The Unknown River of Central Texas

A characterization of the James River, its springs and its watershed

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Summary

The James River, a tributary of the Llano River, is a relatively unspoiled gem in an arid and remote region of Central Texas. This little known spring-fed river provides exceptional aquatic habitat and flowing waters for domestic, livestock and wildlife purposes, even during drought.

Understanding the characteristics of the James River and its tributaries is vital to its protection; the most effective method for protecting and preserving this resource may lie in the hands of local and regional stakeholders. This report will facilitate potential stakeholder efforts by assimilating existing data, reports, and research to provide a characterization of the James River, its springs, and its watershed. Recommendations are included, which address identified natural resource issues within the watershed.

Due to the pristine nature and relatively constant flow of the river's contributing springs, the James River has remained a healthy ecosystem. However, subtle changes due to land fragmentation, increased groundwater use, loss of riparian habitat, and encroachment of juniper species on upland habitats may threaten both the water quality and quantity of the river.

Efforts to protect the river are complicated by a lack of understanding about the connection of the river to its contributing springs and underlying source aquifers. In addition, many property owners in the watershed are "absentee" landowners, owners who do not reside on the land, who may be unaware of the James River and how the use of groundwater affects the river. Further, the main entities with authority to manage groundwater resources, local groundwater conservation districts, are limited in their ability to regulate the increasing number of domestic wells tapping the underlying aquifer.

The formation of a regional stakeholder interest group would be beneficial in facilitating the coordination of efforts to protect the region's natural resources. It would also provide a forum for educational outreach to local citizens and absentee landowners about the river, its contributing springs, and source aquifers.

Introduction

The James River is little known in Central Texas, but it is an ecologically unspoiled and economically significant tributary of the Llano River. Although the spring-fed flows of the James River and its tributaries are small in comparison to other nearby rivers, they provide exceptional aquatic habitat for unique biological communities, and provide water supply for domestic, livestock, and wildlife purposes in an area otherwise void of surface water.

The springs supplying the James River are primarily outflows from the Edwards-Trinity (Plateau) aquifer. Water originating from these springs maintains the flow of the river during dry periods. For instance, the James River maintained some flow during the summer of 2009, even when several rivers across Central Texas ceased to flow.

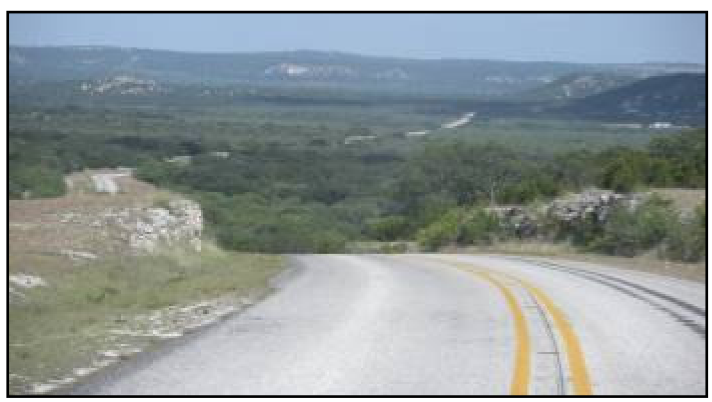
Understanding the environmental, economic and cultural role that the James River plays in Central Texas is vital to its protection. Little research and data are available for the river and few people are aware of its existence.

This report characterizes the river and describes its significance to the Central Texas region. It also examines the framework in which water management decisions in the James River watershed are made. Finally, recommendations to deal with identified potential issues are included.

Environmental Defense Fund prepared this report to facilitate stakeholder involvement around the James River. Collaborative efforts by local stakeholder groups, such as the South Llano Watershed Alliance,[1] could potentially create and implement action plans for addressing potential issues related to the river.

General Description

The James River is a 37-mile tributary of the Llano River in Central Texas. The headwaters of the James River (Figure 1) begin along the Kimble and Kerr County line at an elevation over 2,200 feet above sea level. The river flows in a northeasterly direction, dropping about 900 feet to its confluence with the Llano River about seven miles south of the city of Mason.

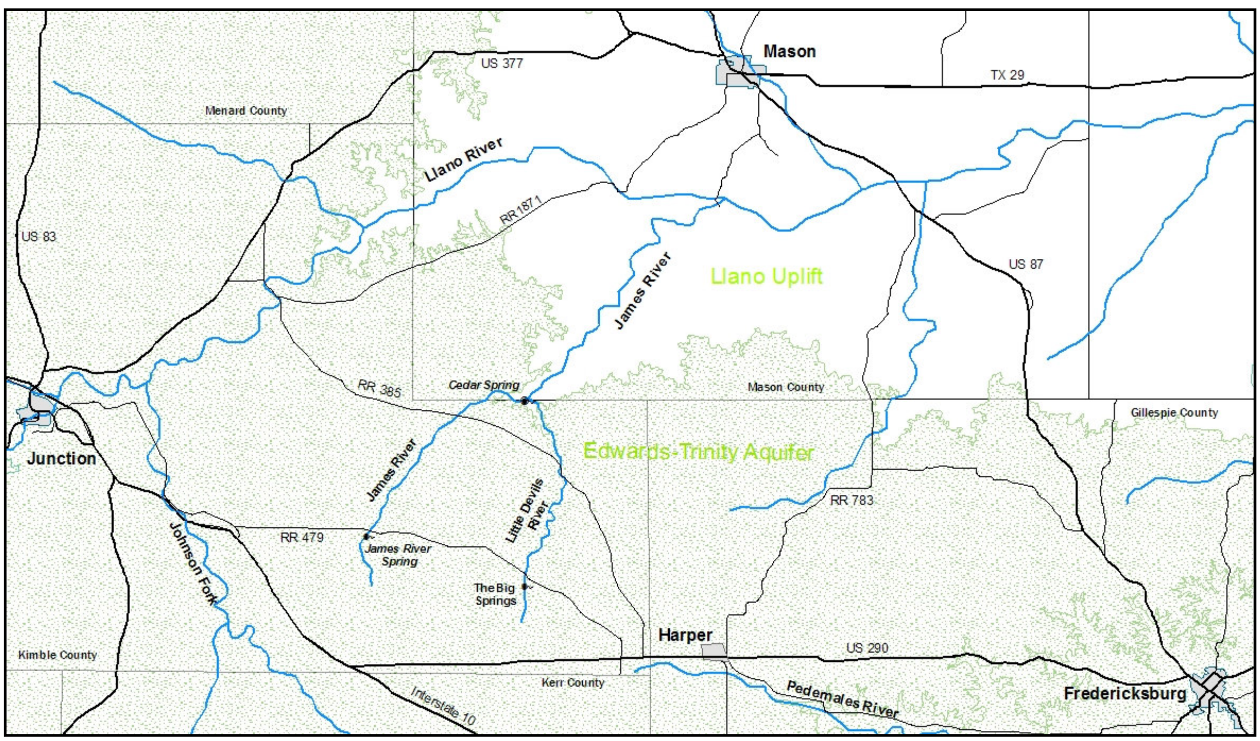

James River Watershed at the edge of the Edwards Plateau.

