
CHAPTER FOUR

ACTION PLAN TOPICS: ESTUARY MANAGEMENT

SHORELINE DEVELOPMENT

In 1960, the four counties bordering Galveston Bay had a population of about 1.65 million people. By 1990, the population had grown to about 3.6 million. Increases in population create severe pressures on the bay from increased water use, sewage and waste disposal, industrial activity, and recreational use. Similar increases in the population of many areas along the Trinity River only exacerbate the pressures on the bay by creating demands for water diversion and by raising the likelihood that pollutants will flow into the bay from the river.

Growth management is perhaps the most serious of all the problems facing Galveston Bay, because it poses most starkly the conflict between economic development and environmental protection. Yet it is the problem least amenable to a coherent resolution, because land use is controlled only by localities. Under Texas law, only incorporated municipalities have the power to zone property; counties may not do so unless explicitly authorized by the state. Counties may create other political subdivisions such as drainage districts to perform environmental functions. However, the general effect of Texas law is to limit growth management functions to municipalities.

Zoning might provide a tool for controlling the environmental effects of development. However, at the present time, three of the largest cities on the bay, Houston, Baytown and Pasadena, do not have any zoning ordinances in place. Houston is now formulating zoning ordinances to be implemented by July 1992. The Houston Zoning Strategies Committee of the Planning and Zoning Commission has agreed that zoning in Houston will create four types of zoning districts: single-family detached residential, exclusively residential, heavy industrial districts, and multiple use district. The clear intent of these ordinances is to protect residential areas from industrial development, not to protect natural resources; under the proposed ordinance, most development will still be allowed.

Even where present, zoning ordinances are not usually an effective tool for comprehensive or coordinated policymaking. The cities bordering the bay that do have zoning ordinances, such as Seabrook, Texas City, and Deer Park, have not included provisions to protect natural resources. Instead, efforts are directed towards the separation of different land uses. For example, industrial and residential areas are generally not allowed to intermingle. Texas City does, however, require a percentage of all lots developed to be landscaped in an attempt to reduce the negative effects of noise, erosion, and sedimentation caused by impervious or unvegetated areas. The largest amount, 20 percent, is required for residential lots.

In addition, zoning boards consider applications on a case-by-case basis; although general

criteria guide decisions, the overall effect of case-by-case decisionmaking often runs counter to that intended. If decisions are not always consistent within a single jurisdiction, it is clear that they are even less consistent across jurisdictions. Appendix 3 lists eighteen cities, five counties, and several other local or regional authorities which have some jurisdiction in the Galveston Bay area. Zoning ordinances of different localities may impose different criteria and be of widely varying levels of detail.

Perhaps even more difficult than the gaps in jurisdiction and the inconsistencies among jurisdictions is the fact that many localities have strong incentives to encourage, not discourage, growth, even in areas closely affecting the bay. The bay area was seriously hurt by the precipitate decline in oil prices starting in 1986; since that time, localities have vied with one another to lure new employers with tax abatements and other incentives. In such an economic climate, it is unlikely that localities will also impose stringent environmental constraints on potential employers.

Most cities surrounding Galveston Bay have Chambers of Commerce or Divisions of Economic Development to attract new businesses to their areas. Houston has combined the programs of the Chamber of Commerce, Economic Development, and the World Trade and Partnership Resources Division to work for the growth of Houston's business community through the Greater Houston Partnership. The Partnership is the voice of Houston area business, with 80 percent funded by private donations. It promotes the growth of small businesses, attracts new large businesses through a national marketing program, and actively seeks international corporations through international marketing. The Partnership provides information about the price of property, labor and operational costs to potential new businesses and puts interested owners in contact with consultants who can assist them in obtaining the necessary permits.

The City of Galveston is also involved in several projects to increase economic activity. The city is actively recruiting high tech biomedical industry in order to capitalize on the presence of the University of Texas Medical Branch and is exploring plans to form a regional port operation through the consolidation of the **Port of Houston Authority** and the Galveston Wharves. The city also hopes to revitalize its delapidated shipyards. Additional projects with environmental impacts include a new transfer/storage warehouse as part of the Texas Copper operation and the possibility of developing an onshore oil transfer terminal on Pelican Island. Such facilities would obviously increase employment in the areas, but are not without environmental risks.

