

Chapter 7

Freshwater Inflow And Bay Circulation

Priority Problem

Adequate seasonal inflow of high quality fresh water into the Galveston Bay Estuary is critical for the survival of most estuarine species and is therefore vital to the maintenance of biodiversity within the estuarine system. Despite this fact, few assurances exist to provide for fresh water resources necessary to maintain estuarine health and productivity. Rather, inflow to Galveston Bay is now dealt with on a case-by-case advocacy process presided over by the Texas Natural Resource Conservation Commission (TNRCC). To ensure that the freshwater inflow requirements of the estuary are met, the management of freshwater inflow on a comprehensive watershed basis is recommended.

Tools for determining the amount, quality, and timing of inflow required to maintain biological productivity and diversity in the Galveston Bay Estuary are being developed as a part of studies mandated by the Texas legislature. This effort is scheduled for completion by February, 1995. Pending completion of these ongoing studies, it is recommended that flexible management targets for freshwater inflow be established, and that Galveston Bay inflow requirements be given high priority in the watershed water allocation process. Further improvement of freshwater inflow management can be achieved by optimal routing of return flows and the conservation of water on a Galveston Bay watershed basis.

Management Goals and Objectives

Task Force members established the following high-priority management goals:

- At a minimum, maintain freshwater inflow to ensure maintenance of ecosystem conditions at present levels and
- If feasible, maintain freshwater inflow at levels that will enhance selected populations and communities identified by the Species Population and Habitat Protection Task Forces

These initial management objectives were further modified and are now the four freshwater flow (FW) objectives and seven FW actions set forth in the Galveston Bay Plan:

Objective 1	Determine annual and seasonal inflow needs to the bay by 1995
Action FW-1.	Complete current studies to determine freshwater inflow needs for the bay
Action FW-2.	Expand stream flow, sediment loading, and rainfall monitoring
Objective 2:	Incorporate inflow needs in regulatory authority and planning processes by the year 2000
Action FW-3.	Establish management strategies for meeting freshwater inflow needs
Action FW-4.	Establish inflow regulations to protect ecological needs of the estuary
Action FW-5.	Explore means of providing sediment to the estuary
Objective 3	Increase water use efficiency within the Galveston Bay Program area by 10% by the year 2005
Action FW-6.	Reduce water consumption
Objective 4	Complete an evaluation of bay circulation patterns and their effects on bay habitats and species by the year 1999
Action FW-7.	Evaluate the effects of channels and structures on bay circulation, habitats, and species

Data Information Needs

Task Force members agreed to use the results of the Texas Water Development Board's (TWDB) TXEMP model, a freshwater inflow-biological resources optimization model, to determine the quantities and timing of freshwater inflows needed to maintain current abundance's of selected biological resources.

The goal of Plan Objectives 1, 2, and 3 is to establish and ensure beneficial freshwater inflows necessary for a salinity, nutrient, and sediment loading regime adequate to maintain the productivity of the Bay. Information needed to assess

these management objectives include:

- Identification of indicator parameters for freshwater inflows,
- Status and trends in the quantity, location, and timing of freshwater inflows,
- Status and trends in the magnitude and distribution of water quality parameters for freshwater inflows.

Freshwater inflow data are needed to gain a fundamental understanding of how Galveston Bay works. The status and trends in the quantity and timing of freshwater inflow are needed to characterize the freshwater inflow to the Bay. The status and trends in the magnitude and distribution of water quality parameters are needed to assess the physical and biological effects the freshwater inflow regime may have on the Bay. Freshwater inflow data will be used to evaluate the strength of the relationship between the volume and timing of freshwater inflow and:

- Local and bay-wide water quality,
- Abundance of selected species, and
- Quantity and quality of selected habitats.

Task Force members identified candidate indicator parameters to assess the quantity and timing of freshwater inflows (Table 7-1). Direct measurements of freshwater inflow volume are highly recommended; precipitation, land use, and run-off coefficients are required to estimate freshwater inflow volumes where direct measurements are not available. Input parameters to TWDB's TXEMP model were also identified as key information needs in developing water quality parameters.