In its first five miles, the James River flows intermittently across the Edwards Plateau. The Edwards Plateau is a 24,000 square mile upland region extending from the Pecos River on the west to the Balcones Escarpment on the east and south. Capping the Edwards Plateau is thick limestone rock that has dissolved over time to form what is considered the largest continuous karst[2] areas in the United States.[3]

A major tributary of the James River is the Little Devils River. Until 1976, Little Devils River was known as the East Fork of the James River.[4] Just to the south of Ranch Road 479, both the James River and the Little Devils River have carved small canyons into the limestone cap. Here, water stored in the karst features of the plateau emerges as springs. These springs, located at an elevation between 1,900 and 2,000 feet, cause the James River and the Little Devils River to take on a more perennial nature.

Near the Mason and Kimble County line and close to the confluence of the James River and Little Devils River, the stream channel intersects the edge of the Llano Uplift[5] and changes from mostly gravel to primarily bedrock. Here, the channel widens to over 200 feet in places and forms steep-walled canyons up to 100 feet tall. The rocks of the Llano Uplift are generally less permeable than those found in the Edwards Plateau. However, along the margins of the uplift, springs form along fractures and faults within the rock formations, contributing additional flow to the river.

Figure 1. Map of James River and surrounding area



The James River watershed drains 339 square miles in portions of Mason, Kimble, Gillespie and Kerr counties.[6] Lands within the watershed can be characterized as agricultural, primarily consisting of ranches used for livestock production. A large source of income for these ranches is hunting leases for white tail deer and exotic species. A wallboard manufacturing company, National Gypsum, operates a mine in northeastern Kimble County.

The estimated 2008 population of Kimble County is 4,666 and the population of Mason County is 3,676. Kimble County has experienced a four percent growth rate since 2000, while Mason County has experienced a two percent decrease in population since 2000.[7] However, population figures alone do not provide a clear picture of the demographics in these counties. For example, of the 9,000 parcels in Kimble County, non-Kimble county residents own 55 percent, and non-Texas residents own an additional five percent.[8]

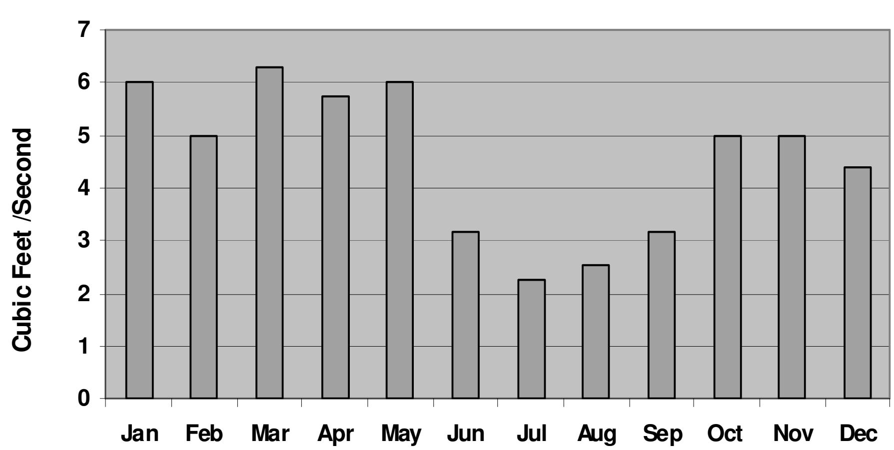
Based upon field observations, it is estimated that between 300 and 400 residents live in the James River basin, with the large majority of the residents living in the upper portion of the watershed in Kimble County. It is also estimated that about 75 percent of these residents live within the Little Devils River portion of the watershed.[9] Such a population distribution, coupled with limited accessibility and separate names for the James River and Little Devils River, likely contributes to the fact that few people are very knowledgeable of the James River's existence.

Water Resources

There is little long-term streamflow data for the James River. Previous studies estimated flood flows on the James River in excess of 200,000 cubic feet per second (cfs)[10] and calculated the 100-year flood event to be 101,176 cfs.[11] The Lower Colorado River Authority (LCRA) installed a streamflow gauge eight miles above the river's mouth in 1999, following large flood events in 1996 and 1997 that originated in the watershed.[12] Daily discharge values from the James River gauge show that between the period 1999 and 2009, the maximum flow was 39,301 cfs on November 15th, 2001. The gauge recorded no flow on an intermittent basis from August 19-23, 2003.

Figure 2 shows the median monthly discharge, or flow, for the James River gauge for the period 1999-2009 and reflects the area's normal rainfall distribution, with most of the precipitation occurring in spring and fall. During dry summer months, the majority of the flow at the gauge comes from springs.

Figure 2. Median Monthly Discharge for James River, 1999-2009 [13]



During the summer of 2009, discharge was estimated at several publicly accessible locations along the James River and Little Devils River. These estimates, along with the recorded streamflow measurement for the LCRA gauge are presented in Table 1.

Table 1. Selected discharge estimates for locations on the James and Little Devils River

River	Location	Discharge (cfs)	
		June 18, 2009	August 20, 2009
James River	LCRA Gauge	0.87	0.35
James River	Mill Creek Road	0.2	0.2
James River	Ranch Road 385	1.5	1.8
James River	Ranch Road 479	No measurement	0.5
Little Devils River	East Mill Road	0.4	0.4
Little Devils River	Ranch Road 432	0.6	0.3
Little Devils River	Ranch Road 4732	1.5	No measurement

James River below James River Springs.

Little Devils River below the Big Springs.

Springs

There are several small springs that contribute to flows within the James River basin. The Texas Springs Database[14] notes 11 springs within the James River watershed. An additional 19 springs, not included in the database, are located on USGS topographic maps. Likely, there are numerous additional unmapped springs and seeps in the watershed. Table 2 shows selected springs located in the Edwards Plateau. Table 3 shows selected springs located in the Llano Uplift.

