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Big Creek and Its Fishes

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BIG CREEK AND ITS FISHES

By
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with illustrations by Joe Tomelleri

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Hays, Kansas

Fort Hays State University is located on the eastern margin of the High Plains, an area of one of the most complete sections of late cretaceous rocks in North America. The terrain of the Fort Hays region is not that of the forests to the east nor of the mountains to the west. It is High Plains country, a land where gently flowing grasslands and golden fields of grain meet high blue sky. **Fort Hays Studies** encourages research by faculty, students, alumni, and other individuals associated with the University by providing an international series for the publication of scholarship. The *Fort Hays Studies Series* is the physical manifestation of this encouragement.

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Big Creek (background) as it flows into the Smoky Hill River - 1985.

"I never lost a little fish, yes I am free to say, it always was the biggest fish I caught that got away."
Eugene Field, 1850-1895

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FORWARD

Big Creek flows through the farm on which I was born (1921), not far from its origin. The water was crystal clear and there were pools twenty feet deep with a gravel or rock bottom. These pools were unisex swimming holes and also great places to fish. You could stand on the bottom of the pond and wiggle your toes without a bit of mud "squishing" up between them. My first fish was a largemouth bass that fell victim to an earthworm impaled on a hook attached with a string to a freshly cut willow pole.

Sixty years later, Big Creek is a temporary stream—dry part of the year and, at other times, carrying murky water laden with silt. You would not expect many fish to still be living in such an undesirable habitat and thus the results of this study are quite surprising.

It would be nice to find a way to rejuvenate Big Creek back to the way it was sixty years ago—much like they have done with some of the major river systems of the northeast. The authors feel that the condition of Big Creek may not be as bad as it appears and that much can be done to improve it. Let's hope they are right and that we get the rejuvenation started soon.

G.W. Tomanek
President, Fort Hays State University
Professor of Biology

PREFACE

"I didn't know anything could live in Big Creek."

When we heard those words in the early spring of 1983 we knew there was life in Big Creek, but we realized that none of us knew just how many kinds of fish, plants, and other forms of life survived in the much-maligned creek. As stream biologists, we are familiar with the attitude expressed in that quote, but we could not have responded with any certainty had that person asked us, "What *does* live in Big Creek?" And so, we undertook the task of learning about the nature of the stream and the life within it.

When we began our task, we thought that finding 20 species of fish and a handful of species of larger invertebrates, such as crayfish and clams, was an optimistic goal. Certainly, many of the 26 species of fish found in Big Creek during the past 50 to 100 years would have been extirpated from the once cleaner stream. Unfortunately, this is the case for at least four of the former inhabitants of Big Creek, and for two of these species, the Topeka shiner and the hornyhead chub, their survival elsewhere in Kansas is threatened. Yet, despite the loss of these four species, the diversity of fish in Big Creek has exceeded our expectations. From the spring of 1983 through the spring of 1985, we found 28 species of fish inhabiting the waters of Big Creek.

In addition to the relatively large number of fish species, we found a variety of animals we did not expect to see in Big Creek, such as freshwater sponges. We found stretches of the creek where the bottom is still covered with sand and the stream is fed year-round with clear water from springs. We found largemouth bass, catfish, and crappie that any angler would be happy to take home. We found a stream that is far from dead; a stream that has watered leagues of prairie for thousands of years in a land that was never richly blessed with flowing waters; a stream that is still capable of providing us with a valuable aesthetic and recreational natural resource, if we are willing to take care of it.

This book is a brief account of Big Creek: the stream, the life, the geology, the history. We hope that it will at least stimulate your appreciation of what Big Creek was and still is. Should you desire to learn more about the topics covered here, publications that served as our sources and those that cover the material in more detail are listed at the end of the book under the titles of the sections in the text.

ACKNOWLEDGMENTS

We are indebted to several people and organizations for their assistance. Dr. Thomas Wenke of the Department of Biological Sciences at Fort Hays State University contributed to all aspects of this project through discussions, field and laboratory work, and review of our manuscripts. Dr. John Ratzlaff of the Department of Geological Sciences at Fort Hays State University assisted us with discussions of geology and hydrology. Historical information was provided by Mr. Ron Parks of the Fort Hays Historical Museum and Mr. James Drees of the Ellis County Historical Society Museum. Information about the fishes of Big Creek was supplied by Mr. Randy Schademann and Mr. Troy Schroeder of the Kansas Fish and Game Commission, and by Dr. Frank Cross of the Museum of Natural History at the University of Kansas. Technical assistance with the color plates was provided by Drs. Frank Cross and Joseph Collins of the Museum of Natural History at the University of Kansas, and by Dr. Thomas Wenke at Fort Hays State University. Discharge data for Big Creek during 1983 and 1984 were supplied by Mr. Claude Geiger of the U.S. Geological Survey in Lawrence, Kansas.

Ms. Patti Hubbard, Mr. Bill Stark, Mr. Jim Stroh, and Mr. Kevin Williams contributed their time in the water pulling the seine, and Ms. Hubbard also helped catalog the specimens. Additional assistance with field work was provided by Ms. Shelley Ernsting, Mr. Bernie Geier, and Mr. Sherm Karl. Ms. Theresa Pfeifer helped compile precipitation and flow data. Financial support for this study was provided by the Department of Biological Sciences at Fort Hays State University (Dr. Eugene Fleharty, chairman) and the Nongame Wildlife Fund of the Kansas Fish and Game Commission (Mr. Ken Brunson, chairman of the Fish Committee). Money for an aerial survey of Big Creek in Russell, Ellis, Trego, and Gove counties in April 1984 was supplied from residual funds from a Graduate Council Research Committee grant to Dr. Robert Nicholson of the Department of Biological Sciences at Fort Hays State University, and Mr. Jack Wieland contributed his time as a pilot. An aerial survey in August 1984 was arranged in conjunction with aerial stream surveys being conducted by Mr. Ken Brunson with the Kansas Fish and Game Commission's plane.

We also thank Mr. Richard Driscoll of Russell, Kansas, for access to the confluence of Big Creek and the Smoky Hill River.

INTRODUCTION

Big Creek originates as a shallow, narrow valley on the treeless high plains of northwestern Gove County, Kansas. From its headwaters, the stream courses on a southeasterly direction through the chalky, rolling rangelands of Gove and Trego counties, then flows through the predominantly agricultural lands of Ellis County and empties into the Smoky Hill River in western Russell County (Figure 1).

Big Creek wanders through western Kansas for a total of 163 miles. Though Big Creek flows over a wide variety of sands and gravels, much of its banks and floodplain is comprised of silt and clay. These consolidated soils along the banks of Big Creek have given rise to physical characteristics that are uncommon along other streams of western Kansas. For instance, Big Creek was more heavily wooded than either of the nearby rivers, the Smoky Hill or the Saline rivers. The late Dr. Fred Albertson, a long time biological researcher at Fort Hays Kansas State College, noted in the late 1930's that the heavier soils along Big Creek were more conducive than sandy soils to growth and establishment of cottonwood trees. Dr. Albertson postulated that heavy rains and flash floods washed away many of the young trees that became established in sandy soil. Thus, Big Creek has generally been endowed with better forest cover and wooded animal habitat than either the Smoky Hill River or the Saline River.

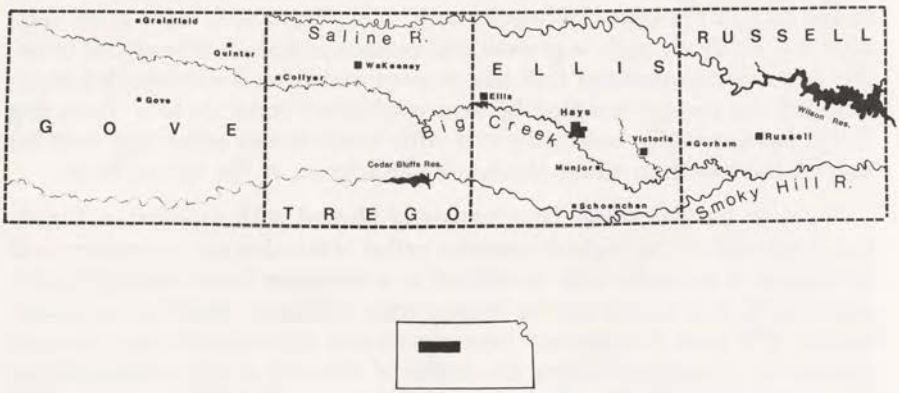
Not only has Big Creek been naturally blessed with a gallery of forest, but it has one of the highest meander ratios of streams in the western half of Kansas. A meander ratio is defined as a deviation from a straight path, meaning that a stream with a higher ratio follows a winding or sinuous course. The ratio is important because streams with meandering channels are known to support higher diversities of fish and wildlife. Meandering streams can have both a greater area of forested floodplain and a wider diversity of fish habitats.

The drainage basin of Big Creek is comprised of 824 square miles. J.A. Allen, a famous naturalist of the 19th century, remarked how the original basin of Big Creek was almost entirely shortgrass rangeland. Though tallgrasses and trees were quite abundant in the hollows and bottomland of the creek, the remainder of the plains was a roughcut carpet of buffalograss frequented by bison, wolves, elk, and pronghorn "antelopes." When the Fort Hays Military Reservation was surveyed in July of 1867, writers noted that Big Creek was 13 to 33 feet wide and "running." Soldiers at Fort Hays could usually enjoy a refreshing bath or drink from the cold, clear water in Big Creek's gravelly bed, and they also used the stream for fishing and depositing waste. The most noteworthy features of the stream at the Fort were the clarity and dependability of the water. The early settlers and soldiers were almost certain to find water in the creek throughout Trego and Ellis counties. Occasionally though, Big Creek ceased to flow during excessively hot, dry summers, and water in pools became stagnated. Thirsty regiments, however, could always dig beneath

the gravels in the stream bed and find copious amounts of cool, clear groundwater. Soldiers, however, were hard pressed to find clean water after exceptionally heavy rainfalls when soil, buffalo dung, and animal carcasses were washed into the flooding creek.

Today, due to the effects produced by cultivation, irrigation, and civilization, Big Creek and its basin are considerably different. Runoff of rainfall into Big Creek has been reduced by conservation measures that have been designed to retain water on range and farmland. Drainage into the creek is further compounded by heavy silt loads that are suspended in runoffs from poorly managed agricultural lands. Many tons of silt that have filtered out of muddy waters have changed the characteristics of the creek and affected to an appreciable degree the quality and dependability of Big Creek as a recreational and domestic source of water.

Figure 1.—The channel of Big Creek in the four-county study area of northwestern Kansas.



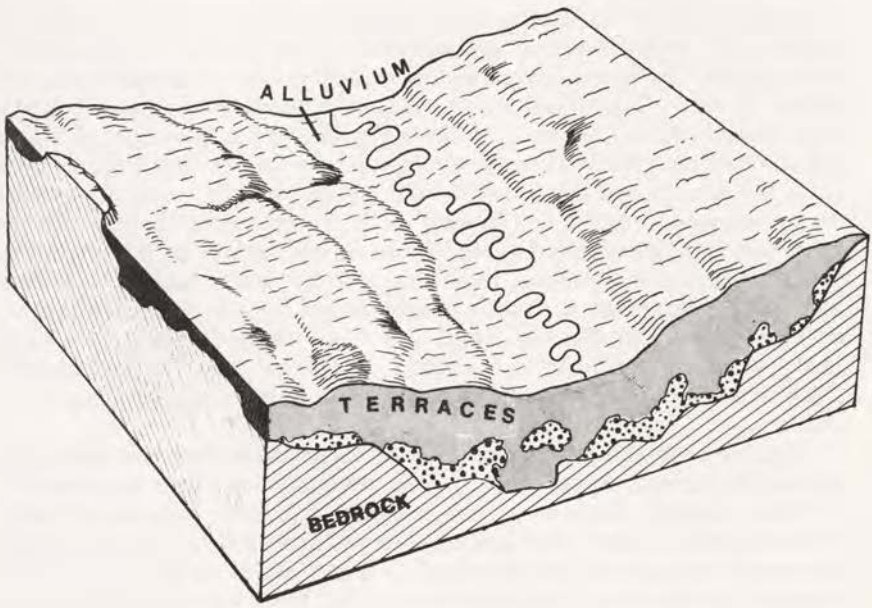
GEOLOGY AND HYDROLOGY OF BIG CREEK

Geologists estimate that Big Creek has watered western Kansas for at least two hundred thousand years. The valley and its drainage were originally etched into accretions of sand and gravel that were deposited by ancient rivers over 5 million years ago. Throughout millions of years, surface runoff gradually eroded these gravelly deposits, eventually downcutting the valley to its present day topography. Most of the sand and gravel that comprises Big Creek's alluvial fill was derived from such erosion of the Ogallala formation.

The valley of Big Creek consists of a relatively narrow floodplain that is skirted by low terraces (Figure 2). The present floodplain was formed by deposits of silt carried by floods of Big Creek over many thousands of years. The abandoned floodplains, or terraces as they are more commonly known, were formed by similar processes during various stages of the Pleistocene (Ice Age) when climatic and other environmental conditions were different. At Hays the upper terrace is approximately four miles wide, a phenomenon that suggests that the stream was once considerably larger than it is today! A smaller, inner terrace and valley were formed within the last 120,000 years and sport sand and gravel terrace deposits that are 30 to 50 feet thick.