Most of the cities have provisions for giving new businesses tax abatements. The new businesses may increase the demand for services at the same time that the abatements decrease the tax base. This tendency may adversely affect the cities' ability to maintain environmental standards in providing wastewater treatment, infrastructure improvements, and solid waste disposal. In addition, cities often offer to abate taxes that are specifically intended to control the environmental side effects of growth, including fees for extending water and wastewater services or fees that fund erosion control. In these cases, growth will

have clear adverse effects on the environment of the bay. In contrast, the new, more stringent clean air standards that will take effect under the Clean Air Act of 1990 may have the effect of limiting the number of new manufacturers that can enter the bay area because they would not be able to emit pollutants without obtaining an equal reduction in emissions from some other local facility.

The City of Galveston employs two methods of tax incentives to attract additional economic development: tax abatement and tax reinvestment zones. The first applicant for the tax abatement program was the San Luis Hotel, which plans a \$2 million expansion to its current facility. The city currently maintains eight tax reinvestment zones. Under the Texas Tax Increment Financing Act of 1981, incorporated cities or towns may issue bonds to finance public improvements in reinvestment zones. The tax base of the zone is frozen at the rate before development. Taxes may not be levied in excess of this rate for a stipulated period after which the full tax due is paid to jurisdictions having taxing authority.

Although economic growth may often conflict with the need for environmental protection, one important factor tending in the other direction is that tourism, a very important source of revenue for many communities near Galveston Bay, is dependent upon the continued health and beauty of the bay. Thus economic development and environmental protection maintain an uneasy balance.

The City of Galveston has recognized this balance in some local provisions concerning sand dunes. The zoning standards of the City of Galveston require that a Dune Improvement Plan be submitted to the City whenever an individual wants to build a structure within 50 feet of the vegetation line. A plan is also required whenever there is removal, relocation, or movement of sand dunes, construction of sand dunes or vegetation, movement or construction of sand fences or placement of fill in dune area. Dune walkovers, elevated walkways constructed above the dune area, are required for any new house constructed on a beach front lot in order to prevent damage to the dune area by reducing trail and road cuts. Each year the City of Galveston in cooperation with the Boy Scouts of America and many other volunteer groups, conducts a successful program entitled Trees for the Dunes. This project collects discarded trees during the first week of January to be staked on the beachfront to trap sand and encourage dune growth.

In addition to the relatively weak protections accorded by local ordinances, there is some potential protection of the shoreline against development in the new state Coastal Management Plan and the associated federal Coastal Zone Management Program. These laws are discussed in the section on shoreline erosion and subsidence, the final section in this chapter. The federal Coastal Barrier Resources Act discourages development on undeveloped coastal barriers. Locations near Galveston Bay included in the Coastal Barrier Resources System are Bolivar Peninsula, Follets Island, and High Island.

HABITAT PROTECTION

Maintenance of habitat is closely allied to maintenance of the overall health of the estuary and contributes to the continued success of living resources. Wetlands, for example, filter pollution, store floodwater, replenish groundwater, and generally protect and buffer sensitive estuaries. Estuarine wetlands serve as nursery areas for many fish and shellfish, serve as habitat for wildlife, and supply nutrients and organic matter to the estuary. Thus the wetlands delineation process described above in the dredge and fill section is one important feature of habitat protection. Indeed, water quality itself is a very important feature of the habitat for all creatures in the estuary that rely directly or indirectly on the water.

The Section 404 program described under the Dredging/Filling section is significant not only because the program represents the primary mechanism for protecting wetlands, but also because of the activities the 404 program does not encompass. First, normal farming, ranching, and silviculture activities are exempt from the process. Considerable wetland loss from farming has occurred on the east side of Galveston Bay. Furthermore, the 404 program covers only the disposal of dredge and fill materials in the waters of the United States. Other activities which impair the functional values of wetlands, such as clearing or draining, are not covered by the program. In fact, a 1988 (federal) General Accounting Office report concluded that the 404 program as currently structured "does not regulate most of the activities that result in wetland losses" (U.S. Congress, House, 1988, p. 72). While many of the wetlands, even in Galveston Bay, are thus not covered by the 404 process, it is true that many of the bay's most critical wetlands are covered. Despite the weaknesses of the 404 program, it does provide the most direct regulatory means available to protect wetlands.

