



II. Habitat/Living Resource Conservation

This section of *The Galveston Bay Plan* deals with maintenance and restoration of the critical habitats which make up the Galveston Bay Estuary ecosystem, and protection of the many species which make their home in the estuary or depend upon the estuary during a portion of their life cycle. Action plans were developed for two interrelated aspects of the bay's living resources.

Habitat Protection The continued health and biodiversity of the estuarine system depend on the maintenance of varied and abundant high-quality habitat, particularly wetlands. A trend of wetlands decline has been identified within the estuary, threatening the sustainable productivity of the bay. This problem of habitat degradation has been identified as the **most critical** of all the problems currently facing the bay. To meet this challenge, the Habitat Protection action plan calls for acquisition and/or conservation of existing wetland habitats; restoration or enhancement of degraded wetland habitats; beneficial use of dredged materials to create additional habitat; and minimization of erosion which leads to habitat loss. A variety of approaches, ranging from the development of tax incentive programs to the creation of bird nesting islands using dredged materials, have been recommended as effective means to protect the vital habitats of the estuary (see page 29).

Species Population Protection Species protection is inextricably linked to habitat protection, as all species are dependent upon the maintenance of their essential habitats. Even if habitats are maintained, however, pressure can be applied to species populations from a variety of sources, such as abnormal weather patterns, over-fishing, or the introduction of exotic species which drive out species from their original habitat. To closely monitor the status of species populations within the estuary, this action plan calls for the formation of a task force to coordinate and focus species management issues. To address current species management problems in the bay, the strengthening of species management plans; the reduction of by-catch, impingement, and entrainment; the protection of oyster reefs; and the control of exotic species is recommended (see page 53).

Habitat Protection

The Galveston Bay Plan Galveston Bay National Estuary Program

OVERVIEW OF THE ACTIONS

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THE ISSUES

The Galveston Bay Estuary is composed of a variety of aquatic habitats ranging from open water areas to coastal wetlands that support numerous plant, fish, and wildlife species. Maintaining varied and abundant high-quality habitat helps ensure the health and biological diversity of the entire estuarine system. *The Galveston Bay Plan* advocates an ecosystem approach to habitat protection that will ensure the existence of an optimal variety and distribution of aquatic habitats, and will sustain the physical and hydrological connections required between adjacent habitats.

Strategies for the protection of the Galveston Bay estuarine habitats were evaluated by the Management Conference along with the results of technical research, and the historical and current management efforts of natural resource agencies. The following initiatives were identified as keys to the continued productivity and biological diversity of the estuary:

- Wetlands Management and Protection: Four actions were developed by the Management Conference to acquire, manage, and protect coastal wetlands. Improved coordination among the agencies involved in habitat management is recommended for

the development and implementation of a regulatory strategy applicable to all Galveston Bay estuarine habitats. Measures to halt declines in coastal habitat quantity and quality, better utilize existing manpower resources, maximize beneficial uses of dredged materials, and improve service to the public are also promoted by the actions.

- **Beneficial Uses of Dredged Materials:** Actions are proposed to support beneficial uses of dredged materials and minimize negative impacts on bay resources. Dredged materials can be used in a variety of beneficial manners such as creating, restoring, or enhancing estuarine habitats and building bird nesting islands. Obstacles to the use of dredged materials such as agency regulation, public resistance, availability of dredged materials, and costs can be overcome.
- **Erosion Mitigation:** Actions to minimize erosional processes that result in the loss of habitats are supported by *The Galveston Bay Plan*. Erosion threatens residential and industrial areas as well as plant and wildlife communities and may cause the loss of private and public lands. Common remedies to erosion problems such as the construction of bulkheads, shoreline stabilization and restoration measures often result in the loss of coastal habitat, sediment starvation, and interruption of the natural riverine sediment transport system that supplies nourishing sediments for fringing marshes.
- **Subsidence Reduction:** *The Galveston Bay Plan* endorses the efforts of the Harris-Galveston Coastal Subsidence District in reducing the rate of subsidence throughout the Galveston Bay Estuary. Subsidence, a permanent and irreversible sinking of the ground surface, is primarily caused by the excessive withdrawal of subsurface fluids, principally groundwater. Coastal habitat has been lost in areas of the Galveston Bay Estuary that are susceptible to flooding due to high tides, heavy rainfall and hurricane storm surge. Efforts of the Harris-Galveston Coastal Subsidence District have significantly reduced the rate of subsidence throughout shoreline areas in recent years, although subsidence remains a problem in the northwestern portion of the lower watershed. Therefore this action plan requires no further action other than endorsing the current work by the Subsidence District to correct remaining problems.

ENVIRONMENTAL STATUS

Status and Trends

Two bay habitats are of particular importance to the tremendous diversity and overall abundance of bay life. First, wetlands (including submerged aquatic vegetation) serve important biological, hydrological, and ecological functions in the bay ecosystem. Second, oyster reefs are important habitats as indicators of the overall condition of the ecosystem and are the basis for an important commercial fishery. Oyster reefs are discussed in detail in the Species Protection Action Plan. More information regarding wetlands (including bird habitat) follows.

Wetlands

Wetlands are transitional areas between land-based and water-based systems, normally covered by shallow water, or with a water table very near the surface of the ground. These areas include some of the most productive biological areas on the planet, and evidence indicates that wetlands are a more important part of the Galveston Bay system food chain than in many other bays. Galveston Bay's marshes are an important source of nutrients and organic matter which become food for organisms throughout the estuary.

Wetlands serve as vital habitat for many species of plants, fish, birds, and wildlife. In Galveston Bay, many of the principal fishery species rely on coastal wetlands during at least some part of their life cycle. These species include brown shrimp, white shrimp, blue crab, red drum, spotted seatrout, southern flounder, and Gulf menhaden. In the same way, wetlands are important nurseries to many non-commercial species that comprise a large part of the food web in Galveston Bay. Several bird species, such as snowy egrets, roseate spoonbills, tricolored herons, black skimmers, and great egrets use the marsh as feeding habitat.

Overall, coastal wetlands provide physical, chemical and biological processes that keep the bay ecosystem healthy. They serve as filtering zones for polluted runoff and provide beneficial organic nutrients to other bay habitats. They serve as good flood-control areas, releasing runoff water more slowly to the bay than the rapid discharge from man-made drainage systems. They even help treat the water by processing organic compounds and permitting excess sediment to settle out before reaching the bay. By stabilizing shorelines subject to wind and waves, wetlands reduce or prevent shoreline erosion, helping maintain water clarity in the process.

Extent of Wetlands in Galveston Bay

Based on recent studies, the Galveston Bay Estuary contains an estimated total of approximately 138,600 acres of vegetated wetlands (marshes and forested wetlands). Marshes constitute 94 percent (130,400 acres) of all vegetated wetlands. Salt and brackish marshes (108,200 acres) are much more prevalent than fresh or inland marshes (22,200 acres). Forested and scrub/shrub wetlands encompass approximately 8200 acres, or six percent of all vegetated wetlands. Submerged wetlands, commonly referred to as sea grasses, have a total mapped area of only 700 acres. Of these, the majority (386 acres) are found in Christmas Bay and most of the remaining areas near the Trinity River delta.

Bird Habitat

Bird populations have significant commercial, recreational, ecological, and aesthetic value to many users of the bay. In addition, they are important indicators of the health of the upper food web and the status of various bay habitats. Observers have noted 139 bird species associated with Galveston Bay wetlands and open-bay habitats. As most waterfowl breed elsewhere, control of Galveston Bay waterfowl by addressing local problems is limited.

While the total number of colonial waterbirds has remained relatively stable since the early 1980s, there has been a decline for estuarine-dependent bird species which feed at the marsh-bay interface (i.e., tricolored herons, snowy egrets, black skimmers, roseate spoon bills, and great egrets). This could be the direct result of habitat losses, or the indirect result of declines

in habitat-dependent species preyed upon by the birds. Inland colonial waterbirds (such as little blue herons, white ibises, cattle egrets, white-faced ibises, and great blue herons) showed no significant changes from 1973 to 1990. Open-water birds such as royal terns, Caspian terns, olivaceous cormorants, Forster's terns, and Sandwich terns showed increases in both the number of birds and the number of colonies over the same study period.

The total Intertidal flats on Bolivar Peninsula and on either end of Galveston Island are the primary habitats for migrating shorebirds, and the bay supports more than five percent of all mid-continental shorebird populations during their annual migrations.

Two roosting sites, but no nesting sites, are known for brown pelicans, an endangered species which declined in the 1960s due to the toxicity and bioconcentration of pesticides. This species has shown increases in Galveston Bay during the past few years, probably because of the reduction/and or elimination of specific pesticides known to be harmful. The bald eagle, an endangered species, has nesting sites in Chambers, Galveston, and Harris counties. The Arctic peregrine falcon and piping plover are listed as threatened in some of the counties around the bay, but do not nest in the area.

Emergent Wetland Losses Over Time

A comparison of the wetland distribution in the Galveston Bay estuary between the 1950s and 1989 indicates that a net decrease of approximately 19 percent of the total vegetated wetlands has occurred over this period (171,700 acres in 1950s to 138,600 acres in 1989, for a *net* loss of 33,400 acres). In some areas wetlands were created, so the net loss equaled a *gross* loss of 88,000. The overall rate of loss averaged approximately 1,000 acres per year between 1953 and 1979, and slowed to 720 acres per year between 1979 and 1989.

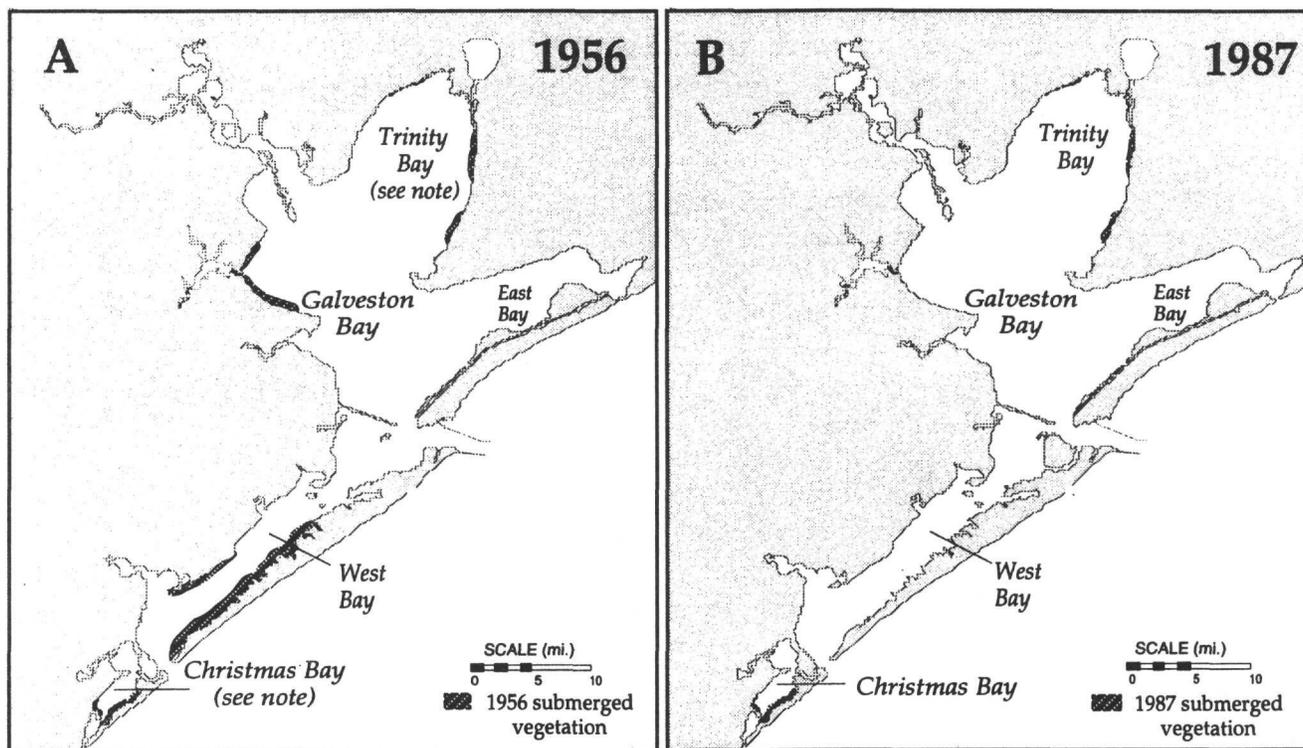
Total scrub/shrub wetlands decreased by 900 acres, representing a 25 percent loss of the 1950s resource. Forested wetlands, on the other hand, increased by 3,600 acres, representing almost twice the 1950s area. Almost all of this gain was in the Trinity River valley. Much of the gain in forested wetland area was due to 1) growth of shrubs and trees in areas previously mapped as scrub/shrub wetlands, and 2) interpretation inconsistencies among data from various years. In addition, most of the forested wetland gain since the 1950s, was due to the invasion of Chinese Tallow, an exotic species with rapid growth potential and low wildlife value.

The quality of coastal wetlands is as important as the total area. Pollution, fresh or salt water inflows, isolation, disturbance, and exotic species are capable of causing detrimental effects on wetlands with subsequent results for the quality of the bay. Declines in the quality of remaining wetlands could represent substantial problems capable of limiting the productivity of these areas.

Loss of Submerged Aquatic Vegetation (SAV)

The area of submerged aquatic vegetation (primarily sea grasses), an important and productive habitat type, decreased from 2,500 acres in the 1950s to just 700 acres in 1987 (see Figure HP-1). This represents a decline of 1,800 acres, or over 70 percent of the 1950s habitat. Although a definite cause-and-effect relationship is not known, the most plausible explanations for the losses are 1) subsidence and Hurricane Carla in Western Galveston Bay,

and 2) human activities such as development, wastewater discharges, chemical spills, and dredging. Light limitation has also been identified as a potential cause for the decline of SAV in Galveston Bay, although the large decline of suspended solids and phytoplankton in the bay over the past 20-30 years may not provide full support to this hypothesis.



Note: Although present, submerged aquatic vegetation was not mapped in Christmas Bay and Trinity Bay locations in 1956. The 1987 distribution of SAV in these locations is shown for comparison.

FIGURE HP-1. Change in Area of Submerged Aquatic Vegetation Between 1956 and 1987.

Causes of Wetlands Losses

Five main causes for wetland losses have been identified: 1) man-induced subsidence and associated relative sea-level rise; 2) erosion; 3) direct conversion for agricultural, urban, industry, and transportation purposes; 4) dredge-and-fill activities; and 5) isolation projects, in which shoreline areas have been artificially cut off from the bay system.