The goal of Plan Objective 4 is to ensure that alterations to Bay circulation do not negatively affect Bay productivity. Information needed to assess this management objective include:

- Identification of indicator parameters for circulation,
- Descriptions of large-scale circulation patterns.

Depth related temperature and salinity (conductance) measurements are needed to identify distinct water masses. Current meters may be used to measure the speed and direction of these water masses.

A primary purpose of Plan Objectives 1 through 4 is to ensure conditions in the Bay will maintain and enhance Bay species. Information on the status and trends in abundance and distribution of species whose existence depends on specific freshwater flow regimes is required to assess whether freshwater flow controls are having the desired effect on animal populations.

TABLE 7-1. PARAMETERS USED AS INDICATORS OF FRESHWATER INFLOW QUANTITY AND QUALITY.

Candidate Parameters

Inflows - In areas with gauging stations

- Tidal flow
 - Freshwater flow
- Volume, timing, location

Inflows - In areas without gauging stations

- Precipitation
- Runoff coefficients

Inflow Water Quality

In situ Measures

- Temperature
- Conductance
- pH
- Dissolved Oxygen
- Turbidity

Analytical Samples:

- Oxygen demand, BOD (5-day)
 - TSS, VSS
 - Nutrients:
 - Nitrogen - NH₃-N, nitrate, nitrite,
 - Phosphorous - Total and ortho-
 - Carbon - TOC
 - Fecal coliform
 - Total/dissolved metal COCs
 - Organic toxic COCs
 - Pesticide COCs
 - Ambient toxicity
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Monitoring activities must provide information to evaluate whether progress toward these management objectives is being made. The freshwater flow component of the regional monitoring program must provide data to assist in:

- Determining whether severe alterations in freshwater inflow are occurring,
- Ascertaining whether severe changes in freshwater inflows may cause alterations in aquatic populations and habitats, and
- Evaluate alternative actions to mitigate identified adverse impacts due to alterations in freshwater inflows in Galveston Bay.

The following monitoring objectives have been used to design the regional monitoring program for Galveston Bay:

- Improve and maintain a system for accurately monitoring freshwater inflow to the Galveston Bay. This information will be evaluated for trends in timing and flow volume.
- Evaluate status and trends of and to make biennial water quality assessments, based on TNRCC segmentation schemes, of Tier One and Tier Two water quality parameters in Bay watersheds.
- Characterize the distribution and trends of parameters (salinity, temperature) selected as indicators of freshwater impact in the Bay,

Assessments of freshwater flow will be based on the weight of evidence from several indicator parameters. From identified Plan objectives and information needs, it is clear that the freshwater flow and bay circulation component of the regional monitoring program must provide local and bay-wide status and trend data.

Programmatic Monitoring

Programmatic monitoring is necessary to fully assess the effectiveness of Plan actions. It is the primary assessment tool for several plan actions and is less critical for other actions. Proposed programmatic monitoring activities are highlighted below.

For actions FW-1, 2, 5, and 7 only administrative monitoring functions are recommended. For action FW-3 activities of the TNRCC will be monitored with respect to the development strategies to assure a consistent inflow management plan. Action FW-4 will monitor the regulatory status of inflow for any legislative changes in authority. Activities for these actions are not expected until 1999. Action FW-6 calls for the reduction of water consumption through a long-term strategy of water conservation. The Program will work with all identified groups to develop a methodology for monitoring water use in the watershed.

Environmental Monitoring

The Monitoring Work Group does not recommend the addition of new elements to current monitoring elements. The Work Group does recommend evaluation and expansion of the role of several important data collection efforts. Results from the TWDB/TPWD modeling efforts to characterize inflow needs to Galveston Bay will be used to make modifications to monitoring activities. This model considers nutrient and sediment requirements, salinity restrictions and fishery productivity to produce a predicted freshwater need to maintain desired levels of biological productivity and diversity. These inflow requirements will be used to provide target numbers for use in future management of freshwater inflow.

