, the identification of potential new sources of funding, and a determination of feasible funding options that should be pursued.

As the Program moves forward to implement the ***Bays Plan***, identified lead and partnering organizations for each action will meet to jointly develop a detailed work plan to

include definitive costs and sources of funds. Program staff will play a prominent role in identifying these funds, through such activities as grant writing, solicitation of funds from private foundations, and several other activities to round out a total 'portfolio' of revenue sources for Plan implementation. To proceed at an acceptable pace with project implementation, additional funding in the amount of $750,000 to $1.5 million per year is being sought.

## Program Office Roles

- Acquire, manage, and disperse funds to implement the ***Bays Plan***.
- Develop and implement partnership projects vis-à-vis local governments, state and federal agencies, and private organizations.
- Monitor, track, and report on implementation performance by implementing partners, and work to maintain implementation commitments.
- Coordinate the environmental monitoring and assessment of Plan implementation effectiveness; develop and oversee a data and information management plan that coordinates the accessibility of relevant future monitoring and assessment.
- Provide communication and coordination with the Texas Coastal Management Program and the Coastal Coordination Council, the Gulf of Mexico Program, the Texas Clean Rivers Program, and other relevant coastal/watershed programs.
- Develop and utilize outreach and educational materials to increase public awareness and foster local stewardship; maintain web site(s) and respond to public requests for information.
- Provide communication and coordination among state and federal resource agencies for cross-jurisdictional issues.
- Coordinate the review of proposed actions and federal, state, and local projects in an open process for consistency with the ***Bays Plan***.
- Undertake the USEPA-required biennial review of the Program.
- Develop a prioritized biennial work plan and budget for Estuary Council review and approval.
- Coordinate the periodic update of the ***Bays Plan***, the State-of-the-Bay Report, the ***Implementation Strategy***, and other key documents of the Program.
- Provide a forum for technical and stakeholder input during implementation of the ***Bays Plan*** and the biennial review process.
- Track legislative initiatives and issues and bring forth policy or legislative recommendations for Estuary Council action.
- Provide logistical support for all meetings, workshops, symposia, and special events related to Program mission.

## Implementing Partners Roles

- Enter into an implementation agreement vis-à-vis other implementation partners, and take the lead role in implementing, evaluating, and reporting to the Estuary Council on results of action implementation.
- Allocate staff and budgetary resources for the implementation of specific actions identified in the ***Bays Plan***.
- For some partners: allocate budgetary resources for Base Program Support.
- Assist to identify, design, and implement new or revised regulations or ordinances.
- Identify and assist with legislative initiatives.
- Enter into Memoranda of Understanding (non-binding instruments that target specific goals and responsibilities) with the Program and other implementing partners.
- Adopt resolutions of support for the regional goals and objectives of the ***Bays Plan***; solicit citizen involvement for specific actions.

Some of the actions in the ***Bays Plan*** can be accomplished with existing resources or by redirecting current funding allocations to better address the needs of the project area. In other cases, actions seek to improve coordination and planning among local governments and agencies and may actually result in cost savings for currently funded activities. Any additional funds required will be subject to public review to ensure that issues of affordability, accountability, and environmental responsibility are given a fair hearing.

In keeping with this theme, the Coastal Bend Bays and Estuaries Program advocates the following approach for funding the ***Coastal Bend Bays Plan***:

- Maintain existing levels of expenditures for programs making cost-effective contributions to the goals.
- Evaluate programs that fall short of plan objectives and investigate opportunities to redirect resources to accomplish more with existing funds.
- Promote public-private partnerships with the potential for bottom line benefits for the estuary and the economy.
- Pursue state and federal funding opportunities for environmental improvement.
- Pursue new funding sources only if the above strategies fail to achieve adequate progress toward improvement.

***There are two types of costs associated with* Bays Plan *implementation: maintaining a small program office staff and implementing individual actions contained in the Plan.***

## *Regional Monitoring Strategy*

The Program has developed a Regional Monitoring Strategy to assess the effectiveness of Plan implementation and future trends in overall environmental health of the bay system. A series of monitoring objectives were established to address both programmatic and environmental monitoring purposes. Programmatic monitoring objectives are those dealing with specific actions to change program processes which are needed to improve coordination and communication or to enhance implementation of certain activities. Environmental monitoring objectives address the collection of scientific data and information in order to assess changes or trends in water quality, living resources, habitats, or other physical components of an ecosystem.

Each monitoring objective is designed to answer questions over time, such as:

1. Are the goals and objectives of the Action Plans and their 50 specific actions being met?
2. Are commitments made by the various implementing partners being fulfilled?
3. Are the implemented actions having the desired effect on environmental health of the bay system?

*The Regional Monitoring Strategy attempts to coordinate and build upon existing monitoring programs.*

The answers to these questions will assist Program management in making necessary modifications to the ***Bays Plan*** during a biennial review process.

About 40 federal, state, local, private, and academic organizations currently collect environmental and related data and information in the project area, at more than 1,000 monitoring stations. The Regional Monitoring Strategy will attempt to coordinate and build upon these existing programs.

A key effort for the future is to encourage all monitoring agencies to post their data in Internet web pages available to technical staffs and link the monitoring web pages together in a common system. Future data analyses to describe the ongoing status of bay health and productivity will be greatly facilitated by a common web-based data management sytem available to all monitoring agencies and to the CBBEP Program Office.

The ***Coastal Bend Bays Plan*** has been developed by the people who will be affected by its actions — local industry and agriculture, cities and counties, conservation and other key stakeholder groups, and state and federal agencies. It is a detailed, yet flexible, regional framework for action that will be used by implementing partners to realign their own resources and programs to voluntarily participate in Plan implementation. The Program will continue to build local understanding and consensus on key management issues within the context of the needs of the ecosystem. Implementation of the Plan will benefit local governments, the private sector, and communities in a number of ways. It will not carry with it any regulatory, enforcement, or taxing authority.

Other plans and programs exist that complement the ***Bays Plan*** in important ways. First among these is the Texas Coastal Management Program (CMP), approved in 1997 as a means to improve interagency coordination and increase government accountability to citizens. The CMP establishes the overarching policy framework for the entire Texas coast and serves as a forum for regulatory agencies and the public to resolve inconsistencies or major use conflicts. The Program has statutory authority and relies on a set of rules as the basis for its decision-making. In short, the CMP coordinates the review and permitting of certain types of activities and requires that federal actions (e.g., permitting, sponsored programs, and direct activities, such as dredging, construction, and other resource uses in the coastal zone) be consistent with the goals and objectives of the state plan. The CMP annually funds approximately $2 million worth of projects on the coast. It will be necessary for the ***Bays Plan*** to be consistent with the CMP. Clearly, the larger geographical scope and the regulatory aspect of the CMP are key differences with the CBBEP.

Another related program is the Texas Natural Resource Conservation Commission's Clean Rivers Program. A primary focus of the Clean Rivers Program is water quality monitoring and assessment. This program works in partnership with river authorities and provides additional opportunities for stakeholder participation. The Clean Rivers Program has its authority grounded in state legislation and is funded by fees assessed to wastewater and water use permit holders. The Clean Rivers Program has worked to expand upon the upland (watershed) component of studies sponsored thus far by the CBBEP. Biennial updates of the river basin assessments are a principal goal, a task that will continue to be of relevance for those components of the ***Bays Plan*** that deal with watershed management. In short, the goals of the two programs are highly complementary, although the CBBEP will have a much larger set of management issues to address in implementing this Plan.

