

# **Water Rights and Instream Uses**



*Laying out cross-sections for an instream flow study*

# Water Rights and Instream Uses

Water availability is an issue in Texas due to the increasing difficulty of meeting the needs of people, industry, wildlife, and habitats. Climatic factors provide a gradient of rainfall and available water across the state, but much of the state can be classified as sub-arid. Across the state, naturally occurring periods of low water availability are exacerbated by the increases in human population and in activities that require water and projections of future demands on the water supply are for increased needs. According to the State Water Plan the total projected demand for water is expected to increase 18 percent, from nearly 17 million acre-feet in 2000 to 20 million acre-feet in 2050.

## Flow Modification in Streams and Rivers

Modifications in the natural flow regimes of rivers and streams to prevent flooding and to meet demands for reliable water supplies have become commonplace. In no place has this become more apparent than in Texas, where water resources have been developed for more than 150 years to supply water for a variety of municipal, agricultural, and industrial uses. Additionally, the conversion of vast areas of native forests and grasslands into rangeland and cropland in the 1800s has had profound impacts on Texas' rivers and streams. Brune (1981) provides an excellent historical perspective on the decline of water resources in the state. Of 281 springs that were identified as historically significant, more than one-fourth (80) no longer flow, and those that remain have significantly reduced discharges.

During the last one hundred years, many streams have been impounded to make surface water resources more reliable. Because reservoirs are planned, constructed, and operated to modify the spatial and temporal availability of surface water within a drainage basin, they dramatically alter the hydrological conditions to which the native aquatic communities have become adapted. The aquatic community is dependent upon sufficient quantities of water for growth, survival, and reproduction. Reduced streamflow alters the type of habitat available and may compress aquatic habitat, increase competition among species, and cause the loss of some species. Reservoirs also directly affect physical habitat and water quality characteristics of the impounded stream. Impounded streams tend to be clearer, have lower silt loads and nutrient levels, and exhibit different temperature profiles than unmodified streams. These changes persist for the life of the impoundment and may cause substantial changes in community composition downstream. The impact of impoundment on the hydrological characteristics of a stream, on the other hand, can be managed in

part through the incorporation of appropriate release schedules in reservoir operation plans.

Riparian ecosystems include the stream, its biota, the associated riparian habitat, and the physicochemical conditions to which these habitats have been exposed. Any ecologically healthy, natural aquatic community should exhibit the following:

- ! the physical characteristics of the stream are consistent with the geomorphic characteristics of its drainage basin;
- ! the water quality supports the growth, survival, and reproduction of the ecological community that was historically characteristic of the stream;
- ! the hydrological characteristics of the stream emulate historically observed seasonal and long-term variations in flow; and
- ! the biological communities are comprised of native flora and fauna known to have occurred naturally in the stream and at levels of abundance and diversity previously observed. Non-native populations should not be allowed to degrade the native species present. Non-natives may be from another continent (exotic) or from North America (exogenous).

## Biogeography

Conner and Suttkas (1986) described the fish species distributions for the major drainages of the Western Gulf Slope. The Western Gulf Slope encompasses portions of three physiographic provinces: the Gulf Coastal Plain, the Great Plains and the Central Lowlands. The Sabine drainage is confined to the Coastal Plain while the remaining drainages extend onto one or both of the interior provinces. From east to west, the major drainages entering the Gulf of Mexico between the Mississippi and Rio Grande Basins are the Sabine lake (Sabine and Neches River systems), Galveston Bay (Trinity and San Jacinto River systems), Brazos, Colorado, San Antonio Bay (Guadalupe and San Antonio River systems) and Nueces.

The seven drainages form a convenient unit for biogeographic study since the Mississippi Basin/Western Gulf Slope and Nueces drainage/Rio Grande Basin divides, respectively constitute more marked distributional barriers for fishes than any of the intervening divides. One hundred ninety five species of fish representing 47 families are known to occur in the seven major drainages. Of these species, 102 occur strictly in freshwater

The Colorado and Brazos Rivers have large, distinctive fish faunas with a large number of species that reach either the northeastern or southwestern limit of their geographic distributions. In addition, the Brazos drainage is home to two endemic species of river shiner. One of these species, *Notropis buccula*, has undergone an extreme contraction of its previous

distribution within the basin. It is now restricted to less than 25 percent of the basin. The Colorado drainage has 59 native strictly freshwater species; the Brazos has 68 native freshwater species.