Subsidence

Subsidence became a serious problem in Harris and Galveston counties during the 1950s when the rapidly growing metropolitan area increased its demand for water. Rates of natural subsidence were dwarfed by rates associated with man-induced subsidence. Under the Harris-Galveston area are two aquifers with an abundance of inexpensive freshwater. As industry and municipalities tapped this resource, the rate of subsidence increased. From 1906 to 1987, the land subsided more than ten feet along the Houston Ship Channel. The Clear Lake

area, including the Johnson Space Center, lost six feet of elevation and nearly all of the two-county area sank at least one foot (see Figure HP-2). Conversion from ground water to surface water between 1976 and 1992 reduced subsidence from as much as 0.25 feet per year to 0.025 feet per year along Galveston Bay.

Approximately 26,400 acres of marsh were drowned since the 1950s due to the effects of subsidence. However, losses are offset to some degree by the growth of new wetlands in areas where the land surface subsided. In fact, a substantial amount of 1950s uplands, about 21,000 acres, was emergent wetlands in 1989. Some increases have resulted from implementation of extensive water management programs for waterfowl habitat. Development and expansion of wetlands in some areas appear to be associated with subsidence and faulting. Changes toward wetter soil conditions occur as land-surface subsidence results in lower surface elevations, thereby increasing the frequency and duration of inundation. Transitional areas and uplands with gentle sloping surfaces that grade into adjacent intertidal wetlands are prime candidates for this type of conversion.

While significant progress has been made to control subsidence in the flood-prone coastal areas, ongoing management of regional ground water resources is needed to continue improvement and stability. Since the 1970s, the cause of subsidence itself has been addressed. Regulation of ground water withdrawal by the Harris-Galveston Coastal Subsidence District has almost eliminated excessive pumping in the near-bay areas, virtually stopping further elevation loss around the bay.

Erosion

Shoreline erosion contributes to the conversion of vegetated wetlands to open water. Comparative shoreline data indicate that 78 percent of the shoreline in the Galveston Bay system eroded to some extent between the 1850s and 1982. Average rates of erosion have increased from 1.8 feet/year between the 1850s and 1930 to 2.4 feet/year between 1930 and 1982.

Natural causes of shoreline erosion include wave activity, storms, relative sea-level rise, and bluff failure. Wave activity, in order of increasing severity and decreasing incidence, is caused by the predominant southeasterly winds, strong northerly winds accompanying the passage of polar fronts, and extreme winds associated with tropical cyclones. Shorelines with long northerly and southeasterly wave fetches commonly have the highest rates of shoreline erosion.

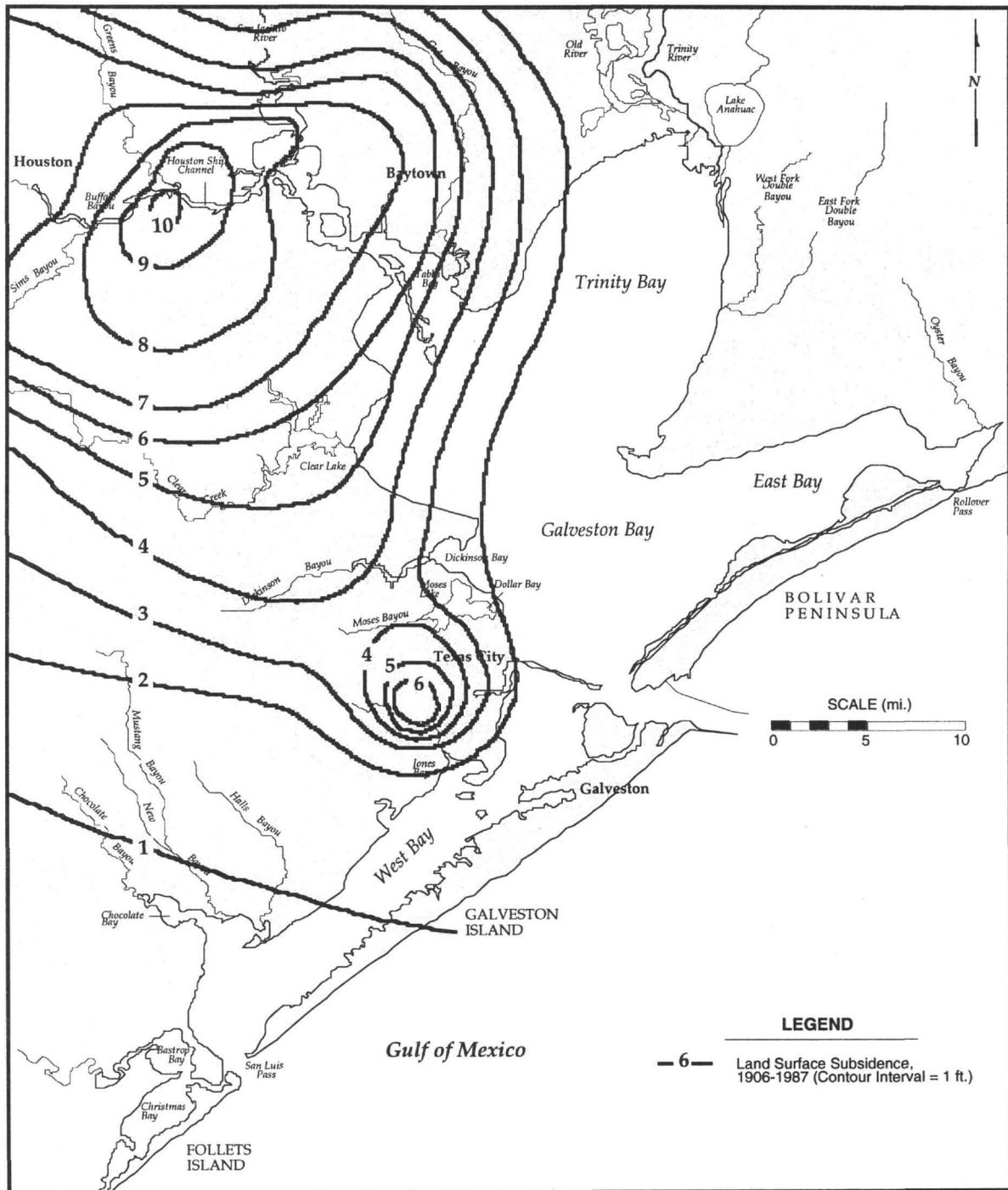


FIGURE HP-2. Land Subsidence in the Galveston Bay Area Between 1906 and 1987

Hurricanes are capable of producing the most dramatic changes in shorelines. During Hurricane Carla in 1961, more than 800 feet of land were eroded from one shoreline facing the gulf, while about 500 feet of accretion occurred on the bay side of the barrier island. In 1983, Hurricane Alicia was responsible for an 80-foot retreat of the vegetation line on Galveston Island, and caused most shoreline bluffs surrounding the bay to retreat between 5 and 20 feet. Tropical cyclones, in addition to producing destructive waves, raise bay water levels enough to cause waves to break on the middle and upper parts of the bluffs. Storm waves may exceed the low points along Galveston Island, Bolivar Peninsula, and Follet's Island and cause erosion on the landward side of the dunes.

Human causes of erosion include increased wave activity from commercial ships and recreational and fishing boats. Dredging in channels, waterways, and marinas also contributes to erosion problems. Structures like riprap, bulkheads, and groins have slowed erosion locally, but contribute to bay-wide erosion by removing shoreline-derived sediments.

Inland improvement projects such as damming rivers for hydroelectric power, water supply projects, and flood control projects, trap sediments that would ultimately be deposited into the bays and estuaries by natural stream flow. Such sediment provides a crucial replenishment to the shoreline and wetlands of the bay. When a regular flow of sediment is impeded from reaching the bay, natural sea level rise (estimated by one researcher to be about 0.8 ft per 100 years) can drastically affect marshlands, causing them to migrate inland. The slightest subsidence can further worsen this problem. Reductions in riverine sediments resulting from reservoir construction slow expansion of the Trinity Delta (the only area of extensive shoreline progradation in the last century). The construction of upland reservoirs has probably contributed to the acceleration of marsh erosion since the 1930s by robbing the bay of sediments transported down the rivers. In addition, reduced erosion rates due to changing land uses in the upper watershed may also be responsible for reducing sediment loads to the bay.

Conversion

Conversion of wetlands to uplands has substantially contributed to wetland losses. Much of this loss has occurred in freshwater marshes as opposed to the saltwater or brackish marshes. Conversion to upland range was the most significant human land use change affecting wetlands, with 25,000 acres of wetlands lost between the 1950s and 1989 (primarily inland from West and Christmas Bays). While conversion appears to have natural causes, much of the change may be attributable to drainage ditches constructed to reduce flooding and increase the area available for livestock grazing. Other agricultural conversions claimed 5,700 acres of wetlands, and oil and gas production resulted in a net loss of 800 acres. Conversion to urban uses destroyed 5,700 acres of natural wetlands, although in some cases alternative beneficial habitats have been created (such as rice fields that support waterfowl).

Dredging and Filling

Dredging may also change water circulation patterns, alter freshwater flow patterns, or create oxygen-poor water conditions bay-wide. For example, construction of the Houston Ship Channel in the open portions of the bay breached Red Fish Bar, an oyster reef complex that stretched across the bay, and increased salinity in the upper bay. On a more localized scale,

the actual site of dredged material deposition will be affected. At open water sites, benthic habitat may be destroyed, and wetland habitat may be converted to uplands. The magnitude of each of these impacts will vary depending on 1) the nature and size of the dredging project, 2) the characteristics of the project site, and 3) the configuration of the disposal site. Dredging projects are shown on Figure HP-3.

Since the 1950s there has been only a 500 acre net loss of wetlands due to dredged material disposal, mostly associated with the Gulf Intracoastal Waterway. Since 1900 there has been an estimated loss of 7,070 acres of marshland have been lost to dredging, filling, and disposal activities. Of this loss, 2,920 acres was lost due to creation of designated disposal areas, 860 acres to navigation channels, and 3,290 to private dredge and fill operations (if the actual permitted activity was constructed) under the US Army Corps of Engineers Section 10/404 permit program.

Traditional dredging and dredged material disposal practices can directly eliminate, displace, or modify habitat through conversion to deep water coverage, erosion, and turbidity effects. Sedimentation and turbidity hinder filter feeders such as oysters, and disposal of dredged materials can convert wetlands to uplands. Dredge/fill projects may alter bathymetry, circulation, and salinity, thus affecting living resources. Some dredged material (particularly maintenance material from the upper estuary) may contain soluble contaminants that enter the water column which can produce toxicity or be taken up by organisms.

Isolation Projects

Isolation projects have resulted in large areas of open bay and marshland being separated from the bay proper, causing ecological changes that result in loss of wetlands. The most significant of these was the closure of Turtle Bay, now called Lake Anahuac, in 1936. Closure of this area near the mouth of the Trinity River eliminated about 6,000 acres of shallow bay bottom and 10,000 acres of marshland from the estuarine system. Overall, there has been a loss of 7,500 acres of bay bottom and 16,000 acres of estuarine marsh due to all isolation projects since 1900.

MANAGEMENT STATUS

Regulatory Basis

Although no comprehensive law has been passed to protect habitat or wetlands, these areas are partially protected under Section 404 of the Clean Water Act (CWA), the River and Harbor Act, the Endangered Species Act (ESA), the Fish and Wildlife Coordination Act, the National Environmental Policy Act and other regulatory programs. The U.S. Fish and Wildlife Service (USFWS) designates critical habitats for the conservation of federally listed endangered or threatened species under provisions of the ESA. The Fish and Wildlife Coordination Act requires USFWS and the National Marine Fisheries Service (NMFS) to review federally funded or permitted activities that may have an impact on endangered or threatened species and their habitats. USFWS uses its authority under the Fish and Wildlife Coordination Act to address impacts to wetlands and other habitats.

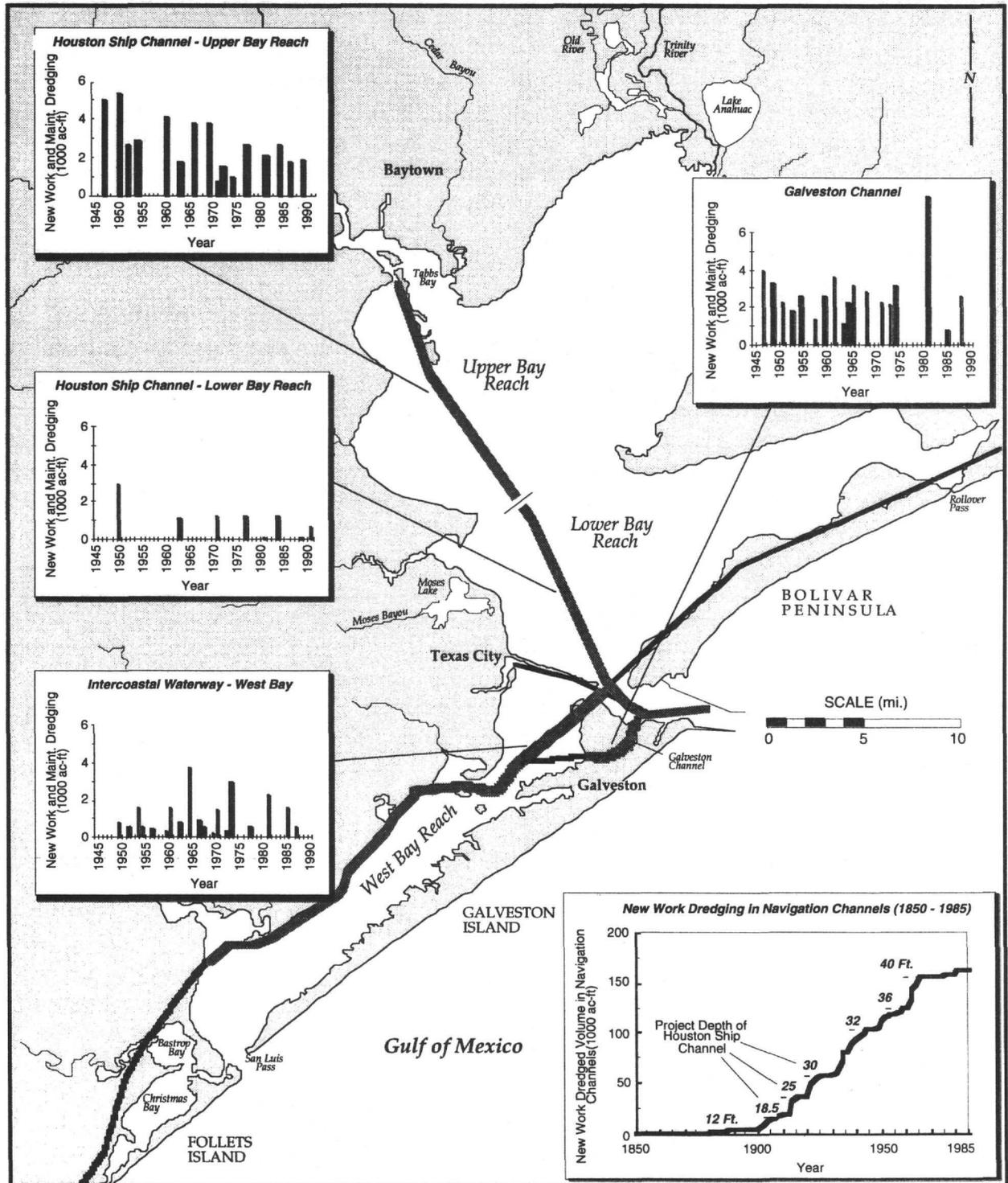


FIGURE HP-3. Major Dredging Projects in the Galveston Bay Area.