Recently, the definition of wetlands that are to be covered by the 404 program has become a matter of policy debate. In January 1989, the four federal agencies (the Corps, EPA, FWS, and the SCS) with programs affecting wetlands adopted a common set of criteria for identifying and delineating wetlands known as the Federal Manual for Identifying and Delineating Jurisdictional Wetlands. Under this manual, an area must have wetlands hydrology and supporting vegetation, and hydric soil to qualify as a wetland. The manual represented one of the first steps in providing a more consistent application of federal programs in regard to wetlands. As noted, the Corps and the EPA have recently signed several MOAs which further clarify agency roles in the 404 program. The new manual became a source of contention as people discovered that large areas previously not defined as wetlands qualified under the new definition. The four agencies considered recommendations for changes to the manual in the fall of 1990, and forwarded recommendations to the Office of Management and Budget.

On August 9, 1991, President Bush proposed a "no-net-loss" policy for wetlands including a new definition of affected land. Whereas the existing manual defines wetlands as those mucky or peat-based soils saturated for as few as 7 straight days to a depth of 18 inches during the growing season, the new definition requires a 21-day saturation period during the

growing season or standing water for 15 consecutive days any time during the year. Critics argue that the new definition will remove 10 to 30 percent of those lands presently defined as wet, presenting a boon to shore developers as well as helping those farmers who were the intended beneficiaries of the redefinition (Weisskopf, 1991). Bush's proposed wetlands program, which must be published for public notice and comment, also establishes new criteria for evaluating the ecological value of wetlands according to three categories, with the highest receiving the most protection. The exact extent of any of these categories of land will not be known until late 1993.

Meanwhile, on August 17, 1991, Congress passed a law containing an unrelated amendment requiring a return to the wetlands manual in effect prior to 1989 (PL-102-104). The exact status of wetlands protection thus remains in flux.

The **1990 Food, Agriculture, Conservation, and Trade Act**, known as the 1990 Farm Bill, represents an indirect means of protecting wetlands. The 1990 Farm Bill modified the "swampbuster" provisions of the 1985 Food Security Act, which first introduced disincentives to converting wetlands into parcels for agricultural production. Under the 1990 Farm Bill, farmers become ineligible for federal benefits under the U.S. Department of Agriculture programs from the time a wetland is converted to make agricultural production possible. Under the Food Security Act, agricultural producers became ineligible for such benefits only during years a crop was planted. This enabled farmers to plant on wetlands during years of high crop prices, when federal subsidies were less important. The 1990 Farm Bill closed this loophole, but also contains a "minimal effects" provision. Agricultural producers will not be ineligible for federal benefits if their activities have minimal effects on wetland values. At the same time as the law provides an incentive for farmers to maintain wetlands, however, it also provides a disincentive by requiring them to disclose the existence of wetlands to bankers and prospective purchasers. Such disclosures usually reduce the value of the land and may place existing loans in jeopardy or limit resale value.

The 1990 Farm Bill also creates a wetlands preserve program through the use of easements. Under this provision, the Secretary of Agriculture may protect up to one million acres of farmed wetlands through the use of federal payments to farmers to place wetlands in 30-year or permanent easements. Although the Farm Bill may have a greater effect on inland farming due to the sheer magnitude of such operations (coastal farming is, of course, subject to the provisions of the bill), it is important in that the program targets an activity expressly exempted from the Section 404 program. The protection of additional inland wetlands should provide benefits for migratory species as well. Both farm bills depend heavily on the definition of wetlands and will be strongly affected by the President's proposal.

The **Endangered Species Act** (ESA) expressly authorizes the Secretary of the Interior (through the **Fish and Wildlife Service**, or FWS) to designate areas as "critical habitat" for endangered or threatened species. Unlike the process of listing such species, economic factors may be considered in the designation of their critical habitat, unless a failure to designate an area as critical habitat would result in the extinction of the species. Once a

species has been listed as threatened or endangered, the FWS and the **National Marine Fisheries Service (NMFS)** may review all federally funded or permitted activities which may affect the listed species and its habitat. Federal agencies and permit applicants may apply for an exemption to the provisions of the ESA after the review process and a determination that there is no alternative to the agency's action or permitted activity. The Endangered Species Committee reviews applications for exemptions. For an exemption to be granted, the Committee must make a determination that there are no alternatives to the action, the benefits of the action clearly outweigh the costs in relation to not protecting the species or habitat, the action is nationally or regionally significant, and the action does not represent an irretrievable commitment of resources (Corn, May 8, 1990). If an exemption is granted, it must also include measures for mitigation.