Much of the perennial flow in Big Creek that was mentioned in accounts from old Fort Hays was a result of groundwater seepage.

Figure 2.—Diagrammatic cross-section of the valley of Big Creek.



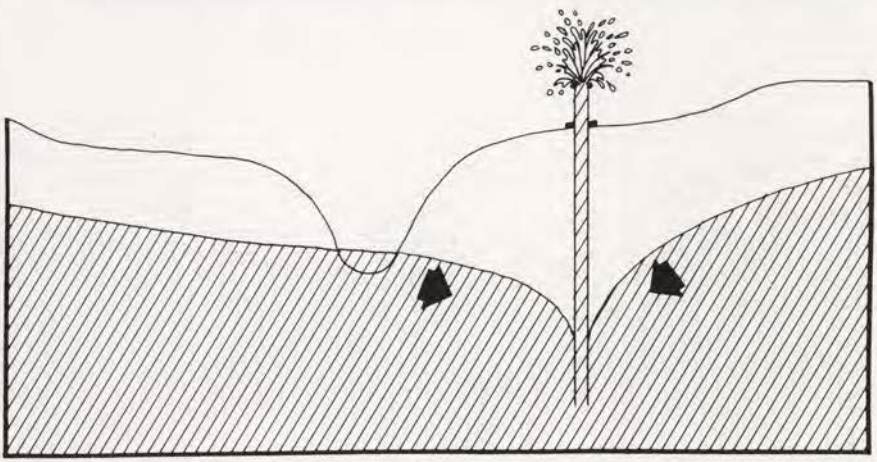
Throughout the length of Big Creek in Trego, Ellis, and Russell counties, an alluvial aquifer is contiguous with the channel. This aquifer is comprised of unconsolidated sands and gravels that were deposited in ancient channels of Big Creek many thousands of years ago. These porous deposits are saturated with water, and the water slowly percolates downhill toward the creek in response to gravity. Some of the water eventually escapes to the surface and flows into sloughs, springs, and Big Creek. When the flow in a stream is thus replenished by groundwater, the stream is said to be gaining underground water and is simply referred to as a *gaining* or *effluent* stream. To the contrary, if a stream is losing part of its flow to the underground aquifer, the stream is said to be a *losing* system. At the turn of the century, when the consumption of groundwater was relatively light, the water table in the Big Creek Valley was close to the surface, and Big Creek gained much of its flow from underground percolation. In 1902, for example, the Hays City Commercial Club mentioned that in "part of the creek's course through the [former military] reservation, water runs nearly the year round, though most of the water runs as an underflow in sand."

In eastern Gove and western Trego counties, the alluvium of Big Creek is in contact with the eastern edge of a vast supply of underground water, the Ogallala aquifer. Water from the Ogallala can percolate into the surrounding alluvium and subsequently into Big Creek. However, if the water table in the Ogallala drops below the zone of contact between the Ogallala and the Big Creek alluvium, no water can move into the alluvium and the channel of Big Creek. We are not certain if the Ogallala aquifer still supplies water to Big Creek in eastern Gove and western Trego counties, but it is possible that this is the case at some of the isolated pools in that area.

Because the flow in Big Creek is partially dependent on the depth to the water table, withdrawals of groundwater affect the flow of the creek to some extent. Extensive irrigation or domestic use of groundwater can reduce flow in Big Creek by causing a lowering or *depression* in the groundwater table (Figure 3). Such a depression has the effect of reversing the natural gravity flow of underground water so that it flows away from the stream and towards the void created by the pump. If groundwater removal becomes too intense, as is the case near Hays, the water table can be temporarily lowered beneath the surface of the streambed and a portion of the stream "loses" water to the water table. Under these conditions, the stream is usually characterized by a dry channel. It is important to note that Big Creek can also "lose" water during times of high flow, when water from the stream percolates into the surrounding floodplain and becomes an important source of recharge for the groundwater.

Big Creek and other western Kansas streams differ from eastern streams in one important aspect: there is less precipitation, thus less runoff in western Kansas. Because of the frequent rainfalls, streams of wetter climates tend to flow year around and are known as *perennial* streams. Perennial streams are characterized by water tables above the bed of the stream. On the other hand, waterways that have water tables that drop

Figure 3.—Diagrammatic illustration of the result of excessive groundwater pumping on the flow of the groundwater. Normally, the groundwater would flow toward the stream.

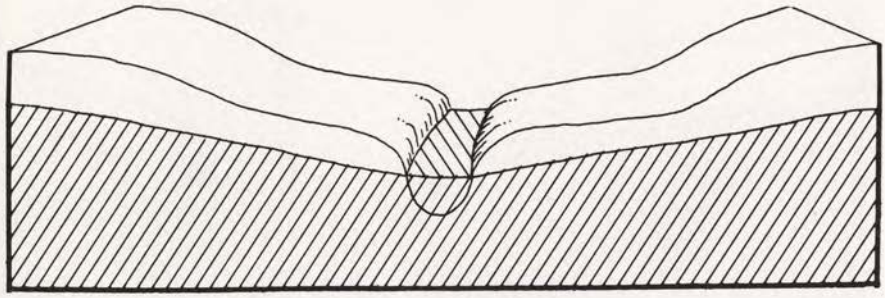


below the bed of the stream during portions of each year are termed *intermittent. Ephemeral* streams carry water only after heavy rains, and their channels are always above the water table (Figure 4). Big Creek has characteristics of ephemeral, intermittent, and perennial streams. In certain parts of Trego, Ellis, and Russell counties where the creek is fed by unfailing springs, Big Creek is perennial. In western Trego County and portions of Ellis County, Big Creek is termed intermittent, because it flows throughout the spring but tends to dry in the hot summer months. In parts of Gove County, Big Creek only retains water for short periods after heavy rains and is thus an ephemeral stream in that area.

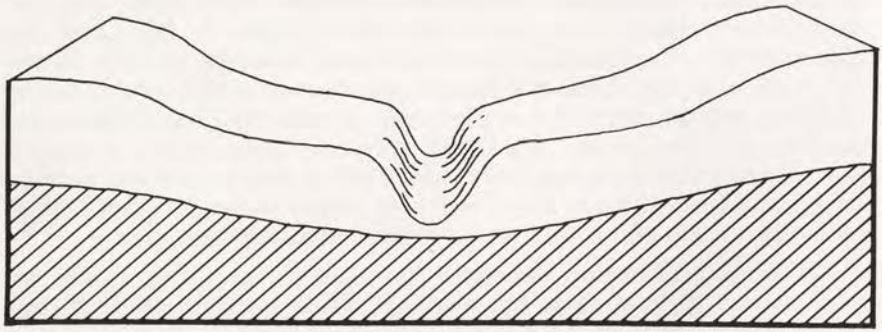
Big Creek is ultimately dependent on precipitation for flow. The annual precipitation at Hays has averaged 23.36 inches since 1868, and approximately 60% of the mean annual precipitation falls as rain from May through August, a period that is characterized by high winds, high temperatures, and high amounts of evapotranspiration. Evapotranspiration is the loss of water from soil through evaporation and transpiration (the uptake and release of water by plants). The Kansas Geological Survey has estimated that a volume of water equivalent to 90% of the annual precipitation that falls near Hays is returned to the atmosphere via transpiration and evaporation. Of the remaining percentage, most leaves the valley via streamflow, and only a small amount of the total precipitation ever recharges the alluvial aquifer. Thus, streams in western Kansas reflect a delicate balance of nature that is easily disrupted by irrigation, domestic withdrawals, and farming and ranching techniques.

The effects of drought are generally considered to be serious when the precipitation drops below 85% (19.8 inches) of the long-term average. Since the early days of Fort Hays in 1868, precipitation has been less than the 23.36 inch average in 61 of the 117 years. In 34 of those 61 years, precipitation has dropped below 85% of normal. During these drought

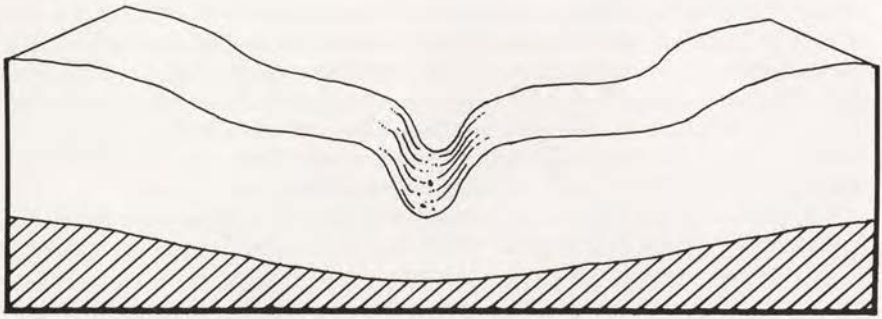
Figure 4.—Diagrammatic illustration of the three types of flow patterns in streams such as Big Creek. Perennial streams flow year-round, intermittent streams flow during some seasons of the year, and ephemeral streams flow only when there is sufficient precipitation.



Perennial



Intermittent



Ephemeral

years, the precipitation averaged about 16.5 inches, or roughly 71% of the normal amount. The most severe drought on record was recorded from 1893-1895 when the average annual precipitation was only 14.2 inches. Droughts that encompassed two consecutive years occurred in 1910-1911, 1916-1917, 1921-1922, 1933-1934, and 1936-1937. The most prolonged dry period occurred from 1933-1939 when the precipitation was below normal each year, and drought conditions occurred during five of the seven years. During the period of 1952-1956, precipitation was again below normal, and in 1956, only 9.21 inches of precipitation was recorded, the lowest total on record. Several abnormally wet years have also occurred at Hays. The wettest year on record was 1951 when the total precipitation reached 43.34 inches. Graphs of annual precipitation show that dry years are usually followed by wet periods, suggesting that periods of abnormal precipitation might follow a cyclical pattern.

The United States Geological Survey has maintained records on the streamflow of Big Creek since 1947 (Table 1). From 1947-1983, the

TABLE 1.—Annual precipitation at Hays and annual discharge of Big Creek determined at gaging stations southeast of Hays.

YR	PRECIP.	DISCHARGE	YR	PRECIP.	DISCHARGE
1947	22.65"	24,360 ac-ft	1966	17.14"	16,050 ac-ft
1948	26.19"	17,880 ac-ft	1967	23.64"	14,610 ac-ft
1949	23.62"	26,060 ac-ft	1968	18.83"	11,060 ac-ft
1950	25.59"	38,820 ac-ft	1969	25.12"	15,040 ac-ft
1951	43.34"	168,000 ac-ft	1970	18.23"	11,060 ac-ft
1952	13.39"	9,690 ac-ft	1971	23.75"	8,250 ac-ft
1953	21.07"	4,990 ac-ft	1972	22.39"	8,120 ac-ft
1954	18.56"	8,300 ac-ft	1973	35.00"	39,950 ac-ft
1955	21.16"	9,660 ac-ft	1974	15.23"	17,200 ac-ft
1956	9.21"	2,630 ac-ft	1975	22.60"	33,240 ac-ft
1957	28.33"	107,000 ac-ft	1976	20.73"	10,930 ac-ft
1958	31.21"	45,170 ac-ft	1977	20.28"	8,010 ac-ft
1959	24.43"	16,890 ac-ft	1978	17.43"	4,230 ac-ft
1960	20.47"	40,300 ac-ft	1979	23.62"	15,960 ac-ft
1961	28.31"	47,720 ac-ft	1980	18.03"	7,510 ac-ft
1962	23.09"	28,730 ac-ft	1981	23.91"	5,880 ac-ft
1963	22.17"	10,760 ac-ft	1982	20.68"	9,320 ac-ft
1964	19.76"	4,570 ac-ft	1983	15.98"	3,450 ac-ft
1965	24.49"	64,910 ac-ft			

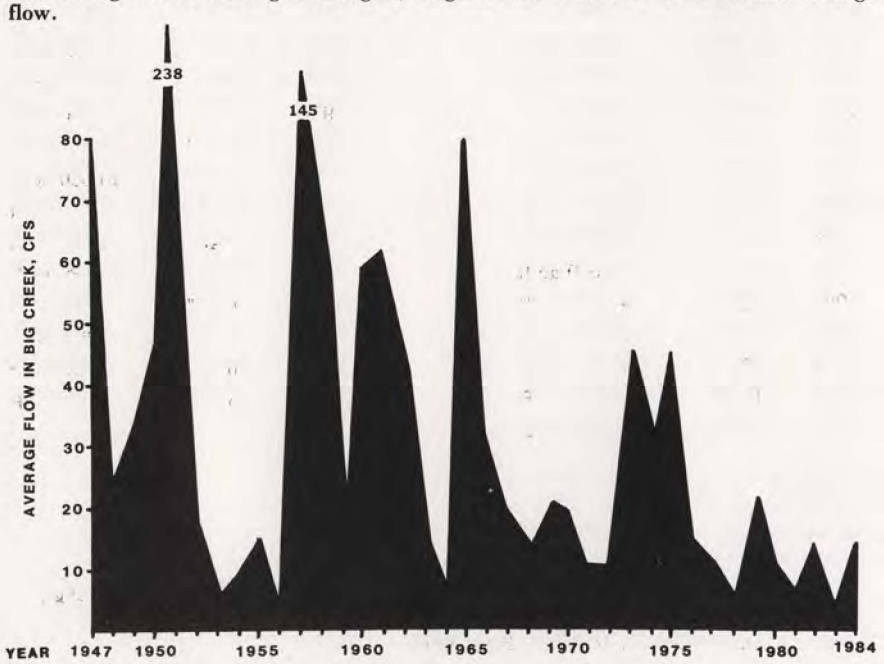
Highest annual precipitation: 1951 43.34"
Lowest annual precipitation: 1956 9.21"
Highest annual discharge: 1951 168,000 ac-ft
Lowest annual discharge: 1956 2,630 ac-ft
Average annual precipitation: 22.42"/yr (19 years below avg. - 18 years above avg.)
Average annual discharge: 24,820 ac-ft/yr (26 years below avg. - 11 years above avg.)
Median annual discharge: 14,610 ac-ft/yr (1967)

median flow in Big Creek near Hays was 20 cubic feet per second, meaning that on the average, about 150 gallons of water flowed past the gaging station near Hays every second. These figures translate to a median annual flow of 14,610 acre feet per year, enough water to fill 4,760,000,000 gallon jugs with water! It takes a lot of water to maintain just a moderate flow in Big Creek each year, and much of this water comes from precipitation and runoff in the Big Creek Valley. For instance, during the driest year on record in 1956, annual flow of Big Creek at Hays was only 2,630 acre feet, the lowest total on record. In June of 1951, though, Big Creek Valley received an incredible 13 inches of rainfall, and Big Creek was transformed into a raging flood. In June alone of that year, 107,000 acre feet of water flowed through the stream (and surrounding floodplain) at Hays. In general, the discharge of Big Creek is dependent on the amount, extent, and intensity of rainfall in the valley. The timing of snowfall and spring thaws are also important factors that contribute to the amount of water in Big Creek.