Currents

There are no ongoing programs for recording currents in the bay. The COE and other agencies have had short-term current monitoring efforts usually to assess the

potential effects of proposed projects on bay circulation. The TWDB operates 5 permanent continuously recording probes for collection of data to support their modeling programs for circulation and salinity and analyses of the relationship between salinity and freshwater inflow in the bay. Assessing currents will not be considered as a monitoring element for the GBRMP. However, the Monitoring Work Group recognizes the need for surveys to assess specific problems associated with bay circulation on a case-by-case basis to enable the determination of any effects of future large-scale projects on bay circulation. The use of USGS doppler methodologies for current surveys has been discussed and will be considered as a monitoring survey program. It is recommended that research efforts be undertaken to provide additional information to characterize the effect of impoundments, dikes, navigation channels, and levees on freshwater inflow to the Bay and circulation patterns within the Bay.

Freshwater Inflow Quantity and Timing

The Monitoring Steering Committee will work with appropriate agencies to improve coordination of monitoring activities to more accurately measure the volume and timing of freshwater inflow at critical locations within the Bay watershed. Estimates of freshwater contributions to the Bay show that the Trinity River watershed accounts for 54% of the freshwater inflow to the Bay. The second highest contributor is the San Jacinto River watershed with 28% and other local watersheds 18%. In deference to the magnitude of these estimates, priority will be placed on improving direct inflow measures for the Trinity and San Jacinto River systems and maintaining capabilities in other systems. Specific improvements identified are the addition of sediment measuring stations, increased numbers of rainfall stations for better inflow estimates in watersheds without flow gauges, and improved accuracy of the rating curve for the spillway at Lake Houston to improve accuracy of San Jacinto River flow.

The primary source of information on freshwater inflow are the USGS gauging stations located in various bay watersheds (Figure 7-1) Several types of flow monitoring stations are operated by the USGS. Some have records of gage-height record only while others are continuous recording stream flow stations. In addition to stream-flow information many of the stations are also water quality stations. Water quality stations may have continuous-recording instrumentation and are sampled routinely by USGS water quality personnel. As described in Chapter 3 the USGS operates four continuous recording monitoring stations for the City of Houston. These stations located on major bayous in the city are continuously monitored for surface water elevation, temperature, conductivity and DO. In addition to these parameters the stations are periodically sampled for a wide range of water quality parameters. The USGS also operates 12 additional stations in the Galveston Bay watershed which can be used to provide information on freshwater inflow.