Table 2. Selected James River Watershed Springs located in the Edwards Plateau

Spring Name	State Number	Remarks
Walnut Springs	5629502	Elevation 1945'
Unnamed spring on Jim Little Draw north of Highway 479	5636901	Elevation 1975' Estimated flow of 5 gpm in 1966
James River Spring (Kimble County)	None	Elevation 2000' Estimated flow at Highway 479 crossing (0.6 mi downstream) of 200 gpm in 2009
The Big Springs	5645302	Elevation 1912' Estimated flow at Highway 479 crossing (0.6 mi downstream) of 290 gpm in 1966 and 137 gpm in 1996 [15]

Table 3. Selected James River Watershed Springs located in the Llano Uplift

Spring Name	State Number	Remarks
Unnamed spring on unnamed tributary eight miles from river mouth	5630201	Elevation 1545' Estimated flow was 300 gallons per minute (gpm) in 1961
James River Spring (Mason County)	5630401	Elevation 1500' Reported flow of three gpm in 1940
Unnamed spring on unnamed tributary 14 miles from river mouth	5629901	Elevation 1620' Estimated flow of five gpm
Cedar Spring	5637301	Elevation 1640'* Measured flow 424 gpm in 1961 and 102 gpm in 1999 [16]

*The elevation of the spring is incorrectly listed in the TWDB database as 1746'.

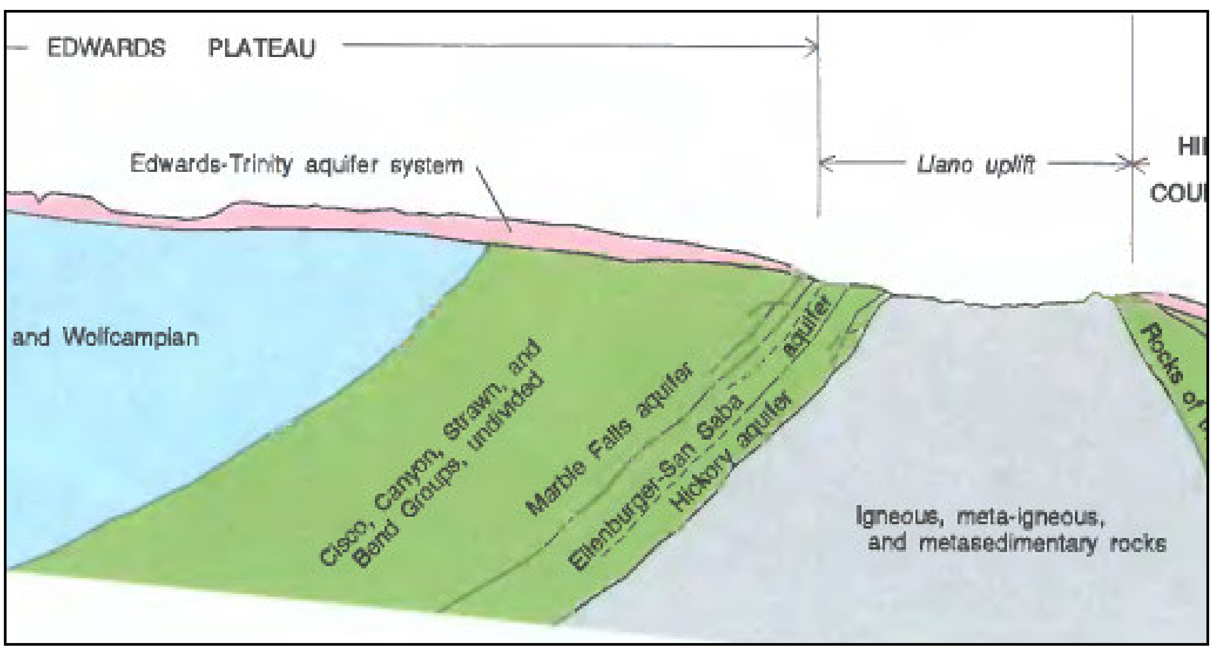
The James River Spring (Kimble County) and The Big Springs are the largest springs emanating from the Edwards Plateau in the upper portion of the watershed. The James River Spring is essentially the headwaters of the James River, while The Big Springs are essentially the headwaters of the Little Devils River. In the lower portion of the watershed, Cedar Springs adds additional flow to the James River just above the confluence with the Little Devils River.

Source of the Springs

The most likely sources of the springs in the James River are the Edwards-Trinity (Plateau) and the Ellenburger-San Saba Aquifers. The Edwards-Trinity (Plateau) Aquifer is comprised of the Edwards Limestone that caps the Edwards Plateau, as well as the underlying Glen Rose Limestone and Hensel Sands. The Ellenburger-San Saba Aquifer is made up of tilted limestone and dolomite strata overlying the granite slopes of the ancient Llano Uplift (Figure 2).

The Edwards limestone, which makes up the Edwards Plateau, is a karst terrain characterized by the presence of caves, sinkholes and subsurface drainage networks. On average, approximately 26-28 inches of precipitation falls annually within the James River watershed. Where the Edwards Plateau exists in the watershed, any precipitation that occurs tends to fall on thin soils atop limestone bedrock and runs off quickly. However, some of this precipitation finds its way through sinkholes, caves, rock fractures, and root zones to enter the Edwards-Trinity (Plateau) aquifer.

Figure 2. Cross-section of Edwards-Trinity Aquifer and Llano Uplift (From Baker et al, 1994) [17]