High flows in Big Creek serve a dual purpose. Not only do peak flows replenish groundwater supplies, but they also scour silt and debris from the creek channel, oxygenate the water, and thus help to maintain the integrity of the stream.

The flow records of the United States Geological Survey show that the annual discharges of Big Creek from 1976-1984 have been substantially lower than the 37-year long-term average. In fact, the average discharge seems to have been declining gradually since the early 1960's (Figure 5).

Figure 5.—Graph of the average flow in Big Creek as cubic feet per second during the years 1947 through 1983. Allowing for droughts, the general trend has been toward a lower average flow.



This decline in discharge is strongly correlated to increased pumping of groundwater, reduction of runoff from farmland and rangeland, and different rainfall patterns. To illustrate the recent rainfall patterns (Table 2), we grouped the monthly precipitation totals into two categories: winter/fall precipitation (October-March) and spring/summer precipitation (April-September). In five of the six years from 1978-1983, the spring/summer precipitation total was well below the 37-year average. Because the spring/summer period is also the period of maximum evapotranspiration, irrigation, and domestic use, it is reasonable to assume that the stream would not have been able to support a "normal" flow during those years. Though trees are blamed for transpiring groundwater, they also protect the stream from wind and sun, keep the water relatively cool, and thus significantly reduce the amount of water lost to evaporation.

The extent of the impact that groundwater withdrawal has had on the surface flow of Big Creek is not known; however, clusters of wells in the

TABLE 2.—Precipitation during Winter/Fall (January-March and October-December) and Spring/Summer (April-September) measured at Hays.

YR	WINTER/FALL	SPRING/SUMMER	YR	WINTER/FALL	SPRING/SUMMER
1947	5.13"/22.6%	17.52"/77.4%	1966	2.52"/14.7%	14.62"/85.3%
1948	6.66"/25.4%	19.53"/74.6%	1967	1.01"/ 4.3%	22.63"/95.7%
1949	6.49"/27.5%	17.13"/72.5%	1968	4.88"/25.9%	13.95"/74.1%
1950	4.02"/15.7%	21.57"/84.3%	1969	6.80"/27.1%	18.32"/72.9%
1951	5.89"/13.6%	37.45"/86.4%	1970	2.16"/11.8%	16.07"/88.2%
1952	4.33"/32.3%	9.06"/67.7%	1971	8.75"/36.8%	15.00"/63.2%
1953	6.96"/33.0%	14.11"/67.0%	1972	4.09"/18.3%	18.30"/81.7%
1954	2.91"/15.7%	15.65"/84.3%	1973	15.07"/43.1%	19.93"/56.9%
1955	1.74"/ 8.2%	19.42"/91.8%	1974	4.77"/31.3%	10.46"/69.3%
1956	2.21"/24.0%	7.00"/76.0%	1975	5.38"/23.8%	17.22"/76.2%
1957	4.85"/17.1%	23.48"/82.9%	1976	3.18"/15.3%	17.55"/84.7%
1958	6.39"/20.5%	24.82"/79.5%	1977	2.83"/13.6%	17.45"/86.4%
1959	5.39"/22.1%	19.04"/77.9%	1978	5.15"/29.5%	12.28"/70.5%
1960	6.42"/31.4%	14.05"/68.6%	1979	13.05"/55.2%	10.57"/44.8%
1961	4.61"/16.3%	23.70"/83.7%	1980	5.88"/32.6%	12.15"/67.4%
1962	2.94"/12.7%	20.15"/87.3%	1981	6.62"/27.7%	17.29"/72.3%
1963	3.66"/16.5%	18.51"/83.5%	1982	7.06"/34.1%	13.62"/65.9%
1964	3.44"/17.4%	16.32"/82.6%	1983	7.98"/49.9%	8.00"/50.1%
1965	4.17"/17.0%	20.32"/83.0%			

Highest Winter/Fall precipitation: 1973 15.07"
Lowest Winter/Fall precipitation: 1967 1.01"
Highest Spring/Summer precipitation: 1951 37.45"
Lowest Spring/Summer precipitation: 1956 7.00"
Average Winter/Fall precipitation: 5.28"/23.6%
Average Spring/Summer precipitation: 17.14"/76.4%

valley of Big Creek in and around WaKeeney, Ellis, Hays, and Victoria probably impair the stream's ability to support a flow despite normal amounts of precipitation. As demands for water increase in the future, groundwater withdrawal will continue to pose a serious threat to streamflow in Big Creek.

Western Kansas has never been richly blessed with surface waters; and, until recently, because of the remote locality and relatively low density of population, few stream-related studies had been conducted. The natural scarcity of water is, however, all the more reason to implement studies that promote knowledge and conservation of the resource.

HISTORY OF SETTLEMENT OF THE VALLEY

West-central Kansas has a rich and varied pre-settlement history. Prior to the coming of European settlers, Big Creek Valley was primarily inhabited by Cheyenne and Arapaho Indians, although other nomadic tribes such as Kaw, Comanche, and Pawnee would occasionally wander into its bounds searching for bison. The first regular traffic route across this region of the High Plains was established in 1859 as the Smoky Hill Trail. The Trail, later popularized as the Butterfield Overland Dispatch, was the primary route that connected the eastern United States with the gold fields of Colorado.

Increased traffic on the Butterfield Trail in the early 1860's prompted the United States Government to build forts to provide travelers with protection against raiding parties of Cheyenne Indians. In the autumn of 1865, Fort Fletcher, a military outpost, was commissioned on the banks of Big Creek about 14 miles southeast of present-day Hays. In June of 1867, however, torrential rains caused massive flooding along Big Creek, and the post, renamed Fort Hays, was destroyed. A month later the outpost was relocated on a terrace of Big Creek just south of the present city of Hays. Early and thorough accounts of the wildlife and general aspect of the area near the Fort were recorded by the post's medical officers until the post was decommissioned in November of 1889.

The first white settlements near Big Creek were established along the route of the Kansas Pacific (Union Pacific) Railroad in the mid 1860's. The Kansas Pacific reached the townsite of Hays in 1867. The area near Hays is rich with legendary figures of the old west including "Buffalo Bill" Cody, "Calamity Jane" Canary, "Wild Bill" Hickok, and Brevet General George Armstrong Custer.

As townsites became firmly entrenched along Big Creek and the railway, activities began to have a noticeable impact on the stream. At Ellis, for example, a large wooden dam was constructed in the late 1800's to retain water for steam locomotives. In the early 1900's, earthen and stone dams were periodically built (though often destroyed by floods) to provide recreational opportunities for citizens of Hays. In the early 1930's, small concrete dams were constructed on Big Creek at Frontier

Historical Park and Custer's Island on the outskirts of Hays. A large concrete dam replaced the wooden structure at Ellis and provided the residents of Ellis with a permanent reservoir. Presently, smaller low-water dams on Big Creek restrict upstream movement of fish at numerous locations.

Of specific, historical interest is a plan that was conceived by the "Smithies," the first English settlers at Victoria. In the late 1870's, the "Smithies" used the labor of the first Volga-German settlers to help construct a limestone dam on Victoria Creek (North Fork of Big Creek). In May of 1878, the British immigrants christened a sixteen-foot steam launch, The Jolly West, at the newly-formed reservoir. The maiden voyage of The Jolly West came to an abrupt end when the unballasted ship capsized and dumped its passengers into the water. The boat and reservoir were used for several years until a flood washed away the dam and the steamboat sank. It is interesting to note (dubiously) that some passengers claimed that the ship could travel to within a few miles of Fort Hays and pick up officers to play in card games.

STREAM ECOLOGY OF BIG CREEK

The diverse flow patterns of Big Creek present problems of survival to some of the local fauna and flora. Undoubtedly the most visible sign of stress is the absence of water. The loss of surface water is an immediate problem not only to fish, but numerous birds, mammals, amphibians, reptiles, and insects as well. Another phenomenon that can be extremely detrimental to wildlife is the depletion of oxygen from surface water. Unfortunately, many of us do not see the effects of dangerously low levels of oxygen until a fish kill occurs. The oxygen demand of fish and other aquatic organisms can overtax oxygen supplies during times of low flows and high temperatures.

Big Creek is usually sufficiently aerated in the spring when the discharge is relatively high and the water can mix with the atmosphere. During the summer, however, if the water stagnates, the mixing and aeration are severely retarded and much of the oxygen is respired by fish and other organisms. Oxygen is also less soluble in warmer water; thus, relatively cool water can usually support larger and more diverse populations of fish. For this reason, the shade provided by trees along Big Creek is a valuable component of the stream ecosystem. The effects of oxygen depletion can be devastating because fish will actually suffocate for lack of oxygen. In Big Creek, carp and bullheads are the fish most tolerant of low oxygen conditions, but under deteriorating conditions, they can often be seen gasping for oxygen at the surface of the water.

The problem of a low oxygen supply can be compounded during the winter by ice cover. Cloudy or snow-covered ice on a pond or reservoir might also cause oxygen depletion. Areas of Big Creek that harbor impounded water, such as the Ellis Reservoir, depend on sunlight for reple-

tion of oxygen during the winter. Thus, when sunlight is shaded from the water by snow and ice, algae cannot photosynthesize, and oxygen supplies can become depleted. In recent years, low water levels and snow-covered ice have resulted in fish kills at the Ellis Reservoir.

Big Creek is also susceptible to silting. Large amounts of suspended silts and clays, a result of runoff from farmlands, have greatly modified the streambed and the water quality of Big Creek. Though part of the stream in Trego County remains relatively clear, waters in Ellis and Russell counties are usually muddy. In fact, since the onset of cultivation in western Kansas, Big Creek's waters have become increasingly turbid, and as a result, several species no longer occur in the stream. Throughout Ellis and parts of Russell counties, Big Creek has a sand and gravel bottom that is covered in areas with as much as 24 inches of silt. Much of Trego County is still free of silt overburden, though some sedimentation occurs in quiet pools. The relatively clear nature of the water in this region is thought to be a result of the broad expanses of rangeland that still skirt the creek.

Reduced streamflows affect not only siltation of the channel, but also the width of the stream. Channel width is a dynamic property of a stream. After several years of relatively low flows and reduced peak discharges, a stream's channel tends to shrink in response to the lower flows. Reaches of Big Creek, particularly in Trego County, are already becoming obscured by cattails, sloughgrass, and woody growth. Channel shrinkage is frequently initiated by storage of water in reservoirs, but can also be induced by siltation, terracing of range and farmlands, and irrigation.

RIPARIAN HABITAT ALONG BIG CREEK

Big Creek has some of the oldest woodlands in western Kansas. In fact, early accounts from Fort Hays mentioned several venerable elms, ashes, and cottonwoods. One such monarch, a 189-year-old dying American Elm, was removed from the Fort Hays State University campus in the late 1930's. D.C. Nettleton, commanding scout of the Second Colorado Cavalry, mentioned the importance of Big Creek's trees in 1865: "But little timber along the Saline, consisting of scattered trees along the bank. Big Creek is well skirted with timber, is six or eight feet wide and six inches deep — a favorite camping place for Indians; but few trees along the Smoky Hill where we traveled."

The Fort Hays Military Reservation Survey of 1867 reported that elm, cottonwood, ash, boxelder, willow, and hackberry comprised most of the woodlands along Big Creek. The composition of Big Creek's gallery forest is much the same today as it was in the early days of Fort Hays. Though many of the large, older trees have been removed for use as firewood, they are being replaced naturally by native trees. Much of Big Creek's floodplain is suited to following a natural succession of tree species. Species such as elm and boxelder, for instance, are better suited to

colonizing the deep, rich soils that are found along some of the steeper banks of Big Creek. Cottonwoods and willows, though, are usually the first species to colonize moist, sandy, and sunny expanses of the creek bed. After the cottonwood forest has matured and enriched the soil with nutrients, other successional species, such as elm, ash, and honey locust, will grow.