The ESA also authorizes the acquisition of land necessary to protect listed species through funds according to the provisions of the Land and Water Conservation Fund Act (LWCF). LWCF monies are not limited to the acquisition of habitat for endangered species. Monies may be used to acquire land as part of the National Wetlands Priority Conservation Plan administered by the FWS. The TPWD is responsible for ranking wetlands for acquisition under this program. The Fish and Wildlife Service also manages the National Wildlife Refuge System to protect flyways for migratory waterfowl. Brazoria and Anahuac National Wildlife Refuges border Galveston Bay.

Many activities that require permits under various laws may be reviewed for their effects on habitat protection. Under the **Fish and Wildlife Coordination Act**, the FWS, NMFS, and the TPWD are entitled to comment on any federal activity or permitted activity which may control or modify any water body. This act enables the agencies to comment on Section 404 (Clean Water Act) and Section 10 (Rivers and Harbors Act) permit applications in regard to habitat. Through such reviews, these agencies may suggest alternatives and make recommendations concerning the effects of projects on living resources and their habitats. For example, the NMFS has a Habitat Conservation Program aimed at identifying acceptable habitat replacement and mitigation efforts. The involvement of federal funds in the NPDES program also gives the NMFS and FWS authority to review wastewater discharge permits.

At the state level, the TPWD has review and research responsibilities concerning fresh water diversions which are described more fully in the Fresh Water Inflow Section. TWC must also assess the effects of diversions of more than 5,000 acre feet on fish and wildlife habitats. Finally, the GLO is responsible for granting easements on state-owned submerged lands and oversees leasing and use of recreational cabins already built in Texas' coastal bays and marshes. These cabins are sources of small discharges of human waste; occupants' boats may hurt local habitats through pollutants, noise, waves, and harm to seagrasses.

In addition to the wetlands delineation conducted by the Army Corps prior to dredge and fill operations, wetlands are protected by several other laws. The federal Soil Conservation Service may provide incentives to farmers not to drain or farm wetlands, while the Water

Bank Program administered by the Agricultural Stabilization Service gives farmers payments for preventing loss of wetlands that are habitat for migratory waterfowl. The Texas General Land Office is charged with protecting many of the state's lands, including sand dunes and coastal wetlands. GLO ranks wetlands for state acquisition and regulates geophysical exploration in all areas within tidewater limits (Tx. Nat. Res. Code §§ 15.51-15.54).

Several programs at the federal and state levels provide for acquiring habitat or creating preserves. The Coastal Preserves Program, founded in 1987, is implemented through a memorandum of agreement between GLO and TPWD; under it, GLO leases state-owned land to TPWD to manage as preserves following a process for nominating areas as preserves. Two of the four coastal preserves are in Galveston Bay: Christmas Bay and Armand Bayou. GLO also leases some state lands to other groups, primarily the Audobon Society, which ensures that they remain in a state appropriate for bird habitat. Of approximately 30 Audobon sanctuaries in Texas, three are in the counties under study: Vingt-un Islands, West Bay Bird Island, and Rollover Pass. Peach Point in Brazoria County is one of six state wildlife management areas. Finally, the National Oceanographic and Atmospheric Administration (NOAA) administers both the National Marine Estuarine Research Reserve Program, of which there are none in Texas, and the National Marine Sanctuary Program. There is one new marine sanctuary out in the Gulf of Mexico: the Flower Gardens.

Habitat protection rests on appropriate resolution of the environmental issues described under "Source Controls." For example, Gulf oysters require favorable salinity and temperature regimes on reefs for successful reproduction and spawning and a clean and firm substrate for maturation. Thus oyster habitat is affected by water quality (determined in turn by point and nonpoint source pollution and spills), water quantity and salinity (freshwater inflow), and the substrate (dredge/fill, marine debris). Habitat protection also forms the basis for protecting the diverse ecosystem of the bay. However, many of the habitat and living resources laws call more for planning than for direct actions. The remaining laws include many exceptions and exemptions. Larger ecosystems such as complete estuaries are particularly difficult to protect. As with other programs, staff and funding tend to be inadequate to oversee large and often remote areas, despite the efforts of game wardens and other field staff to ensure compliance with the law.