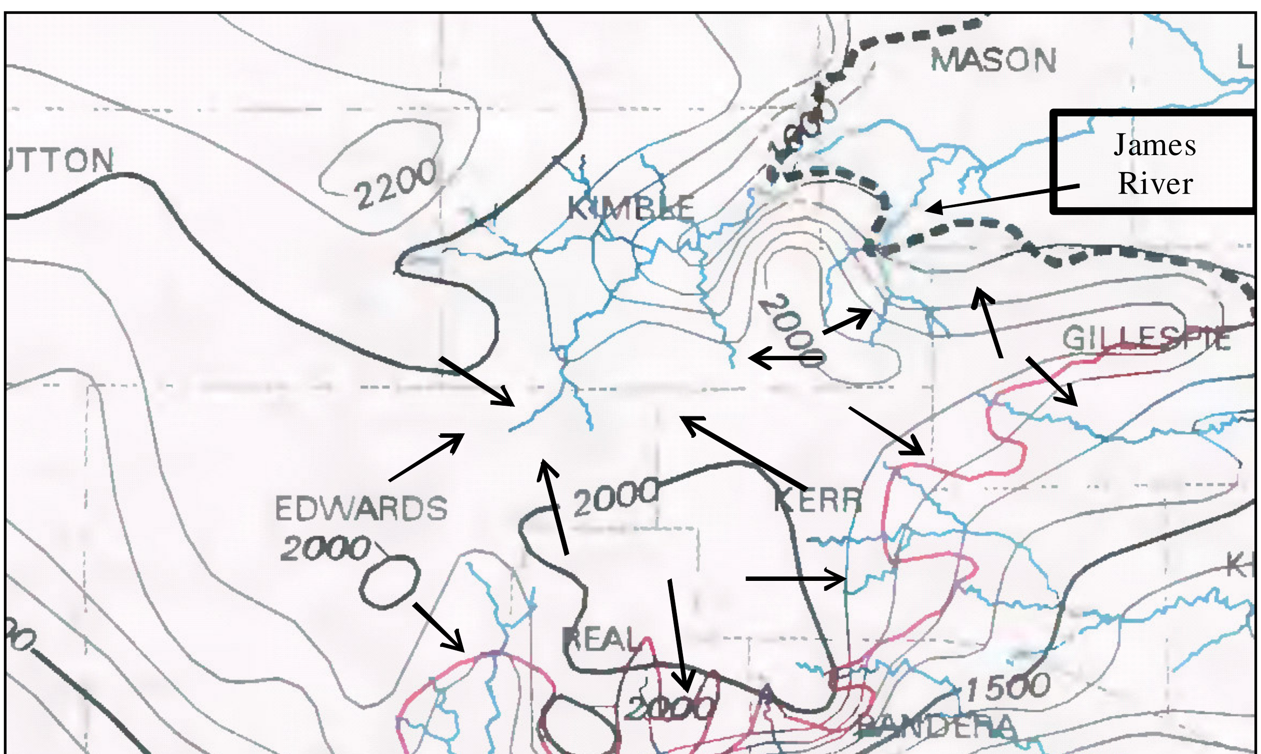


Subsurface drainage networks, or conduits, dominate groundwater systems that drain karst terrain.[18] Precipitation that recharges the Edwards-Trinity (Plateau) aquifer tends to follows these conduits. Where rivers such as the James River carve valleys into the Edwards Plateau, these conduits are exposed, resulting in springs. These springs are usually located where the Edwards Limestone rests on top of the less permeable Glen Rose Formation.

Little is known about the exact origin of the source water for these springs. However, some information can be inferred from topography and existing hydrogeological studies. Kuniansky and Holligan[19] note that the potentiometric surface (the elevation of the top of the water table) and the flow of groundwater tends to follow the topography in the Edwards Plateau region. Figure 3 is a map of the potentiometric surface in the James River area reproduced from the Kuniansky and Holligan report.

Kuniansky and Holligan suggest that the waters that feed the springs originate from an area located in southeastern Kimble County. [20] The elevation of the water table in this area to the south and west of the James River and its tributaries is over 2,000 feet above sea level. The level of the springs in the watershed is approximately 1,900 feet, so it can be assumed that groundwater flows 'down gradient' towards the springs.[21] The portion of the Edwards-Trinity aquifer that feeds the James River is smaller in area and saturated thickness than portions that feed other larger rivers such as the South Llano River (to the west), Frio Rivers (to the south), and Guadalupe River (to the east). Consequently, the flows of the James River are smaller than these other rivers.

Figure 3. Historical potentiometric surface of the Edwards-Trinity aquifer system for the South Llano River watershed, 1915-69 (From Kuniansky and Holligan, 1993. *Arrows added to depict probable direction of groundwater flow*)



Without detailed potentiometric surface mapping and tracer testing, however, it is very difficult to accurately depict actual groundwater movement with any certainty. There are many examples where groundwater movement is not coincident with topographic watershed boundaries.[22]

Source water from the Ellenburger-San Saba Aquifer is not well understood due to the complex nature of its geological formations and fault patterns. Barker and Ardis note that the aquifer is hydraulically connected to the overlying Hensel Sands of the Edwards-Trinity Aquifer and may in fact be recharged through upward-leakage from the underlying formations.[23] In addition, a recent study on the hydrogeology of Kerr County notes that recharge to the Hensel Sands in Kimble and Mason County flows to the south and becomes an important source of groundwater in Kerr County.[24]

Water Use

Water used for domestic and livestock purposes is by far the largest use in the basin. Most of this use is supplied by wells. The Texas Water Development Board Groundwater Database lists a total of 249 wells in the James River watershed (it is presumed that many wells are not included in the database.) About 160 of these well reports are from wells drilled since 2000, with the highest concentration of wells located within ten miles of the community of Harper.

Most wells in the area draw from the Edwards-Trinity (Plateau) aquifer and generally yield less than 25 gallons per minute (gpm).[25] Wells drilled into the aquifers overlying the Llano Uplift (especially the Hickory) in the lower portions of the basin can yield over 50 gpm, with five wells having reported yields greater than 100 gpm.

Groundwater wells producing volumes of water greater than 25,000 gallons per day are required to obtain a permit from the local groundwater conservation district. There are a few permitted irrigation wells in the James River basin. However, no irrigation was observed in any part of the James River watershed during the summer of 2009.

A water right is required from the Texas Commission on Environmental Quality (TCEQ) to use surface water for irrigation in Texas. There are only three such water rights in the James River watershed, totalling 171 acre-feet[26] per year or about 0.25 cfs. All of these rights are located in the Little Devils River watershed.

James River above the confluence with Little Devils River.

Water Quality

The spring-fed waters of the James River are consistently of good quality. There are no point sources of pollution on the James River such as industrial outfalls or wastewater discharge facilities. There is potential, however, for non-point sources of pollution from agricultural runoff or septic systems.

The LCRA has maintained a monitoring program on the river since 2007. Escherichia coli (E-Coli) bacteria was detected at the site where it is measured, at the Upper Mason County Road crossing, 14 miles southwest of Mason (Site 12210).[27] One measurement, taken less than one day after a rain, detected E-Coli bacteria at a level of 460 E-coli per 100 milliliters (ml), which exceeds the Environmental Protection Agency's recommended level for moderate full body contact recreation (298 E-coli per 100 milliliters). The other six measurements at this site were below 23 E-coli/100 ml.