### *Benefits from Implementing the Bays Plan:*

*Decision-making based on sound science*

*Greater consistency in decision-making*

*Technical assistance*

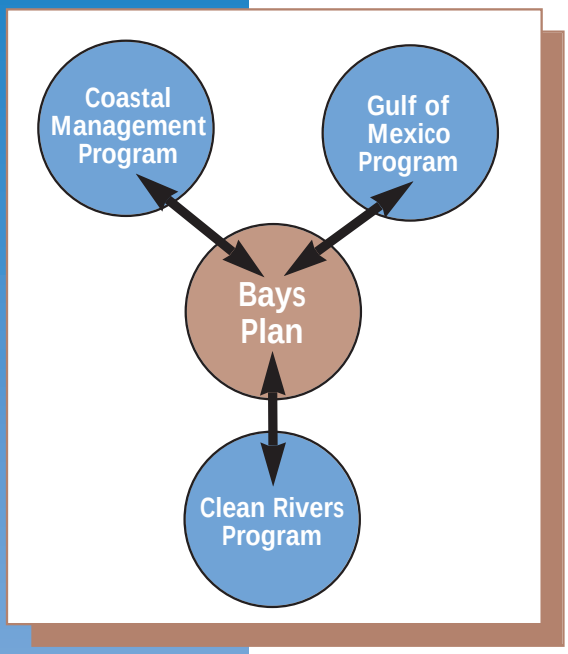
*Forum to address cross-boundary issues and solutions*

*Local plans and solutions with state and federal commitments for implementation partnerships*

*Greater efficiency in use of existing (local, state, and federal) resources*

*Public understanding of the critical linkages between the economy and environment*

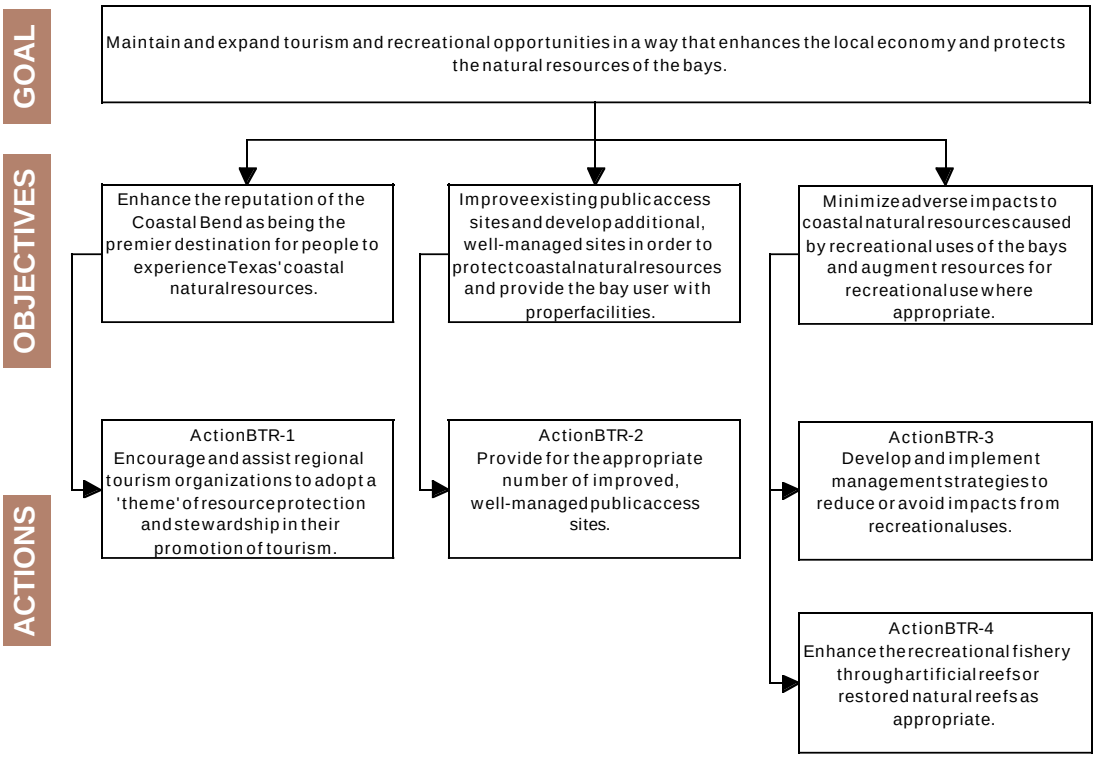
*Public support for local government initiatives*



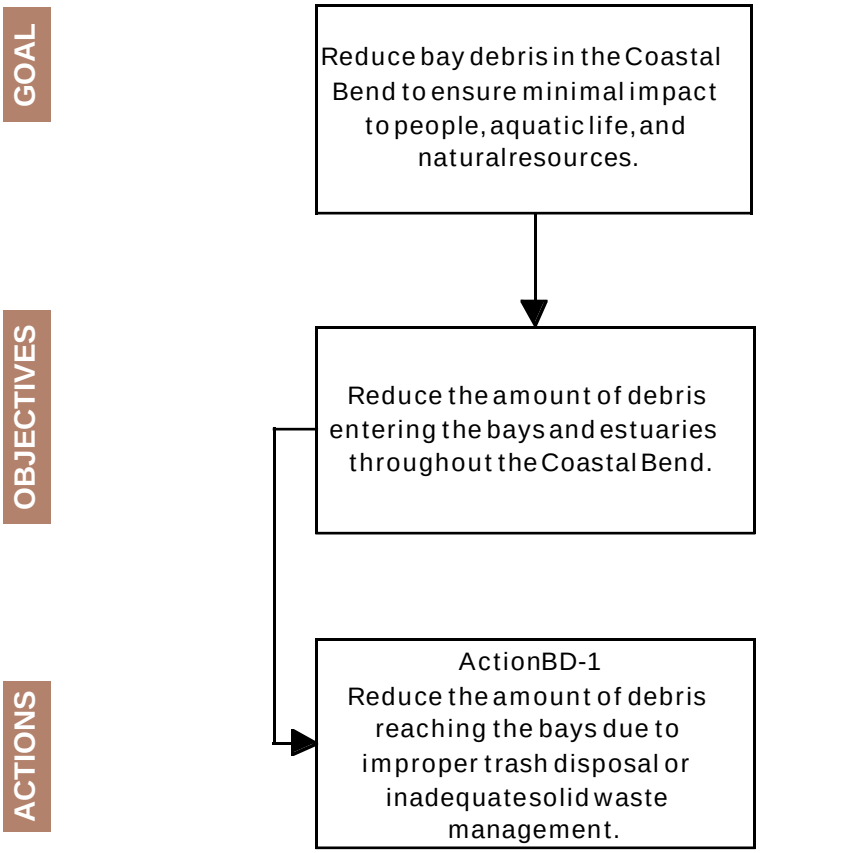

Thirdly, the ***Gulf of Mexico Program*** (GOMP) is a complementary resource management program encompassing the five Gulf states and a possible source of implementation funding for specific components of the ***Bays Plan***. The GOMP also uses stakeholder participation to guide the development of its management framework, which is more focused on the large-scale marine ecosystems of the Gulf. Hypoxia (a condition of low dissolved oxygen), shellfish bed closures, the introduction of exotic species, and habitat protection are the four principal management issues under investigation by the GOMP.

These three programs, while distinct from one another in mission and objectives, do not represent a duplication of effort. Rather, they will continue to serve important complementary roles in furthering the mission of the CBBEP.

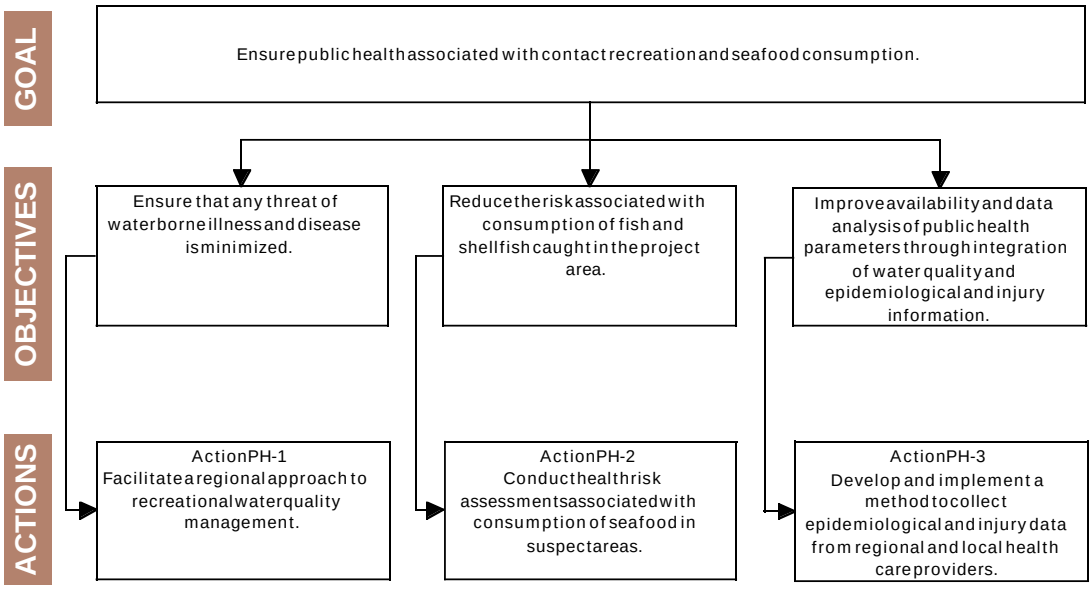
## Bay Tourism and Recreation Action Plan Flowchart