SPECIES PROTECTION

Galveston Bay and the surrounding wetlands are home to several threatened and endangered species, including the brown pelican, piping plover, bald eagle, wood stork, and several kinds of sea turtles. In addition, other species, including commercially and recreationally important finfish and shellfish, as well as the species upon which they depend, constitute an important resource for Texas.

The tools for protecting species fall into three general categories: habitat protection,

discussed above; endangered species protection; and restrictions on hunting and fishing. In this section, we review only those laws not discussed in the habitat section immediately above, especially those concerning hunting and fishing.

As noted, the federal Endangered Species Act, which is implemented by the U.S. Fish and Wildlife Service and the National Marine Fisheries Service, protects living resources and their habitat. The two agencies, along with the Texas Parks and Wildlife Department (TPWD), may review all projects, whether federal or not, which may affect species listed as endangered or threatened. Under the Fish and Wildlife Coordination Act, the same agencies review proposed projects of any federal agency that hopes to control or modify any body of water. In addition to the land use tools and permits outlined above, the law allows prosecution of individuals who violate its provisions. TPWD is responsible for the state component of endangered species protection, but it has had no resources to monitor endangered populations or undertake any active protection measures; at the same time, the regulatory framework for endangered species protection is fragmented.

TPWD also has primary responsibility for overseeing recreational and commercial fishing, which together constitute one of the primary uses of Galveston Bay. Continued availability of oysters, shrimp, and fish depends on careful harvesting practices that allow the young to develop and the mature to reproduce. Many observers believe that in addition to the usual cycles of abundance and scarcity that apparently always characterize fish catches, they detect a general decline in availability of many formerly common bay species. The use of new technologies and the increase in the number of fishermen are increasing the likelihood that the very young are taken along with more full-grown fish, affecting natural replenishment.

Under laws included in the Parks and Wildlife Code, the Fisheries Division of the Texas Parks and Wildlife Department protects fish and their habitat by monitoring abundance of fish, studying fish life cycles and factors affecting the supply of fish, monitoring landings of fish and shellfish, setting limits on fish takes, supervising fish hatcheries, and controlling noxious vegetation. State game wardens may investigate water pollution as well as enforcing wildlife protection rules. TPWD may designate nursery and scientific areas where no fishing is allowed.

The Texas Department of Agriculture advises TPWD when an emergency exemption for pesticide use might affect endangered species. The department is also working on developing forms of resource-conserving agriculture that may assist in habitat and species protection.

In consultation with federal and local soil conservation staff, EPA is developing some county-specific bulletins that will also contain information on endangered species and will list pesticide use limitations. The information will be correlated so that pesticide users can attempt to avoid substances or areas that will adversely affect the endangered species.

In addition, the federal National Marine Fisheries Service implements several laws, including

the Magnuson Fishery Conservation and Management Act, which are intended to ensure that overfishing does not occur. However, these laws provide primarily for planning rather than for enforcement.

TPWD also protects species that are not endangered nor threatened. Both the federal migratory bird treaty and TPWD rules forbid hunting or otherwise hurting migratory non-game birds, except for certain nuisance birds under certain circumstances. Fur-bearing animals (which, according to present regulations, do not include coyotes or mountain lions) and game birds are protected by designating limited hunting seasons, limiting takes, and requiring hunters to purchase a license. Alligators, which are on the federal list of threatened species only because of their resemblance to a truly threatened species, the crocodile, may be hunted in Texas during the designated season. There are no crocodiles in Texas.

As noted, species protection is closely related to habitat protection. Without appropriate habitat, estuarine species will not survive. Other threats include overfishing, overharvesting, and human intrusion into the habitat through boating and building. The regulatory regime for species protection suffers from many of the same problems that affect habitat protection: an emphasis on planning over enforcement, a lack of coordinated oversight for complex ecosystems, and a cumbersome permit process that allows many activities that affect species protection to go unreviewed.