Dissolved oxygen (DO) is also a metric to measure river health. Fluctuating high and low levels of DO over a 24-hour period may suggest the presence of algae blooms, possibly caused by an increase in nutrients reaching the river.[28] High dissolved oxygen (>10) was observed at the LCRA site during five of the seven measurements.[29] Water quality measurements taken in 1989 by the Texas Water Commission (the predecessor agency of TCEQ) at this same location, showed DO levels collected early in the morning to be 6.2, but at levels of 10.5 later, during the day. The same study also showed early morning DO levels for all tributaries for the James River to range between 4.1 and 8.1 with a diel (24-hour) mean between 7.9 and 8.5.[30]

Groundwater wells located in the study area tend to have hard water as a result of the limestone. Of the ten wells sampled in the James River watershed, only two have, or have had, nitrate levels in excess of the recommended drinking water standards of ten milligrams per liter.[31] Elevated levels of nitrates can result from poor well location and construction, agricultural runoff or inadequate septic systems.

Habitats

In addition to being an important water resource, the James River and its watershed provide important and unique aquatic and terrestrial habitats. These habitats play a crucial role to the biological diversity and recreational opportunities of the area.

<u>Aquatic</u>

The physical characteristics of the James River, such as its very clear water and deep pool and shallow riffle development, provide good habitat for aquatic species. The Texas Parks and Wildlife Department identified the James River as an Ecologically Significant Stream due to its high water quality, exceptional aquatic life, and high aesthetic value.

Mayfly

Samples collected during the 1989 Texas Water Commission (TWC) study found fish including Guadalupe Bass, Texas Shiners and Greenthroat Darters. The Guadalupe Bass, a highly regarded game fish, is a 'Species of Concern', meaning that the species is at potential risk due to its hybridization with other bass species. Texas Shiners and Greenthroat Darters are considered 'Indicator Species', meaning they are a good indicator of ecosystem health.[32]

The waters of the James River also provide habitat for insects that are an important component of aquatic diversity and an indicator of stream health. Levine identified six species of mayflies and seven species of caddis flies.[33] The TWC study identified ten species of mayflies and 11 species of caddis flies basin wide. The authors of the TWC study noted the diversity and equitability of these and other benthic macro invertebrate (bottom dwelling species without skeletal structure) species observed in the James River is the highest observed in more than 12 years of surveillance on Texas streams.[34]

During their larval stages, some species of caddis fly require dead and dying plant material for food as well as for the construction of casings used for protection and respiration. Much of this material is often removed because the streams of the Edwards Plateau are subject to flash floods. The James River springs are less likely to be impacted by these floods, thus providing stable habitat for this important group of insects, because they tend to be located above the main river channel. [35] Even when floods do impact these springs, the species that inhabit them rapidly recolonize. In June of 1997, Cedar Springs was severely scoured when nearly 20 inches of rain fell in the watershed above the spring. Three months later, the number of species of mayflies and caddis flies present at the spring nearly equaled the number of species present before the flood.[36]

Terrestrial

The watershed of the James River is composed of two primary vegetation types: Live Oak–Ashe Juniper Parks and Live Oak-Mesquite-Ashe Juniper Parks.[37] Ashe juniper tends to be located in the upland portions of the watershed that are underlain by Edwards Limestone. From aerial photography, it is roughly estimated that about 50 to 60 percent of the basin is covered in Ashe juniper. These junipers may provide habitat for the endangered Black-capped vireo.

Little specific information is available regarding biological communities found in the watershed, with one exception. The Nature Conservancy's Eckert James River Bat Cave, located nine miles upstream of the mouth of the James River, is home to about four million Mexican free-tail female bats. This nursery cave is one of the largest in the country and is a popular nature-tourism destination.

Land Use [38]

Historic vegetation and land use changes have occurred in the James River basin over the last one and a half centuries. Since 1874, when the Great Western Trail blazed through the area, the lands of the James River watershed have been used for ranching. In some areas, historical overgrazing and the resulting loss of soil, along with the suppression of fire, have changed the Edwards Plateau and the James River basin from grassland savannah to juniper woodlands.

As discussed below, such encroachment of woody vegetation may have had significant impacts on the hydrology of the James River as well as other spring-fed rivers in the Edwards Plateau. Currently, there are efforts to reverse this impact through land stewardship and brush control. At the same time however, the transformation of large agricultural land holdings to smaller ranchettes is fragmenting the landscape, complicating large-scale land management efforts and resulting in potential impacts to wildlife habitat and water resources.

Rollerchopping brush management technique on Live Oak-Ashe Mesquite Junipers Parks

Land Stewardship and Brush Management

Land stewardship utilizes a variety of management practices to balance, preserve and enhance natural ecological systems. Such practices include prescribed burns to enhance grasslands, game management to decrease over-browsing and enhance wildlife populations, and creation of upland water sources to reduce pressure on riparian habitats. One land stewardship technique widely used across the Edwards Plateau is brush control.

The control, clearing, and sculpting of brush species, especially Ashe juniper, is a popular technique used to increase spring flows and improve livestock grazing and wildlife habitat. Some studies have shown that because juniper is evergreen and has a high leaf area, the canopy and litter of a juniper tree can intercept as much as 40 percent of the precipitation falling on a tree.[39] Under grassland cover, precipitation is slowed by grasses and infiltrates into the soils and eventually the underlying water table. With the loss of soil and grasses and an increase in woody species, especially juniper, more precipitation is kept from reaching the ground. What does reach the ground runs off more quickly, rather than infiltrating down to the water table.

Ashe juniper is the primary brush species found in the upper reaches of the James River watershed. There have been a number of field studies done in Texas in recent years to monitor the effectiveness of using brush clearing to augment water supplies. There is much debate in the scientific community as to whether removal of juniper increases water supply on a large scale. However, there is scientific confidence that increased spring flow and/or groundwater recharge (up to 1.5 inches per year) will result from converting Ashe juniper woodlands to grasslands in small catchments and in areas where drainage is rapid and deep, such as the karst systems associated with the Edwards Plateau. At this small catchment scale, it is estimated that clearing brush from eight acres of land may result in an increased yield of one acre-foot. On a larger scale, it is still uncertain if similar increases would occur, though recent research has indicated that reduced grazing pressure in combination with brush control can increase herbaceous cover and result in increased soil infiltration capacity. In karst regions, this can result in slightly increased volumes of baseflow.[40]

Fragmentation

There is a growing trend in Texas whereby large-scale land holdings are being sold and subdivided (fragmented) into smaller parcels, or ranchettes. This trend is driven by the influx of new absentee landowners. As with many areas of the Texas Hill Country, people purchase rural land seeking a weekend retreat to escape urban crowds and reconnect with the land through hunting, fishing, or small-scale agriculture.[41] For many, these smaller parcels are, or will become, a place of retirement. Because these new landowners have outside sources of income, they generally do not need to make a living off of the land. This has the potential to take pressure off of grasslands that are usually stressed during times of drought. On the other hand, these changes also result in a marked increase in land values and increased pressure on water resources and wildlife habitat.