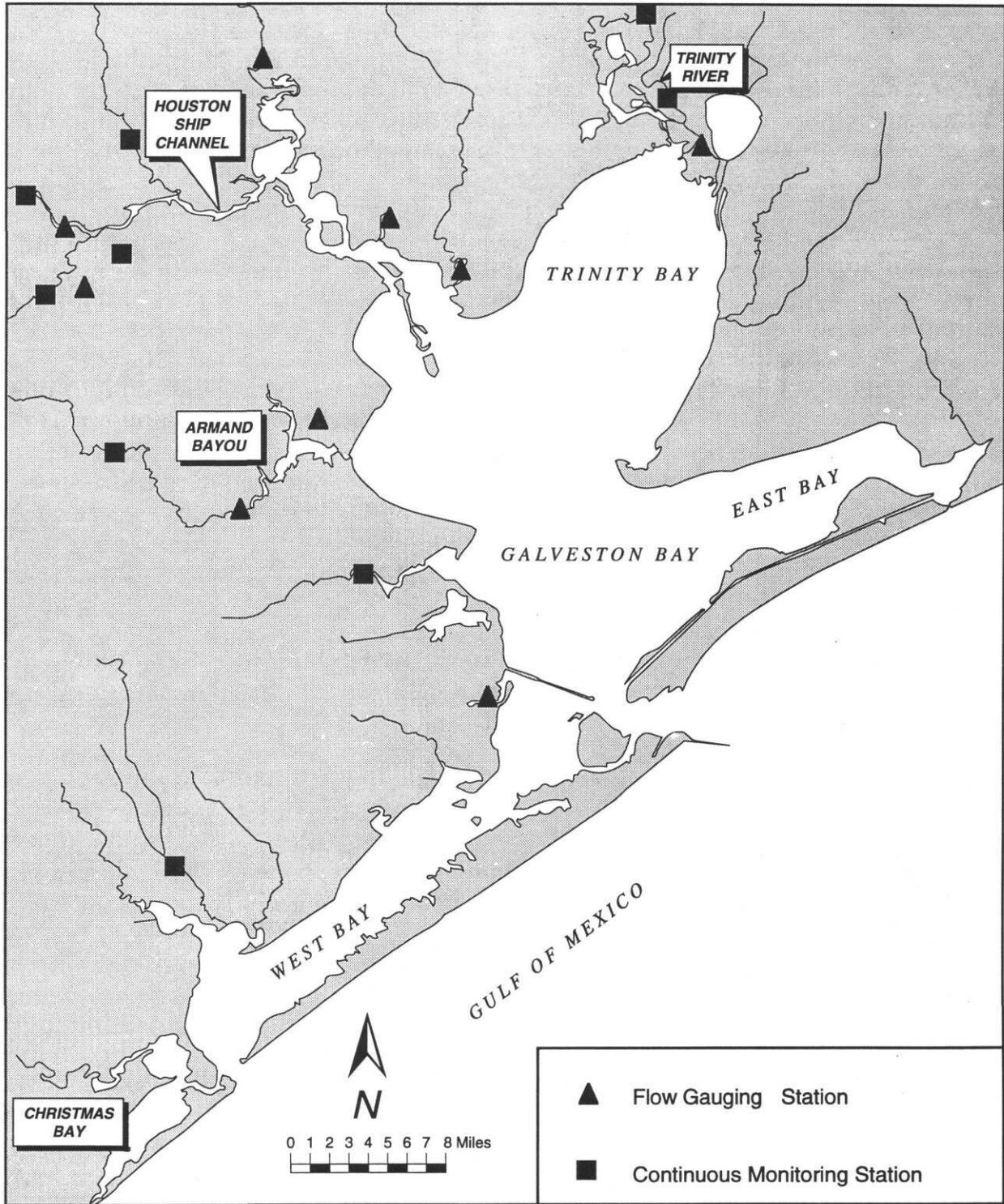


Figure 7-1. USGS flow gauging stations for Galveston Bay inflows.

Steps are currently being taken by the USGS to evaluate the flow measurement capabilities at the Lake Houston spillway. There are concerns for accuracy of this information especially under low flow conditions. An additional flow gauging and water quality station is being constructed by the USGS for evaluation of nutrient loadings from stormwater runoff in Dickinson Bayou (see Chapter 11- Non-Point Sources). With this addition most major inflow contributions will be gauged.

Freshwater Quality

The quality of inflow into the Bay will be evaluated through the integration of efforts of several existing and development programs. The USGS, TNRCC and numerous city and county agencies maintain water quality sampling stations at key locations in the Bay watershed. The state of Texas through the Clean Rivers Program will be conducting biennial assessments of water quality on a basin and sub-basin basis. This information will provide the types of information required to make assessments of water quality and to identify localized problems. A more complete discussion of the relationship between Clean Rivers and the Galveston Bay Program can be found in Chapter 10 - Water and Sediment Quality.

Bay Monitoring

Bay monitoring stations operated as part of the GBRMP will provide information on the effect of freshwater impacts to the Bay. Complete discussion of this program element can be found in Chapter 10 - Water and Sediment Quality. Additional monitoring efforts that have been recommended are the establishment of permanent real-time monitoring stations within the bay. These can be used to supplement the stations currently operated by the TWDB and TPWD.

In addition to water quality parameters other monitoring elements that will provide indirect information on the effect of freshwater impacts include: species population protection and habitat protection.