The narrow band of trees that lines Big Creek provides many benefits to western Kansas. These woodlands provide firewood, protect the banks of Big Creek from erosion, and shade the water from direct heat of the sun. Another important benefit is reaped by many of the birds and mammals of western Kansas. Big Creek's trees provide a corridor of habitat and an avenue of dispersal to many of these animals. In effect, Big Creek and many other western Kansas streams provide the High Plains with a biological link to the forested acres of eastern Kansas. As early as 1871, the naturalist J.A. Allen noted that: "The most striking feature of the avian fauna here is the great abundance of more or less strictly woodland species, considering the scantiness of forest vegetation . . . tree nesting species are very abundant." Many of these species still inhabit Big Creek and the immediate vicinity. Such forest species as the blue grosbeak, wood duck, sharp-shinned hawk, horned owl, and brown thrasher inhabit these woodlands. Other species of birds including the great blue heron, green heron, kingfisher, and numerous ducks are not dependent on trees, but require standing or flowing water.

Big Creek is extremely important as a source of water and habitat to many species of mammals. Several species are ultimately dependent on riparian forest for natural habitat and dispersal in western Kansas. These mammals include the white-tailed deer, beaver, red fox, opossum, mink, raccoon, fox squirrel, and the white-footed mouse. Porcupines also have been known to turn up occasionally in woodlands along Big Creek. Early accounts from Fort Hays mentioned that river otters also were occasionally seen in and along Big Creek!

AQUATIC PLANTS AND INVERTEBRATES

At the base of the food web in Big Creek are algae, small plants that produce their food through the process of photosynthesis using the nutrients around them in the water. Some kinds of algae join together to form filamentous colonies which are mistakenly called "moss" by many people. One of the most important kinds of algae is the group known as the diatoms. These one-celled algae are golden brown in color, and they often dominate the aquatic substrate, forming a slippery brown coating on the surface of rocks and other submerged objects. Although these plants are not large, they play several important roles in the stream ecosystem. In addition to serving as a food source at the base of the food web, they produce relatively large amounts of oxygen during photosynthesis that can be consumed by other organisms in the stream. Filamentous forms can also serve as a miniature "forest" habitat for small

plants and animals that are barely visible to the naked eye.

The larger, flowering plants living in Big Creek serve some of the same functions in the aquatic ecosystem as the algae. Plants, such as cattails, arrowleaf, pondweed, and duckweed, are less important as a source of food, but they release oxygen into the water during photosynthesis, provide a substrate for the attachment of microorganisms eaten by fish, and offer cover to fish and other animals in the stream. Fish and other animals need a certain amount of cover, as provided by rooted vegetation and submerged debris, to furnish a hiding place for themselves or a nursery for their eggs and young.

Several kinds of invertebrate animals live in Big Creek and play an important role in the stream ecosystem. Many of these organisms are microscopic and are never seen by the casual observer. Among these minute creatures are single-celled animals collectively referred to as protozoans. Although they are composed of only one cell, they come in a variety of shapes and designs. In addition to these unicellular protozoans, there are other microscopic animals made up of many cells. Together, these tiny organisms and the algae comprise an important source of food for larger invertebrates and fish, such as gizzard shad and minnows, that live in Big Creek.

Insects are the most common group of macroinvertebrates in Big Creek. Several kinds of insects inhabit the stream as larvae, including mosquitoes, dragonflies, damselflies, and deer flies. Many people, however, are more familiar with the winged adult forms of these aquatic insect larvae. Other insects live in the creek as adults. These include water striders, whirligig beetles, and water boatmen. As with the microinvertebrates, aquatic insects serve as an important source of food for many species of fish.

Freshwater sponges are present in Big Creek, although they are not very abundant. A sponge colony forms a low-growing, white mat that normally grows on the underside of fallen trees or similar debris. Sponges survive the winter in a concentrated form known as a gemmule, from which the animal emerges in the late spring.

At the time of settlement, three species of crayfish were reported from collections from Big Creek. During the 1983-1985 survey, only one species was found in the stream, but it was sometimes collected in large numbers at various localities.

The number of species of small, thin-shelled fingernail clams and larger, thick-shelled mussels living in Big Creek also has been reduced since the settlement of the valley. Reports from the turn of the century recorded six species of freshwater mussels and two species of fingernail clams. Recent surveys have found only three species of mussels and one species of fingernail clam. Mussels and clams filter microorganisms from the water as food, and for this reason, they are extremely sensitive to high levels of turbidity and other types of pollution. A sufficient number of clams and mussels can serve the valuable function of filtering a relatively large volume of water. In fact, a freshwater mussel is capable of cleaning the microorganisms from the water as efficiently as a comparably sized aquarium filter . . . and the mussel uses less electricity!

FISHES OF BIG CREEK

Studies of the fishes of Big Creek have been conducted sporadically since 1870. The first account is a confusing report by the post surgeon at Fort Hays, who stated that the fish found near the post "belong to the Cyprinidae, or carp family." He also mentioned that "the catfish or common horned pout" was found in Big Creek, but it is uncertain which species of catfish he was referring to. In 1880, the State Fish Commissioner reported the stocking of 5,000 chinook salmon at both Hays and Ellis. The eggs were shipped by railroad from California to Chicago to Ellsworth, where they were hatched and distributed throughout the state. Despite this monumental effort, considering the year in which it was undertaken, few of the salmon were reported to be caught on hook and line.

Most of our knowledge of the species of fishes living in Big Creek is the result of work organized by F.W. Cragin at Washburn College during the 1880's. With the assistance of noted ichthyologist Charles Gilbert, he identified seven species of fish collected near Ellis. Five of these species (fathead minnow, stoneroller, plains killifish, orangespotted sunfish, and orangethroat darter) are still found in Big Creek. The common shiner and Topeka shiner no longer live in the stream.

The fishes of Big Creek are not mentioned again until 1940 when John Bruekelman reported orangethroat darters collected south of WaKeeney. He also reported an American eel from Big Creek in the fish collection at Fort Hays State University, but this specimen could not be found. American eels apparently breed in the Sargasso Sea northeast of Cuba and migrate upstream through the Mississippi River drainage to Kansas and other states. Only the females swim far enough to reach Kansas. Their migration into Big Creek is now restricted by the dam at Kanopolis Reservoir on the Smoky Hill River. More recently, monographic works by Dr. Frank Cross and Artie Metcalfe listed several additional species of fishes from Big Creek. In 1979 the Kansas Fish and Game Commission published information on the fishes of the Smoky Hill River Basin including several sites on Big Creek.

Previous records provide a list of 26 species of fish from Big Creek (Table 3). Our survey and a collection by ichthyology students from Fort Hays State University give us a list for 1983-1985 of 28 species of fishes (Table 4). Six species recorded by earlier investigators were not collected during our survey. Eight species collected during 1983-1985 had not been reported from Big Creek until this survey.

We have divided the Big Creek Basin into five distinct regions, four of which were found to have fish: Trego County, the Ellis Reservoir, the area near Hays, and the confluence with the Smoky Hill River. The ephemeral channel of Big Creek in Gove County, where we made no collections, is the fifth region.

TREGO COUNTY: In central and eastern Trego County, 13 species of fish were collected from five localities (Table 5). The land adjacent to Big Creek at the sampling sites was predominantly rangeland or a combination of rangeland and cropland. South of WaKeeney there are several

TABLE 3.—Species of fish previously reported from Big Creek (1880-1980).

Freshwater Eels (Family Anguillidae)
Anguilla rostrata (LeSueur) — American Eel

Minnows (Family Cyprinidae)
Cyprinus carpio Linnaeus — Common Carp
Carassius auratus Linnaeus — Goldfish
Semotilus atromaculatus (Mitchill) — Creek Chub
Nocomis biguttatus (Kirtland) — Hornyhead Chub
Phenacobius mirabilis (Girard) — Suckermouth Minnow
Notropis cornutus (Mitchill) — Common Shiner
Notropis lutrensis (Baird & Girard) — Red Shiner
Notropis topeka (Gilbert) — Topeka Shiner
Notropis stramineus (Cope) — Sand Shiner
Pimephales promelas (Rafinesque) — Fathead Minnow
Pimephales notatus (Rafinesque) — Bluntnose Minnow
Campostoma anomalum (Rafinesque) — Stoneroller

Suckers (Family Catostomidae)
Carpiodes carpio (Rafinesque) — River Carpsucker

Catfishes (Family Ictaluridae)
Ictalurus melas (Rafinesque) — Black Bullhead
Ictalurus natalis (LeSueur) — Yellow Bullhead
Ictalurus punctatus (Rafinesque) — Channel Catfish
Pylodictis olivaris (Rafinesque) — Flathead Catfish
Noturus flavus Rafinesque — Stonecat

Topminnows (Family Cyprinodontidae)
Fundulus zebrinus Gilbert — Plains Killifish

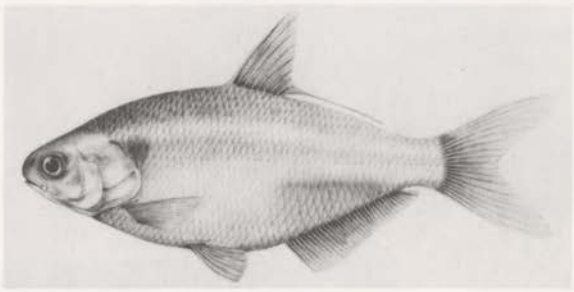
Sunfishes (Family Centrarchidae)
Micropterus salmoides (Lacepede) — Largemouth Bass
Lepomis cyanellus Rafinesque — Green Sunfish
Lepomis macrochirus Rafinesque — Bluegill
Lepomis humilis (Girard) — Orangespotted Sunfish
Pomoxis annularis Rafinesque — White Crappie

Perches (Family Percidae)
Etheostoma spectabile (Agassiz) — Orangethroat Darter

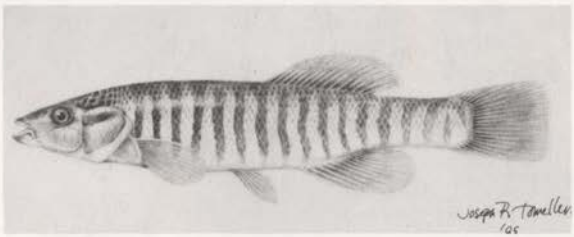
irrigation and public water supply wells located near the stream channel, but throughout Trego County there is no urban development adjacent to the creek. Water flows through this part of Big Creek during the late winter and spring. At some localities, groundwater seeps into the channel and flows for a short distance during most of the year. The stream bottom is principally sand, although it is covered by silt in some places. Pools are six feet or less in depth. The population of fish in this region of the stream is isolated from the remainder of Big Creek by the dam at Ellis. Game fish of a harvestable size that were collected in Trego County included largemouth bass, black bullheads, and common carp.

ELLIS RESERVOIR: A dam and small reservoir have been maintained at Ellis in western Ellis County since the late 1800's. The reservoir is well-shaded with cottonwood trees and a small park located on the south side of the impoundment provides easy public access. Downstream from the dam, the creek has small cottonwood and willow trees along its banks,