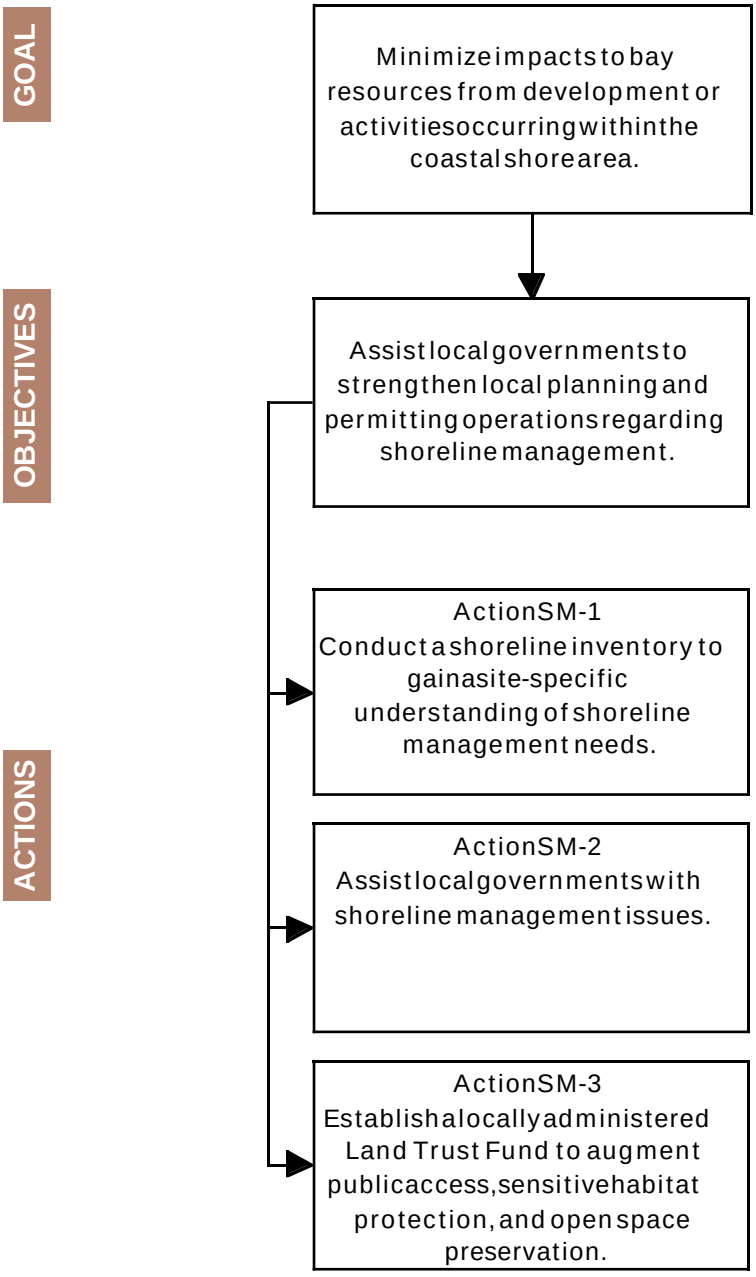
## Bay Debris Action Plan Flowchart



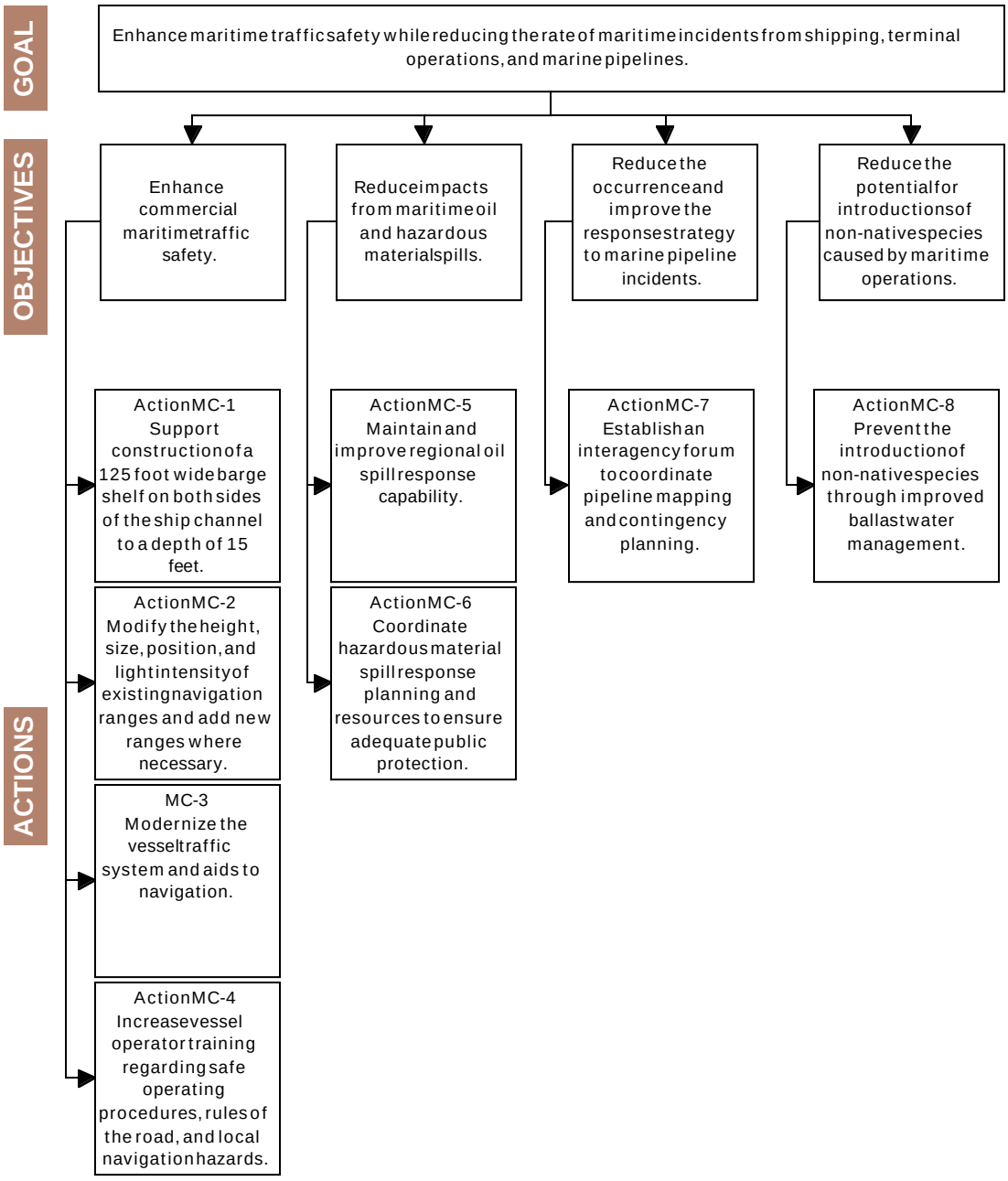
## Public Health Action Plan Flowchart