The U.S. Army Corps of Engineers (Corps) administers Section 404 of the CWA regulating the discharge of dredged or fill material into waters of the United States including wetlands. Section 404 is the primary federal regulatory program addressing wetlands. The Corps also administers the program through Section 10 of the River and Harbor Act of 1899, which requires a permit for any structure and/or work in the navigable waterways of the United States.

The Corps administers the Section 404 program with oversight from the Environmental Protection Agency (EPA). EPA's roles in the program include the following:

- Development of guidelines by which permit applications must be evaluated;
- Review of proposed permits;
- Prohibition of discharges with unacceptable adverse impacts;
- Interpretation of Section 404 exemptions; and,
- Enforcement of Section 404 violations.

Other federal agencies involved in wetlands programs include the USFWS, NMFS, the National Parks Service, the National Forest Service, the Soil Conservation Service, and the Bureau of Land Management. The USFWS administers the National Wetlands Priority Conservation Plan to aid in the identification of wetlands that warrant consideration for state and federal acquisition. The National Wetlands Inventory is maintained by the USFWS for information and maps on the status of wetlands. Federal projects that affect aquatic habitats can be reviewed under NEPA by the EPA, USFWS, NOAA, and other agencies.

Management of dredging activities in Texas is overseen by the Corps, the Texas General Land Office (GLO), port authorities and navigation districts. GLO is supportive of wetlands protection under its jurisdiction; but must also address the welfare of the citizens of the State, including important economic and social development.

The Texas Natural Resource Conservation Commission (TNRCC) certifies Section 404 permits and prohibits any permit that violates state water quality standards. The TNRCC also issues water quality certifications under Section 401, a program with potential wetlands protection applications. The Texas Parks and Wildlife Department (TPWD) reviews permits for the potential impact dredge and fill activities may have on wildlife habitats. Section 404 permits are also reviewed by the NMFS, USFWS, and the GLO. The developing Texas Coastal Management Program will address consistency of dredge and fill projects with other state and federal regulations.

The state and federal agencies are working towards the development of a management strategy to promote the beneficial uses of dredged material. Potential uses include enhancing or restoring marshes, shorelines, beaches and rookery islands.

Texas House Bill 552 regulates subsidence caused by groundwater removal by industry, farmers and cities. The Bill established the Harris-Galveston Coastal Subsidence District to monitor groundwater removal in Harris and Galveston counties. The district was charged to develop a regional plan to reduce groundwater use and provide for alternate water supplies.

The Plan has been successful in the areas where the District's efforts have been concentrated. Groundwater pumpage has decreased significantly in the Galveston Bay area and the Houston Ship Channel by conversion to surface water systems consisting of rivers, man-made lakes and reservoirs, and canals.

Problems

Most habitat regulatory problems stem from limited authorities of individual agencies with duplication of effort and a lack of resources for effective permit enforcement. Funds are inadequate for land purchase, which is the only effective method presently available for ensuring continued protection of habitat. The combination of fragmented and indirect authorities and low capacity along with the extreme importance of wetlands in cleansing the water and providing nursery habitat makes wetland loss perhaps the most important problem facing Galveston Bay.

The viability of the bay may depend on a comprehensive planning and management plan for dredged material which should be considered a resource for habitat creation and other uses. The current lack of consistent policy, interagency coordination, and funding limit disposal sites and beneficial uses for dredged material. Implementation of an efficient, coordinated review process would help to balance dredging with environmental productivity.

Other issues which may need to be addressed include 1) developing a system that indicates the degree of wetlands degradation (such as quality and function), 2) developing programs to prevent the future impoundment of coastal wetlands, and 3) development of water quality protection for submerged vegetation.

HABITAT PROTECTION ACTION PLAN

To provide optimal fish and wildlife habitat supporting the Galveston Bay system by effectively regulating wetland habitat to preclude net losses; conserving habitat through public ownership or control; implementing habitat creation, restoration, and improvement programs; reducing the adverse impacts from dredging and filling; and ensuring management practices that maximize beneficial uses of dredged material.

OVERVIEW

Priority Problem

Lost or degraded aquatic habitats: Vital Galveston Bay habitats have been lost or reduced in quality by a range of human activities, threatening the bay's future sustained productivity. Habitat loss has resulted from various processes including subsidence, erosion, conversion to agriculture, urban development, and dredging and filling activities.

Goal

Expand areas and restore quality of wetland habitats. Increase the quantity and improve the quality of wetlands and habitat for fish and wildlife in the Galveston Bay system.

Objective

Create or restore 15,000 acres of vegetated wetlands within 10 years. Specific targets include a) 1,400 acres of submerged aquatic vegetation; b) 5,000 acres of fresh marsh; and c) 8,600 acres of estuarine emergent marsh.

- Action HP-1: Restore, create, and protect wetlands.
- Action HP-2: Promote beneficial uses of dredged material to restore and create wetlands.

Objective

Restore natural functions and values to 50 percent of degraded wetlands within 20 years.

- Action HP-3: Inventory degraded wetlands and fund remedial measures.

Goal

Halt the conversion of wetlands to other uses. Eliminate or mitigate the conversion of wetlands to other uses caused by human activities .

Objective

Sustain no net loss of existing wetland areas.

Action HP-4: Implement a coordinated system-wide wetland regulatory strategy.

Goal

Acquire existing wetlands and encourage conservation. Acquire existing wetland habitats and provide economic incentives for conservation. Placing wetland areas in permanently protected status will ensure future contributions from these areas for support of plant, fish, and wildlife species.

Objective

Place 50,000 acres of wetland and floodplain habitats in public ownership over the next 20 years. Include in this total both large tracts of land and small parcels not traditionally managed by public entities.

Action HP-5: Acquire and protect quality wetlands.

Objective

Develop economic incentives that would encourage landowners to protect wetlands from development.

Action HP-6: Develop economic and tax incentive programs to protect wetlands.

Goal

Restore and create colonial bird nesting sites. Restore deteriorated colonial bird nesting sites and create new islands where nesting habitat is inadequate.

Objective

Improve and protect habitat on ten major colonial bird nesting sites of the Galveston Bay system within five years.

Action HP-7: Facilitate bird nesting on existing sites.

Objective

Create two additional bird nesting islands within ten years.

Action HP-8: Build nesting islands using dredged materials.

Priority Problem

High erosion rates and loss of vegetation. Some bay shorelines are subject to high rates of erosion and loss of stabilizing vegetation due to past subsidence/sea level rise and current human impacts.

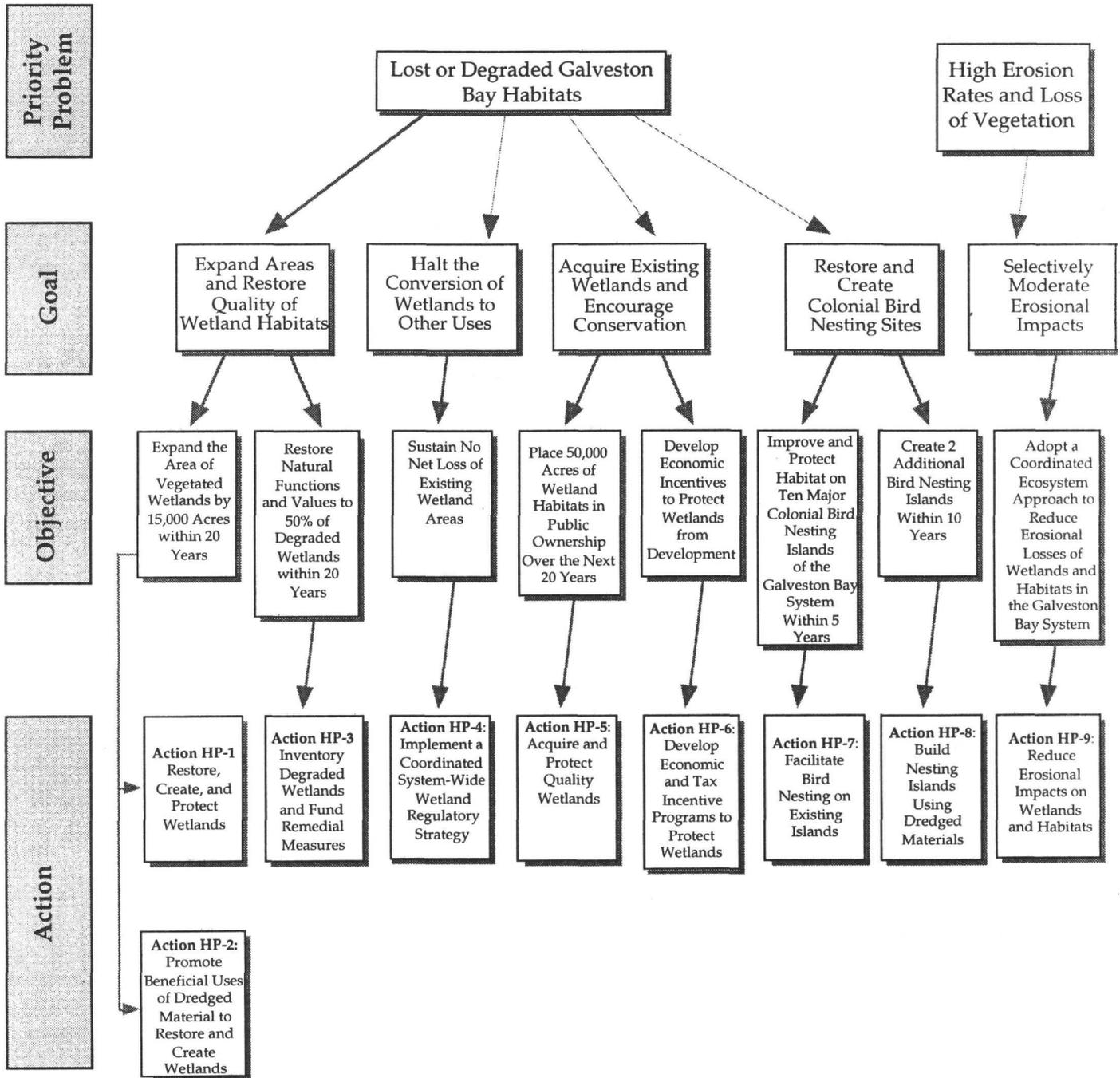
Goal

Selectively moderate erosional impacts. Selectively moderate erosional impacts to the bay and associated shorelines.

Objective

Adopt a coordinated ecosystem approach to reduce erosional losses of wetlands and habitats in the Galveston Bay system.

Action HP-9: Reduce erosional impacts on wetlands and habitats.



Habitat Protection Action Flowchart

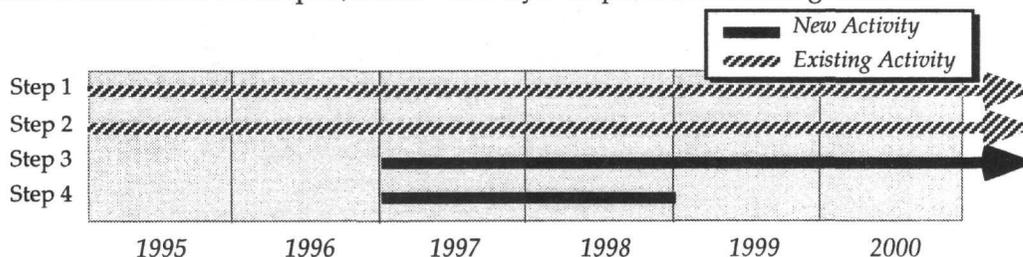
ACTION HP-1: Restore, Create, and Protect Wetlands

What Implement a wetland habitat restoration, creation and enhancement program to create or restore 15,000 acres of vegetated marine, estuarine, and shoreline wetlands within 10 years. Specific targets: a) 1,400 acres of submerged aquatic vegetation; b) 5,000 acres of fresh marsh; and c) 8,600 acres of estuarine emergent marsh.

How

- Step 1 TPWD, SCS, Corps, USFWS, and NMFS will create, restore, and protect wetlands and sea grasses utilizing proactive efforts such as Partners for Wildlife, Coastal Wetlands Planning Protection and Restoration Act (Breaux Bill), Department of Agriculture Wetland Reserve program, GBNEP, beneficial uses of dredged material, and other programs. Projects on state lands will require the approval of GLO.
- Step 2 TPWD and GLO will pursue ONRW through the TNRCC and other means of protection for excellent/high quality aquatic habitats. Utilize TPWD and GLO authorities to avoid adverse effects to submerged aquatic vegetation beds in Christmas Bay. Consider buoys to define a boat-free zone to eliminate damage from boat props, and consider eliminating clamming in submerged grass beds. Consider establishment of additional coastal preserves.
- Step 3 TPWD, USFWS, and GLO will increase public outreach and education to encourage habitat conservation practices: 1) coordinate and increase state, federal and private education programs to deliver a consistent message and maximize use of these limited resources; 2) improve recognition of businesses, governments, and individuals who promote and practice habitat conservation; 3) encourage cooperative education and awareness efforts between industry and government entities; 4) identify opportunities for hands-on experiences for the public to become involved (including using volunteers and inmates for labor-intensive cord grass planting). Balance effectiveness of marsh creation after accounting for all relevant factors such as wind, waves, depth, vessel traffic, etc.
- Step 4 TPWD, NMFS and National Biological Survey (NBS) will research the causes of seagrass loss (including water quality) and techniques to restore submerged aquatics. Evaluate the effectiveness of various marsh creation and enhancement techniques, such as thin layer disposal on subsiding marshes.