As new owners purchase lands for scenic and recreational value, rather than productive value, land prices escalate. Such escalation places pressure on traditional rural agricultural economies, as producers are able to make more money from the sale of land than from production from the land, resulting in less land being utilized for agriculture. The subdividing of large ranches into smaller tracts also increases pressure on wildlife habitat and water resources, as more homes, roads, fences, and more wells and septic systems are introduced to the landscape. It also complicates the efficient implementation of land stewardship practices such as brush control, rotational grazing, and controlled burning.[42]

The impacts of fragmentation in Mason and Kimble counties are shown in Table 4. Between 1997 and 2007, the average ranch size in Kimble County decreased 31 percent from 1,414 acres to 970 acres and the amount of land in ranching declined by 23 percent. From 1997 to 2007, land values nearly tripled from $532 per acre to $1,492 per acre. In Mason County, the average ranch size decreased by 13 percent and the total amount of land in ranching declined by 11 percent. Land values in Mason County increased by a factor of two and half during this period.

These countywide figures can generally be applied to the James River watershed, though more of the fragmentation in Mason County has occurred outside of the basin. The scenic nature of lower James River has created coveted tracts of land that have changed some in ownership, but little in tract size over the years. In Kimble County, fragmentation has occurred mostly along the upper reaches of the Little Devils River near the community of Harper.

Table 4. Changes in Ranching Acreage and Land Values for Kimble and Mason Counties [43]

	Avg. Ranch Size (acres)		***Avg. Land (million acres)***		***Avg. Land Value ($/acre)***	
	1997	**2007**	**1997**	**2007**	**1997**	**2007**
Kimble County	1,414	970	0.81	0.62	$532	$1,492
Mason County	955	829	0.61	0.54	$704	$1,832

Natural Resource Management and Planning Efforts

There are a number of agencies and organizations that play a role in the natural resource issues of the James River. At the local level, groundwater conservation districts in Kimble, Mason, Kerr and Gillespie counties manage the groundwater resources of their respective counties. All four of these districts participate in a state-mandated Groundwater Management Area joint planning program. A regional water planning process also provides an opportunity for local stakeholders and the community to develop strategies for meeting regional water needs. At the federal level, the Natural Resources Conservation Service, an agency within the U.S. Department of Agriculture, works with local and state soil and water conservation boards to coordinate land stewardship efforts in the area. Educational programs and activities related to water are provided by governmental, volunteer, and commercial organizations.

Groundwater Conservation Districts

Groundwater conservation districts (GCDs) are the preferred method for managing groundwater in the state.[44] There are four GCDs that have jurisdiction over parts of the James River watershed: the Hickory Underground Water Conservation District #1 Mason County,[45] the Kimble County Groundwater Conservation District GCD,[46] the Hill Country Underground Water Conservation District in Gillespie County[47] and the Headwaters Underground Water Conservation District in Kerr County.[48] All four of these districts have rules and management plans that govern the groundwater resources in the counties.[49] State law does not allow groundwater districts to require or issue permits for wells on tracts larger than ten acres, which are used for domestic use and livestock watering and produce less than 25,000 gallons per day.[50] Most of the wells in all four districts are exempt from permitting.

For those wells that do require a permit, several considerations apply. Three of the districts have a "drilled to density" provision in their rules that prohibit too many wells or too much pumping from occurring within a one-square mile area or section (640 acres). Kimble County allows four wells per square mile but has no total production limits; however, the maximum production from wells in this GCD is about 20 gallons per minute.[51] The Hill Country Underground Water Conservation District (UWCD) maintains spacing and total production requirements that limit production to about 3,200 gallons per minute, or 640 acre-feet per year. The Headwaters UWCD uses similar production limits, plus limits production from wells to a maximum 80,000 gallons per acre per year, and attempts to maintain an average of not more than one well per five acres.

Groundwater districts may also implement other methods to manage permitted wells. The Hill Country UWCD utilizes High Historical Groundwater Use Areas and Critical Groundwater Depletion Area designations when considering permitting spacing and production requirements. The Hickory UWCD will not grant a permit if the proposed production volume has a high probability of causing more than seven feet of drawdown in the water table over a three-year period. In addition, the Hickory District requires wells permitted to withdraw more than 1,000 acre-feet to install a monitoring well(s) to evaluate possible impairment to adjacent wells.

By law, districts cannot impose more restrictive production limits on groundwater exports outside the boundaries of a district,[52] but they can require an export permit. All four groundwater districts require such a permit. In the granting of an export permit, districts require consideration of such items as the total groundwater available in the district, any impacts to nearby well owners, the projected effect on aquifer conditions, the indirect costs and social impacts associated with the transfer, and whether or not the transfer is consistent with the approved regional water plan. During the five-year review and renewal of a transport permit, the Hickory UWCD may reduce the amount of water permitted by ten percent per year until water table declines cease in the affected area of the aquifer.

Groundwater Management Area Joint-Planning Process

Currently, the amount of water actually available for withdrawal in each aquifer and groundwater district is not definitively quantified. To complicate matters, groundwater district boundaries are often based on county boundaries, resulting in several sets of rules and management plans for one aquifer. In an effort to better coordinate the determination of availability, the state initiated a process in 2005 that requires groundwater districts within a designated groundwater management area (GMA) to meet on a regular basis, share management plans, and participate in joint planning for the various aquifers within the GMA boundaries. It also requires that each of the groundwater management areas adopt "desired future conditions" for each aquifer within the GMA. Three groundwater districts in the James River basin are in GMA-7, which coordinates efforts for the Edwards-Trinity (Plateau) aquifer.[53] The Headwaters Groundwater District participates in GMA-9.[54]

As part of the process of adopting a desired future condition (DFC) for an aquifer, the GMA member districts determine their goal for the condition of the aquifer 50 years into the future. A goal can be a particular groundwater level, level of water quality, volume of spring flows, etc. Based on this DFC, the Texas Water Development Board (TWDB) determines the physical volume of groundwater available from the aquifer. The groundwater districts in the GMA-7 area that lie within the James River watershed are moving toward adopting a desired aquifer condition where there is no net depletion of the aquifer over the next 50 years, in order to protect spring flows. The groups are currently working with TWDB to develop a methodology for modeling the sustainability of spring flows.[55] Some of the initial modeling efforts for the area predict how aquifer levels and spring flows may react to certain scenarios, and demonstrate the importance of setting good desired future conditions.