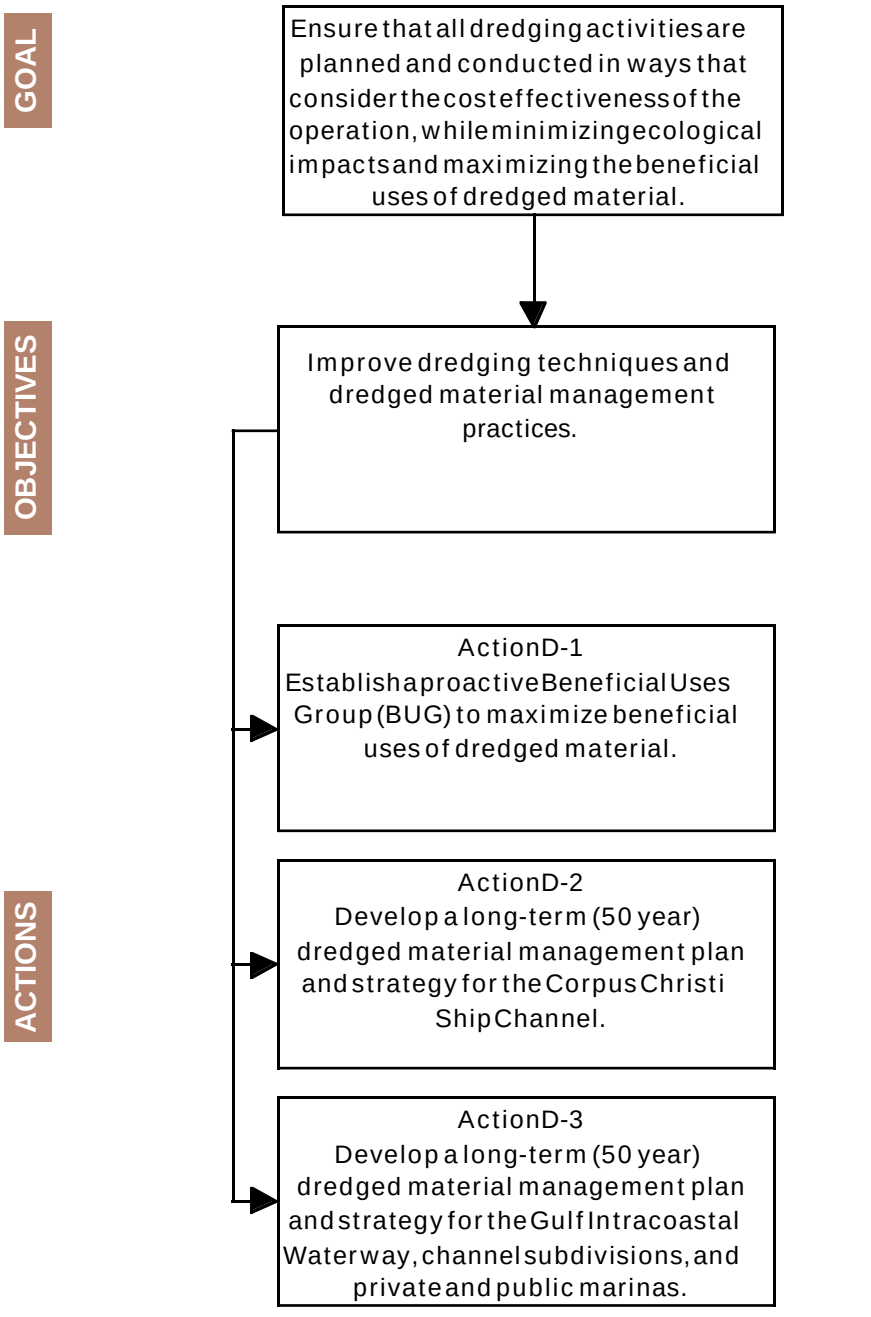
## Shoreline Management Action Plan Flowchart



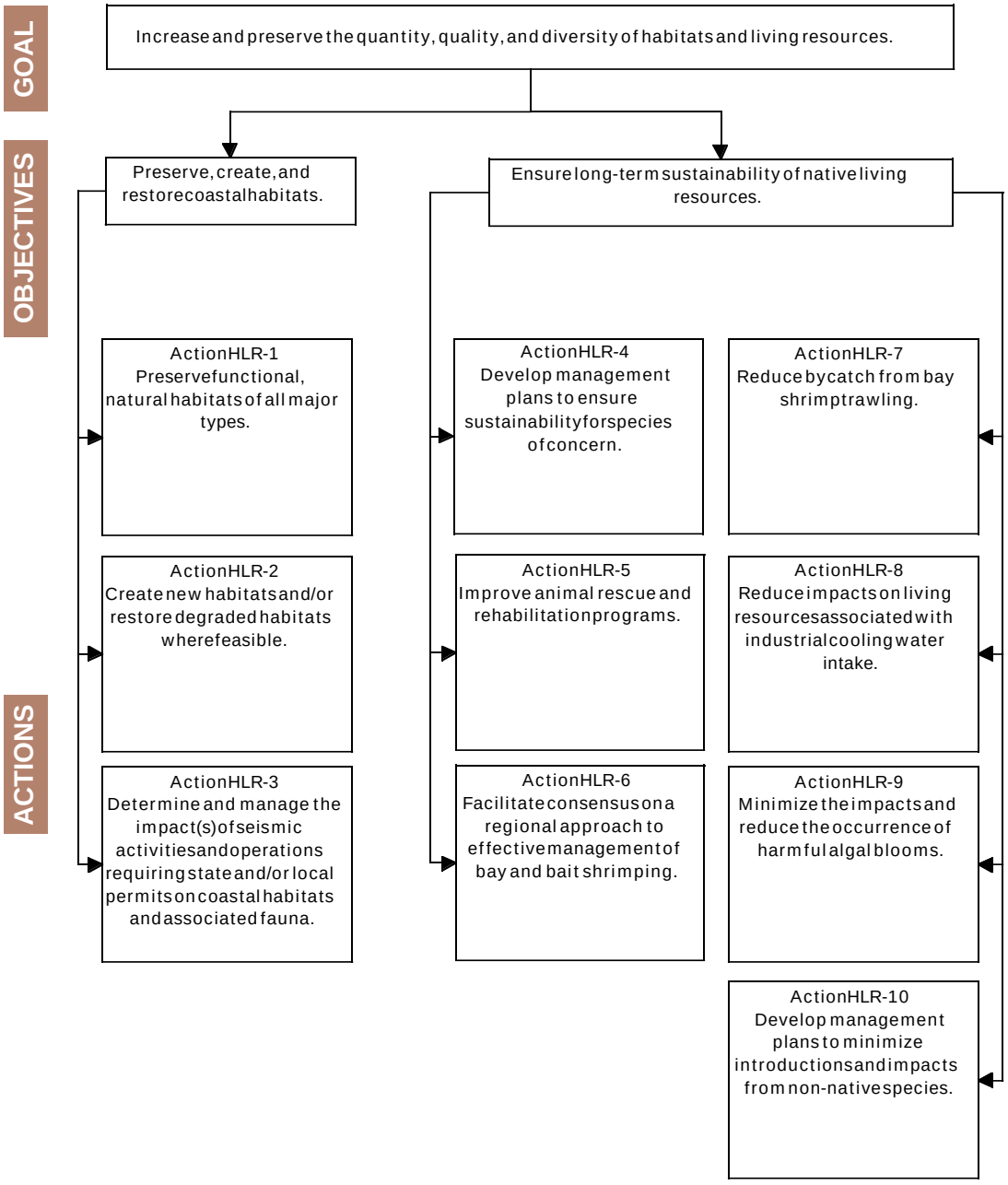
## Maritime Commerce Action Plan Flowchart