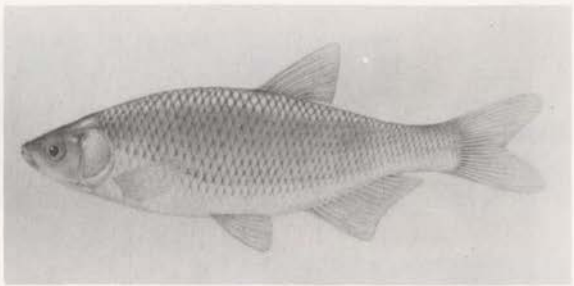
PLATE ONE



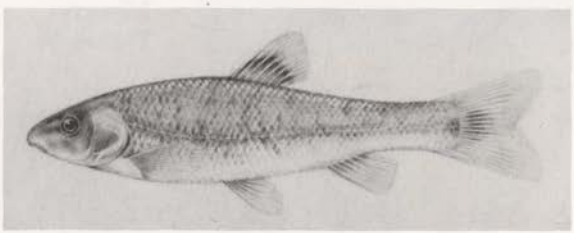
Gizzard Shad, Figure 7



Plains Killifish, Figure 8

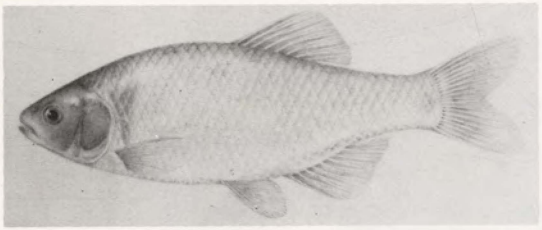


Golden Shiner, Figure 9

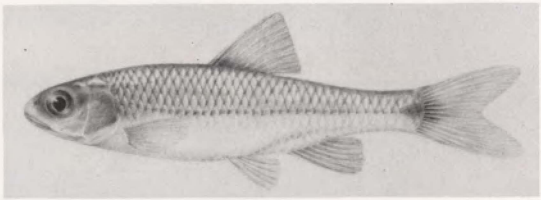


Stoneroller, Figure 10

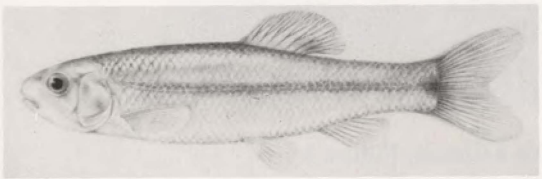
PLATE TWO



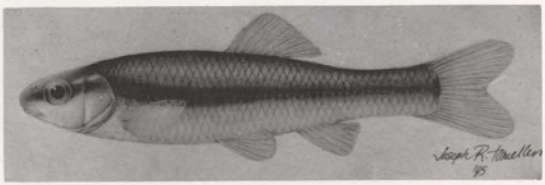
Red Shiner
Figure 11



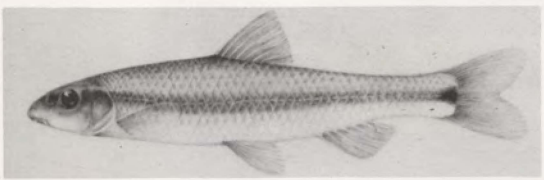
Sand Shiner
Figure 12



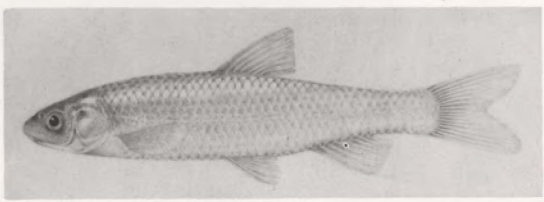
Fathead Minnow
Figure 13



Bluntnose Minnow
Figure 14



Suckermouth Minnow
Figure 15



Plains Minnow
Figure 16

PLATE THREE

Creek Chub
Figure 17

Fathead Minnow
Figure 18

Bluntnose Minnow
Figure 19

Goldfish
Figure 20

Red Shiner
Figure 21

Orangethroat Darter
Figure 22

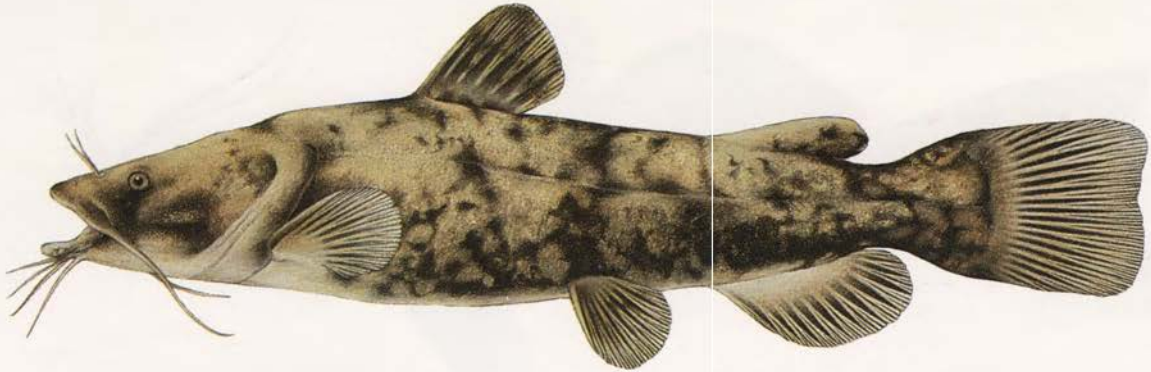
PLATE FOUR

Black Bullhead
Figure 23

Yellow Bullhead
Figure 24

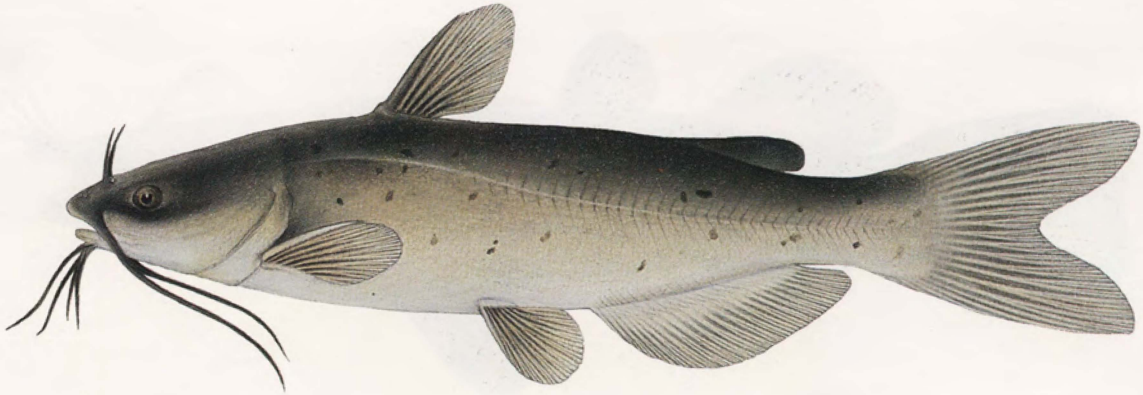
Stonecat
Figure 25

PLATE FIVE



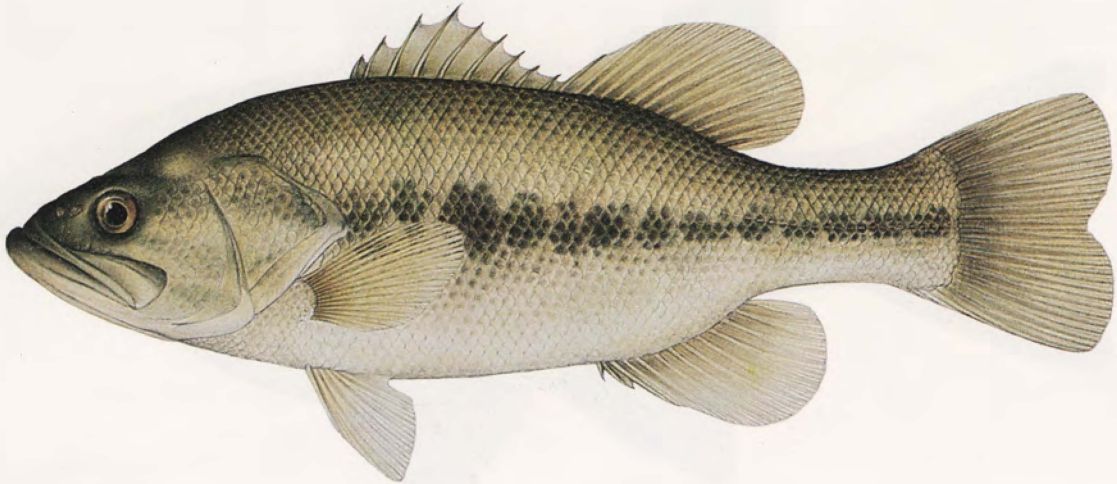
Flathead Catfish - Figure 26

PLATE SIX



Channel Catfish - Figure 27

PLATE SEVEN



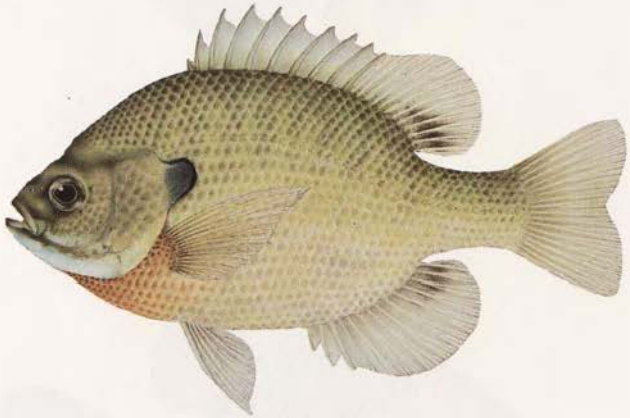
Largemouth Bass - Figure 28

PLATE EIGHT

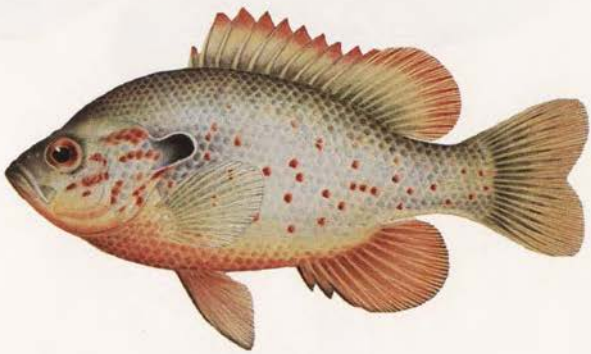
White Bass - Figure 29

PLATE NINE

Green Sunfish
Figure 30

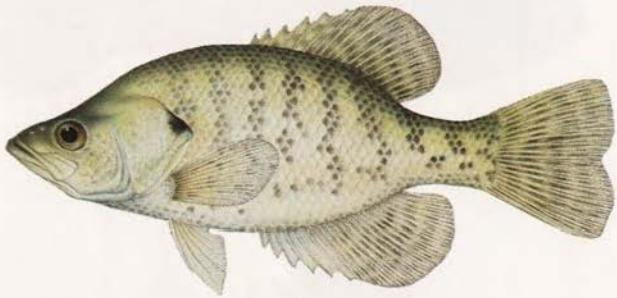


Bluegill
Figure 31

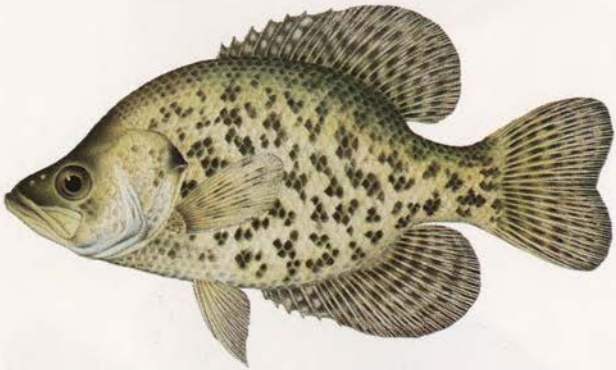


Orangespotted Sunfish
Figure 32

PLATE TEN

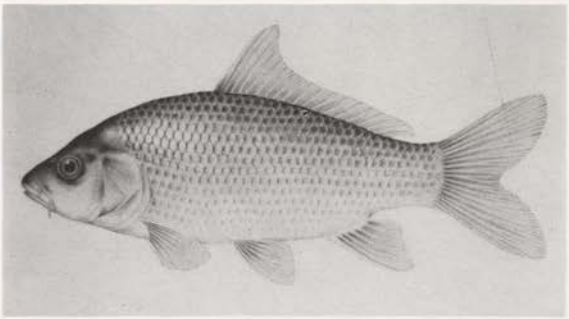


White Crappie
Figure 33

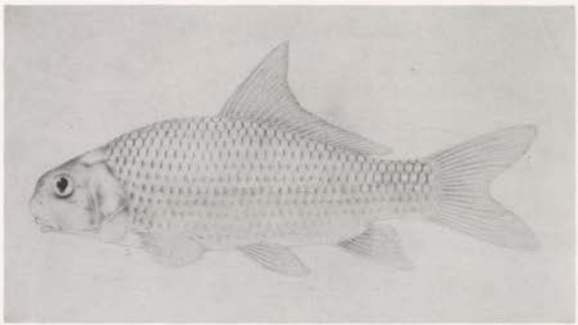


Black Crappie
Figure 34

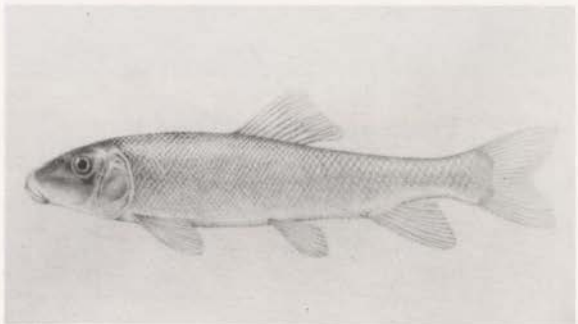
PLATE ELEVEN



Common Carp, Figure 35

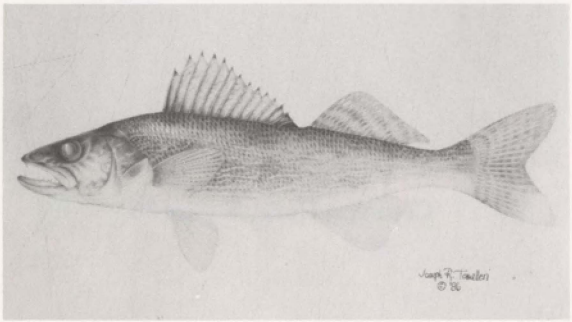


River Carpsucker, Figure 36

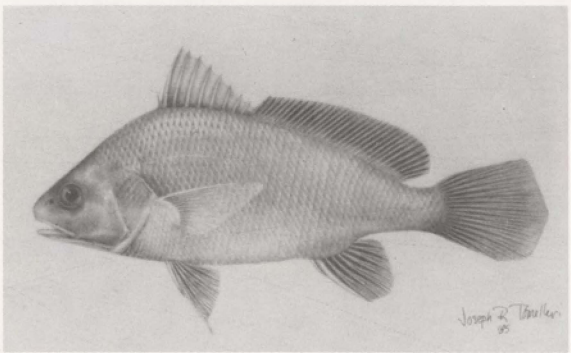


White Sucker, Figure 37

PLATE TWELVE



Walleye, Figure 38



Freshwater Drum, Figure 39

TABLE 4.—Species of fish collected in Big Creek from 1983 through 1985.