HUMAN HEALTH

The health of humans, as with other living resources, depends on the quality of the water and general environmental quality of the estuary. Although all the laws concerning water quality and hazardous waste disposal discussed above have protection of human health as one goal, the most important aspects of human health clearly linked to the estuary are human health risks associated with consumption of chemically contaminated fish and shellfish and microbiologically contaminated shellfish. "Contact recreation," which includes swimming and related activities that get people into the water is another potential source of human health problems.

The Division of Shellfish Sanitation Control (DSSC) in the Texas Department of Health (TDH) oversees human health aspects of the consumption and processing of aquatic life and shellfish under Section 436 of the Texas Health and Safety Code. Shellfish are particularly susceptible to contamination due to the large volume of water they pump through their bodies during their normal feeding process. Additionally, shellfish are relatively immobile, and thus are less free to move in and out of polluted areas. Contaminated shellfish pose a particular threat to human health because many such species are eaten raw without the protection cooking provides. Other forms of aquatic life are subject not only to threats imposed by poor water quality, but also to bio-concentration of contaminants passed on through the food chain. Such species are more mobile than shellfish, but this mobility increases the difficulties involved in monitoring and making

determinations as to the possible sources of contaminants found in such species.

The Division of Shellfish Sanitation Control (DSSC) is responsible for surveying and classifying shellfish growing areas as to the suitability of such areas to produce shellfish fit for human consumption. The Division regulates shellfish harvesting areas primarily through the implementation of the guidelines detailed in the National Shellfish Sanitation Program (NSSP) Manual of Operations. The NSSP represents a cooperative and voluntary effort between the U.S. Food and Drug Administration, the appropriate state regulatory agencies, and the shellfish industry. Currently, the DSSC implements the NSSP, but the state program entails some specific differences from the national program in certain areas. Senate Bill 1463 in the 72nd Texas Legislature provided for a revision of definitions and a consolidation of some of the provisions of Section 436 of the Health and Safety Code, in addition to the elimination of the differences between the NSSP and the state program. This bill did not pass, but similar legislation making the state program consistent with the NSSP program is likely to be introduced and passed in the near future (Thompson, interview, June 17, 1991).

The process of classifying shellfish harvest areas involves conducting a growing area survey. The survey includes a determination of all pollution sources; a hydrographic survey (water dynamics, dispersion, etc.); a meteorological survey (quantity and frequency of rains, effects of winds ect.); and a bacteriological survey (identification and assessment of possible contaminants). The results of such a growing area survey are used to classify harvesting waters. Presently, the Division utilizes a three-tier classification system: approved, conditionally approved, and polluted. Shellfish harvested from approved areas may be marketed directly. Conditionally approved areas represent harvest sites from which shellfish may be harvested for direct marketing, but are subject to reclassification based on changes in meteorological conditions (such as rains over a certain amount in a specified time period) or a bacteriological event creating possible hazard. Areas are designated as polluted if contaminants are found to be in excess of NSSP criteria for restricted shellfish areas, or if a determination cannot be made as to the source or form of the hazard in the area. Shellfish cannot be directly marketed from polluted areas, but may be moved to more pure waters for natural cleansing or may be artificially cleansed. If the state program is modified to be entirely consistent with the NSSP, the five-tier NSSP classification system is likely to be adopted (approved, conditionally approved, restricted, conditionally restricted, prohibited).

A minimum of 15 samples under varying conditions is required for classification of the harvest areas. Samples in Galveston Bay are taken at least monthly to monitor conditions at harvesting sites. The frequency of these samples increases with meteorological changes, as changes in storm water runoff and hydrology have a corresponding effect on the suitability of harvesting sites. The Division currently maintains between 50 and 60 monitoring stations in Galveston Bay. The classifications are updated annually, and revised. The entire classification system is completely revamped every twelve years. Enforcement concerning classified shellfish waters is handled by the Texas Parks and Wildlife Department. In 1990, 35 percent of Galveston Bay's total of 331,000 acres were approved, 60 percent were closed,

and 5 percent were conditionally approved (Texas Water Commission, 1990, p. 25).