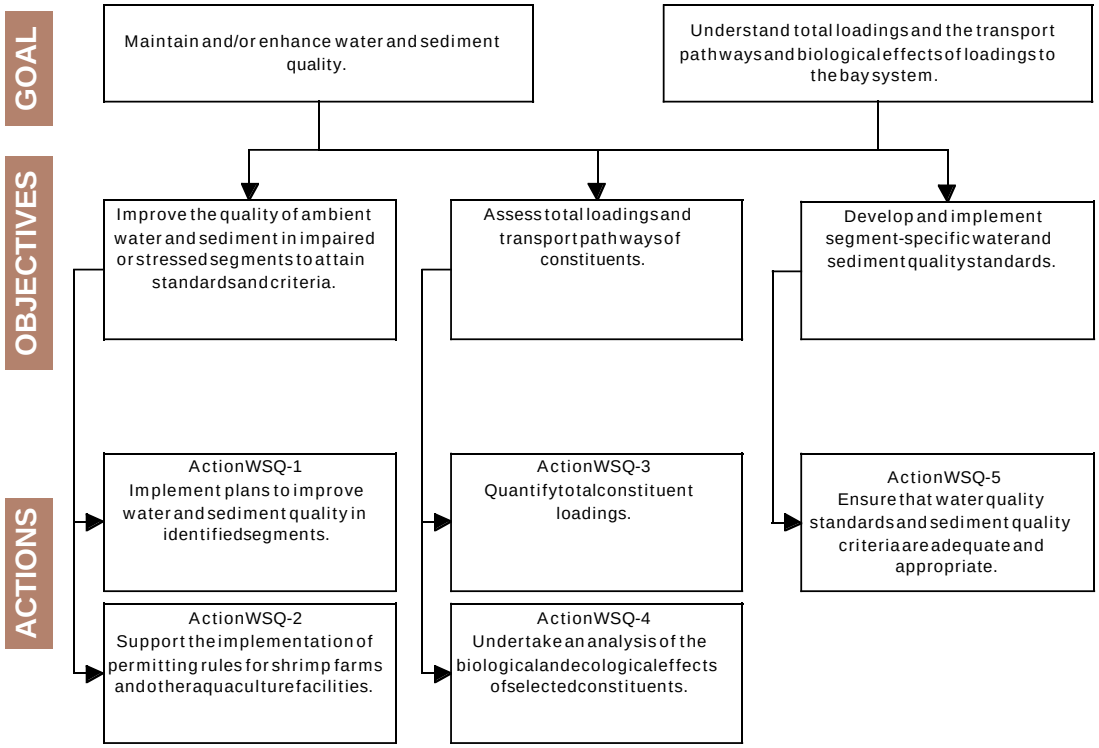
## Dredging Action Plan Flowchart



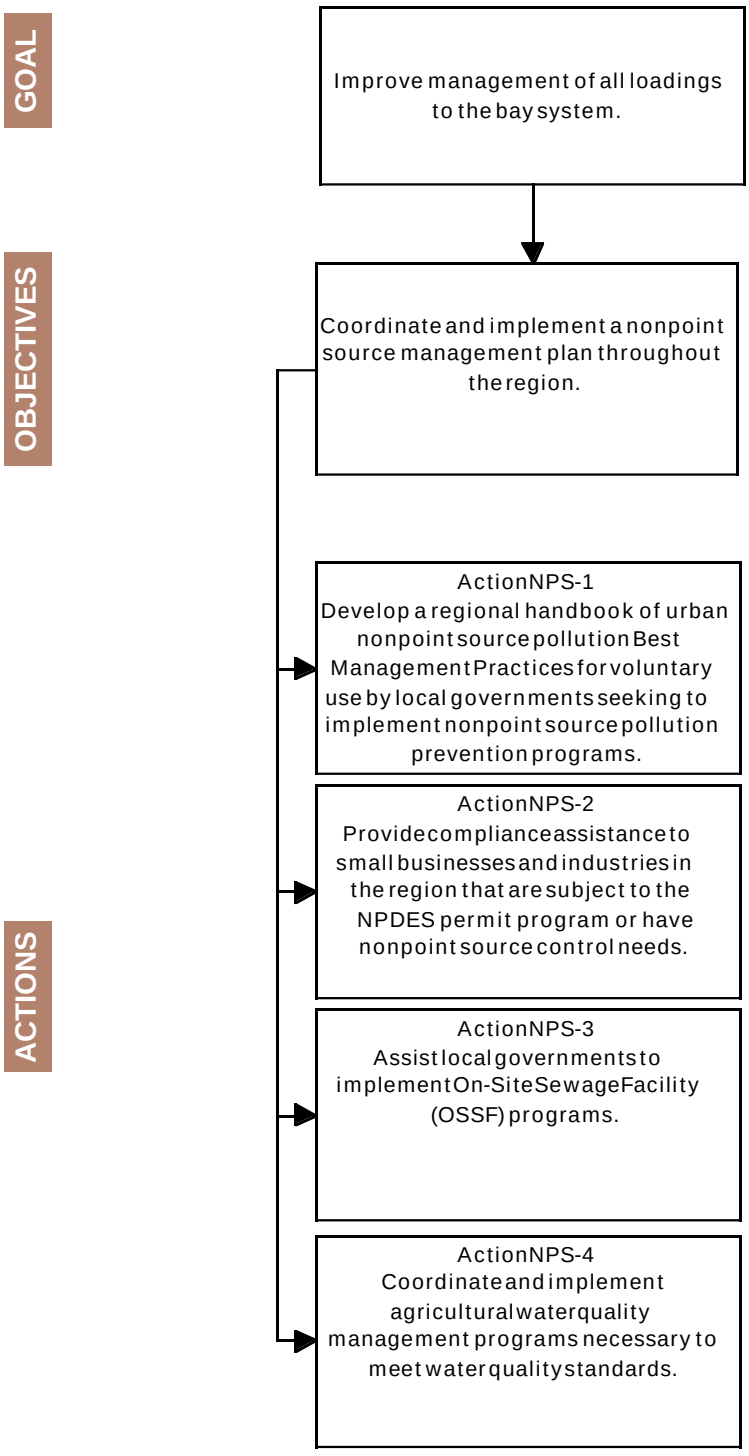
## Habitat and Living Resources Action Plan Flowchart



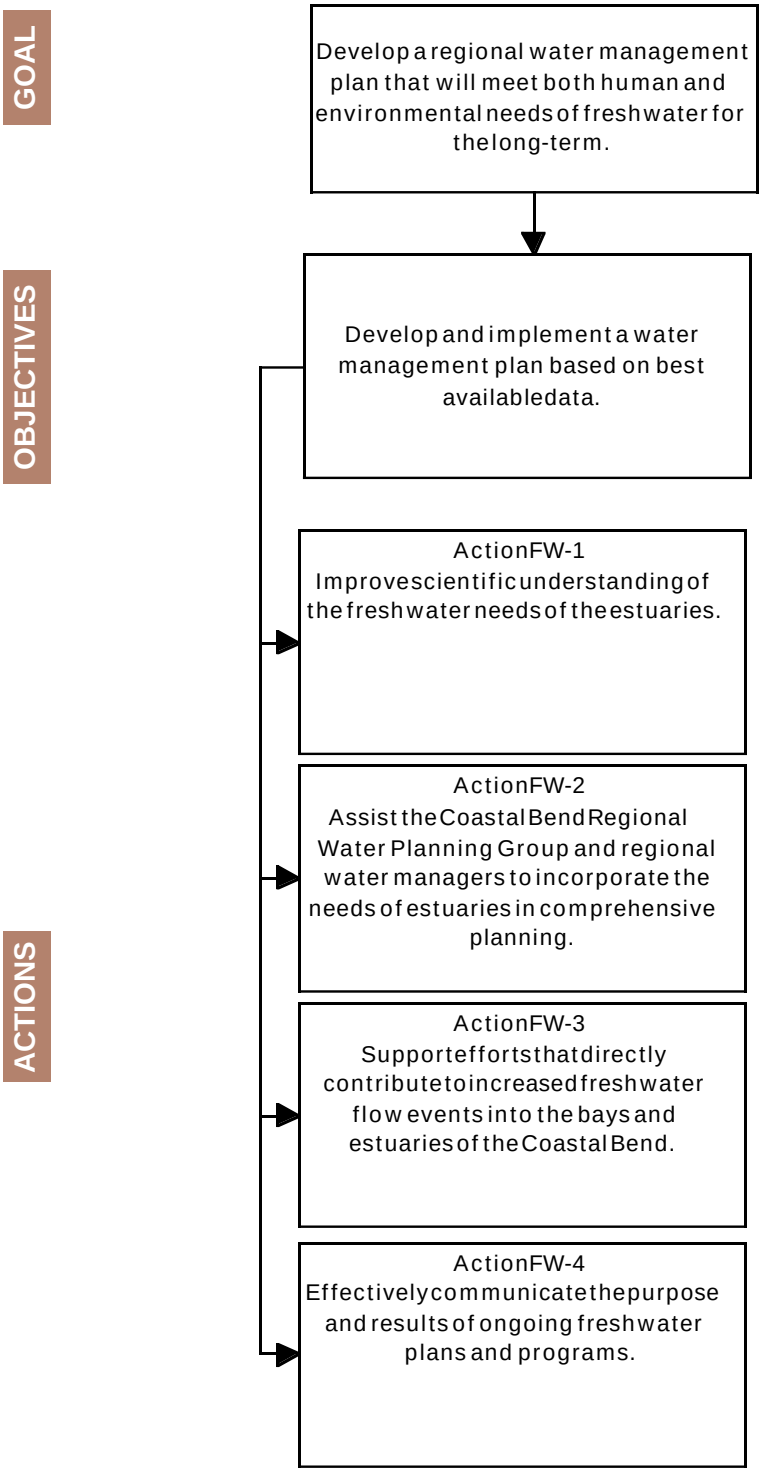
## Water and Sediment Quality Action Plan Flowchart



