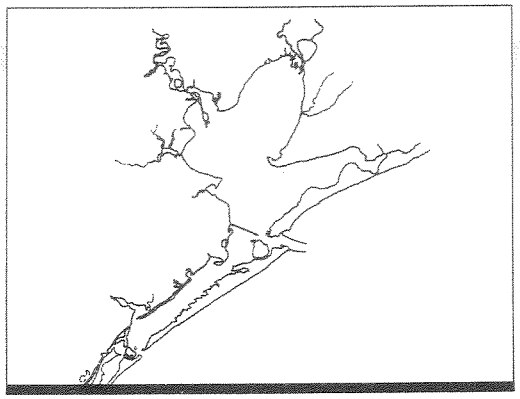
Circulation, Salinity and Freshwater Inflows

Life Support Systems for Galveston Bay



The Galveston Bay system lies in a warm, temperate climatic zone on the upper Texas coast and covers an area of about 600 square miles, with the largest volume of all seven major bay and estuary systems in the state. Although bisected by a 40-foot deep ship channel nearly 50 miles long (35 miles through open Bay waters), the average depth of the Bay is only 8.5 feet, making it a shallow water body perched above the deeper Gulf of Mexico.

Potential Impacts

Proposed plans for navigation improvement and safety in the estuary would create a channel depth of 45 ft. and increase channel width to 530 ft. from the current 400 ft.- wide Houston Ship Channel (HSC). Such projects can affect the ecological health of the estuarine system by: 1) increasing tidal flows of sea water, intrusion of bottom-hugging saltwater further upstream, and incidence of marine predators, parasites and disease organisms; 2) decreasing effectiveness of freshwater inflows and associated sediments, nutrients, and ***salinity gradients*** (area of gradual transition between saltier and fresher water) that provide healthy environmental conditions; and 3) changing circulation and salinity patterns that fish and shellfish use for migration, reproduction, and feeding.

Circulation and Salinity

One way to evaluate these potential impacts is through the development of a computer model to simulate the ***hydrodynamics*** (circulation) and salinity of the estuary under various scenarios representing existing and potential future conditions. Two recent, significant modeling studies were performed on Galveston Bay.

In the first, the U.S. Army Corps of Engineers applied an expanded three-dimensional model to evaluate the physical effects of proposed HSC enlargements on Bay circulation and salinities. This model showed that the most significant salinity shifts, with a 45-foot channel, would be in the upper channel and deeper into Trinity Bay. The August-October shifts would be most dramatic. Most of the high oyster-producing areas of the Galveston Bay system would experience a small increase in bottom water salinity of up to 2.5 ppt.

Results from the Corps' model were used as the basis for two models developed by scientists at Texas A&M University and Old Dominion University. These models were intended to predict oyster distribution, growth, and reproductive potential as a function of factors such as energy and water flow, salinity, temperature, food supply, population density, fishing mortality, and marine predators and diseases.

After an extensive review of the model design, methodology and analysis, researchers agreed that this oyster model was the best available integration of data needed for the study. Results of this process concluded that no net indirect adverse impacts to the oyster community in Galveston Bay would occur as a result of the HSC project.

While the project would cause a direct loss of 118 acres of existing oyster reef, oyster production in the Bay is projected to decline over 50 years even without the project. This projection is based on changes in volume, location and timing of future freshwater inflows, including the decrease in total freshwater inflow into the Bay and an increase in freshwater inflow into the San Jacinto River watershed as a result of diversion from the Trinity River watershed for municipal and industrial uses. However, these forecasts will need to be updated, since current projected water demands are lower than those projected in 1990. The HSC project is expected to ameliorate some of the oyster decline—certain individual reefs

will be adversely affected and others will benefit. Additionally, oysters that were previously surviving in marginal areas of the Bay might be successfully located into more saline waters that encourage better growth.

Freshwater Inflows

In another modeling effort, the Texas Water Development Board has developed a two-dimensional computer model which is being applied to the estuary as part of a cooperative project with the Texas Parks and Wildlife Department and the Texas Natural Resource Conservation Commission to determine the freshwater inflow needs of the estuary. Galveston Bay receives an average 10.1 million acre feet per year of freshwater inflows from the Trinity River basin (54%), the San Jacinto River basin (28%), the San Jacinto-Brazos coastal basin (10%), the Neches-Trinity coastal basin (6%), and the Trinity-San Jacinto coastal basin (2%). Typically, freshwater inflows peak in May, followed by minimum summer inflows in August.