Herrings (Family Clupeidae)
Dorosoma cepedianum (LeSueur) — Gizzard Shad

Minnows (Family Cyprinidae)
Cyprinus carpio Linnaeus — Common Carp
Notemigonus crysoleucas (Mitchill) — Golden Shiner
Semotilus atromaculatus (Mitchill) — Creek Chub
Phenacobius mirabilis (Girard) — Suckermouth Minnow
Notropis lutrensis (Baird & Girard) — Red Shiner
Notropis stramineus (Cope) — Sand Shiner
Hybognathus placitus Girard — Plains Minnow
Pimephales promelas (Rafinesque) — Fathead Minnow
Pimephales notatus (Rafinesque) — Bluntnose Minnow
Campostoma anomalum (Rafinesque) — Stoneroller

Suckers (Family Catostomidae)
Carpiodes carpio (Rafinesque) — River Carpsucker
Catostomus commersoni (Lacepede) — White Sucker

Catfishes (Family Ictaluridae)
Ictalurus melas (Rafinesque) — Black Bullhead
Ictalurus natalis (LeSueur) — Yellow Bullhead
Ictalurus punctatus (Rafinesque) — Channel Catfish
Pylodictis olivaris (Rafinesque) — Flathead Catfish

Topminnows (Family Cyprinodontidae)
Fundulus zebrinus Gilbert — Plains Killifish

Temperate Basses (Family Percichthyidae)
Morone chrysops (Rafinesque) — White Bass

Sunfishes (Family Centrarchidae)
Micropterus salmoides (Lacepede) — Largemouth Bass
Lepomis cyanellus Rafinesque — Green Sunfish
Lepomis macrochirus Rafinesque — Bluegill
Lepomis humilis (Girard) — Orangespotted Sunfish
Pomoxis annularis Rafinesque — White Crappie
Pomoxis nigromaculatus (LeSueur) — Black Crappie

Perches (Family Percidae)
Stizostedion vitreum (Mitchill) — Walleye
Etheostoma spectabile (Agassiz) — Orangethroat Darter

Drums (Family Sciaenidae)
Aplodinotus grunniens Rafinesque — Freshwater Drum

and in several places the channel is crowded with cattails. The reservoir is heavily silted and is generally less than eight feet deep, except near the dam. Fluctuations of the water level in the reservoir can be dramatic enough to kill many of the larger fish because of oxygen depletion. Water usually flows over the dam during the spring.

The dam at Ellis is unique for Big Creek because it provides the public with access to a small reservoir. We collected eight species of fish in the reservoir (Table 6). Most of these species are in the sunfish family, which includes largemouth bass and crappie. Flathead catfish and walleye were reported after fish kills in 1983 and 1984. Conversations with local fishermen indicated that they will sometimes stock walleye and white bass

TABLE 5.—Thirteen species of fish collected from Big Creek in Trego County from 1983 through 1985.

Common Carp	Bluntnose Minnow	Largemouth Bass
Creek Chub	Stoneroller	Green Sunfish
Red Shiner	Black Bullhead	Orangespotted Sunfish
Sand Shiner	Yellow Bullhead	Orangethroat Darter
Fathead Minnow		

into the reservoir to enhance fishing. We observed harvestable largemouth bass, white crappie, channel catfish, and common carp during our trips to the reservoir. Ten species of fish were collected in the stilling basin and the narrow reach of Big Creek below the Ellis Dam (Table 6).

HAYS: Big Creek flows through the Fort Hays State University campus and Frontier Park on the southern edge of Hays. Portions of the channel have been modified by the U.S. Army Corps of Engineers to minimize potential flood damage. The original parts of the channel are shaded with

TABLE 6.—Species of fish collected from Big Creek at the Ellis Reservoir (*) and below the dam (°) from 1983 through 1985.

Golden Shiner * °	Yellow Bullhead °	Bluegill * °
Red Shiner °	Channel Catfish *	Orangespotted Sunfish *
Fathead Minnow °	Largemouth Bass * °	White Crappie * °
River Carpsucker °	Green Sunfish * °	Black Crappie * °

a variety of tree species, and straightened sections of the channel generally are lined with a narrow band of young cottonwoods and sandbar willows. A small, concrete dam in the park impounds less than 10 acres of water, and there is a series of pools in the flood channel bypass west of the main university campus. This series of pools is cut lower than the water table and is fed by groundwater seeps. The current extent of groundwater withdrawal through municipal, university, and private wells at Hays is not known, but demands for this resource could jeopardize the maintenance of significant water volumes within this part of Big Creek by lowering the water table. The channel bottom in this part of the stream is sand, which is covered in most places by silt.

Ten species of fish were collected at Hays during 1983-1985 (Table 7), and channel catfish were stocked by the Kansas Fish and Game Commission. Public access to the stream near Hays enhances the potential for use by local anglers. Harvestable channel catfish, largemouth bass, white crappie, and common carp were observed during our study.

CONFLUENCE WITH SMOKY HILL RIVER: Big Creek is dominated by high, steep banks where it empties into the Smoky Hill River in southwestern Russell County. Mature cottonwoods, green ash,

TABLE 7.—Ten species of fish collected from Big Creek near Hays, Ellis County from 1983 through 1985.

Common Carp	Largemouth Bass	Orangespotted Sunfish
Red Shiner	Green Sunfish	White Crappie
Sand Shiner	Bluegill	Black Crappie
Black Bullhead		

and boxelder shade the creek, but the adjacent land is cultivated, grazed, and mined for oil. Water flows in this stretch of Big Creek during most of the year, although the volume of water can fluctuate greatly. The streambed is comprised of sand, silt, and gravel. The influence of the Smoky Hill River enhances the number of species of fish in this part of Big Creek. Twenty-one species of fish have been collected there since 1983 (Table 8). Although this area has a relatively diverse population of fishes, the movement of fish upstream into other regions of the creek is restricted by low-water dams in Russell and eastern Ellis counties, and by dams at Hays and Ellis.

TABLE 8.—Twenty-one species of fish collected from Big Creek in Russell County from 1983 through 1985.

Gizzard Shad	Bluntnose Minnow	White Bass
Common Carp	Stoneroller	Largemouth Bass
Suckermouth Minnow	River Carpsucker	Green Sunfish
Plains Minnow	White Sucker	Bluegill
Red Shiner	Black Bullhead	Orangespotted Sunfish
Sand Shiner	Channel Catfish	Orangethroat Darter
Fathead Minnow	Plains Killifish	Freshwater Drum

SPECIES ACCOUNTS OF FISH

The 28 species of fish known to be living in Big Creek are grouped into nine families of related species (Table 4). The most common family in Big Creek is the minnow family, which is represented by ten species. Most people associate the name "minnow" with any small fish, but the minnow family contains some very large species, such as the common carp, which can easily grow to more than 24 inches in length. Golden shiners and creek chubs can reach a length of 12 inches. Most other minnows found in Big Creek, however, are usually less than five or six inches long.

Two other small species of fish are sometimes referred to as "minnows," but actually belong to other families. These species are the plains killifish (or zebra minnow) and the orangethroat darter. Plains killifish are in the topminnow family and are adapted for feeding at the water surface,

hence the name "topminnow. " Orangethroat darters are in the perch family and are related to the walleye and yellow perch. Whereas topminnows swim near the surface of the water, darters normally perch on the stream bottom. The name "perch" is sometimes used for members of the sunfish family, a group that includes sunfish, crappie, and largemouth bass. Sunfish have the stiff spines and the flexible rays of the dorsal fin united into a single fin. Although this dorsal fin might be deeply notched, the two parts are not completely separated as they are in true perch, such as walleyes and darters. White bass are freshwater members of the temperate bass family. They also have two, separate dorsal fins, but the second dorsal fin has one stiff spine.

The 30 species of fish that one might find in Big Creek are described below. The species that we found in the stream from 1983 through 1985 also are illustrated in color or black and white drawings prepared especially for this book. These will help to identify almost any fish collected in Big Creek or in other streams and ponds in northwestern Kansas.

To further assist with the identification of individual fish, a *dichotomous key* is included. This key is simply a series of two choices that lead to the name of the fish. To use the key, start with choice number one. Read both alternatives, and decide which one best fits the specimen you have. The alternative you choose will either direct you to another pair of choices or it will give you the name of the fish. While working through the key you may find it helpful to refer to the illustrations of the fishes or the diagram of the parts of the fish (Figure 6). Even with the key and the illustrations, some species of fish are difficult to identify. With a little practice, a little patience, and maybe a little help from someone with more experience, anyone can learn to identify all of the species of fish living in Big Creek.

Figure 6A.— Illustrations of typical fish representative of the catfish family (whose members have no scales), and parts of their anatomy useful for identifying the different species.

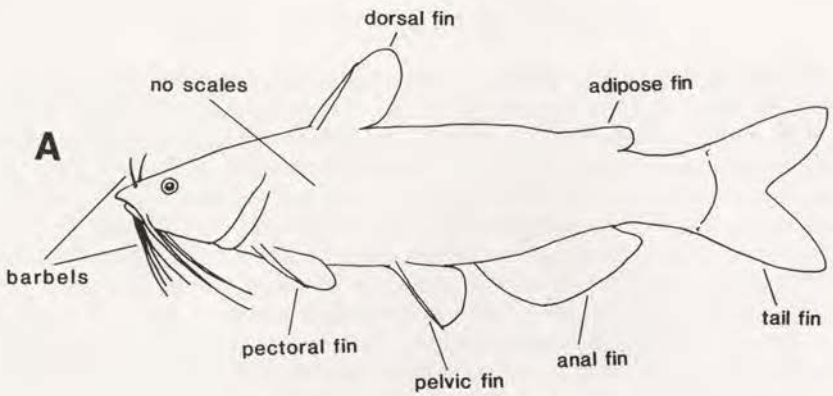
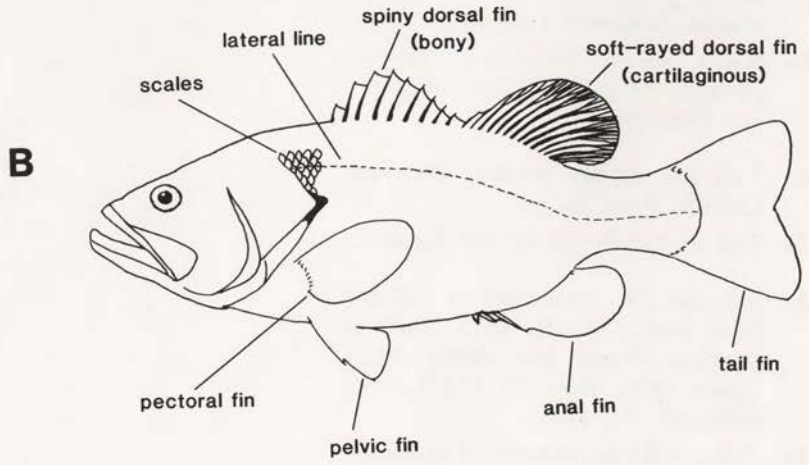


Figure 6B.— Illustrations of typical fish representative of the families of scaled fish, and parts of their anatomy useful for identifying the different species.



Identification Key for the Fishes of Big Creek

1. Scales present. Barbels (whiskers) absent. Adipose fin absent. Go to 6.

1a. Scales absent. Barbels (whiskers) present. Adipose fin present. Catfish Family. Go to 2.

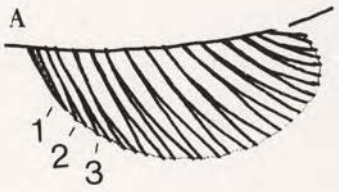
2. Tail fin deeply forked. **Channel Catfish**. Page 33.

2a. Tail fin not deeply forked. Go to 3.

3. Adipose fin connected to tail fin (not free). Mouth with obvious overbite, lower jaw shorter than upper jaw. Rare in Big Creek. **Stonecat**. Page 33.

3a. Adipose fin not connected to tail fin (free). Go to 4.

4. Jutting lower jaw (underbite). Anal fin with 14-17 supporting rays (A). Broad, flat head. **Flathead Catfish**. Page 33.



4a. Fish without obvious underbite. Anal fin with 17-27 supporting rays. Go to 5.

5. Barbels on chin darker than skin around them. Anal fin broadly rounded, with 17-21 supporting rays. **Black Bullhead**. Page 32.

5a. Barbels on chin creamy-white, like skin around them. Anal fin nearly straight, with 24-27 supporting rays. **Yellow Bullhead**. Page 33.

6. Three or more hard spines at front of dorsal fin. Go to 7.

6a. One, large, serrated (toothed) hard spine or no hard spines at front of dorsal fin. Go to 15.

7. Two spines at front of anal fin. Go to 8.

7a. Three or more spines at front of anal fin. Go to 10.

8. Spiny dorsal fin and soft-rayed dorsal fin united. Tail fin rounded. Lateral line extends onto tail fin. **Freshwater Drum.** Page 36.