Regional Water Planning

In 1997, the state began a locally driven regional water planning process. As part of this process, the state was divided into 16 planning regions and representatives from all the water user groups within a particular region were charged with developing a regional water plan that provides for the fifty-year water needs of their region. The resulting water plans evaluate water needs for various categories such as domestic, industrial, irrigation, and livestock based on population projections developed by the TWDB. The regional plans are modified every five years, with the most recent round of planning completed in 2006. At the end of each five-year cycle, the state compiles the regional water plans and prepares a State Water Plan. Three regional planning groups cover the James River: Region F, which includes Kimble and Mason Counties Region J (Plateau), which includes Kerr County, and Region K (Lower Colorado), which includes Gillespie County.[56] [57] [58]

Many regions of the state are experiencing water shortages and looking outside their immediate area for water sources. However, the 2006 plans for Region F, Region J (Plateau), and Region K (Lower Colorado) do not identify any water shortages that require additional water supplies that would significantly impact the James River,[59] [60] nor did other regions look to the James River for additional water supplies. Both the Region F and Region J planning groups specifically note the potential impact that increased aquifer withdrawals could have on spring flow and baseflow to the rivers. The Region J (Plateau) plan comments, “Protection of these spring flows is important to the continued flow of many of the rivers in the region.”[61]

Lower Colorado River Authority

The Lower Colorado River Authority (LCRA) does not have direct water management authority in the area. Such authority only applies to the Authority’s original statutory district, which stops at the Llano-Mason County line.[62] However, the LCRA is involved in water management activities on the James River.

The LCRA does not hold any water rights on the James River; however, they are the largest holder of downstream water rights in the Colorado River basin. As such, they have an effect on water distribution from the James River. Upstream water rights with a priority date later than the LCRA rights, must not withdraw water if there is not enough water available to meet the downstream LCRA demands. Consequently, there is little or no additional water available for additional surface water rights in the James River. However, use of surface water may be obtained by means of contract with LCRA.

In 2006, LCRA approved a ten year contract for the sale of 59 acre-feet annually to a James River landowner seeking to place two dams on the James River. In approving the contract, LCRA stated that because it is a statutory raw water provider, it is required by law to sell water to users in its service area, provided the water is available.[63] [64]

National Resource Conservation Service

In Kimble and Mason County, the Natural Resource Conservation Service (NRCS) works with local Soil and Water Conservation Districts to assist local landowners with the conservation, maintenance, and improvement of natural resources.[65] Much of the current effort to improve natural resources is through the Environmental Quality Incentives Program (EQIP). Agricultural producers who participate in the program are eligible for a 75 percent reimbursement from NRCS for up to $300,000. Lands that are in wildlife habitat plans are not eligible for these funds, but may participate in the Wildlife Habitat Incentive Program that provides up to $50,000 in matching funding to complete projects that improve habitat, including brush management. Other NRCS programs designed to promote land stewardship include the Conservation Reserve Program and the Conservation Stewardship Program.

Texas Parks and Wildlife Department

The Texas Parks and Wildlife Department (TPWD) operates the Private Lands and Habitat Program to provide assistance to land owners interested in the conservation and development of wildlife habitats. Through the program, TPWD biologists provide services to landowners interested in maintaining sustainable wildlife populations on their lands. TPWD also facilitates the formation of Wildlife Management Associations and Co-ops across the state.[66] These associations consist of groups of interested landowners, wildlife enthusiasts, hunters, and other interested parties who have organized to cooperatively manage their wildlife and its habitat. The association members operate under a non-binding agreement to cooperate on issues such as land stewardship, habitat improvement, and wildlife and game management. Over 150 Wildlife Management Associations and Wildlife Co-ops currently operate across the state.

Mexican Free-tailed bats emerging from James River Bat Cave

Additional Organizations

In addition to the entities mentioned above, there are several other organizations that promote water resources education and or activities as a component of their programs. At the state level, Texas Tech University Llano River Field Station at Junction offers three week college courses in freshwater ecology, mammalogy, and herpetology. They also offer classes in aquatic biology, ecology, and stream flow velocity for K-12 students in the summer Outdoor School.[67] Texas AgriLife Extension (formerly, Texas Agricultural Extension Service) provides landowner information on successful land stewardship practices developed through university research.[68] AgriLife Extension also works with the Texas Soil and Water Conservation Board to promote the Texas Watershed Steward Program, which engages local stakeholder participation in the planning and implementation of water resource management and protection programs in selected watersheds.[69]

Regionally, The Nature Conservancy of Texas has implemented the Western Rivers Project in the Sabinal, Frio and Nueces rivers. This project provides assistance to landowners and develops voluntary public and private partnerships to conserve terrestrial and aquatic resources in the Edwards Plateau. The Conservancy also manages the eight acre Eckert James River Bat Cave, providing interpretive tours during the summer bat emergence.[70]

Locally, the Master Naturalist Program, a program coordinated through Texas Parks and Wildlife and Texas AgriLife Extension, educates volunteers to provide education, outreach, and service for beneficial management of natural resources within the local community.[71] The Edwards Plateau Prescribed Burning Association helps provide the education and resources necessary to use fire as effective range management tool.[72] Native American Seed Company, a commercial enterprise located near Junction, promotes and sells native grasses and plants as an important component of land stewardship.[73] Plateau Land and Wildlife Management provides landowners a variety of land and wildlife management services.[74]

Ongoing Research

Chad Norris, a Texas Parks and Wildlife Department biologist, is compiling an Assessment of Biological and Hydrologic Conditions in Selected Texas Springs. The study measures spring with flow and collects biological data at springs to provide baseline data or to document major changes that may have occurred since springs were visited by Gunnar Brune 20 to 30 years ago during the *Springs of Texas* compilation.

The Hickory UWCD has funded the development of a three dimensional structural model of aquifers in the Llano Uplift. Such an effort will help determine potential well production and the volume of water in the aquifer.[75]

Identified Water Resource Issues

Basic Data Needs

Hydrological Data

Although based on sound hydrologic principles, groundwater models that track the movement and volume of water available in the aquifers that underlie the James River are rough estimates at best. Some of the basic components of the hydrological budget, such as the flow of water between aquifer formations and recharge, are difficult to determine. In addition, because two aquifers underlie the watershed of the James River, two different groundwater models are necessary to predict aquifer responses.