The Guadalupe-San Antonio River basin has fewer species, but it is well known for the number of genetically distinct populations and its endemic species. These include the Guadalupe bass, *Micropterus treculi*, and the fountain darter, *Etheostoma fonticola*. The basin has 49 recorded native freshwater species. In addition to fish species, this basin and the Colorado basin have a number of spring-fed perennial streams that contain very diverse aquatic invertebrate communities.

The Nueces River basin has a reduced fish fauna compared to other basins its size. However, the spring-fed stream of the Frio River drainage as well as other streams of the Edwards Plateau contain very diverse invertebrate communities. The Texas Ecoregion project found that Edwards Plateau streams and rivers were the most diverse instream invertebrate communities in the state. This area, rich in aquatic invertebrate species, includes portions of the Colorado, Guadalupe, San Antonio, Nueces, and Devils River drainages.

## **Freshwater Inflows to Bays and Estuaries**

Estuaries are transitional areas between freshwater and saltwater systems. Estuarine systems are among the most productive ecosystems in the world. Freshwater inflows are important to estuarine species because the inflows provide 1) low salinity habitats for juveniles, 2) a medium to transport beneficial sediments, nutrients, and organic matter, and 3) control over the timing of movement of some estuarine species.

The Texas Legislature, through House Bill 2 (1985), Senate Bill 683 (1987), and other legislative directives have charged the state agencies responsible for water and wildlife management to determine the quantity of water needed to maintain the ecological health and productivity of Texas bays and estuaries.

The TWDB and the TPWD are the lead agencies responsible for producing the Bays & Estuaries Studies. The purpose of these studies is to determine what estuarine conditions and freshwater inflow regimes are needed to maintain an ecologically sound environment and the productivity of fish, shellfish, and other estuarine life. A comprehensive methodology for establishing the necessary level of inflows to Texas estuaries was presented in the report "Freshwater Inflows to Texas Bays and Estuaries" (Longley, 1994). The amount of freshwater inflows needed to maintain this environment are calculated using statistical analyses, computer simulations, and a mathematical optimization program, TxEMP. The optimiza-

tion model has certain constraints in place to ensure the resulting requirement falls within a feasible range of values. Constraints used in Texas Estuarine Mathematical Program (TxEMP) include a lower and upper bound on the amount of monthly inflow reaching the estuary, a lower and upper salinity bound at selected sites within the estuary, fisheries harvest targets for selected species, the probability of reaching harvest targets, a biomass ratio apportioning fisheries harvest, a minimum annual nutrient (nitrogen) load to the estuary, and a minimum annual sediment load to the estuary.

The optimization model produces a range of feasible solutions, of which both the monthly pattern of inflows and annual total are important. Four model solutions receive further attention:

- ! Min Q inflows represent the minimal inflows at which all constraints are met
- ! Max H inflows represent the flows at which the maximum harvest is attained
- ! Critical inflow, or Min Q-sal, are inflows satisfying only the salinity constraint or otherwise defined to represent flows that should be maintained during drought conditions to ensure that the estuary will contain some areas of refuge for the survival of estuarine organisms.

Presently, the TWDB and TPWD have determined Max H and Min Q recommended inflow values for the seven major estuaries: the Guadalupe-San Antonio Estuary, the Lavaca-Colorado Estuary, the Trinity-San Jacinto Estuary, the Sabine-Neches Estuary, the Nueces Estuary, the Mission-Aransas Estuary, and the Laguna Madre Estuary. Freshwater recommendations are projected to be available for the five minor bay systems and river estuaries by 2006.

The TCEQ and TPWD are the agencies responsible for determining how to best manage inflows to the Texas bays and estuaries, and they are in the process of determining implementation strategies. The ultimate goal is to develop a management strategy that will be used to maintain a level of inflows that will support the historical composition of the estuarine community, and support a productive fishery in the estuary. Presently, two of the seven major Texas estuaries have freshwater inflow management plans, the Nueces Estuary and the Lavaca-Colorado Estuary.

## **Instream Flow Studies**

Under Senate Bill 2, the TPWD, TCEQ, TWDB in cooperation with other appropriate governmental agencies are tasked with jointly establishing and continuously maintaining an instream flow data collection and evaluation

program and conducting studies and analyses to determine flow conditions in the state's rivers and streams necessary to support a sound ecological environment. Instream flow studies for selected priority basins are to be completed by the end of 2010.