The DSSC also has authority to regulate aquatic life with respect to human health concerns. Despite this authority, the aquatic life program is essentially nonexistent due to a severe lack of staff and funding. Some Division staff time is devoted to monitoring efforts in Lavaca Bay. Nearly 70 percent of the Division's budget is devoted to the bay classification program, and the Department of Health's laboratory is currently operating at capacity. The DSSC shellfish sampling program utilizes all of the Division's allotted laboratory time, which is barely sufficient to maintain the current program. With the exception of the limited efforts in Lavaca Bay, there is no program in operation that specifically addresses the protection of human health from the consumption of aquatic life in the state. The TWC monitors water quality and informs TDH of water quality problems which may affect human health. Both TDH and TWC also monitor the concentration of various contaminants in fish and shellfish. This program assists in identifying risks to human health, although there is no system for coordination. Similarly, the fish sampling of TPWD, which primarily concerns species propagation, could be used indirectly to monitor potential human health problems.

Based on past budget appropriations, neither the shellfish or the aquatic life program is likely to be expanded in the near future. The Division received its last significant increase in appropriations in Fiscal Year 1982, when roughly \$68,000 and \$10,000 were appropriated for the operating budget and capital outlays respectively. In the mid-1980s, appropriations for the operating budget and capital outlays peaked at \$82,000 and \$14,000 respectively. Recently, appropriations have declined. For example, in Fiscal Year 1989 operating appropriations were \$71,000 and capital outlay appropriations were roughly \$5,000. The Division has received some additional monetary support from within TDH. However, such support has not been sufficient to staff a program for aquatic life. Indeed, appropriations for capital outlays have often been insufficient to meet the current needs of the shellfish program, which entails substantial capital costs such as the purchase of boats. Finally, the one toxicologist position for the entire TDH is currently vacant (Interview, Thompson, June 17, 1991). County health departments, which may also monitor water quality and shellfish, are also lacking in resources and usually devote more attention to problems of drinking water, septic tanks, and vaccinations.

Human health is also affected to the extent that people swim or, as is more likely in Galveston Bay, water ski and windsurf. The programs for guarding human health from contact recreation are those that protect water quality overall. Local health departments may post areas unsafe for swimming.

SUBSIDENCE/ SHORELINE EROSION/ SEA LEVEL RISE

Land subsidence and coastal erosion threaten both the wetlands and the economic activity of Galveston Bay. Since the beginning of the century, the land surface of the Houston area has subsided up to 10 feet in some areas. Subsidence in the Houston-Galveston area has exceeded 1 1/2 feet in an area 70 miles across. Corpus Christi and Beaumont have sunk 5

feet each. The effects of subsidence in the Houston-Galveston area are loss of elevation, change in the slope of the land, and active fault movements (Harris-Galveston Coastal Subsidence District, 1991). Of these, loss of elevation is the most dramatic. Low lying areas become susceptible to inundation from storm tides and runoff; even under normal conditions, some lands have already been lost to flooding. Subsidence also exposes shores to greater wave activity as well as allowing water to come up higher on the coastal banks, contributing in turn to increased erosion rates. By 1974, the cost of property damage in the Houston-Baytown area caused by subsidence was estimated to be \$113 million.

Although subsidence, erosion, and sea level rise are distinct phenomena, we treat them together because they are closely related. A rise in the sea level would inundate additional coastal lands; subsidence, or lowering of the land, has the same effect. Erosion, as noted, results from either of these two phenomena.

Subsidence

Land subsidence in Harris and Galveston Counties results primarily from groundwater withdrawal. This extraction of groundwater from underground aquifers reduces the pressure necessary to maintain the water content in the surrounding clay soil. The reduced pressure allows the water to escape from the clay and causes the clay layers to compress, permitting the overlying ground layers and therefore the land surface to subside, or sink. Production of oil and gas may also cause subsidence, but it tends to create greater stress over a smaller area than groundwater withdrawal. Some subsidence has occurred over six oil and gas fields in Harris County.

Although the effects of subsidence are irreversible, there are ways to abate continuing subsidence: artificially recharging the aquifer, re-pressurizing the underground area to prevent soil compaction, and, most important, limiting withdrawals. **The Harris-Galveston Coastal Subsidence District** was formed in 1975 as a direct result of the flooding problems caused by subsidence. The governing body is a 17 member board of directors and is supported by water well permits. It is responsible for ending subsidence by regulating withdrawal of groundwater within its boundaries. The Subsidence District is enforcing a plan for surface water conversion and water conservation. The plan divides Harris and Galveston counties into eight regulatory areas and requires that water wells within the district with a casing diameter of 5 inches must have a permit to withdraw a specified amount of water. The plan has been successful in reducing groundwater pumpage. There are no similar controls on groundwater withdrawal in other areas around Galveston Bay but outside the jurisdiction of the HGCSA.