Information on what the effect of a prolonged drought would have on the flows of the James River is also lacking. Currently, the drought of the 1950s is considered the drought of record for the rivers of the Edwards Plateau, but no hydrological data are available for this period. Evidence from a report by Dr. Malcolm Cleaveland on tree ring data has shown that droughts during the 1100s and 1200s, while not as severe in terms of drought intensity, were more severe from the standpoint that the region was in drought conditions for approximately 40 to 50 years.[76]

Ecological Data

Tracking changes in ecological habitats and aquatic resources is difficult without an adequate baseline inventory of these resources. While some baseline aquatic information was established in 1989 for several locations on the James River, it is uncertain to what extent two large flood events in the mid-1990s altered the riparian and aquatic habitat. Information on aquatic species found in the upper portions of the basin and at springs is lacking.

Recommendations

The following recommendations are suggested to address the identified basic data needs:

- Conduct further research into the volume of water that annually recharges the aquifer; including, the identification of important recharge areas and key recharge features such as sinkholes, streambed fractures, and caves;

- Conduct further research into quantifying the volume, location, and timing of the water that discharges from the aquifer through springs, seeps, and base flows to the river;

- Assess recharge and discharge variability due to changes in precipitation in the region; and

- Build an ecological data inventory of the area to include information on some of the more sensitive aquatic habitat areas within the watershed.

Land Management Issues

Riparian Habitat

Maintaining and preserving riparian habitat is key to maintaining and preserving aquatic habitat, water quality and quantity. Riparian habitat in the upper portion of the basin is vital to storing and releasing flows as well as helping to dissipate floods. Due to the bedrock nature of the stream channel, there is less riparian habitat in the lower portions of the James River.

Fragmentation

The division of large tracts into smaller "ranchettes" is a primary concern of many residents in the area. Such subdividing places stress on water resources, wildlife habitat, and rural infrastructure, and decreases the effectiveness of resource management efforts such as brush management, rotational grazing and controlled burning.

Land Stewardship

Land stewardship is practiced throughout much of the James River watershed to increase spring flows and improve livestock grazing and wildlife habitat. Currently, matching funds for brush management on lands in agricultural production are available through NRCS. However, there is no mechanism to ensure ongoing funding and coordination for these and other land stewardship efforts. At the same time, there is continued scientific debate about the benefits of brush control and watershed yield on a large-scale basis.

Recommendations

The following recommendations are suggested to address the some of the identified land management issues:

- Promote riparian health through education and coordination of private landowners using tools such as the Nueces River Authority field guide;[77]

- Conduct a more detailed analysis on the effects of current fragmentation and foster discussions among local stakeholders about how to prevent further fragmentation or reduce its impacts;

- Explore additional mechanisms for funding and coordinating land stewardship efforts in the basin; and

- Further research the change in spring flows following brush removal in large catchment areas underlain by karst, such as the upper James River watershed.

Water Management Issues

Ownership of Streambed

Texas statutes distinguish between private and public ownership of streambeds. However, this distinction is often confusing and results in conflicts over navigation, access, the use of water from streams, and the removal of materials from streambeds.

Under Texas Law, a stream is considered public if it is navigable in fact or navigable by statute, the latter referring to any stream that retains an average width of 30 feet from the mouth up. As the entire streambed is considered in calculating width, there is no distinction made as to whether the stream is dry.[78]

During the original survey of Texas in the 1840s, John Borden, the first commissioner of the Texas General Land Office, instructed surveyors to not extend survey lines across navigable waterways. As a result, in many rivers in the state, such as the Llano, the streambeds are owned by the state, in trust for the public. However, on many smaller waterways, including the James River, survey lines were extended across the streambed.[79]

In 1929, in an attempt to remedy some of the confusion resulting from survey lines crossing navigable waterways, the State passed the Small Bill that validated these surveys. [80] However, the Small Bill noted that such validation did not impair the rights of the general public and the state in the waters of the streams. Such rights include navigation. Thus, even if a landowner's deed includes the bed of a navigable stream, the public retains its right to use it as a navigable stream.[81]

In addition, the state lays claim to any water within a defined watercourse. The Texas Administrative Code defines a watercourse as “a definite channel of a stream in which water flows within a defined bed and banks…”[82] The use of waters of the state requires a water rights permit from the TCEQ.[83] Under the Small Bill, the state also retains possession of the sand and gravel found in the streambeds. Consequently, the removal or disturbance of these materials may require a permit issued by the TPWD.[84]

Groundwater and Surface Water Interaction

More than 160 new wells have been drilled in the James River watershed since 2000. Most of these wells are located up gradient from springs that feed the James River and Little Devils River. While water yield and the water use from these wells is relatively small, it is not certain how the increasing number of wells may impact the discharge from these small, but critically important springs.

Aquifer Contamination

The very porous nature of Edwards Limestone makes the aquifer that feeds the springs of the James River very susceptible to contamination. As the number of wells and septic systems in the watershed increases, the possibility of such contamination also increases.

Recommendations

The following recommendations are suggested to address the identified water management issues:

- Provide education and foster local stakeholder involvement in the protection and conservation of groundwater resources and springs; and

- Provide continued support of local groundwater districts and their efforts to provide for the protection of the groundwater resources within their jurisdiction.

Community Involvement

Geographical Awareness

The James River is not well known to many residents of the Hill Country. Access to the lower areas of the watershed is by way of an unpaved county road with two river crossings more than 200 yards in width. In the upper portions of the watershed, only two lightly traveled highways cross the James River and its tributary, the Little Devils River. At these crossings, both streams are small and there is no indication that they are tributaries.

Landowner Involvement

James River basin residents, as well as the community at large, seem interested in the protection of the James River. However, many of the landowners, who may be both part of the problem and the solution, do not reside in the watershed, complicating outreach efforts and community involvement.

Recommendations

The following recommendation is suggested to address the identified Community Involvement Issue.

- The formation of a regional stakeholder interest group would be a good avenue for natural resource management education, discussion, and community action. Two such existing groups are located near the James River watershed.

- The South Llano Watershed Alliance [85] was organized in 2008 to preserve and enhance the South Llano and adjoining watersheds by encouraging land and water stewardship through collaboration, education and community participation.

- The Doss-Harper Wildlife Management Association is one of the 150 associations and co-ops statewide organized to cooperatively manage wildlife and habitat through land stewardship, habitat improvement, and wildlife and game management. These associations are facilitated through the TPWD.

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James River Watershed at edge of Edwards Plateau, author

James River below James River Springs. and Little Devils River below The Big Springs, author

James River above the confluence with Little Devils River, author

Mayfly, Texas Parks and Wildlife Department

Rollerchopping brush management technique on Live Oak-Ashe Mesquite Junipers Parks, author

Mexican Free tail Bats emerging from Eckert James River Bat Cave, Texas Nature Conservancy

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