## **Regulatory Program Overview**

The TCEQ has the authority to grant water rights permits for unappropriated waters of the state. Chapter 11 of the TWC specifies that before the TCEQ grants a right to use state water, it must first determine whether unappropriated water is available at the applicant's requested location. Current procedures define unappropriated water as the amount remaining in the stream after all existing authorized water rights holders withdraw their permitted amounts and after all environmental needs for instream uses have been met. Granting water rights without a review of water availability would compromise existing authorizations and threaten aquatic natural resources. The TCEQ has developed computer models to make specific estimates of water availability. These models are based on long-term hydrological data and the locations of water diversion points for previously granted water rights. Other considerations, such as instream flows and freshwater inflows into bays and estuaries, also enter into determinations of water availability in the form of streamflow restrictions on each diversion. These streamflow restrictions are assumed to be adequate to protect the ecological health of the aquatic communities.

## ***Description of the TCEQ Program***

In 1997, the TCEQ was required by the 75th Legislature (in Senate Bill 1 - SB1) to develop new surface water availability models. The required models were subsequently completed in December 2001. A surface water availability model is a computer program that can calculate the amount of water in a river basin or stream using hydrologic principles and actual historical measurements of streamflows. At a minimum, a water availability (or accounting) model requires two distinct types of data: data on streamflows and data on water demands or water rights. The water availability model tracks demands against supplies with specific demands being met in a specified priority. The model also uses groundwater interactions, reservoir system operations and other data to produce water volume information at designated points along a stream network. The new modeling system replaces outdated water availability models for eight of the State's 23 river basins and, for the first time, provides water availability modeling capabilities for the other basins.

## ***Environmental Review***

Environmental reviews of water rights applications are conducted in accordance with §11.147, §11.1491, §11.150, and §11.152 of the TWC and with TCEQ administrative rules which include 30 Texas Administrative Code (TAC) §297.53 through §297.56. These statutes and rules require the TCEQ to assess the possible impacts of granting of a water right on fish and wildlife habitat, water quality and the instream uses associated with the affected body of water. In addition, possible impacts to bays and estuaries are addressed for those permits within 200 miles of the Gulf of Mexico. Examples of significant impacts that affect natural resources including those which: result in deterioration of water quality or flood protection; result in unallowable reduction of identifiable instream uses; endanger species of plant and animal life and their habitat; significantly reduce productivity of the bay and estuary systems; or contribute to a series of related projects that involve individually minor but collectively significant adverse impacts.

At present, the environmental reviewer utilizes county maps, USGS 1:24,000 scale maps, United States Fish and Wildlife Service (USFWS) wetland maps (where available), and photographs and descriptions of the project area provided by the applicant. Information concerning threatened and endangered species is obtained from the TPWD and USFWS. The *State of Texas Water Quality Inventory* (305b report), the *State of Texas Clean Water Act Section 303(d) List*, the *TSWQS* (30 TAC §307), and the TPWD publication, *An Analysis of Texas Waterways* as well as other available documents are consulted for relevant information. On a case-by-case basis, information is also obtained from the SWQM Team of the Monitoring Operations Division and the WQS Team of the Water Quality regarding water quality, previous receiving water assessments, water quality certification reviews, and permitted discharges.

The characteristic hydrology of the area is reviewed using historic flows from USGS records and 1:24,000 scale maps. For perennial streams, reviewers work with Surface Water Availability & Interstate Compacts Team hydrologists to calculate monthly-median daily flows and water availability. The seven-day, two-year low-flow (7Q2) value is obtained from the Texas Surface Water Quality Standards.

Assessments for large projects vary in form and scope depending on the size and nature of the proposed project. For example, assessments of large reservoir projects can often include an environmental impact statement (EIS) or at a minimum, a quantitative/qualitative evaluation of the area to be inundated. The TCEQ is required to assess the need for mitigation of lost habitat for new projects and project amendments to divert, store, or



take in excess of 5,000 ac-ft of water per year (TWC §11.149; 30 TAC §297.48).

In certain instances, although rare to date, the applicant may be required to conduct an instream flow evaluation using Instream Flow Incremental Methodology (IFIM). IFIM evaluations are used to determine the appropriate flow required to protect the various instream uses. After the information is gathered and assimilated, a decision is made as to the type of restriction that might be required to satisfy environmental concerns. Factors that contribute to the inclusion of a streamflow restriction include: the perennial nature of the stream; aquatic life use and biological integrity of the stream; water quality condition; presence of species of concern; and recreational uses. Flow restrictions to protect instream aquatic habitat and instream aquatic life uses are based upon intensive analyses of instream uses when such analyses are available. If no detailed study is available, restrictions to protect instream uses are based on one or more of the following default criteria where they are appropriate:

- ! modified Lyon's method or Tenent method (i.e., percentage of median flow) for instream variables, including the protection of significant aquatic life and instream or riparian habitat;
- ! low-flow value for protection of instream water quality (7Q2);
- ! federal and state agency publications regarding flow needs for aquatic species, recreational uses and terrestrial habitat for species of concern

In addition to flow restrictions, mitigation may be recommended for altered, inundated, or destroyed terrestrial or riparian habitat on all permits. These procedures have been standardized by the TCEQ in a document entitled *A Regulatory Guidance Document for Applications to Divert, Store, or Use State Water* (TCEQ, 1995b).

