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.

Instream Flows 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 stream flow 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 province: 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 Texas Parks and Wildlife Department (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 optimization model has certain constraints in place to ensure the resulting requirement falls within a feasible range of values. Constraints used in 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
- Max Q inflows represent the maximum inflow volume at which all constraints are met
- 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 following estuaries: the Guadalupe Estuary, the Lavaca-Colorado Estuary, the Trinity-San Jacinto Estuary, and the Nueces Estuary. Recommended inflow values are in the verification stage for the Mission-Aransas Estuary, and studies are in progress for the Laguna Madre Estuary and the Sabine-Neches Estuary.

TNRCC 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.

Regulatory Program Overview

The TNRCC has the authority to grant water rights permits for unappropriated waters of the state. Chapter 11 of the TWC specifies that before the TNRCC 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 TNRCC 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 TNRCC Program

In 1997, the TNRCC was required by the 75th Legislature (in Senate Bill 1 - SB1) to develop new surface water availability models. 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. Once developed, the new modeling system will replace outdated water availability models for eight of the State's 23 river basins and, for the first time, will provide water availability modeling capabilities for the other basins.

S.B. 1 required the TNRCC to model six river basins by December 1999 and the remaining basins by December 2001. Models for the Sulphur, Neches, Nueces, Guadalupe, San Antonio and the San Jacinto River Basins have already been completed. The Trinity, Trinity-San Jacinto, Lavaca, Lavaca-Guadalupe, Colorado-Lavaca and the Brazos River Basins are in progress. Work on the remaining basins will commence this summer.

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 TNRCC administrative rules which include 30 Texas Administrative Code (TAC) §261.21 through §261.26, §261.41 through §261.43 and §297.53 through §297.56. These statutes and rules require the TNRCC 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. Without fail, 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* are consulted for relevant water quality information, including the nearest downstream classified segment. 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 Permits & Resource Management Division regarding water quality, previous receiving water assessments, 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, usually using the USFWS Habitat Evaluation Procedures (HEP) or the TPWD’s Wildlife Habitat Appraisal Procedure. While the use of HEP is not limited to large projects, the TNRCC 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. The TNRCC and other agencies participate in both the HEP and IFIM analyses.

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;
- expert opinion for aquatic recreational uses and terrestrial habitat for species of concern;
- low-flow value for protection of instream water quality (7Q2); and
- harmonic mean flows to protect human health from toxic discharges.

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 TNRCC in a document entitled *A Regulatory Guidance Document for Applications to Divert, Store, or Use State Water* (TNRCC, 1995b).

Assessment

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 15 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. Of the total number of active water rights, fewer than 25 percent have been subject to review for potential impact on instream uses and bay and estuary freshwater inflow needs. Since 1989, when a team was created to perform environmental assessments of water rights applications approximately 700 water rights applications have been reviewed for potential environmental impact. More than 400 water rights have recommendations to limit environmental impact to instream uses. 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 15. Active Water Rights in Texas Basins
June 2000

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	38	1	1	0	36	164,789
Red	272	1	9	29	233	640,116
Sulfur	54	1	5	6	42	379,291
Cypress	82	1	8	5	68	411,345
Sabine	182	6	5	7	164	1,887,807
Neches	229	5	8	10	1,206	4,064,404
Neches-Trinity	102	1	4	41	56	330,366
Trinity	579	10	21	24	524	4,365,416
Trinity-San Jacinto	17	0	1	7	9	44,524
San Jacinto	112	3	5	9	95	631,194
San Jacinto-Brazos	56	2	4	15	35	4,480,713
Brazos	1,159	7	33	59	1,060	3,850,046
Brazos-Colorado	60	0	2	15	43	86,338
Colorado	1,222	7	12	42	1,161	5,350,019
Colorado-Lavaca	32	1	3	7	21	975,444
Lavaca	52	0	1	12	39	114,367
Lavaca-Guadalupe	5	0	0	2	3	4,560
Guadalupe	349	8	8	18	315	6,196,385
San Antonio	261	0	3	12	246	185,553
San Antonio-Nueces	15	0	2	2	11	33,271
Nueces	261	2	2	14	243	532,240
Nueces-Rio Grande	84	3	2	25	54	1,771,255
Rio Grande	987	11	32	110	834	7,008,361
TOTALS	**6,210**	**70**	**171**	**471**	**6,498**	**43,507,804**

* Contractual permits/agreements are excluded
** Includes both consumptive and nonconsumptive rights