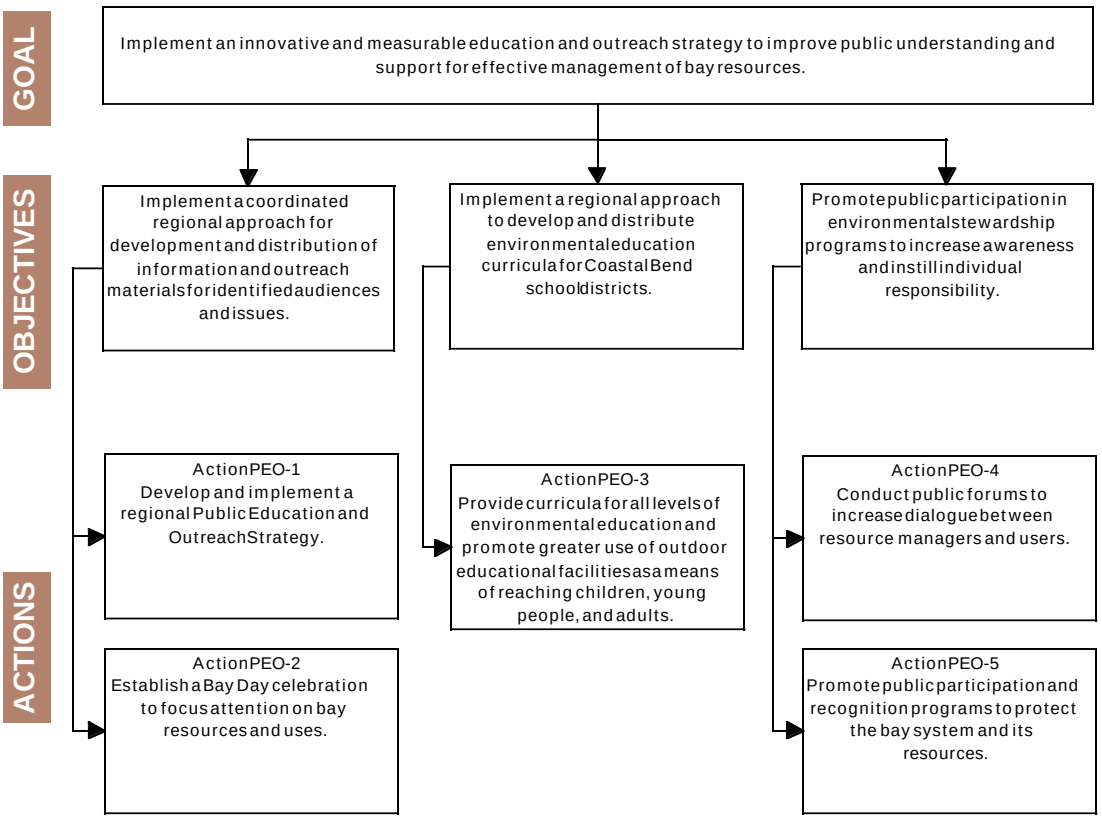
## Nonpoint Source Management Action Plan Flowchart



## Freshwater Resources Action Plan Flowchart



## Public Education and Outreach Action Plan Flowchart



## Management Conference Membership

| NAME | AFFILIATION | REPRESENTING |
|---|---|---|
| **Policy Committee** | | |
| Mr. Ray Allen | Central Power & Light | Local Citizen |
| Commissioner John Baker | Texas Natural Resource Conservation Commission | |
| Mr. Gregg Cooke | USEPA - Region 6 | |
| Commissioner John R. Clymer | Texas Parks & Wildlife Commission | |
| Commissioner Noe Fernandez | Texas Water Development Board | |
| The Honorable Vilma Luna | Texas House of Representatives | Elected State Official |
| Commissioner Garry Mauro | Texas General Land Office | |
| The Honorable Josephine Miller | County Judge of San Patricio | Local Public Official |
| The Honorable Loyd Neal | Mayor, City of Corpus Christi | Local Public Official |
| Mr. Bernard Paulson | | Local Citizen |
| The Honorable Carlos Truan | Texas State Senate | Elected State Official |
| **Management Committee** | | |
| Mr. Ray Allen | | CCBNEP Policy Committee |
| Mr. Tobin Armstrong | Kenedy County | Large Land Holder |
| Mr. John Barrett | | Row Crop Producer |
| Mr. Tony (Duke) Bonilla, Jr. | Bonilla & Berlanga | Recreational Fisheries |
| Mr. Richard L. Bowers | Western Pigments and Minerals, Inc. | Port of Corpus Christi Authority |
| Mr. Allan Colwick | Natural Resources Conservation Serv. | |
| Mr. Robert Corrigan | Citizens Advisory Committee | |
| Dr. Sally Davenport | Texas General Land Office | |
| Mr. Ted Grabowski | US Navy Station - Ingleside | US Navy |
| CAPT. Adan Guerrero | US Coast Guard | |
| Ms. Sally Gutierrez | Texas Natural Resource Conservation Commission | |
| Mr. Mike Hightower | Texas Sea Grant College Program | |
| Mr. Edward (Ted) Jones | Nueces River Authority | |
| Dr. Tommy Knowles | Texas Water Development Board | |
| Mr. Pat McCrary | Padre Island National Seashore | |
| Mr. Rick Medina | US Army Corps of Engineers | |
| Mr. James Moore | Texas State Soil & Water Conservation Board | |
| Dr. Joe C. Moseley | Shiner, Moseley & Assoc., Inc. | Environmental Engineer |
| Mr. Frank Newchurch | Reynolds Metals, Inc. | |
| Mr. George Ozuna | US Geological Survey | |
| Commissioner Gordon Porter | City of Corpus Christi | Local Governments Advisory Committee |
| Dr. Warren Pulich | Texas Parks & Wildlife Department | |
| Mr. Jay Reining | City of Corpus Christi | Citizens Advisory Committee |
| Mr. Terry Ricks | Texas Seafood Association | Bay Shrimpers |
| Mr. Bill Seawell | US Fish and Wildlife Service | |
| Ms. Patricia H. Suter | | Environmental Advocate |
| Mr. Windle Taylor | Texas Railroad Commission | |
| Mr. Richard Thompson | Texas Dept. of Health | |

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|---|---|---|
| **Management Committee *(cont.)*** | | |
| Ms. Mary J. Thorpe | Del Mar College | Coastal Bend Council of Governments |
| Mr. Tom Utter | City of Corpus Christi | |
| Mr. Robert B. Wallace, Jr. | Wallace & Wallace, L.L.P. | Coastal Bend Bays Foundation |
| Ms. Becky Weber | USEPA - Region 6 | |
| Mr. Roger F. Welder | | Ranching |
| Dr. Terry E. Whitledge | UT Marine Science Institute | Scientific/Technical Advisory Committee |
| Dr. Roger Zimmerman | National Marine Fisheries Service | |
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| Mr. Tommy M. Brooks | City of Port Aransas | |
| Ms. Sue Burck | Ingleside On The Bay | |
| Mr. Leon Decker | Nueces County Dept. of Public Health | |
| Mr. Dipak V. Desai, P.E. | Port of Corpus Christi Authority | |
| Mr. James A. Dodson | City of Corpus Christi | |
| Mr. Daniel D. Durnan | Town of Bayside | |
| Mr. John Ford | Kenedy County | |
| Judge Joe B. Garcia | Brooks County | |
| Dr. Donald A. Hegwood | Texas A&M University | City of Kingsville |
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| Mr. Paul Martinez | City of Austwell | |
| Mr. Jim Massey | Kingsville Farmers Co-Op | Kleberg County |
| Dr. Russ Miget | Texas Sea Grant Program | |
| Mr. Con Mims | Nueces River Authority | |
| Mr. Fermin Munoz, Jr. | Texas Railroad Commission | |
| Mr. Ismael (Smiley) Nava | Texas Parks & Wildlife Dept., Resource Protection Div. | |
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| Mr. Carlton (Buddy) Stanley | Texas Natural Resource Conservation Commission | |
| Commissioner Jimmy Strause | Live Oak County | |
| Ms. Jane Ward | City of Ingleside | |
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| Mr. Sam N. Beecroft | B.C. Beecroft Company, Inc. | Contractors |
| Mr. Gene W. Blacklock | Coastal Bend Audubon Society | |
| Ms. Mary Campbell | Port Aransas Rod & Reel | |
| Mr. Chuck Cazalas | Citgo Corpus Christi Refinery | |
| Mr. Robert Corrigan | Ducks Unlimited | |
| Dr. James Dinn, MD | | Recreational Sailing |