8a. Spiny dorsal fin and soft-rayed dorsal fin separate. Perch Family. Go to 9.

9. Tail fin forked. Fish usually longer than 6 inches in Big Creek. **Walleye.** Page 35.

9a. Tail fin square. Fish never longer than 3 inches. **Orangethroat Darter.** Page 35.

10. Spiny dorsal fin and soft-rayed dorsal fin separated, but close together. Soft-rayed dorsal fin with one, hard spine at leading edge. Silvery in color, with flattened sides. **White Bass.** Page 34.

10a. Spiny dorsal fin and soft-rayed dorsal fin united. Sunfish Family. Go to 11.

11. Anal fin with three hard spines. Go to 12.

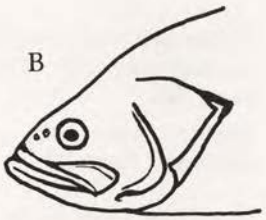
11a. Anal fin with 5 or 6 hard spines. **Crappie.** Page 35.

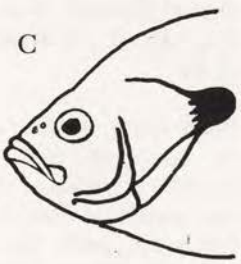
12. Body long and slender. Corner of mouth extending beyond middle of the eye. Gill cover with no rounded "ear" flap (B). **Largemouth Bass.** Page 34.

12a. Body deep, with flattened sides. Rear of gill cover colored or extended into rounded "ear" flap (C). Go to 13.

13. Mouth very small, does not extend below the eye. Ear flap without light-colored border. **Bluegill.** Page 34.

13a. Mouth extends below front margin of the eye. Ear flap with a light-colored border. Go to 14.





14. Scattered brown or orange spots on body. Entire ear flap flexible, not stiff. **Orangespotted Sunfish**. Page 34.

14a. Color greenish, with yellowish breast and blue streaks on head. No brown or orange spots. Ear flap stiff, except for light-colored edge. **Green Sunfish**. Page 34.

15. Thread-like extension on dorsal fin. Body silvery, with a turquoise spot behind the gill cover. **Gizzard Shad**. Page 30.

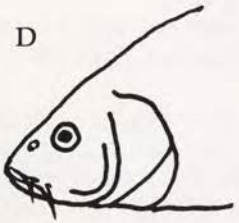
15a. Dorsal fin without a thread-like extension. Go to 16.

16. Tail fin rounded. Scales present on top of the head. Vertical, dark bars on sides of the body. **Plains Killifish**. Page 33.

16a. Tail fin forked. Go to 17.

17. Dorsal fin with one large, saw-toothed spine. Introduced Minnows. Go to 18.

17a. Dorsal fin with no hard spines. Go to 19.

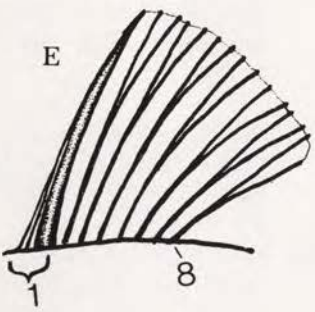


18. Upper jaw with two fleshy barbels on each side (D). **Common Carp**. Page 30.

18a. Upper jaw with no barbels. **Goldfish**. Page 30.

19. Dorsal fin with 11 or more supporting rays. Sucker Family. Go to 20.

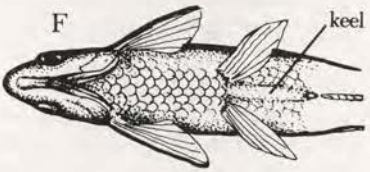
19a. Dorsal fin with 9 or fewer supporting rays (E). Native Minnows. Go to 21.



20. Body deep, similar in appearance to common carp, but without barbels on sides of the mouth. Lips not papillose (not bumpy). Dorsal fin long, with the front portion pointed. **River Carpsucker**. Page 32.

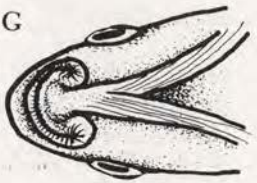
20a. Body long and slender. Lips papillose (bumpy). Dorsal fin short. **White Sucker**. Page 32.

21. Belly behind pelvic fins with a fleshy, scaleless keel (F). Anal fin with 11-15 supporting rays. Lateral line dips sharply downward on front part of the body. **Golden Shiner**. Page 30.



21a. Belly without a fleshy keel. Anal fin with 10 or fewer supporting rays. Go to 22.

22. Mouth small, with lobed lips (G) beneath snout (not on the tip of the snout). Dark spot on base of tail. **Suckermouth Minnow**. Page 31.

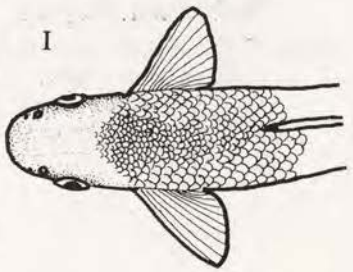


22a. Lips thin, with no lobes. Go to 23.

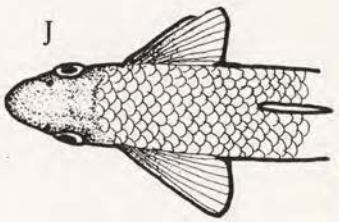
23. Greenish-gray with scattered dark spots. Snout overhangs mouth. Lower jaw has a hard, cartilaginous ridge that is separated from the lower lip (H). **Stoneroller**. Page 32.

23a. Body without scattered, dark spots. Mouth without a cartilaginous ridge. Go to 24.

24. Scales small and crowded in front of the dorsal fin (I). Leading ray of dorsal fin noticeably thickened and separated from second ray. Go to 25.



24a. Scales in front of dorsal fin about the same size as those on the upper sides (J). Leading ray of dorsal fin not noticeably separated from second ray. Go to 26.



25. Mouth nearly horizontal and overhung by snout. Dusky stripe from the nose to the tail usually distinct. **Bluntnose Minnow**. Page 32.

25a. Mouth oblique, not overhung by snout (terminal). Dusky stripe along the body usually indistinct and does not extend onto the nose. **Fathead Minnow**. Page 31.

26. Dark spots on the front of the dorsal fin and at the base of the tail. Mouth large and terminal. Upper lip thicker in center than on either side. **Creek Chub**. Page 30.

26a. No spots present on dorsal fin or at the base of the tail. Mouth not large. Go to 27.

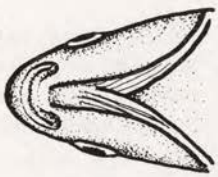
27. Mouth overhung by snout and shaped like shallow crescent (K). Sides of body yellowish-white or silvery. Body of fish caught in Big Creek often robust with a noticeably smaller head. **Plains Minnow**. Page 31.

27a. Mouth terminal and not forming a shallow crescent. Go to 28.

28. Body deep, flattened side to side, silver or blue-tinted. Lower fins might be red. Anal fin with 8-10 supporting rays. Lateral line not highlighted by small, dark dashes. **Red Shiner**. Page 31.

28a. Body slender. Anal fin usually has 7 supporting rays. Lateral line highlighted by small, dark dashes. **Sand Shiner**. Page 31.

K



Gizzard Shad

Dorosoma cepedianum (LeSueur)

Gizzard shad have a long, thin extension of the last dorsal fin ray and a turquoise spot behind the gill cover. Schools of gizzard shad move into Big Creek from the Smoky Hill River, but they probably do not reach Ellis and Trego counties. The Kansas Fish and Game Commission has stocked this species into the Ellis Reservoir in the past, but we have found none there recently. Gizzard shad feed on microorganisms that they filter from the water or from the silt on the stream bottom. They are an important food for game fish. Plate 1. Figure 7.

Common Carp

Cyprinus carpio Linnaeus

Common carp have two barbels on each side of the mouth and serrated spines at the front of the dorsal and anal fins. They live in all regions of Big Creek and are most abundant in the larger, permanent pools. Common carp eat a wide variety of foods, although they seldom prey on other fish. Common carp were first introduced in Kansas during the 1880's and have spread throughout most of the state. Plate 11. Figure 35.

Goldfish

Carassius auratus Linnaeus

Goldfish have one spine at the front of the dorsal and anal fins (as do common carp), but they have no barbels at the corners of the mouth. Goldfish are sometimes thrown into Big Creek, but populations are not known to spread throughout the stream as common carp have done. Plate 3. Figure 20.

Golden Shiner

Notemigonus crysoleucas (Mitchill)

Golden shiners have a thin keel on the belly behind the pelvic fins, the dorsal fin is situated further back than the pelvic fins, and the lateral line is low on the side. They are found at the Ellis Reservoir, probably as a result of bait fish escaping or being thrown into the stream. Individuals might grow up to 12 inches long, but they are only half that size or less in Big Creek. Plate 1. Figure 9.

Creek Chub

Semotilus atromaculatus (Mitchill)

Creek chubs have a large, terminal mouth and a dark spot at the base of the dorsal and tail fins. Small numbers of creek chubs inhabit Big Creek in eastern Trego County and perhaps other regions of the stream. They eat small fish and invertebrates. Creek chubs can reach one foot in length and are occasionally caught on hook and line. Plate 3. Figure 17.

Suckermouth Minnow

Phenacobius mirabilis (Girard)

Suckermouth minnows have a small mouth with lobed lips below a slightly protruding snout. They also have a dusky lengthwise stripe on each side and a dark spot in front of the tail fin. Suckermouth minnows occur in low numbers in Big Creek in Russell County and perhaps in Trego and Ellis counties. They prefer riffles in the stream with a bottom of sand and small gravel. Plate 2. Figure 15.

Red Shiner

Notropis lutrensis (Baird & Girard)

Red shiners have a body that is flattened from side to side and have 8-10 rays in the anal fin (compare with sand shiner). The scales behind the head are about the same size as those on the sides (compare with fathead and bluntnose minnows). Breeding males can be brilliantly colored with blue sides and red fins (except the dorsal fin). This species of minnow is common throughout Big Creek and most of Kansas. Plates 2 and 3. Figures 11 and 21.

Sand Shiner

Notropis stramineus (Cope)

Sand shiners have a body that is not flattened from side to side and usually have seven rays in the anal fin (compare with red shiner). The scales behind the head are about the same size as those on the sides (compare with fathead and bluntnose minnows). The dorsal fin has a black line in its base as viewed from above and the lateral line is highlighted by dark spots on those scales. Breeding males do not become colorful like male red shiners. Sand shiners occur in all regions of Big Creek where the stream bottom is comprised primarily of sand. Plate 2. Figure 12.

Plains Minnow

Hybognathus placitus Girard

Plains minnows have slender bodies with a thin-lipped, ventral mouth that forms a shallow crescent when viewed from below. This species prefers streams with broad beds of sand and shallow flow. In Big Creek it is known only from Russell County in low numbers. Plains minnows are sometimes used as bait because of their relatively large size. Plate 2. Figure 16.

Fathead Minnow

Pimephales promelas (Rafinesque)

Fathead minnows have smaller scales behind the head than those located on the sides (compare with red and sand shiners). The body is stout and the small mouth is oblique and nearly terminal (compare with bluntnose minnow). Breeding males have alternating dark and light bands. Along with the red shiner, the fathead minnow is one of the most common stream fishes in Kansas. A popular bait fish, it is found throughout Big Creek and in the siltier, slower water it is the dominant species. Plates 2 and 3. Figures 13 and 18.

Bluntnose Minnow

Pimephales notatus (Rafinesque)

Bluntnose minnows have smaller scales behind the head than those located on the sides (compare with red and sand shiners). The body is slender. The mouth is overhung by the snout and is not oblique (compare with fathead minnow). Additional identifying characteristics are the dark streak along the side from the snout to the tail fin and a dark spot at the base of the tail. Bluntnose minnows prefer clear pools in streams and can be found in suitable habitat in all parts of Big Creek. Plates 2 and 3. Figures 14 and 19.

Stoneroller

Campostoma anomalum (Rafinesque)

Stonerollers have a protruding snout that overhangs a fleshy mouth and the lower lip has a hard edge used to scrape food, principally algae ("slime"), from the surface of rocks. Stonerollers also have a dark streak through the dorsal fin. They frequently shed scales, which gives the fish a mottled appearance. Stonerollers live in all parts of Big Creek. Plate 1. Figure 10.

River Carpsucker

Carpiodes carpio (Rafinesque)

River carpsuckers are similar in appearance to common carp, but they have a silvery color and do not have barbels on each side of the mouth. They prefer slow water with a silty bottom. We collected them in Big Creek near the Ellis Reservoir and at the confluence with the Smoky Hill River. River carpsuckers feed on tiny organisms living on the stream bottom. Plate 11. Figure 36.

White Sucker

Catostomus commersoni (Lacepede)

White suckers have long, slender bodies and large lips that are papillose (bumpy). These fish occasionally swim into Big Creek from the Smoky Hill River, but they are not abundant. The mouth of the white sucker faces down at the end of the snout, which enhances its ability to feed on insects, algae, and other organisms living on the stream bottom. Plate 11. Figure 37.

Black Bullhead

Ictalurus melas (Rafinesque)

Black bullheads are distinguished from yellow bullheads by the barbels below the mouth that are darker than the yellow/white flesh on the chin. This is the most common of the catfishes in Big Creek, and it is found throughout the stream. It prefers quiet pools. Black bullheads of a harvestable size can be caught in Big Creek. Plate 4. Figure 23.