When



Where Galveston Bay Program Area

Who Lead entity: GLO, TPWD, USFWS, NOAA, and Corps. Other participants: NMFS, SCS, private conservation groups, private landowners, and citizens. Role of Galveston Bay Program: Coordinate by providing education, advocacy, and monitoring and reporting of progress.

Public Costs of New Actions (5 years)

• TPWD.....	\$ 1,133,750	• Program	\$ 37,500
• GLO	\$ 125,000	• Other	\$ 3,000,000
TOTAL.....		\$ 4,296,250	

Beneficial uses of dredged material resulting from federal navigation projects require non-federal cost sharing. Possible Sources of Funding: USDA, NOAA, Corps, USFWS, USGS, EPA, DOT, and The Nature Conservancy.

Regulatory Issues Review and change existing federal, state, and local regulations which discourage habitat creation and restoration initiatives (e.g., liabilities).

Related Actions: HP-4 and HP-2.

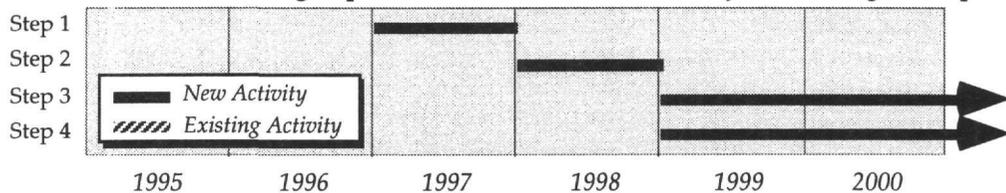
ACTION HP-2: Promote Beneficial Uses of Dredged Material to Restore and Create Wetlands

What Develop a beneficial uses program for dredged material which 1) includes viable mechanisms for funding added costs of handling and processing material; and 2) encourages the beneficial disposal of dredged material.

How

- Step 1 Corps will establish a permanent Interagency Coordinating Committee (ICC) modeled on the Houston Ship Channel Beneficial Uses Group (BUG):
- Step 2 ICC will develop a *Comprehensive Dredged Material Management Plan* for the Galveston Bay estuary. *The Plan* will be a comprehensive construction and management program for federal navigation projects that recognizes the resource value, and minimizes the potential environmental impacts, of the dredged material. *The Plan* will address tasks listed in Step 3 below; items from HP-8, and HP-9, and other actions in *The Galveston Bay Plan* that deal with the use of dredged materials. The ICC will coordinate with developers of the state's Coastal Wetlands Conservation Plan (TNRCC, TPWD, and GLO) as they develop their comprehensive, long-term management strategy for dredging and disposal of dredged material.
- Step 3 Once plan is complete the ICC will implement the following tasks: a) review all new and maintenance dredging within the context of current authority; b) conduct a comprehensive bay-wide beneficial uses inventory; c) oversee impact studies that address species habitats, flood protection, and shoreline issues; d) continue to support development and verification of predictive models to assess impacts of circulation and salinity changes (e.g., effects of Texas City Dike); e) coordinate comprehensive disposal planning and improvement in disposal techniques; f) balance amount of available dredged material with amount of fill required for projects; g) develop an advanced testing program to determine existence of geographic distribution of contaminants for project-by-project dredging/filling in order to manage contaminated sediments safely; h) establish beneficial uses of dredged materials; and i) work with conservation groups to generate public support for implementation of beneficial uses of dredged material.
- Step 4 Corps will seek additional funding required to meet federal consistency and management plan criteria.

When



Where Galveston Bay Program Area.

Who Lead entity: Corps and agencies serving on the ICC. Other participants: GLO, TXDOT, TNRCC, TPWD, and local sponsors. Role of Galveston Bay Program: Tracking and reporting progress. Advocate increasing Corps budget to develop beneficial uses program.

Public Costs of New Actions (5 years)

• ICC.....	\$ 150,000	• Program	\$ 6,750
• Others	\$ 262,500		
TOTAL.....		\$ 419,250	

Non-federal cost share could be substantial. Increased dredged material disposal costs must be addressed in congressional authorization and appropriation. Possible Sources of Funding: USDA, NOAA, Corps, USFWS, USGS, and EPA

Regulatory Issues None identified at this time.

Related Actions: FW-7, HP-4, HP-1, HP-8, HP-10, WSQ-1, WSQ-2, and WSQ-3.

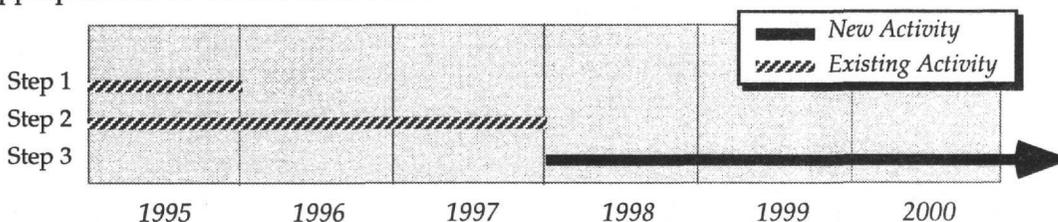
ACTION HP-3: Inventory Degraded Wetlands and Fund Remedial Measures

What Inventory degraded wetlands, identify the causes of deterioration, and fund remedial measures for restoration of 20 percent of degraded wetlands within 20 years. Such measures will include re-establishing sediment sources, restoring hydrology, and others as appropriate.

How

- Step 1 USFWS will take the lead and coordinate with other resource agencies to develop a definition of a degraded wetland for use in inventory and ranking. Higher quality wetlands such as coastal marshes will be emphasized over wetlands in stormwater ditches and impoundments.
- Step 2 USFWS, TPWD, and NMFS will complete an estuary-wide inventory of habitat, and rank degraded habitats in order of increasing need for remediation under existing legal mandate.
- Step 3 USFWS, SCS, National Biological Survey (NBS), NMFS, TPWD, and GLO will evaluate the effectiveness of various marsh creation and enhancement techniques, such as thin layer disposal of dredged materials on subsiding marshes. Evaluate the techniques employed for marsh restoration and creation and prepare a descriptive list of the relative effectiveness of each. Enhance degraded wetlands through restoration of natural functions and values. Work with conservation groups to generate public support for state and federal appropriations for habitat restoration.

When



Where Galveston Bay Program Area.

Who Lead entity: USFWS, NBS, private landowners. Other participants: GLO, TPWD, Corps, NMFS, SCS, and EPA. Role of Galveston Bay Program: Tracking.

**Public Costs of
New Actions (5 years)**

• TPWD.....	\$ 45,750	• USFWS.....	\$ 45,750
• Program	\$ 11,250	• Others	\$ 183,000
TOTAL.....		\$ 285,750	

Unable to estimate cost of remedial measures until after inventory completed. Possible Sources of Funding: USDA, NOAA, Corps, USFWS, USGS, EPA, and DOT.

Regulatory Issues Review and change existing state, and local regulations which discourage habitat creation and restoration initiatives.

Related Actions: HP-5, HP-4, HP-2, and NPS-3.

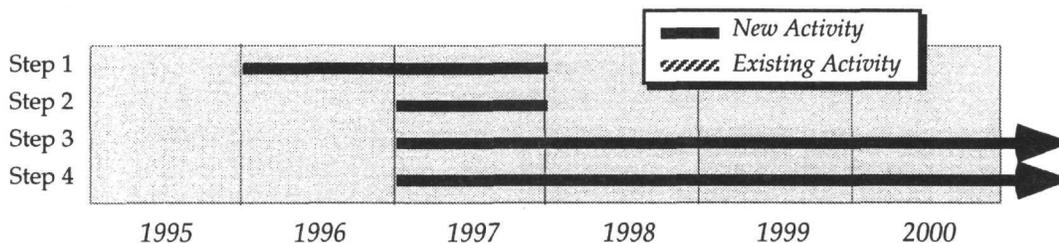
ACTION HP-4: Implement a Coordinated System-Wide Wetland Regulatory Strategy

What Implement a coordinated and effective system-wide wetland habitat regulatory program to 1) minimize licensing uncertainty; 2) provide for appropriate mitigation and monitoring by the permittee; 3) standardize mitigation guidelines/criteria; 4) provide for expanded enforcement oversight and improved enforcement by regulators; and 5) eliminate federal economic support for activities not meeting consistency criteria.

How

- Step 1 TNRCC will adopt water quality standards to strengthen Section 401 permit certification criteria for wetlands. Monitoring (with citizen involvement when appropriate) should be conducted to follow-up on all issued Section 10 and Section 404 permits for compliance with permit stipulations and to assess the effectiveness of mitigation.
- Step 2 GLO will coordinate an effort for federal and state resource agencies (EPA, Corps, USFWS, NMFS, GLO, TPWD, and TNRCC) to agree on an MOU to standardize mitigation criteria, policies, and requirements. The MOU will address acceptable wetlands assessment methodologies, mitigation banking, mitigation ratios, reporting requirements, CMP consistency, and special measures such as performance bonds. Reassess which Nationwide permits are appropriate for regionalization.
- Step 3 EPA will investigate use of advanced identification provisions of 40 CFR 230.80 to carefully evaluate the granting of new Section 10/401 permits in sensitive areas or other areas unsuitable for development.
- Step 4 FEMA and HUD will evaluate actions with federal consistency criteria to ensure that habitat protection is considered as a priority in the implementation of flood control management and issuance of federal flood insurance and other economic supports for development in floodplains and other identified sensitive zones. (Note: TWDB and FEMA have been studying the Trinity River floodplain for the past two years with the objective of eliminating flood insurance in the flood prone sites by buying out the willing sellers).

When



Where Galveston Bay Program Area

Who Lead entity: Corps, EPA, FEMA, USFWS, TPWD, TWDB, TNRCC, NMFS, HUD, GLO, HGAC, RRC, private citizens. Role of Galveston Bay Program: Coordinate by monitoring and reporting progress.

**Public Costs of
New Actions (5 years)**

• GLO	\$ 86,250	• Program....	\$ 37,500
• TNRCC	\$ 123,750	• Other	\$ 72,000
TOTAL.....		\$ 319,500	

Possible Sources of Funding: NOAA, Corps, USFWS, and EPA Office of Water.

Regulatory Issues Generate an MOU as described above. Water quality standards and 401 certification can also be used to assure minimal protection of wetlands.

Related Actions: HP-5, HP-6, HP-1, HP-2, HP-3, HP-7, HP-8, NPS-2, NPS-11, and PPE-5.

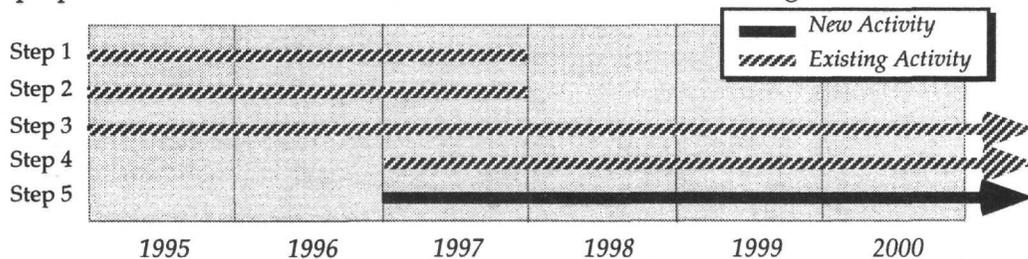
ACTION HP-5: Acquire and Protect Quality Wetlands

What Identify highest priority aquatic wetlands throughout the watershed which can be protected by public ownership or through permanently protected status by private entities. Expand state and federal programs to acquire 1) these high priority tracts, 2) other tracts of habitat and non-developmental easements, 3) smaller blocks of habitat, and 4) non-traditional areas such as wading bird and fisheries habitats. Encourage habitat acquisition by private conservation organizations and voluntary conservation programs by land owners.

How

- Step 1 USFWS, TPWD, GLO, and EPA will conduct a detailed inventory of coastal aquatic habitats (all coastal aquatic habitats, not just jurisdictional wetlands) and an accompanying quality assessment, particularly for habitats interspersed with or in close proximity to development. Habitats will be ranked for acquisition based on this inventory. As part of the state's Coast Wetlands Acquisition Act, GLO will work with the TPWD in certifying coastal wetlands most essential to the public interest and assign priorities for acquisition. In addition, GLO, TPWD, EPA, and other agencies will develop the Coastal Wetlands Priority Acquisition Plan, which will 1) create a framework, criteria, and guidance for identifying key wetlands, 2) identify key wetlands, and 3) identify possible funding sources.
- Step 2 TPWD, GLO, and GBP will examine methods of raising or securing funds for habitat acquisition on a statewide and local level. Private conservation groups will be included in fund raising process and in the generation of public support for state and federal appropriations for habitat acquisition. All appropriate federal and state funding programs will be investigated for acquisition and mgt. of wetlands.
- Step 3 TPWD and USFWS will expand private cooperative joint acquisition and management programs with state and federal entities.
- Step 4 TPWD, USFWS, and National Park Service will elevate acquisition in the estuarine wetlands and bottom land forested habitats of the San Jacinto River and Trinity River floodplains to a higher level of priority.
- Step 5 Corps will utilize provisions in the Water Resources Development Act of 1986 for habitat acquisition. Acquired properties will be turned over to USFWS and/or TPWD for management.

When



Where Galveston Bay Program area.

Who Lead entity: TPWD, USFWS, GLO. Other participants: Corps, National Park Service, EPA, NMFS on a consulting basis), private sector, and private conservation groups. Role of Galveston Bay Program: Coordinate by providing advocacy at the state and federal level.

Public Costs of New Actions (5 years)

• TPWD	\$ 1,584,375	• Program ...	\$ 99,750
• USFWS	\$ 1,537,500	• Other	\$ 3,046,875
TOTAL.....		\$ 6,268,500	

Market value of wetlands and floodplain habitat ranges from \$300 to \$750 per acre. Significant public and private costs may be involved in acquiring tracts of land from land owners willing to sell. Possible Sources of Funding: USDA, NOAA, USFWS, USGS, NPS, EPA, DOT, and The Nature Conservancy.

Regulatory Issues Congressional authorization and appropriation will be required for federal funding appropriations to acquire wetlands.