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|---|---|---|
| **Citizens Advisory Committee *(cont.)*** | | |
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| Mr. James B. Gafford | Valero Refining | |
| Ms. Corando Gallegos | Hispanic Women's Network of Texas Association | |
| Mr. William Goldston | Goldston Engineering, Inc. | Coastal Bend Bays Foundation |
| Mr. Richard Gonzales | New America Marketing | |
| Ms. Grace Gonzalez | | LULAC Council #1 |
| Mr. Frank Hankins | Organization for the Protection of an Unblemished Shoreline | |
| Mr. Scott Hedges | National Audubon Society | |
| Mr. Thomas B. Henderson, Jr. | Geologist | |
| Mr. John Craig Hill | Hoechst Celanese | |
| Mr. Eric Kaysen | Koch Refining Co. | |
| Mr. Rick Kocurek | Kocurek Family Farms | Agriculture/Farmers |
| Mr. Patrick McGloin | McGloin & Sween | Architect |
| Mr. August Meinrath | Association for the Advancement of Retired Persons | |
| Mr. Harold Moore | NAACP | |
| Mr. Joe P. Mueller | Mueller Engineering Corp. | Oil and Gas Producers |
| Mr. Ancel Newman | Save Lake Corpus Christi Foundation | |
| Mr. P.W. (Corky) Nieschwietz | Dupont Chemical | |
| CAPT. Jay Reining (Ret.) | Coastal Bend Bays Foundation | |
| Ms. Cecilia Riley | Gulf Coast Bird Observatory | Biologist |
| Mr. Stuart Sasser | Texas SW Cattle Raisers Association | Ranching |
| Mr. Allen Shifley, P.E. | Betz Industrial | Industrial Water Treatment |
| Ms. Mary Pat Slavik | Organization for the Protection of an Unblemished Shoreline | |
| Mr. Jack Solka | Architect | |
| Mr. Hal Suter | Tax Payers Association | |
| Mr. Butch Thompson | King Ranch | |
| Ms. Judith Tor | Sierra Club | |
| Mr. Leroy J. Wieting | Reynolds Metals | |
| **Scientific/Technical Advisory Committee - Steering Directory** | | |
| Dr. Steve S. Barnes | National Spill Control School Texas A&M | |
| Mr. Bob Bass | US Army Corps of Engineers | |
| Mr. Paul D. Carangelo | Port of Corpus Christi Authority | Port of Corpus Christi Authority |
| Ms. Robyn A. Cobb | US Fish and Wildlife Service | |
| Mr. Mike Cox | Valero Refining Company | |
| Mr. Philip A. Crocker | USEPA - Region 6 | |
| Dr. Lynn Drawe | Welder Wildlife Foundation | |
| Mr. Andy Garza | Texas State Soil and Water Conservation Board | |
| Mr. Jim Gooris | Koch Refining Company | |
| Dr. Joan Holt | UT Marine Science Institute | |
| Mr. Marshall E. Jennings, P.E. | US Geological Survey | |
| CAPT. Mike Kershaw | | |

| NAME | AFFILIATION | REPRESENTING |
|---|---|---|
| **Scientific/Technical Advisory Committee *(cont.)*** | | |
| Mr. John Lloyd-Reilley | Kika de la Garza Plant Materials Ctr. | Natural Resources Conservation Service |
| Mr. Lawrence W. McEachron | Texas Parks and Wildlife Department | |
| Mr. John A. Michael, P.E. | Naismith Engineering, Inc. | |
| Dr. Russ Miget | Texas Sea Grant Program | |
| Dr. Joanna Mott | Texas A&M University - Corpus Christi | |
| Mr. Bruce Moulton | Texas Natural Resource Conservation Commission | |
| Mr. Fermin Munoz | Texas Railroad Commission | |
| Mr. Jim P. Naismith | San Patricio Municipal Water District | |
| Ms. Leah Pagan Olivarri | Olivarri & Associates, Inc. | |
| Dr. Chris Onuf | National Biological Service | |
| Mr. Mike Ordner | Texas Department of Health | |
| Mr. George W. Pollitt | Mine Warfare Command | |
| Mr. Gary Lee Powell | Texas Water Development Board | |
| Dr. Jennifer S. Prouty | Texas A&M University - Corpus Christi | |
| Ms. Cecilia C. Rhoades | | |
| Mr. Leo B. Trevino | | |
| Dr. Wes Tunnell | Texas A&M University - Corpus Christi | |
| Dr. Jerry Wermund | UT Bureau of Economic Geology | |
| Dr. Terry E. Whitledge | UT Marine Science Institute | |

STAC Ex-Officio Directory

| | |
|---|---|
| Mr. Tony Amos | UT Marine Science Institute |
| Mr. Darwin J. Anderson | |
| Mr. Charlie Belaire | Belaire Consulting, Inc. |
| Dr. Ed Buskey | UT Marine Science Institute |
| Dr. Scott Carr | National Biological Service |
| Mr. Chris Caudle | Texas Natural Resource Conservation Commission |
| Mr. Terry J. Cody | Texas Parks and Wildlife Department |
| Dr. Hudson R. DeYoe | UT PanAmerican |
| Dr. Quenton R. Dokken | Texas A&M University - Corpus Christi |
| Dr. Ken Dunton | UT Marine Science Institute |
| Dr. Robert J. Edwards | UT Pan American |
| Mr. Carlos Garcia | Texas General Land Office |
| Mr. Scott A. Holt | UT Marine Science Institute |
| Mr. David A. Jensen | National Spill Control School |
| Dr. Paul A. Montagna | UT Marine Science Institute |
| Mr. Darwin Ockerman | US Geological Survey |
| Mr. Ken Roberts | Hoechst Celanese |
| Mr. C.J. Romero | Citgo Refinery |
| Mr. Harold Stone | Texas Agricultural Extension Service |
| Ms. Christina Thompson | Texas A&M University - Corpus Christi |

*continued next page*

| NAME | AFFILIATION |
|---|---|
| **Action Plan Task Force Members** | |
| Bay Tourism and Recreation | |
| Andy Agan | Coastal Conservation Association |
| Ray Allen | Local Citizen |
| Maureen Bennett | Ecotourism |
| Richard Bullock | Coastal Bend Council of Governments |
| Paul Carangelo | Port of Corpus Christi Authority |
| Quenton Cook | Corpus Christi Marina |
| Tom Curlee | Port Industries of Corpus Christi |
| Ed Hegen | Texas Parks & Wildlife |
| Kay Jenkins | Aransas County |
| Stan Kotzer | Texas Seafood Association |
| Christopher Lawrence | Nueces County |
| Malcom Matthews | City of Corpus Christi |
| William McDowell | Corpus Christi Yacht Club |
| Dewey McTee | Coastal Conservation Association |
| Russ Miget | Texas Sea Grant College Program |
| Will Myers | Coastal Kayaking |
| Marilyn Pierce | Greater Corpus Christi Business Alliance |
| Jennifer Prouty | Texas A&M University - Corpus Christi |
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| Quenton Cook | Corpus Christi Marina |
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| Norb Hart | City of Corpus Christi |
| Brandol Harvey | City of Corpus Christi |
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## Glossary

***Atmospheric deposition:*** A complex phenomenon that occurs when emissions of sulfur, nitrogen compounds, and other substances are transformed by chemical processes in the atmosphere and then deposited on earth in either a dry or wet form.

***Aquaculture:*** The production of stocks of marine or estuarine organisms by rearing in a controlled environment. A controlled environment provides and maintains throughout the rearing process one or more of the following: predator protection, food, water circulation, salinity, or temperature controls.

***Benthic*:** Referring to the community of plants and animals that live on the bottom of waterbodies.

***Best Management Practice (BMP):*** A method, activity, maintenance procedure or other practice for reducing the amount of pollution entering a waterbody.

***Bioaccumulation:*** The uptake of toxic chemicals leading to elevated concentrations of those substances within plant or animal tissue.

***Bycatch:*** The unintended taking of a species while net fishing for another species.

***Contact recreation:*** Activities that cause people to contact water, such as swimming, boating, windsurfing, etc.

***Ecosystem:*** An ecological community and its environment functioning as a unit in nature.

***Entrainment:*** Occurs when an organism is drawn into a water intake and cannot escape.

***Epidemiological:*** Relating to the science of addressing the incidence, distribution, and control of disease in a population.

***Estuary:*** A coastal waterbody, with tidal mixing, where fresh water from rivers mixes with salt water from the ocean.

***Eutrophication:*** The process during which a waterbody becomes highly loaded with nutrients, (primarily nitrogen and phosphorous), sometimes causing oxygen depletion from algal overgrowth or blooms.

***Geographic Information System (GIS):*** A computer system that enables one to create and analyze electronic maps that depict various types of data, such as wetland coverages, toxic waste sites, etc.

***Hypersaline:*** Extremely high levels of salinity.

***Impingement:*** Occurs when an entrapped organism is held in contact with the intake screen and is unable to free itself.

***National Pollutant Discharge Elimination System (NPDES):*** A provision of the Clean Water Act which prohibits discharge of pollutants into waters of the U.S. unless a special permit is issued by USEPA or a state.

***Nonpoint Source:*** An indirect discharge, not from a pipe or other specific source. Includes water running off the land's surface directly into waterbodies or running off streets or other paved areas into a centralized collection system.

