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## A Precise Environment

by Lou Ellen Ruesink

Aquarium enthusiasts know just how particular fish are about their surroundings. They know that fish—especially saltwater fish—are downright finicky about their oxygen, food, pH balance, temperature, light and water quality. For fish to reproduce in an aquarium, the owner must provide an environment exactly to their liking.



Fish and shellfish living along the Texas coast require an environment almost that precise. They must have fresh water from rivers mixed with salt water from the Gulf of Mexico at just the right time and in just the right quantities. They are picky about their food, and they refuse to grow and reproduce if their environment does not meet their demands.

Almost all the fish and shellfish species of the Gulf depend on estuaries, the coastal areas where streams and rivers mix with seawater. Some species, such as the oyster, spend their entire lives in estuaries, but most finfish and shellfish use the fertile areas as nursery grounds. Many species migrate into the estuaries to spawn, and the young stages of other species enter them for food, lower salinity, or protection against predators and parasites. Most fishes and shellfish return to the open Gulf as adults.

Marshlands adjacent to Texas bays provide large amounts of organic material, forming the base of the estuarine food chain. Each year the marshes produce as much as 15,000 pounds dry weight per acre of cordgrass and other salt-tolerant plants. Only tropical rain forests, coral reefs and certain algal beds are more productive.

Estuarine productivity depends greatly on how much and when fresh water enters from rivers and streams, diluting the seawater. Salinity of seawater averages 35 parts per thousand, but most immature fish and shellfish prefer water of salinity less than 17.5 parts per thousand. They find it in the estuaries.

Flooding periodically flushes the wetlands, bringing in food and removing or diluting pollutants, parasites, bacteria and viruses. Timing of floods is crucial. Spring floods may be more beneficial to the estuarine system than winter floods because warmer spring temperatures support more biological activity. Because some fishes, such as the red drum, spawn in the fall, the young are particularly dependent on migration to the estuary for survival then. Others, such as the spotted seatrout, may spawn throughout the summer.

The Texas coast is one of the most diverse estuarine regions in the world and includes 1.5 million acres of estuaries and 1.1 million acres of adjacent marshes. The coastal environment ranges from water-rich East Texas forests to semi-arid brush country along the southern third of the coastline. Parts of the Texas coast are among the most heavily populated in the nation, while other areas are seldom visited by man.

Six of Texas' seven major estuaries fit the textbook definition of an estuary: a semi-enclosed body of water, with a free connection with the open sea, in which seawater is measurably diluted with fresh water from land drainage. Texas' seventh estuary, the Laguna Madre, separating Padre Island from the mainland, is also a marine lagoon. Its connection with the sea is not "free," and it is often much saltier than seawater because of evaporation and sporadic freshwater inflow.

Each year sport and commercial fishermen harvest more than 100 million pounds of fish and shellfish from the waters off Texas, and in recent years the harvest has been more valuable than that of any other Gulf state. In 1981 the economic impact of commercial and recreational fishing in Texas was about \$1.25 billion, including direct and indirect gross business, personal income, and tax revenues.

Experts warn, however, that Texas' fertile estuaries are in danger because of development of water supplies for industrial, municipal and agricultural water users. According to the Texas Department of Water Resources (TDWR) the development of river basins can reduce the amount of fresh water and nutrients entering estuaries, trap important suspended sediments upstream, increase estuarine salinity and pollutant concentrations, and alter the seasonal timing of freshwater inflow.

During the severe drought of the 1950s, the salinity of some Texas bay waters exceeded the average salinity of Gulf water by 40 percent due to decreased river flow and increased evaporation. Commercial fish landings from the Gulf declined sharply. Scientists say a similar drought could cause far greater harm to the bays and estuaries today because so much water development has taken place since the 1950s, changing flow patterns in virtually every major river basin in Texas. The number of major reservoirs has more than doubled in the past 30 years and now exceeds 180.

Water in river basins is "managed" primarily for use by cities, industries and irrigators. Large dams hold flood water to be used when needed or to be

released slowly when flood stages have passed, but management strategies insufficiently consider how changes in flow affect estuaries.

Potentially harmful effects of upstream development on coastal environments went virtually unnoticed by state water planners and legislators during the 1960s—the most active decade for water development in Texas history. Since 1971, however, the state Legislature has passed laws acknowledging the importance of the estuaries and issued policy statements to protect them. The Legislature also authorized comprehensive studies of the freshwater requirements of estuaries, which TDWR completed in the summer of 1982. The Department studied each estuarine system in the state, estimating the quantities of fresh water needed, both monthly and seasonally, for marsh inundation, nutrient transport, maintenance of proper salinity, and support of various levels of fisheries harvests. It concluded that controlled introduction of fresh water into an estuary would be a significant contribution to its management if it could be done with enough water at the proper time.



The major estuarine regions of Texas.

TDWR assessed freshwater needs of each estuary to demonstrate a wide range of production potential with different inflow patterns. Scientists evaluated three levels of production:

- The Subsistence alternative minimizes inflow needed by an estuary while still meeting its requirements for salinity, marsh inundation and nutrients.
- The Fisheries Harvest Maintenance alternative requires enough in-flow to support annual commercial harvests of the major seafood species at levels no less than their historical averages. Species considered include spotted seatrout, red drum, black drum, white shrimp, brown shrimp, blue crab and American oyster.
- The Fisheries Harvest Enhancement alternative examines how inflow patterns could enhance specific commercial harvests. The total freshwater

inflow would not exceed historic averages, but the seasonal flow might be redistributed to increase harvests of certain species.

Management of freshwater flow into estuaries will require computer models and continued hydrological and biological studies. Each river and its related estuary require different considerations, including ecological characteristics, upstream water rights, and economic trade-offs.

Texas law requires the maintenance of a healthy environment for fish and other estuarine life, and water planners have analyzed freshwater requirements of the estuaries, but complex issues regarding management and freshwater inflow remain unresolved. Tough questions for Texans to answer in the 1980s, ideally before the next major drought, include the following.

- Surface water belongs to the state, and users must receive permission from the state to use it. Which users will have the right to limited water during drought years: municipal, industrial, agricultural or estuaries?
- If water from reservoirs is to be released for estuaries, who should pay for the storage: reservoir owners, water customers, fishermen, or all taxpayers?
- Should the state continue to fund and coordinate studies of freshwater inflows into estuaries?
- At what productivity level should the state maintain the estuaries, and which species should be enhanced?
- If new reservoirs are required to release water for coastal areas, should the state help finance their construction?
- Should development be limited in river basins in which decreased inflow may affect marine productivity?

Now is the time for Texans to resolve these questions. Their importance and urgency cannot be overemphasized. As all aquarium owners know, it is too late to change the water when the fish are floating on the surface.

Lou Ellen Ruesink editor of Texas Water Resources, the bimonthly newsletter of the Texas Water Resources Institute, in which this article originally appeared.