Freshwater inflows to an estuary are important for the following purposes: 1) transporting and distributing sediments and nutrients throughout the estuarine environment; 2) creating and maintaining a proper salinity gradient between the inflowing rivers and the Gulf of Mexico so as to produce estuarine conditions for adequate growth, survival and reproduction of estuarine-dependent species; 3) maintaining wetland habitats, ***primary*** (plant) and ***secondary*** (animal) productivity of the estuary; and 4) sustaining economically important finfish and shellfish populations with an estimated total value to Texas of over $1.21 billion (1986 dollars) in commercial fishing, sport fishing, and other recreational activities annually.

Dynamic fluctuations within a range that is biologically productive, both seasonally and annually, are desirable for maintaining a sound ecological environment. Permanent or semi-permanent alterations contribute to either reduced freshwater inflow, resulting in higher salinity, or too much freshwater inflow, resulting in lower salinity. This type of long-term change can lead to degraded estuarine environments, loss of important nursery habitats for the young of many economically valuable seafood species, and a reduction in the potential for natural absorption of organic and nutritive wastes produced by human activities.

For example, oysters are usually found where there is suitable substrate, good water circulation and long-term salinity ranges between 10 parts per thousand (ppt) and 30 ppt, but the best ***spat sets*** (attachment of larvae to suitable surface) occur when spring salinity ranges from 17 ppt to 24 ppt. Oysters in Trinity Bay have survived salinity of less than 5 ppt for up to three weeks, but reach over 90% mortality when salinity drops below 2 ppt for an equal period.

Before dams and reservoirs were constructed on rivers flowing into the Galveston Bay system, large floods passed through the Bay quickly, reducing the amount of time oysters and other organisms were exposed to low salinities. Oyster populations could reestablish themselves quickly after such flooding. Dams and reservoirs now regulate the flow of fresh water into the Bay, and effectively extend the length of time salinity is reduced, potentially increasing the stress on oyster populations.

Effects of Development

As the human population in the drainage basins of Galveston Bay increases, so do competitive demands for freshwater supplies for domestic, municipal, industrial, agricultural, and other beneficial uses. Although these uses would be expected to decrease freshwater inflows to the estuary, several factors may act together to offset losses from consumption. These include improved conservation practices, increased rainfall-runoff due to widespread ***impervious cover*** (paved surfaces) in urbanized areas, increased use of groundwater with wastewater discharge to the surface drainages, and transfer of freshwater from sources outside the immediate watershed.

Even if total freshwater inflow remains constant, what is the effect on the Bay if the location of the inflows is modified? For example, the Trinity River delta is largely marsh, while the San Jacinto delta has very little marsh. Altering freshwater inflows through either or both of these systems may change conditions in the Bay. This is an important question that remains to be answered when considering the future needs of a growing population and economy, and is one that scientific modeling efforts can help to answer.

For the entire LRR/Final SEIS for the Houston Ship Channel Project, contact the Galveston Bay Information Center (409) 740-4703. Please also refer to Soundings, Fall 1995 issue.

This fact sheet is one of a series produced through a cooperative agreement between the Galveston Bay Foundation and the U.S. Fish and Wildlife Service. The information in this series was developed by authors from the Galveston Bay Foundation, National Marine Fisheries Service, Sea Grant College Program, Texas Natural Resource Conservation Commission, Texas Parks and Wildlife Department, Texas Water Development Board and the U.S. Fish and Wildlife Service.

The Galveston Bay Foundation is a nonprofit organization whose mission is to preserve and enhance the Bay for its multiple uses through education, conservation, research and advocacy. The mission of the U.S. Fish and Wildlife Service is to conserve, protect and enhance the nation's fish and wildlife and their habitats for the continuing benefit of the American people.

For more information, contact the Galveston Bay Foundation at 17324-A Highway 3; Webster, Texas 77598, or call 713/332-3381.