***Nutrient:*** Any substance assimilated by living things that promotes growth.

***Pathogenic organisms:*** Biological agents, such as bacteria and viruses, that cause sickness or disease.

***Phytoplankton:*** Microscopic algae that are freely floating in aquatic systems.

***Planktonic:*** Referring to tiny plants and animals that live in water.

***Point Source:*** A specific source or point of origin, such as a discharge pipe or outfall.

***Riparian:*** Habitat occurring along the bank of a river, lake, stream, or creek.

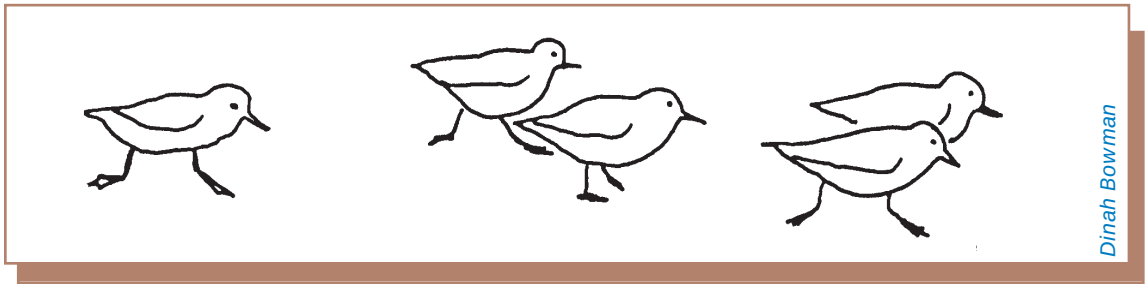
***Sustainable economic growth:*** Growth that meets the needs of the present without compromising the ability of future generations to meet their own needs.

***Stakeholder:*** One who is interested in or impacted by a project.

***Turbidity:*** A cloudy condition in water due to suspended silt or organic matter.

***Watershed:*** The land area that drains into a stream, river, estuary, or other waterbody; same as drainage area.

***Xeriscape:*** The use of native plants and other vegetation for landscaping.



Dinah Bowman

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# Endorsements

*"The approval of the Plan will ensure the preservation of our Coastal Bend wetlands; a natural treasure that requires protection for the approaching millennium!" - Carlos F. Truan, Dean of the Texas Senate*

*"[We] commend the Coastal Bend Bays Plan for its integrated approach towards action to achieve conservation, protection, and judicious development of our natural resources." - Peggy Duran, President, The League of Women Voters of Corpus Christi*

*"As more and more people come to our area... we must have a plan to protect and conserve, but also sustainably use these resources..." - John Wes Tunnell, Director, Center for Coastal Studies*

*"Considering the scope and complexity of the mission and the relatively short period of time allotted to complete it, this has been a formidable task." - Frank Hankins, OPUS*

*"The Coastal Bend Bays Plan will go a long way in ensuring the ecological and economic vitality of the Coastal Bend bays and estuaries." - Vilma Luna, House of Representatives*

*"[We] fully support the Plan's bottom-up, consensus based approach to natural resource management..." - John Barrett, Row Crop Producers*

*"The approach used to build the Coastal Bend Bays Plan...is commendable." - Agnes A. Harden, County Judge of Aransas County*

*"We believe the fundamentals of good science have prevailed...to achieve a sound Bays Plan." - Frank N. Newchurch, III, Chairman, Port Industries of Corpus Christi*

*"[The Bays Plan] truly represents a thorough outline for a coordinated approach for addressing the future management of the bay and adjacent study areas." - Mike Hightower, Deputy Director, TAMU Sea Grant College Program*

*"The conservation of Texas' fish and wildlife resources is [our] primary legislative mandate. The Plan represents an important mechanism to help meet that responsibility..." - Dr. Larry McKinney, Texas Parks & Wildlife*

*"The effort to gather the best scientific protection to help shape public policy has resulted in an outstanding guide for bay resource protection in the 21st century." - Ray Allen, Chairman, Coastal Bend Bays Foundation*

*"The Sierra Club ...believes that [the Plan] has given the area an excellent knowledge of existing conditions and has shown where possible problems lie or may occur in the future." - Patricia H. Suter, Chairman*

*"The estuaries of the Coastal Bend region of Texas are key elements in contributing to coastal living marine resources of the Gulf of Mexico and our nation." - National Marine Fisheries Service, Southeast Fisheries Science Center*

*"The Texas State Aquarium believes strongly in what the Estuary Program represents and we pledge our contribution to educate residents and visitors on the conservation and wise use of our estuaries." - Steve Ordahl, Executive Director, Texas State Aquarium*

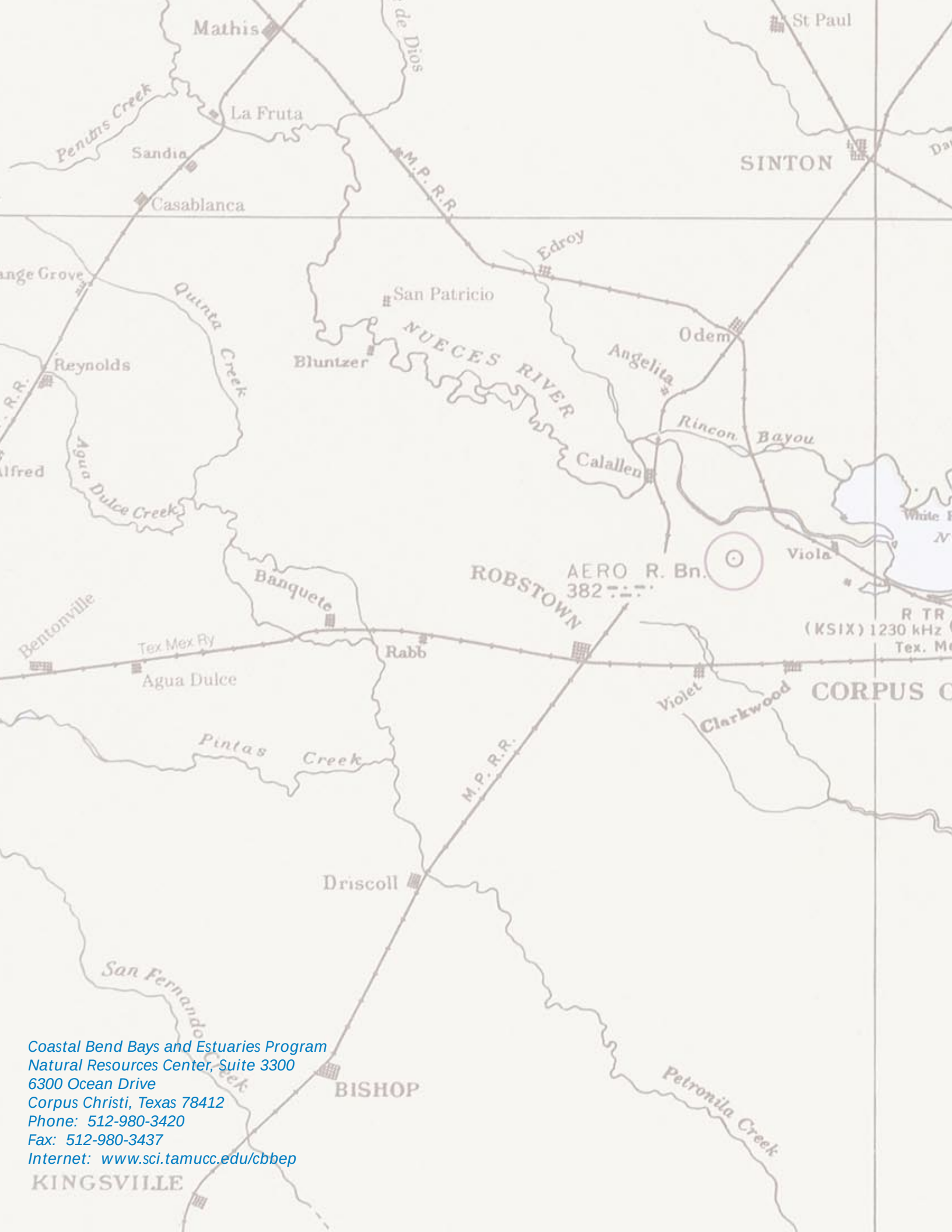
*"Successful completion of the plan reflects the dedication and wisdom of the Texas Coastal Bend community and a strong commitment to its implementation." - Peter M. Emerson, Environmental Defense Fund*

*"Now is the time for our entire community to support... and advocate the implementation of the Plan. We have the opportunity to make a significant contribution." - Robert N. Corrigan, Jr., Co-Chair, Citizens Advisory Committee*

*"The strong local commitment and sense of ownership that led to the development of the Plan will surely lead to swift implementation of its actions." - Bill Hathaway, USEPA Region 6*

*"This overarching plan should help to address preservation and enhancement of many of the values of the bays systems of Texas' Coastal Bend Region." - Robyn Cobb, U.S. Fish & Wildlife Service*

*"The resultant Plan initiatives are consensus based, supported by sound science, and reflect fiscal and political reality." - John LaRue, Executive Director, Port of Corpus Christi*

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