Related Actions: HP-4.

ACTION HP-6:

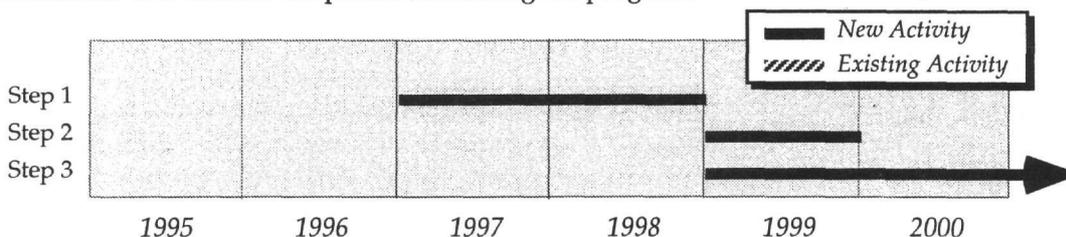
Develop Economic and Tax Incentive Programs to Protect Wetlands

What Develop and implement an ad valorem tax incentive and development disincentive program to be administered by a local government entity. Heighten awareness of existing economic incentives that would encourage aquatic habitat protection to ensure that people are not taxed for highest and best use for property. Seek to put into place a "Wetlands Exemption" (like an agricultural exemption), thereby reducing tax liability for leaving wetlands in their natural state.

How

- Step 1 Local governments will conduct studies to explore use of ad valorem tax incentive and other existing economic incentives that would encourage aquatic habitat protection (primarily freshwater and saltwater emergent wetlands and forested wetlands).
- Step 2 Local governments with support from state natural resource agencies and the Galveston Bay Council will sponsor legislation to implement the program, and solicit public opinion. Note that Proposition 2, which is an ad valorem tax relief measure currently in development, includes wetlands on the current draft list of qualifying properties.
- Step 3 Local governments will educate the public concerning the program.

When



Where Galveston Bay Program Area

Who Lead entity: Local governments. Other participants: GLO, TPWD, Galveston Bay Council, private sector, and private conservation groups. Role of Galveston Bay Program: Coordinate by educating private landowners about programs and advocating for positive legislative changes.

Public Costs of New Actions (5 years)

• TPWD.....	\$ 80,000	• Program .	\$ 22,500
TOTAL.....		\$ 102,500	

Decreased tax revenues and increased indirect private costs may result from less intensive land development. Individuals would experience some tax relief and benefit from incentive programs. Possible Sources of Funding: USDA, Corps, SCS, NOAA, USFWS, and NPS.

Regulatory Issues New tax incentives may require legislation or regulation. The Federal Assistance Program (Water Bank Program) will reward the property owner for preserving wetlands. A definition of wetlands applicable to this initiative would need to be developed or adopted.

Related Actions: HP-4 and HP-1.

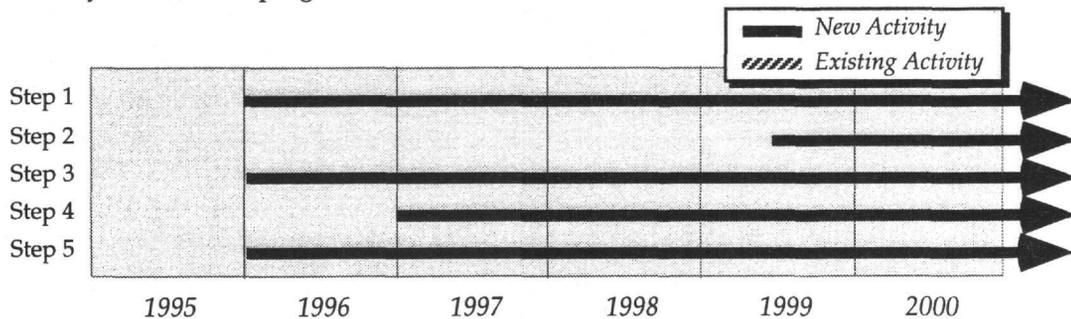
ACTION HP-7: Facilitate Bird Nesting on Existing Sites

What Induce more intensive and dependable bird use of existing islands by regrading the islands to maintain minimum required elevations above sea level, managing the vegetation, and placing signs warning people to stay away from these islands, particularly during the nesting season.

How

- Step 1 USFWS and TPWD will improve coordination with and aid to private groups for erecting signs, providing protection, conducting research, and improving habitats. Habitats include both islands and beaches such as Bolivar Flats and San Luis Pass (important to least terns and black skimmers). Monitor populations on managed islands at frequencies sufficient to determine if proposed actions are successful in increasing bird nesting on these islands.
- Step 2 USFWS and TPWD will promote beneficial uses of dredged material to restore, enhance, or create suitable bird nesting islands.
- Step 3 USFWS and TPWD will improve enforcement of existing state and federal statutes protecting colonial nesting birds. Increase public education regarding existing laws, i.e., Migratory Bird Treaty Act.
- Step 4 USFWS and TPWD will explore and promote the use of Corps Section 1135 (Water Resources Development Act of 1986) and Section 204 (of the 1992 Water Resources Development Act) funds for bird rookery and foraging habitat improvements.
- Step 5 USFWS and TPWD will use existing programs (i.e., North American Waterfowl Management plan, Breaux Bill, Partners for Wildlife) and foster partnerships with National Audubon Society, Ducks Unlimited, etc., to secure funding and help for restoration and creation of bird nesting islands (to induce more intensive and dependable bird use). Enlist the aid of concerned citizen groups to participate in the actions necessary to make this program a success.

When



Where Bird nesting islands and other sites within the Galveston Bay estuary.

Who Lead entity: TPWD, USFWS, and GLO. Other participants: Private organizations and interested citizens.
Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• TPWD.....	\$ 143,500	• USFWS	\$ 37,500
• Program	\$ 11,250		
TOTAL.....		\$ 192,250	

Use of volunteers and private groups for some of this work will help reduce costs. Section 1135 projects require a 25 percent non-federal cost-sharing sponsor. Possible Sources of Funding: NOAA, Corps, and USFWS.

Regulatory Issues No regulatory needs were identified for this action.

Related Actions: HP-8 and SP-1.

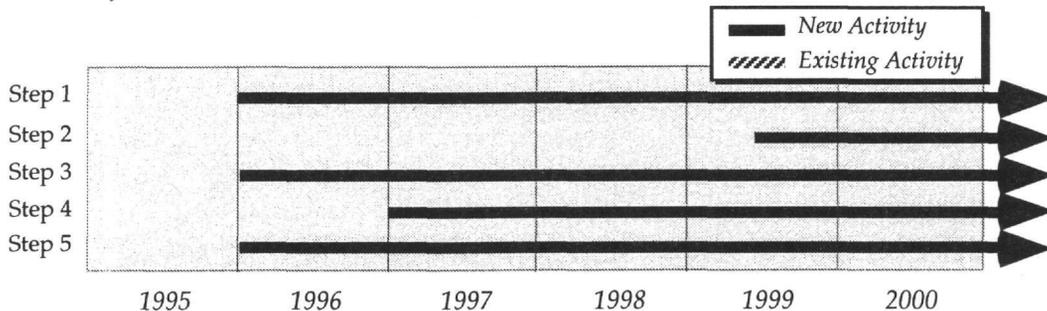
ACTION HP-8: Build Nesting Islands Using Dredged Material

What Use dredged material from public or private activities to build islands at a location and of a size amenable to colonization, and where there is a demonstrated need (i.e., underutilized feeding habitat).

How

- Step 1 Corps will improve operations and maintenance coordination on methods for using dredged material on existing bird rookery islands.
- Step 2 Corps will promote beneficial uses of dredged material to restore, enhance, or create suitable bird nesting islands (some may be part of Houston Ship Channel beneficial uses plan). Monitor concentrations of hazardous/toxic constituents potentially present in dredged materials.
- Step 3 Corps will explore and promote the use of Section 1135 (Water Resources Development Act of 1986) and Section 204 (of the 1992 Water Resources Development Act) funds for bird rookery and foraging habitat improvements.
- Step 4 USFWS and TPWD will use North American Waterfowl Management plan, Breaux Bill, Partners for Wildlife, National Audubon Society, Ducks Unlimited, etc., to secure funding for creation and restoration of nesting islands. Monitor bird populations on new islands to determine if proposed actions are successful in increasing bird use of these islands. Monitor stability of islands and recommend remedial actions if necessary.

When



Where Bird nesting islands within the Galveston Bay estuary.

Who Lead entity: USFWS, Corps, and GLO. Other participants: Local dredging sponsors. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• TPWD.....	\$ 17,500	• Corps	\$ 37,500
• Program	\$ 11,250		
TOTAL.....		\$ 66,250	

Beneficial uses (such as bird islands) associated with federal projects require a non-federal cost share. Possible Sources of Funding: NOAA, Corps, USFWS, EPA, and appropriate project sponsors.

Regulatory Issues Appropriate permits will be necessary for dredging activities needed to complete this action. Houston Ship Channel project requires congressional authorization and appropriation.

Related Actions: FW-7, HP-2, and WSQ-7.

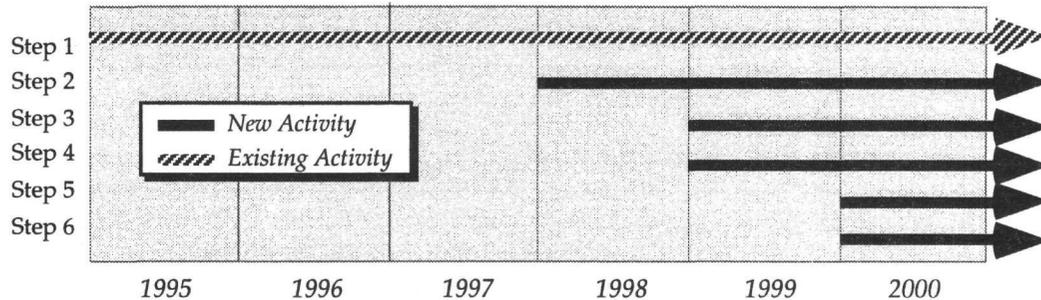
ACTION HP-9: Reduce Erosional Impacts on Wetlands and Habitats

What Establish an integrated bay-wide erosion management program to develop, apply and publicize methods for erosion prevention for wetlands and bay habitats.

How

- Step 1 HGCS D will manage the subsidence that contributes to erosion by continuing conversion from groundwater to surface water and aggressively promoting conservation in coordination with the Subsidence District programs.
- Step 2 GLO, SCS, and others will establish a bay-wide survey and ranking system for erosion problems. Use the data obtained to ground truth erosion rates implied by aerial photography.
- Step 3 SCS and others will pursue nonstructural methods to prevent erosion (i.e., planting of marsh grasses and the use of dredged material disposal to create salt marshes).
- Step 4 GLO will establish and publicize economic and legal incentives for non-structural shoreline management, i.e., mitigation banking, tax incentives, adopt-a-marsh programs.
- Step 5 GLO and TPWD will study the effects of sand and gravel mining on erosion. As indicated by research, improve management of riverine sediments where technically, economically, and environmentally feasible during the construction and review process for new reservoirs or surface impoundments (see also Action FW-5).
- Step 6 GLO will investigate means to reduce erosion and restore eroded fringing marsh in sensitive areas of the bay such as Christmas Bay where the width of the Intracoastal Waterway (GIWW) has been increased by erosion. Research the correlation between magnitude and rate of shoreline erosion to hull configuration, draft, speed, and other appropriate factors for vessels commonly using the bay. Perform a wind wave analysis to distinguish between a ship wake and wind wave erosion problem. Evaluate wake damage caused by recreational vessels, and implement boater education and enforcement to prevent boat-related erosion problems.

When



Where Galveston Bay Program shoreline.

Who Lead entity: SCS and GLO. Other participants: UT, BEG, Corps, Sea Grant, NMFS, TPWD, TWDB, USFWS, NBS, TNRCC, Bureau of Reclamation, USCG, San Jacinto River Authority, and Trinity River Authority, Subsidence District. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• TPWD\$ 25,250	• GLO\$ 200,250
• Program\$ 11,250	• SCS\$ 100,000
TOTAL.....\$ 336,750	

Costs of erosion prevention may be offset by reduced property losses. Costs not available for existing subsidence management program. Possible Sources of Funding: USDA, NOAA, Corps, USFWS, USGS, EPA, and DOT.

Regulatory Issues Standards for erosion may be appropriate for inclusion in Wetland General Permits.

Related Actions: FW-2, FW-5, FW-6, HP-1, NPS-1, NPS-2, NPS-3, and NPS-6.

Species Population Protection

The Galveston Bay Plan Galveston Bay National Estuary Program

OVERVIEW OF THE ACTIONS

<u>Action</u>	<u>Priority</u>	<u>Description</u>	<u>Page</u>
SP-1	Medium	Implement a bay-wide effort to strengthen species management	64
SP-2	Medium	Return oyster shell to designated locations within the bay	65
SP-3	Medium	Promote the development of oyster reefs using alternate materials.....	66
SP-4	Medium	Set aside a portion of reef habitat as scientific research areas or preserves.....	67
SP-5	Medium	Encourage continued development of gear to reduce commercial by-catch.....	68
SP-6	Medium	Conduct educational programs about catch and release.....	69
SP-7	Medium	Investigate potential measures to reduce impingement and entrainment.....	70
SP-8	Medium	Develop management plans for endangered or threatened species.....	71
SP-9	Low	Improve enforcement of prohibitions against introduction of exotic species	72
SP-10	Low	Identify and implement techniques for the control of problem exotic species.....	73

THE ISSUES

The overall health of the Galveston Bay estuary, as measured by its diversity of species and the populations of its major recreational and commercial species, is generally considered to be fair to good. However, some species within the estuary have experienced declines, with the primary suspected causes identified as loss of habitat, fishing, impingement and entrainment, and other types of human intervention. There is concern that these conditions may cause declines in other species. Because species within the estuarine environment are dependent on one another for maintenance of the food chain, the preservation of species populations is critical to the ecological health of the Galveston Bay system. Preservation of habitat is the most essential requirement for effective protection of species populations, as the fate of species is closely linked to that of habitat. The numerous species that depend on the various habitats provided by this estuary require a broad habitat management perspective which encompasses the entire ecosystem to ensure that the variety and distribution of habitats are fully protected.