## **Current Areas of Concern**

Although a current regulatory program exists to provide protection to instream uses, including freshwater inflows to bays and estuaries, there are a number of problems with the potential to place the ecological health of instream and estuarine communities at risk. These include the following:

- ! inadequate regional or basin-specific biological information on instream flow needs of freshwater riverine species or communities;
- ! inadequate assessment of the role of groundwater connections to surface water through springs, seeps, and streambed connections; and
- ! no current framework or regulatory authority to review existing permits that contain no provisions for instream flows or bay and estuary freshwater inflows.

These concerns as well as others can be summarized as a series of potential problems or stress agents. These fall under broad categories:

- ! Increasing use or demand for streamflow and springflow: increasing anthropogenic and phreatophytic use of water decreases the amount of streamflow and springflow available to maintain an ecologically healthy instream community. These reductions in flow have the potential to affect wildlife and terrestrial plant communities as well;
- ! Change in the historical allocation pattern and location of streamflow: modification of stream channels, building of reservoirs, and irrigation of cropland change the seasonal distribution of flows and the location of terrestrial water storage; and
- ! Decrease in freshwater inflows to bays and estuaries: diversion, impoundment, and terrestrial use of water all have the potential to decrease freshwater streamflow from reaching the bays and estuaries along the Texas coast. These freshwater inflows are critical for maintaining the historical productivity of these waters. Elements of concern include maintaining appropriate salinities, nutrient and sediment loading, as well as frequency of inundation for coastal wetlands.

### ***Active Water Rights and Environmental Protection Provisions***

Table 6-1 lists the number of active water rights in Texas by river basin. The largest share of water rights is for annual appropriations of less than 1,000 acre-feet (ac-ft) per year. However, most of the non-coastal river basins have at least one large water right in excess of 100,000 ac-ft/yr. In 1989, a team was created to perform environmental assessments of water rights applications. Following the environmental assessment, recommendations may be made in order to limit or minimize potential impacts. The requirement of streamflow restrictions are based on the perennial nature of the stream, aquatic life use and biological integrity of the stream, water quality issues, presence of species of concern and recreational uses. In addition to flow restrictions, mitigation may be recommended for altered, inundated or destroyed terrestrial or riparian wetland habitats as well as possible adverse water quality impacts.

Table 6-1. Active Water Rights in Texas Basins, August 2002

Basin Name	Active* Water Rights	Size Category of Water Right				Total ** Appropriated Water acre-feet
		>= 100,00 acre-feet	>=10,000- <100,000 acre-feet	>= 1,000- <10,000 acre-feet	<1,000 acre-feet	
Canadian	39	1	1	0	37	164,789
Red	272	1	9	30	232	642,006
Sulfur	54	1	5	6	42	379,291
Cypress	82	1	8	5	68	412,070
Sabine	180	6	5	6	163	1,887,732
Neches	232	5	8	10	209	4,065,309
Neches-Trinity	102	1	4	41	56	330,363
Trinity	593	10	21	25	537	4,367,486
Trinity-San Jacinto	17	0	1	7	9	44,524
San Jacinto	120	3	5	11	101	636,586
San Jacinto-Brazos	58	2	4	16	36	4,484,227
Brazos	1,154	6	34	57	1,057	2,679,164
Brazos-Colorado	66	0	2	16	48	92,396
Colorado	1,222	7	12	42	1,161	5,350,376
Colorado-Lavaca	32	1	3	7	21	975,444
Lavaca	55	1	0	12	42	163,589
Lavaca-Guadalupe	7	0	0	2	5	4,560
Guadalupe	353	9	7	18	319	6,266,722
San Antonio	264	0	3	12	249	186,750
San Antonio-Nueces	17	0	2	2	13	33,408
Nueces	259	2	2	15	240	539,981
Nueces-Rio Grande	84	3	2	25	54	1,771,293
Rio Grande	968	11	33	104	820	6,992,372
<b>TOTALS</b>	<b>6,230</b>	<b>71</b>	<b>171</b>	<b>469</b>	<b>5,519</b>	<b>42,470,438</b>

\* Contractual permits/agreements are excluded

\*\* Includes both consumptive and nonconsumptive rights