Shoreline Erosion

The gulf coast states have the highest average annual erosion rate in the nation of over five feet per year (Leatherman, 1989). Coastal erosion is primarily a natural process and has long been attributed to tidal action, particularly that brought on by severe storms, but it is

exacerbated by subsidence. Of the 370 miles of Texas Gulf shoreline, approximately 60 percent is eroding at rates between one and 50 feet per year; approximately one-third is stable, and the remainder is increasing (GLO, 1990). Erosion is not confined to beaches, but also affects the bay system. The GLO estimates that about two-thirds of the Texas bayshores are eroding, often because of the large wakes created in the relatively shallow bay by passage of both recreational and, especially, large commercial boats.

Prevention of erosion may be accomplished through limiting development in flood and erosion-prone areas and building seawalls. A series of federal flood insurance laws have attempted to limit development in floodplains and erosion zones. The federal Flood Disaster Protection Act directs the Federal Emergency Management Agency to identify flood related erosion zones and encourages demolition or relocation of structures in the hazardous areas by advancing payment. Other efforts to limit development are considered above in the section on shoreline development. Seawalls often disrupt the beach environment, reflecting wave energy, increasing intensity of littoral currents, and concentrating wave and current energy at the ends of the wall, finally leading to the need for ever larger and more expensive walls. Another, more preferable, method for controlling shoreline erosion is salt marsh grass planting, a technique now being demonstrated in several places on Galveston Bay by the U.S. Soil Conservation Service.

Comprehensive planning, including public acquisition of land where necessary, is another response to erosion. Texas remains one of only two coastal states (the other is Georgia), with no federally approved and funded plan to manage the coastal zone. The Coastal Management Act of 1972 offers states financial incentives to develop such plans, and attempts were made in the past to formulate comprehensive management policies towards the coastal zone. However, the Texas Coastal Management Program of 1976 and the Texas Coastal Plan of 1979 failed for myriad reasons, especially the multitude of competing interests along the coast and the desire to avoid creating another bureaucracy. In 1989, the 72nd Texas Legislature enacted SB 1571 which designated the General Land Office as the lead agency to develop a long-term plan for the management of Texas coastal public land, in cooperation with other state agencies that have duties relating to coastal matters, including the Parks and Wildlife Department, the Attorney General's Office, the Texas Water Commission, the Texas Water Development Board, the State Department of Highways and Public Transportation, and the Railroad Commission of Texas. GLO established a Coastal Management Advisory Committee and a State Agency Task Force to help it develop the new Texas Coastal Management Plan. A Federal Agency Task Force was also formed to help coordinate overlapping federal and state interests. As a first step, GLO prepared briefing papers on nine areas of coastal concern: nonpoint source pollution, oil spills, hazardous waste generation and disposal, habitat and wetland loss, freshwater inflow, coastal erosion, beach access, dune protection, and marine debris. After presenting these issues at a series of public hearings up and down the coast, three issues appeared to be of primary concern: coastal erosion, wetlands loss, and beach access.

At the recommendation of the Texas Coastal Management Plan, the 73rd Texas Legislature

(1991) passed the Coastal Management Plan for Beach Access Preservation and Enhancement, Dune Protection, and Coastal Erosion. It generally increases the powers of GLO and local governments to protect public access to beaches, protect sand dunes, and prevent coastal erosion. Coastal counties had no authority to manage beaches in unincorporated areas or ability to create enforceable beach policies; this law provides those powers. Most important, this law calls for state policy to provide for more effective and efficient management of coastal natural resource areas, and to that end makes GLO the lead agency for a comprehensive management plan for the entire coast. The Coastal Coordination Council, consisting of the Land Commissioner, the Attorney General, the chair of the Parks and Wildlife Commission, and the chair of TWC, replaces the governor as the state's representative in negotiations with the federal government. The bill thus appears to lay the groundwork for Texas' belated participation in the federal Coastal Zone Management Act; a plan was rumored to have been sent to NOAA for review as early as August 1991.