In order to facilitate adoption of a regional ecosystem perspective towards species population protection, the species protection initiatives recommended by *The Plan* include:

- **Species Conservation:** Several actions are nominated to reverse the declining population trends for marine organisms and birds. These actions include strengthening species management efforts, developing management plans for endangered and threatened species, promoting favorable habitat conditions for oysters, and increasing efforts to reduce by-catch, impingement, and entrainment.
- **Species Protection:** Initiatives are endorsed by *The Plan* to reduce the threat to native species and habitats posed by the introduction and proliferation of exotic species. The development of legislation to regulate importation of exotic species and of effective control measures for detrimental exotic species are proposed.

ENVIRONMENTAL STATUS

Status and Trends

The Galveston Bay Estuary is an extremely productive and biologically diverse ecosystem. The estuary produces the largest shellfish catch on the Texas coast, is inhabited by at least 162 species of finfish, and serves as the home or as an important feeding and resting stop for many species of birds. Due to the interaction between species in maintenance of the food chain, biodiversity of the ecosystem is essential to the continued health of the Galveston Bay System. However, the many uses of the Galveston Bay Estuary inevitably pose potential threats to the survival of many estuarine species.

General

Based on recent studies of the estuary, the overall health of living resources in the Galveston Bay Estuary is fair to good. There are no observed wholesale declines in species population abundance, and the number of species in different trophic levels indicate that energy and material movement through the food chain is occurring more or less naturally. There have been significant increases in some populations, including American alligator, red drum, spotted seatrout, Atlantic croaker, black-bellied plovers, willets, sanderlings, western sandpipers, olivaceous cormorants, and brown pelican. These increases indicate that the ecosystem is still functional and that species management programs, in general, are working.

However, long-term population declines in striped bass, green turtle, and diamondback terrapin have occurred, and recent population declines have been observed for white shrimp, blue crab, mottled ducks, northern pintail, blue-winged teal, and several species of near-shore feeding colonial water birds. Phytoplankton abundance has varied widely since the late 1950s, first increasing significantly and then decreasing for reasons not well understood at this time, but possibly linked to lower nutrient loadings associated with improved wastewater treatment. In addition, the long-term decline in wetlands acreage, which serves as a critical habitat and nursery for many aquatic species, if not stopped, holds a potential threat to the health of this estuary.

By-Catch

The commercial harvest of shellfish, recreational fishing, urban development, and industrial activities continue to put significant pressure on the renewable resources of the estuary. The annual 3.5-million pound shrimp harvest from the Galveston Bay System impacts finfish and other aquatic invertebrates of commercial or ecological value by generating "by-catch", the unwanted or untargeted portion of the shrimp trawler's catch. Although significant variation by season was noted, a recent study conducted during 1992 showed the overall weight of finfish captured by shrimp trawlers to exceed shrimp landings by a factor of 2.6. Relatively few recreational species were caught by trawls, except for spot, Atlantic croaker, and sand seatrout. An assessment of the ecological damage resulting from trawling by-catch is complicated by a shortage of data regarding the survival rates of the by-catch organisms returned to the bay.

Recreational fisherman catch and release approximately two fish for every fish landed, with the annual catch-and-release total estimated at 1.2 to 3.5 million fish per year in the Galveston Bay Estuary. Again, little data is available regarding the survival rates of the released fish, although available literature suggests that up to 30 percent of released spotted seatrout die from related injuries or stresses within seven days of release.

Impingement

The impingement of fish and crustaceans at the cooling water intakes of power generating stations bordering Galveston Bay represents an additional source of fish mortality. An estimated 32 million organisms, representing a total biomass of 234,000 kg, are impinged per year into the cooling system of four power plants which have been evaluated. Studies indicate that most impinged organisms survive, with survival rates for crustaceans ranging from 30 to 95 percent, and survival rates for fish ranging from 10 to 90 percent. However, considerable uncertainty is included in this estimate of survival rate, which may be considerably lower under typical operating conditions. Commercially and recreationally important species such as spotted seatrout, black drum, red drum, and southern flounder were infrequently impinged.

Other Aquatic Losses

Numerous fish kills, due to accidental spills, wastewater releases, seismic detonation, and storm water runoff, have been reported within the Galveston Bay Estuary and associated tributaries. Finally, natural causes, such as freezes, red tides, droughts, storms, etc., are major factors in the variation of species populations over time.

Oysters

Overall, Galveston Bay appears to have grown substantial oyster reefs in the last 20 years, although data is not available to definitively characterize the size or health of the current oyster population compared to previous periods. The location and mechanisms of reef accretion suggest that natural responses to changes in circulation and salinity by the oyster population are primarily responsible for this increase, rather than the direct production of new reef habitat by human activities. Some reef growth has been attributed to the transport of oyster shell off reef edges onto the surrounding bay bottom by oyster harvesters and

leaseholders. Within the bay, projects are currently underway to create additional reef habitat using alternate materials, such as coal combustion by-products, as reef substrate.

Birds

Observers have noted 139 bird species that are associated with Galveston Bay wetlands and open-bay habitats. Based upon the limited available data, the total number of colonial water birds appears to have remained relatively stable since the early 1980s. The number of active colonies, consisting of gravel and shell bars, marshes, cypress stands, dredged material islands, and industrial and developed locations, have increased from 20 in 1973 to 42 in 1987. Although the total number of these birds appears to have remained constant, there are now fewer wading marsh feeders, perhaps due to the overall decline in wetlands acreage. The loss of these marsh birds has been accompanied by an increase in open-bay feeders.

Brown pelicans, an endangered species which declined in the 1960s due to toxicity and bioconcentration of pesticides, have shown increases in Galveston Bay over the past few years, probably because of a reduction in pesticide pollution. Other threatened or endangered bird species present in the Galveston Bay system include the piping plover, Eskimo curlew, interior least tern, bald eagle, peregrine falcon, and wood stork.

Endangered Species

Sea turtles were once present in the bay in relatively large numbers, and supported a commercial fishery in Galveston in the 1890s. Today the following sea turtles that reside in Texas waters have been identified as threatened or endangered species: the leatherback sea turtle, Kemp's ridley sea turtle, loggerhead sea turtle, and the green sea turtle. Apparent long-term declines in the population of diamondback terrapin and green turtle populations have been observed in the Galveston Bay Estuary (at one time a commercial turtle fishery operated in the Galveston Bay area). Little is known about the behavior and habitat selection of Texas sea turtles. Currently the National Marine Fisheries Service (NMFS) is using satellite, radio, and sonic tracking of sea turtles in estuarine and offshore waters to provide more data on turtle biology.

Exotic Species

In many locations worldwide, the introduction of exotic species has had a dramatic impact on the ecology of estuarine systems. For example, within San Francisco Bay, the unintentional introduction of the Asian marine clam *Potamocorbula amurensis* has resulted in a ten-fold reduction in the phytoplankton levels within a two year period and has caused a potentially catastrophic disturbance of the estuarine food web. The development of faster cargo ships and increased worldwide trade has heightened the potential for such unintentional introductions of harmful species. Within the Galveston Bay Estuary, the introduction and proliferation of exotic opportunistic species has also contributed to the degradation of some portions of the estuarine habitat. Significant populations of nutria, a large beaver-like rodent which strips vegetation within freshwater and brackish water marshland, and grass carp, which strips aquatic vegetation, have been reported in the Trinity River and San Jacinto River portions of the estuary. The encroachment of fire ants into the estuarine ecosystem poses an increasing threat to nesting bird populations.

Probable Causes

In the analysis of species population decline, it can be difficult to separate the effects of human activities on estuarine species from climatic and other naturally-induced cycles. For blue crab, one of two commercial species for which chronic population declines have been identified, commercial harvest appears to be a factor in population decline.

For white shrimp, the other species for which chronic population declines have been identified, a significant population decline was observed from 1982 through 1990, leading to concern about the condition of the white shrimp population. Similar declines were noted in the Aransas, Corpus Christi, and Laguna Madre estuaries. This long term trend of population decline was reversed in 1991, when sampling results exhibited a rebound to 1983 population levels (see Figure SP-1). This rebound is probably the result of increased freshwater inflow due to extremely wet conditions in 1990 and 1992, and management regulations implemented in 1990 that prohibit harvesting of white shrimp during two summer months. In the case of both blue crab and white shrimp, the relative effect of human activities versus that of naturally-induced cycles on species population is difficult to evaluate with certainty.

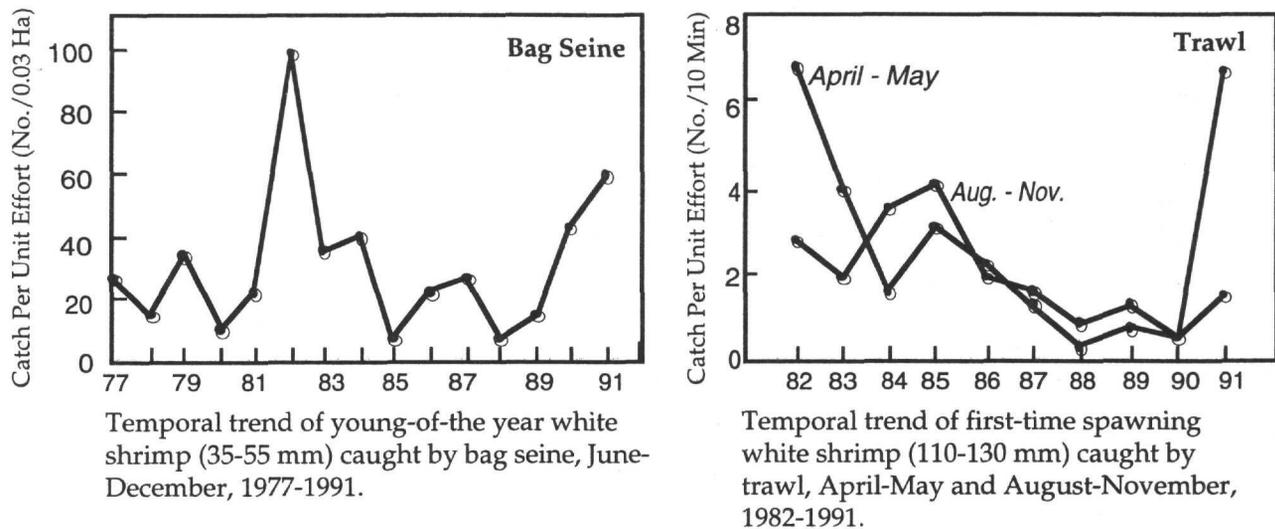


FIGURE SP-1: Temporal Trends for White Shrimp

The long-term health of species populations is dependent on the maintenance of essential wetlands habitat. Any decline of high-quality wetlands nursery habitat would certainly affect the fisheries of blue crab, white and brown shrimp, spotted seatrout, red drum, southern flounder, and other commercially and recreationally valuable species. In the Galveston Bay Estuary, a 19 percent loss in wetlands has occurred since the 1950s due to subsidence, conversion of land to other agricultural usage, and other human activities. Quantity and quality of habitat is the most important issue affecting bird populations and nesting patterns. For this reason, actions aimed at preserving estuarine bird populations are primarily addressed in the Habitat Action Plan.

Adequate freshwater inflows to the estuary are also essential to the long-term health of species populations within the Galveston Bay system. Freshwater inflows affect circulation, salinity regimes, and nutrient loading within the estuary, and are therefore critical for the maintenance of high-quality habitat. Circulation of water within the estuary, which can be affected by dredging and construction projects, is also essential to the preservation of salinity gradients and the health of species populations. Freshwater inflow and circulation issues are addressed in the Freshwater Inflow and Bay Circulation Action Plan.

MANAGEMENT STATUS

The U.S. Fish and Wildlife Service (USFWS) determines whether species are endangered or threatened in accordance with provisions of the Endangered Species Act (ESA). Any species that is proposed or listed as endangered or threatened is protected from removal, sale or distribution. The USFWS also develops plans for the recovery of federally listed endangered and threatened species.

The Fish and Wildlife Coordination Act requires USFWS to review federally funded or permitted activities that may affect an endangered or threatened species. USFWS is also responsible for improving and maintaining fish and wildlife resources through refuge management, disease and population distribution studies and enforcement of the ESA.

The National Oceanic and Atmospheric Administration National Marine Fisheries Service (NMFS) administers the ESA as it applies to marine fish and mammals. NMFS is responsible for the conservation, management, and development of marine resources and the protection of endangered marine species. Conservation and protection of habitats are also the responsibilities of the NMFS. The Fish and Wildlife Coordination Act requires the NMFS to comment on proposed federally funded or permitted activities that may have an impact on marine life and habitat. NMFS implements several other laws, including the Magnuson Fishery Conservation and Management Act, that are intended to prevent overfishing. Under the Magnuson Act, fishery management plans are required to be developed and implemented to maintain the optimum sustainable yield from certain marine fisheries.

The Texas Parks and Wildlife Department (TPWD) is the principal agency that establishes and enforces limits on the recreational and commercial harvest of species in the Galveston Bay estuary system. The Texas Parks and Wildlife Code provides the TPWD with the authority to preserve and protect the state's natural and coastal resources including fish and wildlife. TPWD programs include acquisition of land, management of fish and game resources, protection of species listed under the ESA, research on species populations, and designation of scientific areas. Under the Fish and Wildlife Coordination Act, TPWD also reviews and comments on federal permits potentially affecting the wildlife resources of Texas.

TPWD works with the Texas General Land Office (GLO) and private and public organizations in the Texas Coastal Preserve Program to protect coastal natural resources. The goals of the Coastal Preserve Program are:

- Protect fragile biological communities
- Protect unique coastal areas
- Identify methods for recognizing preservation and enhancement opportunities
- Actively involve all concerned and knowledgeable persons and organizations

Waterfowl management is also a responsibility of TPWD. The Department is involved in acquiring and managing waterfowl habitat and provides nesting boxes to enhance waterfowl reproduction. TPWD also conducts an urban and non-game wildlife management program, focusing on species such as songbirds.

TPWD works closely with USFWS to maintain an active program for the conservation of endangered and threatened species. The Resource Protection Division of TPWD maintains an inventory of all threatened and endangered species for potential listing under the ESA.

Species protection measures implemented by TPWD, USFWS, and NMFS have proven generally effective in protecting species populations from long-term or irreversible decline. In the case of white shrimp, a species for which a long-term decline was identified, shrimping in nursery areas was restricted in 1979, followed by a ban on shrimping in two summer months and a ban on springtime night shrimping in 1990. The white shrimp population has recently rebounded to historical levels. In response to declining populations of red drum and spotted seatrout, commercial sale was banned in 1981, net fishing was disallowed in 1988, and minimum and maximum size limits and daily bag limits for recreational fisherman were implemented in 1988. Because of these management actions, the red drum and spotted seatrout fisheries are exhibiting a rebounding population trend. The TPWD is currently considering new fishing limitations for blue crab, due to their apparent population decline within the Galveston Bay estuary system.