Yellow Bullhead

Ictalurus natalis (LeSueur)

Yellow bullheads are similar to black bullheads except that the barbels on the chin are creamy white and are not darker than the flesh on the chin. Yellow bullheads are not nearly as common in Big Creek as black bullheads. They prefer clearer water than do black bullheads, so they principally live in eastern Trego and western Ellis counties. Plate 4. Figure 24.

Channel Catfish

Ictalurus punctatus (Rafinesque)

Channel catfish are the only catfish in Big Creek with a deeply-forked tail fin. Younger fish are greenish in color with scattered dark spots. This species is located throughout Big Creek and is stocked at various localities in the stream. Harvestable-sized channel cats can be caught with hook and line in Big Creek. Plate 6. Figure 27.

Flathead Catfish

Pylodictis olivaris (Rafinesque)

Flathead catfish have a mottled appearance and the lower jaw extends forward of the upper jaw. In Big Creek, flatheads are not numerous and are most likely to be found in the Ellis Reservoir or near the confluence with the Smoky Hill River. They are known to reach 35 pounds or more in the Ellis Reservoir. Plate 5. Figure 26.

Stonecat

Noturus flavus Rafinesque

Stonecats have the adipose fin on the back narrowly continuous with the tail fin and the upper jaw extends beyond the lower jaw. Stonecats are one of a group of small catfishes known as *madtoms*. Madtoms have sharp spines at the front of the pectoral fins that contain a mild poison, which can produce a painful, but not too serious wound. No stonecats were collected in Big Creek during 1983-1985, but the Kansas Fish and Game Commission reported them from Ellis County south of Victoria in the mid-1970's. Plate 4. Figure 25.

Plains Killifish

Fundulus zebrinus Gilbert

Plains killifish have narrow "zebra" bars on their sides. They eat insects on the water surface or on the bottom. Plains killifish prefer shallow water that is highly alkaline or saline and a bottom substrate of sand. In Big Creek they still live in Russell County, and collections in the 1970's indicate that this species formerly inhabited the stream in Ellis and Trego counties. It is sometimes referred to as the "zebra minnow," "tiger minnow," or the "penitentiary minnow." Plate 1. Figure 8.

White Bass

Morone chrysops (Rafinesque)

White bass have flat, silvery sides, and the dorsal fin is completely split into the front, spinous fin and the rear, soft-rayed fin. They feed on schools of smaller fish, such as gizzard shad. White bass (and gizzard shad) move into Big Creek near the confluence with the Smoky Hill River in Russell County. Fishermen sometimes put white bass, which they have caught elsewhere, into the Ellis Reservoir. Plate 8. Figure 29.

Largemouth Bass

Micropterus salmoides (Lacepede)

Largemouth bass have the mouth extending behind the eye and a darkened, lengthwise stripe on their sides. The first dorsal fin is highly arched as compared to those of the other "black" bass (smallmouth bass and spotted bass); the last spine is less than one-half the length of the tallest spine. Largemouth bass are the only species of "black" bass found in Big Creek, and they occur throughout the stream. They are more tolerant of warmer, slightly siltier water than smallmouth and spotted bass. Largemouth bass of harvestable size can be caught in all four regions of Big Creek. They feed on fish and invertebrates. Plate 7. Figure 28.

Green Sunfish

Lepomis cyanellus Rafinesque

Green sunfish have a large mouth that extends below the eye and dark blotches at the rear end of both the dorsal and anal fins. This is a common sunfish in all parts of Big Creek, and it occasionally reaches a harvestable size. Green sunfish sometimes hybridize with bluegills, which makes identification difficult. Green sunfish feed on invertebrates and small fish. Plate 9. Figure 30.

Bluegill

Lepomis macrochirus Rafinesque

Bluegills have a small mouth and a dark spot at the rear of the dorsal fin. The bluegill is the least common of the sunfishes in Big Creek, but it lives in all parts of the stream. Bluegills feed on small invertebrates. Plate 9. Figure 31.

Orangespotted Sunfish

Lepomis humilis (Girard)

Orangespotted sunfish have scattered orange or brown spots on their sides. It is one of the most brilliantly-colored fishes in Big Creek. They are always small, less than four inches in length. This species is common throughout Big Creek and it feeds primarily on insects. Plate 9. Figure 32.

White Crappie
Pomoxis annularis Rafinesque
and
Black Crappie
Pomoxis nigromaculatus (LeSueur)

White crappie and black crappie might be difficult to distinguish. Characteristics given by various authors are summarized in Table 9. Black crappie prefer clearer, cooler water than white crappie, which is the most common species in Big Creek. It is possible that these two species hybridize ("gray crappie") which hampers identification. White crappie are found in Big Creek in western Ellis County. Black crappie occur at the Ellis Reservoir and in pools near Hays. Both species feed on invertebrates and small fish. Plate 10. Figures 33 (white) and 34 (black).

TABLE 9.—Characteristics used to distinguish white and black crappie.

White Crappie	Black Crappie
5-6 dorsal fin spines	7-8 dorsal fin spines
length of dorsal fin shorter than distance from front of dorsal fin to the eye	length of dorsal fin as long as distance from front of dorsal finto the eye
color plain white or silvery with faint vertical bars	body with irregular, black spots
body relatively long and slender	body relatively deep or "rounded"

Walleye
Stizostedion vitreum (Mitchill)

Walleye are the only fish in Big Creek to have the dorsal fin completely separated into a spinous dorsal fin and a soft-rayed dorsal fin, except for the much smaller orangethroat darter and the white bass. White bass have a spine at the front of the soft-rayed dorsal fin. Walleye are an important game fish that are sometimes stocked into the Ellis Reservoir by anglers to enhance fishing, but there is no established, reproducing population known in Big Creek. Plate 12. Figure 38.

Orangethroat Darter
Etheostoma spectabile (Agassiz)

Orangethroat darters are slender fish with two complete dorsal fins. They are among the most colorful fish in Big Creek. Breeding males have bars of blue and orange around their body and the dorsal fin is orange with a blue edge. They are called darters because they perch on the substrate and then dart a few inches to a new perch. Orangethroat darters live in Big Creek in Trego and Russell counties, but we did not collect any in central Ellis County. Darters eat immature insects and fish eggs. Plate 3. Figure 22.

Freshwater Drum

Aplodinotus grunniens Rafinesque

Freshwater drums have a highly arched back with a long dorsal fin. The tail fin is rounded and the lateral line extends to the end of it. They are found near the Big Creek/Smoky Hill River confluence. Drums primarily eat invertebrates. They can be caught on hook and line, but it is not an important game fish in the Big Creek Basin, although individuals weighing up to two pounds swim in the stream. They are also known as a "sheeps-head." Plate 12. Figure 39.

In addition to these 30 species of fish that have been caught in Big Creek since 1970, four species that originally lived in the stream are thought to be absent. Three of these species, the hornyhead chub, the common shiner, and the Topeka shiner, cannot tolerate the higher levels of silt now found in most of Big Creek. The fourth species, the American eel, can no longer migrate upstream through the Smoky Hill River because of the dam at Kanopolis Reservoir downstream from Big Creek.

Thus, the historical total of fish species living in Big Creek between 1885 and 1985 is at least 34, not counting the chinook salmon. At least 28 of these species were living in Big Creek during the period 1983-1985 and two additional species, stonecats and goldfish, might be present in the stream in low numbers.

THE FUTURE OF BIG CREEK

In this book we have presented information on various aspects of Big Creek as it is today, as well as information on its past and the changes it has undergone. As to its future, nothing is certain except that the fate of the stream is ultimately determined by those of us who live in its valley.

People often look at a small stream and ask, "What good is it?" If a natural resource, such as Big Creek, is to benefit from the effort necessary to manage it properly, it must have some value to those who control its destiny.

To the Europeans who settled this region, Big Creek provided a source of drinking water for themselves and for their livestock. It supplied the steam locomotives with water for their boilers. It served as a recreational center with fishing, swimming, boating, picnicking, and ice skating. And it was a source of ice blocks that made it possible to store food into the hot summer. But that was the turn of the century. What good is it now?

Although we do not drink the silty water that flows in Big Creek, many people still depend on it as a source of water. Surface water is used directly by the oil industry and by cattle ranchers. Water wells located near the stream channel are tapping a groundwater aquifer that is connected with the surface water in the creek. Runoff from precipitation flowing into Big Creek can seep into this alluvial aquifer and help to replace groundwater that has been withdrawn by the wells.

Big Creek is also important to wildlife. It waters the trees and other plants along its banks. These in turn provide food and shelter to many species of birds and mammals. Fish and other forms of aquatic life are obviously dependent on the water in Big Creek for their survival. This riparian forest and the wildlife that inhabit it provide many opportunities for outdoor recreation including fishing, hunting, trapping, picnicking, hiking, and camping. In order to enhance some of the recreational activities made possible by Big Creek and to develop the stream as an aesthetic asset, the cities of Hays and Ellis operate parks along its channel. They are used by large, organized groups as well as by individuals, but efforts to improve or maintain these areas are often hampered by economic constraints, vandalism, and apathy.

In order to manage the Big Creek Drainage Basin properly and derive the most from the benefits offered by the stream, several aspects of stream management need to be addressed.

Water levels in the alluvial aquifer should be monitored at localities where groundwater consumption poses a threat to minimum desirable levels of surface water in the stream. Demand for water in the Big Creek Valley, especially at Hays can be expected to increase, and excessive groundwater consumption from the alluvial aquifer could lower the water table far enough to threaten the stream, the riparian forest, and the dependability of the alluvial aquifer as a source of water. This is the process that took place along the Smoky Hill River near the Hays well field at Schoenchen and near center-pivot irrigation systems located upstream from Cedar Bluff Reservoir during the late 1970's and the 1980's. In these localities, the long-term water levels in the river were reduced to the point

that the stream was of little value, and the water table dropped faster than the roots of the trees could grow, killing large stands of riparian forest. Without proper management of the alluvial groundwater supply, this could happen in the Big Creek Valley.

Silt also presents a problem to Big Creek. This is especially a problem behind the dams at Ellis and Hays. The process of removing the large accumulations of silt from these two small reservoirs is costly, but it would provide two benefits. Water seeps down through the silt at a slower rate than it would through coarser material, such as sand. Better infiltration after dredging would enhance the recharging of the alluvial aquifer. The deeper pools would also be able to hold a larger volume of water with the same amount of surface area from which evaporation takes place. This not only benefits the water supply, but it also improves efforts to manage larger, more stable populations of fish. The larger volume of water would be capable of supporting greater numbers of fish and would be better able to hold oxygen, thus reducing the likelihood of large fish kills.

Regulations designed to prevent damage to streams by various kinds of pollutants are already in place, but pollution is still a potential problem in Big Creek. Feedlot runoff has been a pollution problem in the past; and, in the future, agricultural runoff, improperly treated sewage water, and oil field accidents can produce local pollution problems in Big Creek if adequate precautions are not taken. Fish kills, whether caused by natural phenomena or pollution, should be reported to Kansas Fish and Game personnel so they can determine the cause and assess the extent of the damage to the stream environment.

The straightening of stream channels for agricultural or other purposes can pose problems for small stream ecosystems if it includes sufficiently long stretches of the stream channel. The straightened channel allows the water to move much faster than it would through a meandering channel. This can increase the incidence of flooding further downstream where the channel is not straightened. It can also increase the rate of the erosion of the stream banks, which removes valuable soil and deposits it on the streambed or fills reservoirs, decreasing their volume. Faster moving water is also less likely to infiltrate into the alluvial aquifer and to help recharge the groundwater supply. In the Big Creek Basin, channelization is not currently a major problem. It should be carefully planned and limited to flood control projects around stream-side towns.

The changes brought about in Big Creek by the activities of people living in its valley make intensive management of the stream necessary, especially at the parks in Hays and Ellis. Management of the stream would include projects such as maintaining desirable populations of fish where anglers have easy access to the creek, protecting substantial areas of riparian growth to control silting, repairing and maintaining the concrete dams at Hays and Ellis, and periodically dredging behind dams to remove silt. While improvements in the parks at Hays and Ellis have done much to enhance these areas, only minimal effort has been expended on the stream itself since the construction of the reservoirs in those two cities. Representatives from local and state government and from civic organizations should work together to develop a comprehensive management plan

for the stream and the riparian community, and then they should follow through on that plan.

And, finally, efforts to improve or maintain Big Creek and the adjacent area should not be hampered or prevented by vandalism and apathy. Of the hundreds of people that enjoy the benefits offered by Big Creek and its riparian forest, especially in the public parks at Hays and Ellis, too many are unwilling to help take care of these areas, and some even seem intent on destroying them. Littering, destruction of plant life, and defacing of public property reduce the value of these developed green spaces. The money used to restore these areas would be better spent on improvements in the parks rather than on the reparation of senseless damage.

Although most of Big Creek is privately owned, it is the responsibility of all of us who live in its valley to help maintain it as a source of both water and recreational opportunities.

ANNOTATED LIST OF REFERENCES

The references are listed alphabetically by author under the appropriate section titles used in this book. The date of publication is listed second, followed by the title. The publisher or the name of the scientific journal is listed last. The name of the scientific journal is listed with the volume number and the page numbers. Some entries include notes on the contents of the publication.

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