State advisory committees have also been established for shrimp, blue crab, and oysters. These committees periodically conduct public meetings to review fishery status and to consider initiatives for protection of these commercially important species.

SPECIES POPULATION PROTECTION ACTION PLAN

To assure the conservation, restoration, and enhancement of the total natural community of living species in Galveston Bay, both for the maintenance of balanced, indigenous populations which determine overall ecosystem health, and for the long-term vitality of human recreational and economic activities which depend on these renewable living resources.

OVERVIEW

Priority Problem

Certain species of marine organisms and birds (such as blue crab and birds classified as wading marsh feeders) have shown a declining population trend, with the primary suspected causes identified as loss of habitat, fishing, impingement, and other types of human intervention. Because species within the estuarine environment are dependent on one another for maintenance of the food chain, the preservation of species populations is critical to the ecological and economic health of the Galveston Bay system.

Goal

Reverse the declining population trend for affected species of marine organisms, and maintain the populations of other economically and ecologically important species.

Objective

At a minimum, maintain fish and crustaceans at population levels within 50 percent of the 1975-1985 mean.

Action SP-1: Implement a bay-wide effort to strengthen species management.

Objective

At a minimum, maintain oyster population levels within 50 percent of 1983-1993 mean levels.

Action SP-2: Return oyster shell to designated locations within the bay.

Action SP-3: Promote the development of oyster reefs using alternate materials.

Action SP-4: Set aside a portion of reef habitat as scientific research areas or preserves.

Objective

Reduce by-catch within the estuary by 50 percent by the year 2007, accounting for seasonal patterns.

Action SP-5: Encourage continued development of gear to reduce commercial by-catch.

Action SP-6: Conduct educational programs about catch and release.

Objective

Reduce current levels of fish mortality caused by impingement/entrainment by 50 percent by 2007.

Action SP-7: Investigate potential measures to reduce impingement and entrainment

Objective

Increase the populations of endangered and threatened species.

Action SP-8: Develop management plans for endangered or threatened species.

Priority Problem

Some exotic/opportunistic species (like nutria, grass carp, and fire ants) threaten desirable native species, habitats, and ecological relationships. Significant populations of nutria, a large beaver-like rodent which strips vegetation within freshwater and brackish water marshland, and grass carp, which strips aquatic vegetation, have been reported in the Trinity River and San Jacinto River portions of the estuary. The encroachment of fire ants into the estuarine ecosystem poses an increasing threat to nesting bird populations. The development of faster cargo ships and increased worldwide trade has heightened the potential for introductions of harmful species.

Goal

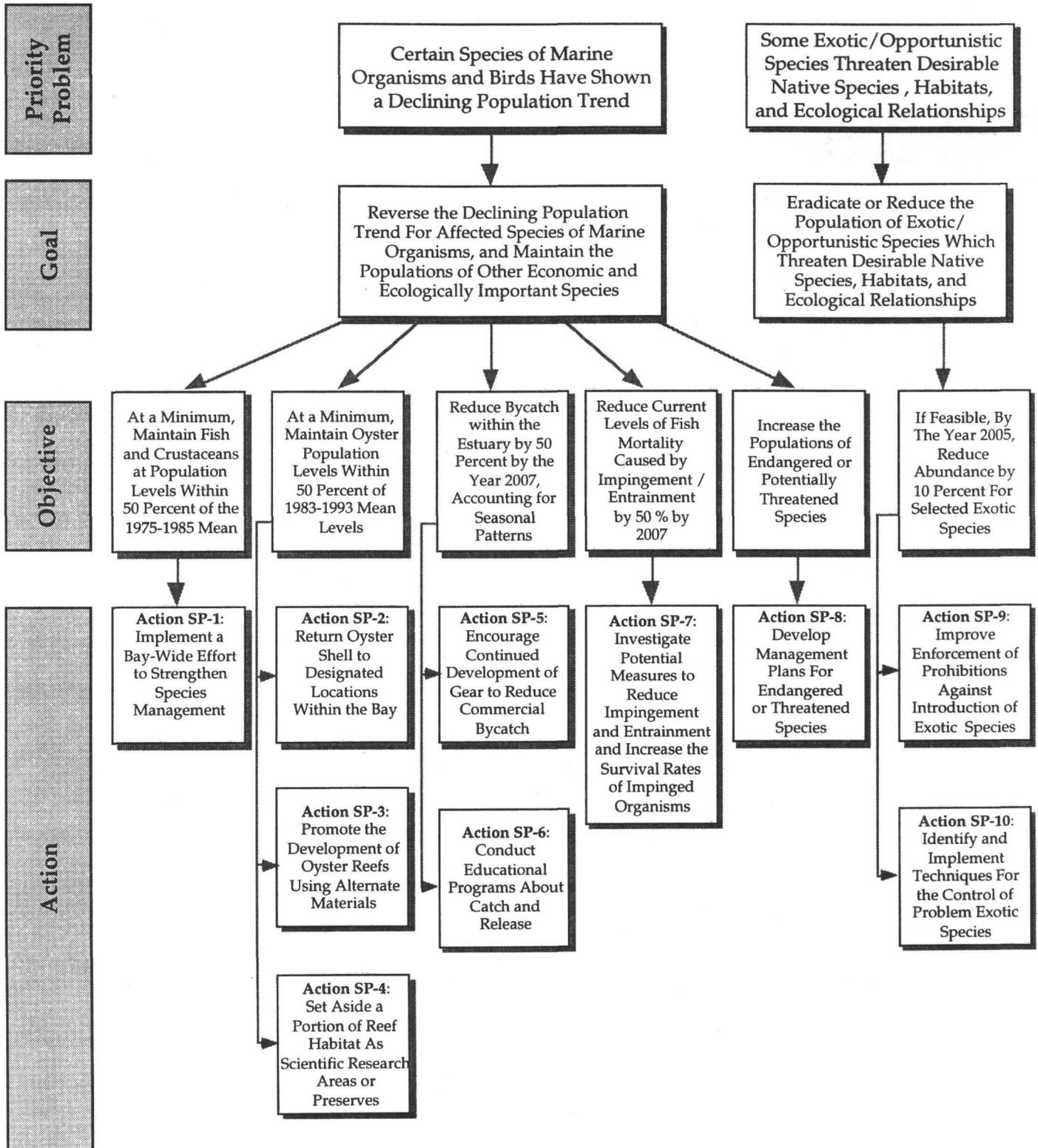
Eradicate or reduce the population of exotic/opportunistic species which threaten desirable native species, habitats, and ecological relationships. Prevent the introduction of additional exotic species.

Objective

If feasible, by the year 2005, reduce abundance by 10 percent for selected exotic species, including nutria and grass carp.

Action SP-9: Improve enforcement of prohibitions against introduction of exotic species.

Action SP-10: Identify and implement techniques for the control of problem exotic species.



Species Population Protection Action Flowchart

ACTION SP-1:

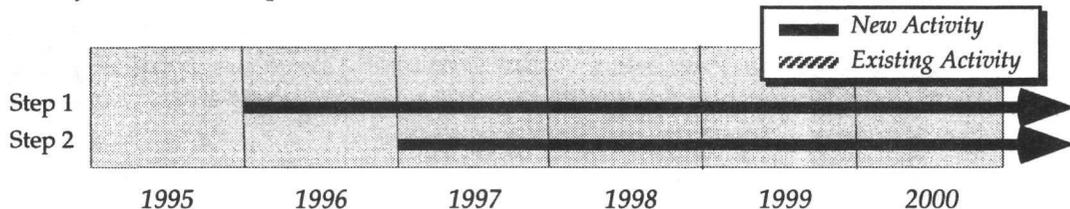
Implement a Bay-Wide Effort to Strengthen Species Management

What Implement a bay-wide effort to strengthen species management and protect biological diversity, including better coordination with state programs concerned with species management.

How

- Step 1 Establish a permanent Galveston Bay species advisory committee to serve as a forum for species management issues affecting the Galveston Bay Estuary. The Committee will:
- a. Be comprised of representatives from the public, industry, commercial fishing interests, TPWD, EPA, NMFS, USFWS, local government, etc.
 - b. Work with the TPWD and other appropriate entities to determine the need for creation and implementation of additional species protection plans or modification to existing plans. The blue crab management plan will be reviewed first in light of recent declining population trends. If appropriate, multi-species protection and biodiversity protection will be addressed.
 - c. Address reasons for identified declines in species populations.
 - d. Investigate possible reintroduction of reduced/extirpated species, such as the Gulf Salt Marsh Snake, with appropriate species/habitat management plans.
 - e. If needed, recommend seasonal or area closures of the estuary. Evaluate implementation of a incentive-based system to price and distribute fishery rights, such as through individual transferable quotas.
 - f. Coordinate with development of the Regional Monitoring Plan to ensure that *The Plan* includes collection of data required for species management.
 - g. Identify areas where additional research is required, including time/trend analysis on factors affecting blue crab population and population of other affected species.
 - h. Work with the TPWD and other entities in plan development and review.
 - i. Conduct public hearings, and make a report to the biennial State of the Bay Symposia regarding the status of estuary species.
- Step 2 The interagency advisory committee will designate a representative to represent Galveston Bay interests at meetings of the statewide species advisory committees. Statewide committees have been established for blue crab, oyster, and shrimp.

When



Where Galveston Bay Program Area.

Who Lead entity: Newly formed species advisory committee, with lead role played by TPWD. TPWD and Galveston Bay Program will organize creation of committee. Other participants: USFWS, TNRCC, GLO, EPA, CCC, Corps, SCS, NMFS, private conservation groups, industry, and the public. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• USFWS	\$ 84,375	• TPWD	\$ 294,000
• Program	\$ 48,750	• Others	\$ 490,625
TOTAL		\$ 917,750	

Potential Sources of Funding: NOAA and USFWS.

Regulatory Issues Potential establishment of additional management plans or regulatory action by TPWD or other entities. No current legislation needed.

Related Actions: HP-7 and HP-8.

ACTION SP-2:

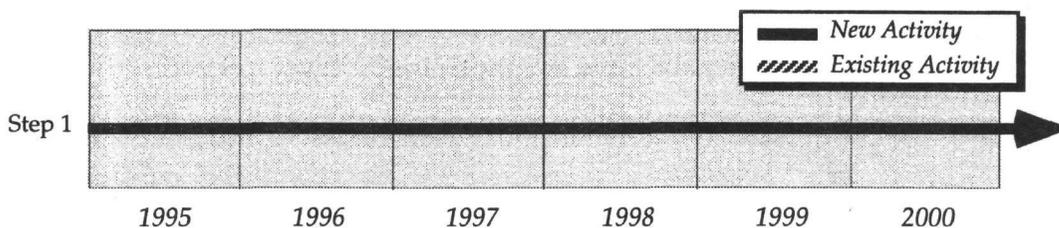
Return Oyster Shell to Designated Locations Within the Bay

What Develop regulations and operate a program which results in oyster shell being returned to designated locations within the bay, in order to encourage the creation of additional reef acreage.

How

Step 1 The TPWD has been developing a program that would require the return of oyster shell to designated locations within the bay by commercial oyster harvesters. Funding constraints have slowed the initiation of this program. Complete development of the regulations and operate a program which results in oyster shell being returned to designated locations within the bay, in order to encourage the creation of additional reef acreage.

When



Where Oyster shell to be returned to designated areas with the bay, as determined by TPWD, with input from the species advisory committee (see SP-1).

Who Lead entity: TPWD. Other participants: Oyster Advisory Committee, NMFS, and commercial oyster harvesters. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• TPWD.....	\$ 423,000	• Others	\$ 30,000
• Program	\$ 9,000		
TOTAL.....		\$ 462,000	

Potential Sources of Funding: NOAA, USFWS, EPA, and Texas Legislature.

Regulatory Issues Funding for this program will require an appropriation from the Texas Legislature. Permits will be required from GLO on state-owned lands.

Related Actions: SP-3.

ACTION SP-3: Promote the Development of Oyster Reefs Using Alternate Materials

What Continue and expand programs which promote the development of oyster reefs using alternate materials.

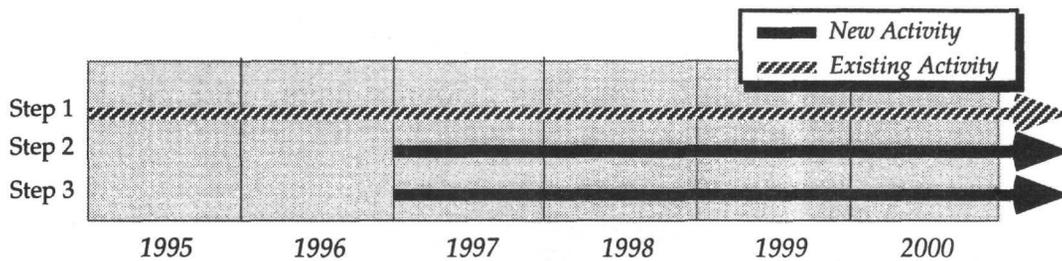
How

Step 1 Houston Lighting and Power (HL&P), under the sponsorship of the Port of Houston Authority and oversight of various state and federal agencies, is currently conducting an experimental project involving the creation of five acres of reef substrate using coal combustion by-products. This project will be completed and then monitored and evaluated to determine the feasibility of creating reef substrate using alternate materials (Note: this project includes a careful evaluation of long-term contamination potential).

Step 2 USFWS and TPWD will make additional efforts to identify potential reef substrate materials, will identify optimal locations for reef creation, and will encourage the creation of additional reef acreage by utilizing these materials.

Step 3 GLO will consider methods to streamline state leasing procedures for oyster reef creation.

When



Where Bay-wide, in areas amenable to reef creation.

Who Lead entity: HL&P (Step 1); USFWS and TPWD (Step 2). Other participants: GLO, TDH, TAMU, Corps, and industry. Role of Galveston Bay Program: Tracking.

**Public Costs of
New Actions (5 years)**

• TPWD	\$ 73,500	• USFWS	\$ 36,000
• Program	\$ 11,250	• Others	\$ 27,000
TOTAL		\$ 147,750	

Potential Sources of Funding: Primary funding provided by HL&P. Additional Potential Sources of Funding: NOAA, USFWS, and EPA. Currently, the five-acre coal combustion byproduct reef indicates costs of about \$100,000 per acre for this type of project.

Regulatory Issues The current leasing process required for the placement of reef substrate needs to be streamlined.

Related Actions: SP-2.

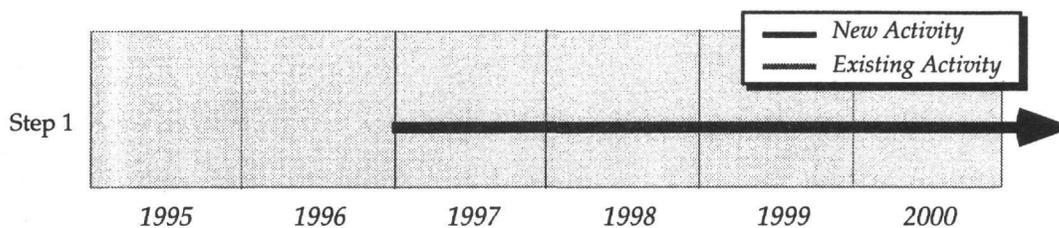
ACTION SP-4: Set Aside a Portion of Reef Habitat as Scientific Research Areas or Preserves

What Set aside a portion of reef habitat as scientific research areas or preserves. The ecology of reef growth and adaptation in the Galveston Bay Estuary requires further study. The creation of new reef habitat offers an excellent opportunity for study of oyster reef accretion and growth processes.

How

Step 1 Designate areas of reef habitat as preserves or research areas by the TPWD. The TPWD will select sites based on input from scientists, commercial oyster harvesters, and the general public. The TPWD will encourage the investigation of reef ecology and the comparison of natural and new oyster reefs established using alternate materials. The TPWD will consider the National Estuarine Research Reserve System in connection with the action to set aside reef habitats.

When



Where At designated locations within the bay, as determined by TPWD.

Who Lead entity: TPWD. Other participants: USFWS, GLO, TDH, NMFS, Sea Grant, industry, and the general public. Role of Galveston Bay Program: Tracking.

**Public Costs of
New Actions (5 years)**

• TPWD	\$ 30,000	• USFWS	\$ 6,750
• Program	\$ 6,750	• Others	\$ 20,250
TOTAL		\$ 63,750	

Potential Sources of Funding: NOAA, Army Corps of Engineers, and USFWS.

Regulatory Issues May require action by the Texas Legislature or other entities in addition to TPWD. Permits will be required from GLO on state-owned lands.

Related Actions: RSC-2.

ACTION SP-5: Encourage Continued Development of Gear to Reduce Commercial By-Catch

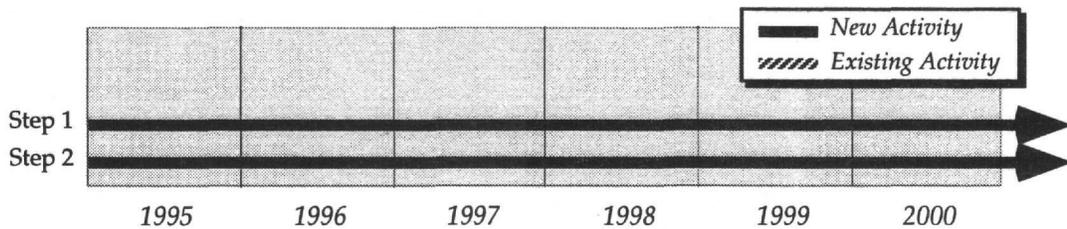
What Encourage continued development of gear and devices to reduce by-catch, and recommend the use of gear and/or devices which can be shown to be both technically and economically feasible and that can significantly reduce by-catch.

How

Step 1 NMFS, with the input of other agencies and groups, will identify gear and devices which can potentially reduce commercial by-catch and continue on-going education programs.

Step 2 NMFS will conduct or sponsor research to optimize design of gear and devices, and will conduct or sponsor pilot studies to assess practicality under actual conditions. These studies will include information regarding the survival rates of by-catch organisms.

When



Where Galveston Bay Program Area.

Who Lead entity: NMFS. Other participants: USFWS, TPWD, Sea Grant, and the commercial fishing industry.
Role of Galveston Bay Program: Tracking.

**Public Costs of
New Actions (5 years)**

• NMFS	\$ 875,000	• Program....	\$ 11,250
• Others.....	\$ 22,500		
TOTAL.....		\$ 908,750	

Potential Sources of Funding: NOAA and USFWS.

Regulatory Issues NMFS has already mandated the use of Turtle Excluder Devices (TEDs).

Related Actions:

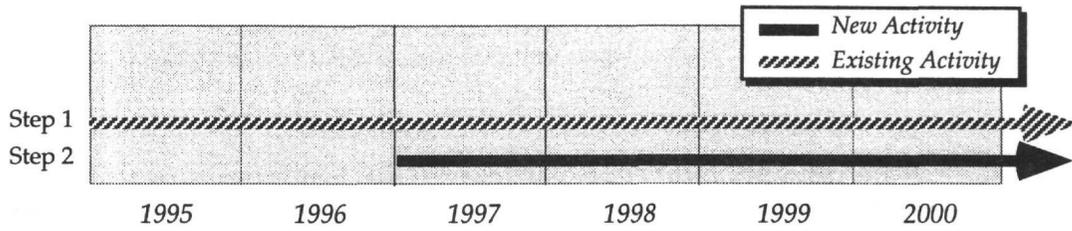
ACTION SP-6: Conduct Educational Programs About Catch and Release

What Conduct educational programs about catch and release (including enhancement of survival rates for released fish) targeted at recreational fishermen.

How

- Step 1 TPWD will continue to produce literature about catch and release (including enhancement of survival rates for released fish). The literature will be distributed to recreational fishermen.
- Step 2 As part of an effort to increase awareness concerning the environmental importance of catch and release fishing, TPWD will establish a certification program for instructors. Certified instructors will provide catch and release workshops at bay area marinas, piers, and tackle shops.

When



Where Galveston Bay Program Area.

Who Lead entity: TPWD. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• TPWD	\$ 90,000
• Program.....	\$ 6,750
TOTAL.....	\$ 96,750

Potential Sources of Funding: NOAA and USFWS. Sea Grant will be considered as a potential funding source for catch and release education programs.

Regulatory Issues None.

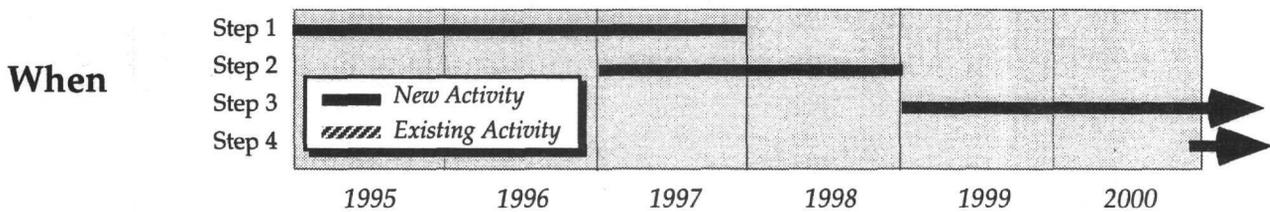
Related Actions: PPE-8.

ACTION SP-7 Investigate Potential Measures to Reduce Impingement and Entrainment

What Investigate potential measures to reduce impingement and entrainment and increase survival rates of impinged and entrained organisms at power generation stations which utilize bay water for cooling.

How

- Step 1 HL&P has conducted and plans to conduct research on potential technology to reduce impingement and entrainment at its five power generation stations which utilize bay water for cooling.
- Step 2 Based on these studies, HL&P will identify practicable methods for reducing impingement and entrainment.
- Step 3 HL&P will support research on impingement reduction methods and monitor the ongoing EPA development of regulations establishing plant intake design standards.
- Step 4 HL&P will implement the requirements of EPA's forthcoming intake design standards regulations.



Where At the five HL&P power generation stations which utilize bay water for cooling.

Who Lead entity: HL&P. Other participants: TPWD, USFWS, and Sea Grant. Role of Galveston Bay Program: Tracking.

**Public Costs of
New Actions (5 years)**

• TPWD	\$ 22,500	• USFWS	\$ 22,500
• Program	\$ 6,750	• Sea Grant.....	\$ 6,750
TOTAL.....		\$ 58,500	

Potential Sources of Funding: Primary funding provided by HL&P. Additional Potential Sources of Funding: NOAA.

Regulatory Issues Any future electric generating stations may have to comply with a proposed CMP policy which states that facilities that use once-through cooling shall be located and designed to have the least adverse effects practicable, including impingement and entrainment of estuarine organisms.

Related Actions:

ACTION SP-8:

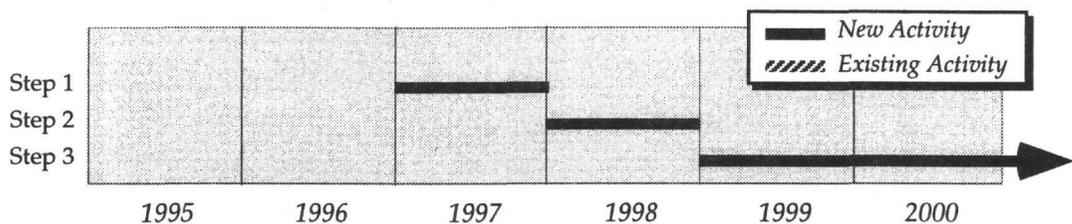
Develop Management Plans for Endangered or Threatened Species

What Develop management plans for the diamondback terrapin and other endangered, threatened, candidate species, or other species of concern. Adopt management plans already in place for sea turtles and other endangered species.

How

- Step 1 TPWD will identify species present in the Galveston Bay Estuary which are endangered or candidate endangered species.
- Step 2 For those species of concern (see above) lacking management plans, including the diamondback terrapin, TPWD will adopt NMFS or USFWS management plans or develop a Galveston Bay management plan for protection of the identified species.
- Step 3 TPWD will take appropriate measures to implement plans.

When



Where Galveston Bay Program Area.

Who Lead entity: TPWD. Other participants: USFWS and NMFS. Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• TPWD	\$ 182,250	• Program	\$ 6,750
• USFWS	\$ 6,750	• NMFS	\$ 6,750
TOTAL		\$ 202,500	

Potential Sources of Funding: USFWS and Corps.

Regulatory Issues None.

Related Actions:

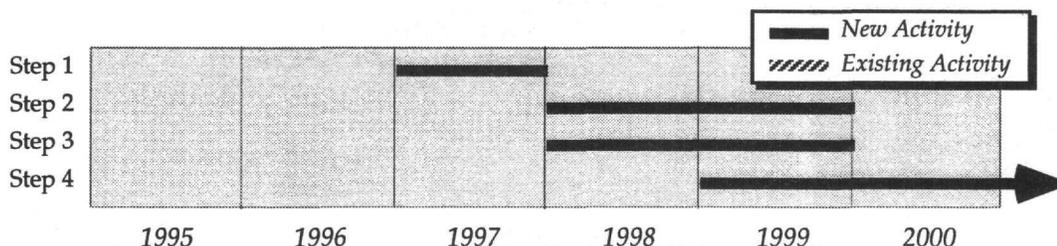
ACTION SP-9: Improve Enforcement of Prohibitions Against the Introduction of Exotic Species

What Identify appropriate legislation which regulates the introduction of exotic species, and use available tools to improve the enforcement of prohibitions against the importation of exotic species.

How

- Step 1 USFWS will identify appropriate national-level legislation which regulates the introduction of exotic species.
- Step 2 USFWS will disseminate information regarding these regulations to enforcement agencies, commercial shippers, and the public
- Step 3 USFWS will conduct training of enforcement officials and hire additional enforcement officials, as needed, to improve enforcement of the regulations.
- Step 4 USFWS will secure the passage of legislation or the creation of regulations which prohibits the discharge of bilge water within the Galveston Bay System. USFWS, TPWD, and USCG will enforce the prohibition.

When



Where Galveston Bay Program Area.

Who Lead entity: USFWS, TPWD, USCG. Other participants: NMFS and EPA Role of Galveston Bay Program: Tracking.

Public Costs of New Actions (5 years)

• USFWS	\$ 252,250	• Others	\$ 13,500
• Program	\$ 6,750		
TOTAL.....		\$ 272,500	

Potential Sources of Funding: USFWS and Corps.

Regulatory Issues Clarification of the scope of enforcement authority will be required.

Related Actions:

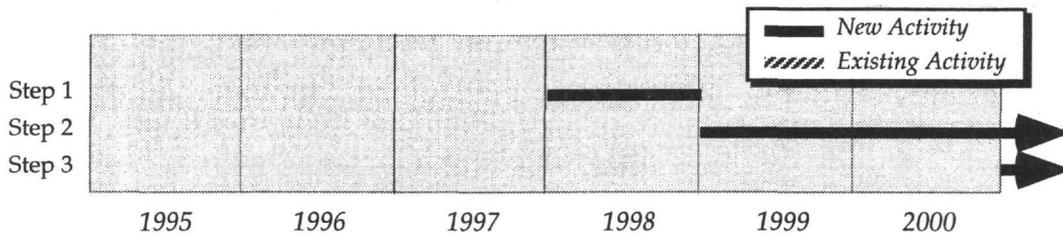
ACTION SP-10: Identify and Implement Techniques for the Control of Problem Exotic Species

What Identify and implement effective techniques for the control of problem exotic species populations, such as nutria, grass carp, and fire ants. Within the Galveston Bay Estuary, the introduction and proliferation of exotic opportunistic species such as nutria, grass carp, and fire ants have contributed to the degradation of some portions of the estuarine habitat.

How

- Step 1 TPWD will identify effective techniques for the control of problem exotic species (i.e., nutria, grass carp, and fire ants).
- Step 2 TPWD will conduct pilot test to determine effectiveness of species control techniques.
- Step 3 TPWD will expand successful programs to control populations of exotic species.

When



Where Trinity River and San Jacinto River portions of the estuary (nutria and grass carp); low-salinity marshes (nutria); and bird nesting areas (fire ants).

Who Lead entity: TPWD. Other participants: NMFS, USFWS, and SCS. Role of Galveston Bay Program: Tracking.

**Public Costs of
New Actions (5 years)**

• TPWD	\$ 150,000	• Others.....	\$ 13,500
• Program	\$ 4,500		
TOTAL.....		\$ 168,000	

Potential Sources of Funding: USFWS and Corps.

Regulatory Issues Need stronger enforcement programs.

Related Actions:

