WICHITA RIVER, BIG

STATE Texas
PROJECT NO. F-7-R-2, jobs A-2 and B-6
PERIOD June 1, 1954 to May 31, 1955

JOB COMPLETION REPORT

Leo D. Lewis and Walter W. Dalquest

TITLE

A basic survey of, and inventory of species in, the Big Wichita River and its watershed in north-central Texas, lying in the following counties: Cottle, King, Foard, Knox, Wilbarger, Baylor, Wichita, Archer and Clay.

OBJECTIVES

To gather fundamental data on the above waters in regard to their physical, chemical and biological aspects, and to determine the species of fishes present in them, as well as the relative abundance and ecological factors influencing the distribution of such fishes.

SCOPE

The entire length of the Big Wichita River is included in the present study, from the uppermost headwaters to its confluence with the Red River of Oklahoma. Excluded are the three major impoundments, Lake Kemp, Lake Diversion and Lake Wichita, of the river or its tributaries. The fisheries biology of these three bodies of water has been discussed elsewhere (Completion Reports, F-7-R-1, jobs B-1, B-2, and F-7-R-2, Job B-7).

TECHNIQUES

A general survey of the river was carried out by traveling along the river as closely as possible, by walking in the upper parts, by car when possible, and by flat-bottomed skiff in the lower parts. At irregular intervals along the river, samples of fishes and water were taken. Samples of fishes and water were also taken at every tributary stream or spring. If the tributary had sufficient volume, a sample of water was taken in the river above the mouth of the tributary, a sample of the tributary, and a sample of the river at the first rapids downstream from the tributary, where waters of river and tributary were thoroughly mixed. This spot-sampling gave us an overall, areal picture of the chemistry of the river as it changed by increased salts or was diluted by the tributaries, and a qualitative inventory of the fishes of the various parts of the river system.

A quantitative and seasonal inventory was made by establishing nine permanent collecting stations on the river, between the headwaters and the mouth of the river, and visiting these monthly to take samples of fishes and water. These samples showed seasonal changes in water quality, relative abundance and seasonal changes in the populations of fishes at the various stations, and also indicated migrations from upstream or downstream.

Samples of the smaller fishes were taken in minnow-seines and preserved in a formalin solution. Identifications and counts were made in the laboratory. Larger fishes were taken in gill nets, coarse-meshed seines, hoop nets or by hook-and-line fishing. The larger fishes were weighed and measured in the field. Stomach contents and ripe ovaries were saved for laboratory examination, and careful notes were kept of spawning, pathological conditions, etc. This data is given elsewhere (Completion Report, F-7-R-2, Job B-4).

ACKNOWLEDGMENTS

We wish to thank Dr. Carl Gray, Soils Scientist of Midwestern University and the Wichita County Water Improvement Districts, for making the many detailed water analyses listed in this report. Mr. Fred Parkey, General Manager of the Water Improvement Districts, furnished access to all data in his files and cooperated in other ways. Mr. John Joerns, United States Geological Survey, Water Resources Division, furnished the information on water flow.

INTRODUCTION

The Wichita River is the major stream draining north-central Texas. This honor would belong to the Red River were it not that, politically, the Red River where it forms the common boundary between Texas and Oklahoma lies in Oklahoma. The Wichita River is the largest tributary of the Red River in Texas. Unlike most Texas streams, that drain southward or southeastward to the Gulf of Mexico, the Wichita River runs northeastward to the Red, and the Red River flows eastward along the Texas-Oklahoma boundary, and into Arkansas and Louisiana before turning southward. Though the Wichita River and some parts of the Brazos and Trinity rivers are, at their headwaters, quite close together, the Wichita follows a widely divergent course to the Gulf of Mexico.

The Wichita is not a large river, its straight-line length from permanent flowing headwaters to its confluence with the Red being only about 165 miles. Nevertheless it drains more than 4,000 square miles of north-central Texas and, located along the river or its tributaries, are three of the moderately large impoundments found in northern Texas.

Geologically the entire Wichita River drainage area lies within the Red Beds of the Texas Permian. These are largely marine and delta sediments of sandstone, shale, dolomite, limestone, gypsum, salt and conglomerate. Locally there are small beds and lenses of Pleistocene sand and conglomerate, largely consisting of reworked Cretaceous materials. Except where removed by erosion, the older rocks and sediments are covered with a thin layer of Quaternary deposits, partly derived from disintegration of underlying rocks and partly of aeolian origin. The Permian geology is especially important in a study of the biology of the Wichita River, for the vast bulk of the solids, both dissolved and suspended as well as bottom materials, are of Permian origin. The salts, especially sodium chloride and calcium sulfate, so important to the ecology of the river, its water, and the surrounding land, are Permian.

The relative hardness of the successive strata of Permian rocks and the later erosional history of the area have determined the geography of the Wichita River. Near the headwaters of the river the land is extremely rough and broken. The river flows in narrow canyons, bordered by high cliffs. The land is typified by exposed rock, steep hills, deep gulleys and almost no level land, except for the floodplains of the river. Farther eastward the land is level to gently rolling and the river has a broad valley, many miles in width.

The land form has determined the nature of the river. Near the headwaters the streams are swift and crystal-clear, descending over beds of rock, sand or gravel in a series of rapids separated by deep pools. Farther downstream the river bed becomes braided sand and quicksand until it enters Lake Kemp. The river between Lake Kemp and Lake Diversion is dependent for flow on the release of water from the floodgates of the Lake Kemp Dam. When the gates are closed, as they are during much of the year, the river is but an inch or so deep over a mud or sandy-mud bottom. Below Lake Diversion, the river becomes a mature stream, turbid, slow and deep, flowing over a sand or mud bottom in a series of wide meanders.

The entire Big Wichita River drainage lies within the Mesquite Plains Biotic District, as defined by Blain (1950). However, there are striking changes in vegetation type as one follows the length of the river. Near the headwaters, in Cottle, King, Foard and Knox counties, the cedar forms the dominant vegetation of the uplands and the area is usually termed the "Cedar Brakes." Further east, away from the desicated canyons and rocky bluffs, where the ground is more level, the mesquite is dominant. Downstream from Lake Diversion the uplands are still covered with mesquite but broad-leafed trees, bramble thickets and vines occur in the river valley. Still farther downstream, between Wichita Falls and the mouth of the river, the mesquite gives way to grassy prairie and the broad river valley is forested with oaks and elms and has a typical, thorny, understory vegetation.

The land immediately adjacent to the river is a sandy floodplain from the headwaters almost to Wichita Falls. In this sandy soil the salt cedar is the most prominent plant. East of Wichita Falls, where the banks are more muddy, a sandy-loam, streamside vegetation consists of cottonwoods and willows that grow almost to the water's edge.

The most striking feature of the Big Wichita River is the burden of dissolved salts carried by its waters. The water is far too salty for human consumption. This dissolved salt is the major factor affecting agriculture in the Wichita Valley and offers enormous problems to irrigation engineers and chemists. The problems of fisheries management are no less challemging. Nearly a third of the length of the river is unsuited to fresh-water game fishes because of excessive salt. Game fishes do live, often in abundance, in the lower two-thirds of the river and the impoundment lakes, but they are adversely affected by the salt. The salt may permit salt-tolerant species of rough fishes, such as thegizzard shad, to become abundant at the expense of the sports species. Local increases in salt concentration, at critical times, result in the death of great numbers of black bass and other game species. When the natural salts are augmented by salts from oil-well waste water, the sports fisheries is seriously menaced.

In the following pages we have attempted to summarize the results of our intensive investigations of the past year. Because dissolved salts so greatly affect the fish population as well as the aquatic biology of the river, we have emphasized the chemistry of the water and viewed the fish populations against a background of salinity.

BASIC SURVEY OF THE BIG WICHITA RIVER

Throughout its length, from sources in the cedar brakes and dessicated desert hills to its mouth in the post oak forest of Clay County, the Big Wichita River varies constantly and greatly, physically, chemically and biologically. For convenience we have referred to three general divisions of the river, each separated geographically by artifical dams. These are: (1), the upper river, including headwater streams and tributaries, downstream to Lake Kemp; (2), the middle river, between Lake Kemp and Lake Diversion; (3), the lower river, below the Lake Diversion Dam.

In the upper river the stream gradient is high. The river and its major tributaries flow through deep valleys or steep-cliffed canyons. The stream beds consist of sand, gravel or solid rock. The streams are shallow and swift, and in many places consist of deep, broad pools separated by rapids or waterfalls. Salinity is generally very high, but each tributary stream and large spring entering the major streams either dilutes or increases the salt concentration so the streams differ chemically from mile to mile. Except for a few sweet water headwater springs and pools, the upper river is devoid of game fishes, or of any fishes of large size. Small fishes of the "minnow" type abound in this part of the river, where they have no predatory fishes to contend with.

The middle river is dependent on human agency for its volume. Lake Kemp, at the upper end of the middle river, is a storage reservoir for Lake Diversion. When water is wanted in Lake Diversion a considerable flow is maintained in the river. At other times the middle river is almost dry. In spite of the irregularity of flow, however, the middle river supports numerous large fishes, including game species, in deeper pools. There is a great deal of sports fishing in the middle river, especially just below Lake Kemp Dam, and great numbers of white bass, black bass, crappie and channel catfish are taken there. The middle river has a sinuous course through a rather broad valley. The bed of the middle river is mud and quicksand with some firm sand and gravel where the current is swift.

The lower river is a mature river, flowing to the Red River in a belt of broad meanders with scattered oxbow lakes. The water is generally turbid, deep, and only moderately saline. The bed is sand, quicksand or mud, depending on local conditions. Large fishes typical of the Red River drainage system occur here.

The main stream of the Big Wichita River begins with the junction of two principal branches or "forks" in Baylor County. Of these the North Fork is approximately ten times the volume of the South Fork under normal conditions. The North Fork itself is formed by four tributaries: the North Fork proper, Salt Creek, Cottonwood Creek and the Middle Fork. Contributing springs and tiny spring creeks probably are responsible for as much of the water volume of the river as are the tributaries. The South Fork originates from springs and has no major tributaries.

The North Fork begins as a dry wash or series of dry washes and arroyos in Dickens County but does not become a true valley until it passes from King County to Cottle County. Where crossed by State Highway 70, south of Paducah, the bed is broad and there is a wide floodplain. We judge the river bed to measure at least 100 feet and the valley one mile. However, this river bed is dry through most of the year. The presence of flood-guards at the bridge indicates that a large volume of water passes here in times of heavy rains, but we did not find water here during the past project year. Undoubtedly the soft sand carries some water in underground flow.

Near Sneedville, in Cottle County, the first "wet" stream enters the North Fork. This is Buck Creek (sample locality 1). However, Buck Creek flows only onto the sand of the North Fork, sinks into it, and vanishes. There is no water in the river itself until the springs two and one-half miles west of Hackberry, Cottle County, are reached.

From these springs, the true source of the river, for a distance of three miles, there are numerous contributing springs. This area is at the very edge of the Blain Formation, the main salt-contributing strata of the Wichita Valley. The Hackberry springs are not excessively saline. The water is clear and cold, running swiftly between deep, clear pools. In these pools we found black bass, bluegill sunfish, longear sunfish, and other fishes (see records for Hackberry Station, table 3). In this three miles alone, of the North Fork, do game fishes live. The insect fauna is also very large, including midges, craneflies, damselflies, dragonflies, caddisflies, and stoneflies as well as the usual aquatic beetles. To our knowledge, this is the only area on the Wichita River drainage where stoneflies occur.

About two miles downstream (straight line distance) from Hackberry Station the North Fork is joined by Salt Creek. This creek bears an enormous burden of dissolved salts and from the point where it joins the North Fork to Lake Kemp, it destroys the entire river for game fishes.

Below Salt Creek the North Fork consists of a series of deep, green pools separated by low falls or rapids. In these deep pools one sees ledges of rock, great boulders, and in places the deep, green water is too deep to detect the bottom. The river looks ideal for game fishes but the only "biting" fishes present are green sunfish, rarely weighing as much as 100 grams.

A few miles below Salt Creek, Cottonwood Creek enters the river. This is another broad creek but it is slow-flowing and has a much smaller water volume than Salt Creek. It is relatively sweet water, and contains white crappie, and reputedly black bass also. The waters of the North Fork become slightly less saline where diluted by Cottonwood Creek.

For details of the contamination of the North Fork by Salt Creek see sample locality water analyses 7, 8 and 9. For details of the dilution of the North Fork by Cottonwood Creek see sample locality analyses 15, 16 and 17.

Below the mouth of Cottonwood Creek the North Fork receives water from a large number of springs. The salt content of each spring tested was slightly different so that the salinity of the river differs slightly every few hundred yards. By the time Johnson Oil Field Station is reached, most of the springs end.

A few miles below the Johnson Oil Field Bridge, a tiny spring with its origin in the Johnson Oil Field enters the river. Though small, this stream is so salty that it actually changes the salinity of the river. At times the total salts of this stream are in excess of 27%. For details of contamination of the river, see sample locality water analyses 35, 36 and 37.

Below Johnson Oil Field Creek, no important tributaries are found until the Middle Fork joins the river, in Knox County. The Middle Fork drains the land south of the North Fork but north of the South Fork. The stream contains only about half as much sodium chloride as does the North Fork, and the waters of the North Fork are appreciably diluted. The Middle Fork does contain a large amount of calcium sulfate (gypsum).

The South Fork of the Wichita River begins west of Guthrie, in King County, in a series of moderately saline springs. This water is not too salty to support game fishes and black bass are said to occur there. By the time the water reaches Guthrie it is quite salty, especially after long dry spells when the river does not flow at Guthrie and the water in the pools evaporates, thus concentrating the salts. Some less salt-tolerant species of fishes, such as the black bullhead and red shiner, occur at Guthrie after floods, when they are washed from upstream. As drought continues, these forms die off and leave in the pools only the salt-resistant species.

East of Guthrie extremely saline springs emerging from the Blain Formation pollute the water but result in a constant flow for several miles. What happens to this salty water we do not know. It does not reach Benjamin Station, on

State Highway 283, in Knox County, in dry periods for the river is then dry there and the dry, rock bed of the river is exposed. The strata are level and there is no way in which the water could go underground. In any event, water analyses show that it does not do so.

From Benjamin Station eastward, sweet water springs dilute the saline waters of the South Fork. For example, On April 23, 1955, we took water samples at Benjamin Station, ten miles eastward, and twenty miles eastward. Successive decreases in chloride were: 14,777 ppm., 11,893, and 8,387. Total salts tested decreased as follows: 27,782 ppm., 21,968, and 17,938.

After heavy rainfalls the South Fork becomes a raging torrent, red with mud. This is in extreme contrast to the North Fork which, with the same rains, rises only about twice its volume and becomes, at most, discolored. In dry periods the South Fork is dry except between Guthrie and Benjamin and near its mouth. However, when the South Fork rises so greatly following rains, the water is quite sweet (see Guthrie Station records for December 10, 1954). When the river floods, water from the uppermost reaches flushes away the salty water and then runs sweet, and this sweet water reaches the North Fork. In drought, when the only water reaching the North Fork from the South Fork comes from the springs of the lower part of the river, the water is not excessively saline. Summarized then, much of the salt of the South Fork does not reach the North Fork and Lake Kemp, but we do not know what becomes of it.

As a result of dilution by the fresh water east of Benjamin, the South Fork where it joins the North Fork is quite similar in quality (see sample locality water analyses 51, 52 and 53).

The South Fork and the North Fork join in an inaccessible area on the Wagoner Ranch. We visited this place on March 5, 1955, after a long journey through the mesquite. The junction is in a broad, sandy river floodplain and the joining is uneventful. Fishes present are the usual species of the upper river.

Below the junction of the forks, the Wichita River becomes slightly larger, flowing through a braided sand valley to Lake Kemp. In some places the river bed is quicksand. The fish population, however, is unchanged.

The middle river is the shortest of the three sections discussed. It is approximately seven miles in length (straight-line distance). The river flows in a bed of braided sand, mud and quicksand with but little surface flow when the floodgates of the dam are closed. Large game and rough fishes occur in the deeper holes and there are usually some fishermen attempting to catch them. Creeks that enter the middle river are usually small, except for Spring Creek and Cottonwood Creek (there are two Cottonwood Creeks entering the Big Wichita River) and the water quality is fair to good. Although the river itself is, of course, a navigable stream whose bed belongs to the state, the land around the middle river, except where crossed by the bridge on U. S. Highway 283, is the property of the Wagoner Ranch. Except at the bridge mentioned and by boat from Lake Diversion, fishermen cannot gain access to the middle river.

The lower river begins at the Lake Diversion spillway. Although but a small quantity of water enters the river here during most of the year, there is a large plunge-pool where large fishes are common. Below the plunge-pool, water enters the river a little at a time from irrigation seepage waters, small springs and tiny tributary streams. The first large tributary stream is Beaver Creek. Below Beaver Creek's mouth, numerous small tributaries enter the river (see sample stations 66 to 85). Just east of Wichita Falls, Holliday Creek increases the water volume of the river considerably. Another major source of water and an important factor in the dilution of salts is the waste water of the city of Wichita Falls.

From Lake Diversion Dam to Wichita Falls, the river becomes constantly more saline as a result of escape of irrigation water and pollution by oil well salt water. At times, total salts double between Diversion Dam and Wichita Falls. With the entrance of the waste waters of the city of Wichita Falls, the salts are again diluted to approximately their concentration in the water at Diversion Dam.

The lower river is a mature stream, moving slowly in a series of meanders. Large fishes are numerous in the deeper holes. In the lower reaches, almost all the river is deep and pools are numerous. Aquatic life of all kinds is numerous, including such vertebrates as frogs, snakes, turtles, ducks, geese, beavers, muskrats, minks and raccoons. Zooplankton occurs in the larger pools. Crayfish are abundant, as are several species of freshwater mussels but there seem to be no aquatic snails. Insects are abundant. The usual aquatic species are found: dragonflies, damselflies, midges, craneflies, whirligigs and water beetles of several kinds, backswimmers and water boatmen, and vast numbers of water striders. In the rapids we found large numbers of Dobsonflies but we did not find the larvae of caddisflies. However, tiny caddisflies are found about lights in Wichita Falls in the summer months and these probably spent their larval life in the river.

The river below the mouth of Holliday Creek has few tributaries, and none of any size. The lower ten miles (following the curves of the river) seem to be free of any tributaries except for a spring at the very river mouth. There are numerous oxbow lakes in the lower river valley but we did not check these.

The confluence of the Big Wichita River and the Red River is in a broad, braided valley. During most of the year the Red River runs as a small channel in almost the center of this flat, sandy river bed and the Wichita River flows out onto this sandy bed. Both rivers are shallow, clear and swift at the point of junction.

SAMPLE LOCALITIES UPON WHICH THE BASIC SURVEY WAS BASED

The following brief paragraphs list the principal sample localities taken by us on the Big Wichita River and its tributaries. Each number is the key for the water analyses from those stations, listed in the table at the end of this account. The given date is the date of the first sampling. If additional water samples were taken and analyzed, they are listed under the same number as the first, but by the actual date of sampling.

A vast amount of detailed notes and investigations have gone into the data here condensed. In general, arrangement is from west to east, beginning with the North Fork and taking up each station or tributary to the eastward. The data is often varied and scarcely comparable, but, in most instances, is self-explanatory. One hundred typical sample localities are listed here, exclusive of the nine regular stations that were studied once each month.

SAMPLE LOCALITIES ON THE NORTH FORK (numbers 1 through 46)

1. Buck Creek, March 9, 1955. A small stream, running from pool to pool in a valley at Sneedville, entering the dry bed of the river to sink from sight in the sand. Only in times of flood does the river have water here. However, the creek did contain fish:

9 *Fundulus kansae*
49 *Cyprinodon rubrofluviatilis*

2. North Fork, 2½ miles above Hackberry Station, May 20, 1955. The large but dispersed springs here are the actual head of the permanent river, where the water that flows all year, even in the dry season, emerges from the ground. Fishes were present but we did not take a sample.

3. North Fork, 1½ miles above Hackberry Station, May 20, 1955. Water volume of the river is somewhat greater but conditions otherwise very similar to those at Hackberry Station.

4. North Fork, ¼ mile above Hackberry Station, May 20, 1955. Essentially like Hackberry Station in all features.

HACKBERRY STATION. For details see tables 3 and 4.

5. Between Hackberry Station and the mouth of Salt Creek, January 31, 1955. Here the North Fork flows swift and clear over sand and gravel beds with some bare rock and small waterfalls. Between the rapids there are deep, green pools with rocks and ledges visible. The river flows through sandy flats and gypsum cliffs. We noted some immense schools of Hybognathus placita, numbering tens of thousands of fish. No water sample was taken, for the water should be the same as that at Hackberry Station. A fish sample from the foot of a rapids included:

4	Hybopsis aestivalis
75	Notropis bairdi
8	Notropis lutrensis
77	Notropis oxyrhynchus
17	Notropis potteri
90	Pimephales vigilax
7	Fundulus kansae
31	Cyprinodon rubrofluviatilis

6. A small spring in a denuded flat, extremely salty, located just west of the mouth of Salt Creek, on the north side of the river. The stream from the spring contained no fish on January 31, 1955.

SALT CREEK. This is one of the major tributaries of the North Fork of the Wichita River. It enters the north side of the river about six miles downstream from Hackberry Station, and is the principal salt-contributing stream of the Big Wichita River. For this reason it was studied in some detail and over some time.

Salt Creek is large, approximately 4 cubic feet per second flow in normal stage. It emerges from numerous springs, some large, in the Blain Formation and forms deep pools, some of them 50 feet wide, ¼ mile long, and ten feet or more in depth. The salinity is excessive but the stream contains vast numbers of salt-tolerant fishes and large quantities of aquatic vegetation. No game or predatory fishes occur in Salt Creek, and its mingling with the waters of the main stream so increases the salinity of the river that no game or predacious fishes except the green sunfish occur anywhere between the mouth of Salt Creek and Lake Kemp, 65 miles to the eastward. Some tributary streams and impoundments do have game fishes, but not the main river.

In Salt Creek itself we found only Fundulus kansae and Cyprinodon rubrofluviatilis, but these two species of fishes were present in schools of tens of thousands, and formed columns in the water a yard or more in diameter and several yards long, with the small fishes so densely packed in the schools that the schools appeared to be black cylinders gliding through the water.

7. The North Fork, just above the mouth of Salt Creek, January 28, 1955.

8. The mouth of Salt Creek, where the water was not mixed with that of the North Fork, January 28, 1955.

9. The North Fork, just below the first rapids below the mouth of Salt Creek, where waters of river and creek were thoroughly mixed, January 28, 1955.

10. A moderately large spring on Salt Creek, ½ mile above the mouth of the creek, January 22, 1955.

11. A large spring, one mile above the mouth of Salt Creek, January 22, 1955.

12. A large spring, 1½ miles above the mouth of Salt Creek, January 22, 1955.

13. West Fork of Salt Creek, above the spring located 1½ miles above the mouth of the creek (no. 12). Many Fundulus kansae and Cyprinodon rubrofluviatilis were noted here on January 22, 1955.

14. A small stream from a large spring on the south side of the North Fork, located just across the river from the mouth of Salt Creek and 250 yards downstream, July 19, 1954. A fish sample included:

80 Notropis bairdi
49 Fundulus kansae
249 Cyprinodon rubrofluviatilis

COTTONWOOD CREEK. The second major tributary of the North Fork, this stream is smaller than Salt Creek, and slower-flowing. It also enters the north side of the river but is relatively "sweet" water. In fact, it greatly dilutes the North Fork salts. The deeper pools on Cottonwood Creek were too deep to seine with the small seines we were able to carry on our shoulders but we noted many gizzard shad (Dorosoma cepedianum) and one white crappie (Pomoxis annularis) in the deep pools and have heard that black bass are sometimes taken from the creek. Of the smaller fishes, we took the following sample on January 24, 1955:

6 Dorosoma cepedianum
70 Notropis lutrensis
539 Hybognathus placita
21 Pimephales vigilax
303 Fundulus kansae
29 Cyprinodon rubrofluviatilis
1 Pomoxis annularis

15. North Fork, above the mouth of Cottonwood Creek, January 24, 1955.

16. Cottonwood Creek, near its mouth, January 24, 1955.

17. North Fork, just below the first rapids downstream from the mouth of Cottonwood Creek, where waters of river and creek are thoroughly mixed, January 24, 1955.

SPRINGS BETWEEN THE MOUTH OF COTTONWOOD CREEK AND THE JOHNSON OIL FIELD

18. Small spring on south side of river, just across river from mouth of Cottonwood Creek, January 24, 1955. Emerges from under rock. Flow rate about five gal./minute, estimated.

19. Moderately large spring, 100 yards east of no. 18, and on same side of river, January 24, 1955. Drains to ten acre marsh and pond, and then to river. Many fish in stream and pond, all Fundulus, Cyprinodon and Gambusia.

20. Small spring on south side of river, 200 yards east of no. 19, February 12, 1955. Drains to small marsh before seeping to river; about 2 gal./minute. Fish include Fundulus, Cyprinodon and Gambusia.

21. A small, seepage spring entering a deep pool at the base of a gypsum cliff beside the river, February 12, 1955. No apparent surface runoff to river but, as level is two feet higher, must reach river beneath ground. Fundulus and Cyprinodon noted.

22. Double spring arising from conglomerate layer about two miles east of mouth of Cottonwood Creek, February 12, 1955. Flow about 5 gallons per minute. Fish taken include: Notropis bairdi, N. lutrensis, Fundulus, Cyprinodon and Gambusia.

23. Small spring, about one gallon per minute flow, located 100 yards east of number 22. February 12, 1955. Marked odor of hydrogen sulfide.

24. Beautiful, crystal-clear, cold, spring emerging from two areas at base of a conglomerate cliff. Water falls from cliff ten feet to deep pools, then through series of rapids to river. Flow estimated at 20 gallons per minute on February 12, 1955. Fish are abundant and include:

Notropis bairdi
Notropis lutrensis
Pimephales vigilax
Fundulus kansae
Cyprinodon rubrofluviatilis
Gambusia affinis
Micropterus salmoides -- In pool under waterfall.
Lepomis cyanellus -- In pool under waterfall.

25. Spring slightly smaller but otherwise similar to no. 24, located 100 yards eastward. The fish population was similar except that there were no black bass. February 12, 1955.

26. A large spring, emerging from the face of a conglomerate cliff nine feet above the ground, on the south side of the river about five miles west of the Johnson Oil Field bridge, February 13, 1955. Fish present included only Notropis bairdi, Fundulus and Cyprinodon.

27. A tiny spring emerging from mouse-holes beside the river bank 1 mile east of no. 26. Flow about ½ gallon per second on February 13, 1955.

About 100 yards east of no. 27, a deep pool beside the river appeared to be a cut-off pool from the last rise of the river. We seined and took several large green sunfish, fathead minnows (Pimephales promelas), Fundulus kansae and and Cyprinodon rubrofluviatilis.

28. A small creek on the north side of the river with its present surface flow to the river slight, probably not more than 1 gallon per minute. It is about ½ mile east of no. 27. February 13, 1955.

29. A small creek, now almost dry, emerging from a now-collapsed gypsum cave through a thick gypsum strata. There are indications of heavy runoff in rainy seasons. On north side of river. February 13, 1955.

30. A small, stagnant creek with no present surface flow to the river but doubtless some underground flow through the sand. Heavy odor of hydrogen sulfide on February 13, 1955. No fish present.

JOHNSON OIL FIELD STATION. For details see tables 5 and 6.

31. Deep hole in riverbank at Johnson Oil Field bridge, possible spring, on January 29, 1955. The pool is broadly connected with the river.

JOHNSON OIL FIELD CREEK. A small but extremely salty stream that enters the river 1 mile below the Johnson Oil Field bridge. Strangely enough, both *Fundulus* and *Cyprinodon* were noted in this stream, where salt concentration on some occasions reaches 27%.

32. Head of main branch of Johnson Oil Field Creek, March 9, 1955.

33. Creek at crossing of Farm Road 567, July 19, 1954 and other dates.

34. Tributary of creek, entering the main branch 1 mile below the bridge on farm road 567, January 31, 1955.

35. Creek near its mouth, March 13, 1955.

36. North Fork, just above mouth of Johnson Oil Field Creek, March 13, 1955.

37. North Fork just below first rapids below junction of river and Johnson Oil Field Creek, where waters of river and creek are thoroughly mixed, March 13, 1955.

38. North Fork, five miles above mouth of Middle Fork, February 26, 1955. River flows swiftly through cliffs of friable red rock, blue clay and gypsum stringers. Some deep, green pools exist, where we could not see the bottom. Seining took:

Hybopsis aestivalis -- common in riffles.
Notropis bairdi -- Common to abundant.
Notropis oxyrhynchus -- Common in riffles.
Notropis potteri -- Scarce.
Hybognathus placita -- Common and large, up to six inches.
Fundulus kansae -- Abundant.
Cyprinodon rubrofluviatilis -- Extremely abundant in shallows.

39. Middle Fork on Jack Brown Ranch, several miles above mouth, March 9, 1955. Water sample taken by Dr. Carl Gray.

40. North Fork, just above the mouth of the Middle Fork, February 26, 1955.

41. Middle Fork at mouth, February 26, 1955. The stream is deep, slow and turbid, only 35 cm. on the Seichi Disk. There is no definite valley here, only a slot-like gulley through the mesquite flats. Fish samples where we could seine were identical to those of the North Fork (no. 38) but we have no idea what might be in the deep, blue holes.

42. North Fork at the first rapids below the mouth of the Middle Fork, February 26, 1955. The turbidity of the Middle Fork vanishes abruptly on the mixing of the waters of the two streams.

43. Good Creek, February 26, 1955. A stream of some size but dry save for a few remaining pools at the time of our visit. One hole was seined and fishes taken included:

2 *Dorosoma cepedianum*
14 *Notropis lutrensis*
1 *Pimephales vigilax*
2 *Lepomis cyanellus*
3 *Lepomis humilis*

44. River at mouth of Good Creek, February 26, 1955. Here the river is a swift, clear torrent running over a rough, solid, rock bed. The water was shallow but so swift that we had difficulty in crossing from one side to the other. We were unable to seine in the swift current but noted numerous gizzard shad and found about 20 of them freshly dead, apparently killed in trying to ascend the rapids.

45. Foard City Creek, February 26, 1955. A small, intermittent creek flowing over gypsum and red beds. There are some long, rather deep pools but we found no fish.

46. River near mouth of Foard City Creek, February 26, 1955. The river here runs through gravel flats and looks very much like it does at the Crowell Station, a few miles downstream. Fish were collected but seem about the same as occur at Crowell Station.

CROWELL STATION. For details see tables 7 and 8.

GUTHRIE STATION, ON SOUTH FORK. For details see tables 9 and 10.

SAMPLE LOCALITIES ON THE SOUTH FORK. (Numbers 47 through 50)

47. Humble Lease, ten miles east of Guthrie, July 19, 1954. Here the river is narrow, about ten feet in width, flowing swiftly through a deep canyon in gypsum and soft sandstone. Fish taken include:

79 *Notropis bairdi*
7 *Hybognathus placita*
50 *Fundulus kansae*
88 *Cyprinodon rubrofluviatilis*

BENJAMIN STATION. For details see tables 11 and 12.

48. An arroyo, ordinarily dry but carrying rainwater after even moderately heavy rains, sampled January 16, 1955, to check the salts of ordinary rain runoff water. As suspected, the water was very high in calcium and sulfate but not especially high in sodium and chloride.

49. South Fork southeast of Guilliland, on Farm Road 267, June 18, 1954. The river is shallow and flows through a muddy valley but has a firm sand bed. We seined here and took:

1 *Notropis oxyrhynchus*
16 *Hybognathus placita*

4 *Fundulus kansae*
21 *Cyprinodon rubrofluviatilis*
1 *Lepomis cyanellus*

50. South Fork north of Vera, April 23, 1955. The river flows rather slowly through deep pools in a broad, sandy valley. Fishes seined included *Notropis bairdi*, *N. oxyrhynchus*, *Hybognathus placita*, *Fundulus*, *Cyprinodon* and *Lepomis cyanellus*.

JUNCTION OF NORTH FORK AND SOUTH FORK.

51. North Fork just above junction, March 5, 1955.

52. South Fork just above junction, March 5, 1955.

53. River just below first rapids below junction, where waters of both streams are thoroughly mixed, March 5, 1955.

54. River at Cleghorn Ranch, above Lake Kemp, March 13 and other dates. The river is broad and shallow with a quicksand bottom. Fishes taken include:

18 *Hybopsis aestivalis*
11 *Notropis lutrensis*
31 *Notropis oxyrhynchus*
25 *Fundulus kansae*
10 *Cyprinodon rubrofluviatilis*

THE MIDDLE RIVER, BETWEEN LAKE KEMP AND LAKE DIVERSION (numbers 55 through 61).

KEMP DAM STATION. For details see tables 13 and 14.

55. Small creek, usually dry, contained water on June 14, 1955. Located about 100 yards below the Lake Kemp Dam.

56. Stream about one mile below Lake Kemp Dam, with source in cliffs south of river. Measured about 6 feet wide and 18 inches deep on June 14, 1955.

57. Wide, deep creek but scarcely flowing on June 14, 1955. Mouth is about 14 feet wide and three feet deep, located three miles below Lake Kemp Dam.

58. A small stream about four miles below the Lake Kemp Dam, on the north side of the river. Very slow-flowing on June 14, 1955.

59. Whisky Creek, July 13, 1955. Almost dry but there was water in the deeper pools remaining in the stream bottom. The water sample was taken from a hole about eight by ten feet in area.

60. Spring Creek, July 13, 1955. A very broad, still, turbid stream, almost stagnant. It was about 50 feet wide at a point 250 yards from its mouth.

61. Cottonwood Creek, July 13, 1955. A deep, sluggish creek, about 25 feet wide at a point a mile from the mouth.

THE LOWER RIVER, BELOW LAKE DIVERSION.

DIVERSION DAM STATION. For details see tables 15 and 16.

BEAVER CREEK. This a major tributary of the Big Wichita River, with its source on the Wagoner Ranch. Near its source the creek is dammed to form Santa Rosa Lake.

62. Headwaters of the creek, above Santa Rosa lake, March 5, 1955.

63. Santa Rosa Lake, March 5, 1955. The lake contains black bass, sunfish of several species, gizzard shad, river carpsuckers, and other species. It was not sampled during this study, as far as the fish population is concerned, but the water was sampled.

64. Beaver Creek on U. S. Highway 283 crossing, July 9, 1954. The creek here averages about 25 feet wide and 4 feet deep, and has a muck bottom. It flows in a valley heavily wooded with cottonwoods and willows. Fishes taken include:

2 *Carpiodes carpio*
1 *Cyprinus carpio*
5 *Notropis lutrensis*
9 *Pimephales vigilax*
3 *Ictalurus punctatus*
6 *Gambusia affinis*
3 *Lepomis cyanellus*
2 *Lepomis humilis*
9 *Lepomis megalotis*
1 *Pomoxis annularis*
7 *Aplodinotus grunniens*

65. Beaver Creek, ½ mile above its confluence with the river, July 26, 1954. The creek is deep but slow, with a soft mud bottom. Fishes include:

11 *Dorosoma cepedianum*
81 *Notropis lutrensis*
1 *Phenacobius mirabilis*
2 *Pimephales vigilax*
4 *Ictalurus punctatus*
5 *Fundulus kansae*
87 *Gambusia affinis*
3 *Lepomis cyanellus*
17 *Lepomis megalotis*

BIG WICHITA RIVER BETWEEN THE MOUTH OF BEAVER CREEK AND WICHITA FALLS

66. River at Valley View Bridge, April 30, 1955. The river was very low and many bars of sand and quicksand were exposed. European carp were common.

67. A small, swift creek about ½ mile below Valley View Bridge, April 30, 1955. The water was muddy and the only fishes taken were *Notropis lutrensis*.

68. Antelope Creek, April 30, 1955. A large creek entering the south side of the river, six feet wide and three feet deep but sluggish. Not seined.

69. Iowa Park sewer entrance, April 30, 1955. Treated sewer water that enters the river at a high rate of speed from a 12 inch pipe. We found many green sunfishes and red shiners living in the plunge pool.

70. A broad drainage ditch on the north side of the river, April 30, 1955. This is obviously artificial, and contained deep, brown water. Not seined.

71. A small, clear creek on the south side of the river, April 30, 1955.

72. A deep, sluggish creek on the south side of the river, April 30, 1955. An oil well was being drilled near this creek and there was a slight oil slick on the water. However, Notropis lutrensis and Gambusia affinis were common here.

73. A large, clear, swift creek on the north side of the river. This may be irrigation water, for much irrigation was being done on this date, April 30, 1955. We seined here and took hundreds of Notropis lutrensis.

74. A large, muddy creek entering the south side of the river, April 30, 1955. This is a permanent creek, with large sandstone boulders near its mouth. We are surprised to find it not named on our maps.

75. A small, swift stream, possibly irrigation overflow water, located ¼ mile above Deadman Bridge Station, April 30, 1955.

76. River just above Deadman Bridge, April 30, 1955.

DEADMAN BRIDGE STATION. For details see tables 17 and 18.

Deadman Creek, July 13, 1954. This small, permanent creek that enters the river on the north side, at Deadman Bridge, contained the only resident population of spottail shiners known to us in the Big Wichita River drainage system. On the above date we seined:

3 Dorosoma cepedianum
4 Carpiodes carpio
4 Cyprinus carpio
104 Notropis lutrensis
42 Notropis venustus
1 Hybognathus placita
5 Phenacobius mirabilis
4 Cyprinodon rubrofluviatilis
8 Lepomis cyanellus

78. A small creek, 12 inches wide, on the south side of the river one mile below Deadman Bridge, May 1, 1955.

79. A small, swift, clear creek on the north side of the river, May 1, 1955. Seining revealed hundreds of Notropis lutrensis only.

80. A small, swift stream on the north side of the river, possibly all irrigation escape water, May 1, 1955.

81. A broad (6 feet wide), muddy stream entering the river on the south side, May 1, 1955. This stream has a large valley but no name on maps available to us.

82. Pleasant Valley Creek, May 1, 1955. A large, swift, muddy creek on the north side of the river. This stream was greatly swollen by irrigation escape water on the day checked.

83. Seven Springs Creek, May 1, 1955. A short stream about six feet wide and two feet deep at the mouth. It was seined August 3, 1954, and the following fishes were taken:

72 *Dorosoma cepedianum*
28 *Notropis lutrensis*
77 *Pimephales vigilax*
1 *Ictalurus punctatus*
7 *Cyprinodon rubrofluviatilis*
12 *Gambusia affinis*
2 *Micropterus salmoides*
4 *Lepomis cyanellus*
1 *Lepomis humilus*
19 *Lepomis megalotis*

84. A small creek, about two feet wide, entering the north side of the river ½ mile above Wichita Falls, May 1, 1955. No fish present. Possibly irrigation escape water.

85. Wichita River at 10th. street bridge, at western edge of town, May 1, 1955.

HOLLIDAY CREEK. This important tributary is dammed southwest of Wichita Falls to form Lake Wichita. For details of the fishes of Lake Wichita see Completion Report, F-7-R-2, Job B-7. There is some industrial pollution of Holliday Creek and this is described in detail in Completion Report, F-7-R-2, Job C-2, part 2).

86. Holliday Creek at State Hospital, July 26, 1954. The creek here is deep, sluggish, mud-bottomed and cattail lined. Seining took:

2 *Lepisosteus productus*
1 *Dorosoma cepedianum*
3 *Carpiodes carpio*
5 *Cyprinus carpio*
13 *Notropis lutrensis*
18 *Notemigoneus crysoleucas*
1 *Ictalurus punctatus*
4 *Gambusia affinis*
18 *Micropterus salmoides*
1 *Lepomis humilus*
2 *Lepomis macrochirus*
2 *Lepomis megalotis*

87. Holliday Creek at Hampstead Bridge, July 20, 1954. A spring enters the creek here and the water of the creek is diluted by the fresh water of the spring. Fish taken include:

13 *Dorosoma cepedianum*
10 *Notropis lutrensis*
2 *Ictalurus punctatus*
1 *Micropterus salmoides*
3 *Lepomis megalotis*
10 *Aplodinotus grunniens*

88. Holliday Creek at cliffs, 1 mile below Pecan Street Bridge, July 20, 1954. The creek is silted here. Seining in a deep hole took:

2 *Cyprinus carpio*
1 *Notropis buchanani*
10 *Notropis lutrensis*
1 *Phenacobius mirabilis*
1 *Pimephales vigilax*

1 *Ameiurus melas*
7 *Gambusia affinis*
1 *Lepomis cyanellus*
1 *Lepomis humilus*
1 *Lepomis megalotis*
2 *Aplodinotus grunniens*

THE BIG WICHITA RIVER BETWEEN WICHITA FALLS AND THE RED RIVER

PLUM CREEK. This small stream is an extremely important pollution effluent ditch, and several industrial concerns are located beside the creek. Water quality varies greatly from day to day. There are no fish present. For details see Completion Report, F-7-R-2, C-2, part 2.

89. Wichita River at Ohio Street Bridge, April 12, 1955.

90. Small spring on south side of river, ¼ mile below Ohio Street Bridge. Estimated flow 5 to 6 gallons per minute.

91. Flume of city disposal plant.

92. Another flume of the city disposal plant. Six feet wide and very swift.

93. A broad, slow creek, 14 feet wide by three feet deep, April 12, 1955.

94. A small spring, about two feet wide and six inches deep, on north side of river, April 12, 1955.

95. Another small spring with a broad plunge pool beside the river beneath a steep bank, April 12, 1955.

96. A large pond or small lake beside the river with overflow pipe to the river, not flowing to river at present. April 12, 1955.

97. A small creek entering the river on the north side near Iron Bridge, north of Petrolia, April 12, 1955. Estimated flow 30 to 40 gallons per minute.

98. Another small creek on the north side of the river, ¼ mile below no. 97.

99. Another stream, only 6 inches wide, entering the river on the north side one mile upstream from the Iron Bridge.

100. A small spring beside the Wichita River 200 yards above the junction of the Wichita River with the Red River.

TABLE I. WATER ANALYSES AT SAMPLE LOCALITIES LISTED ON PRECEDING PAGES

no.	date	calcium	sodium	chloride	sulfate	carbonates	total salts	pH
1.	3/9/55	1079	208	284	2501	160	4,228	7.80
2.	5/20/55	588	252	444	1138	244	2,666	-
3.	5/20/55	548	252	461	1030	244	2,535	-
4.	5/20/55	562	512	799	1145	232	3,250	8.00
5.	1/3/55							
6.	1/31/55	2694	11859	20058	3872	142	38,725	7.84
7.	1/28/55	1392	1404	3106	1902	205	8,009	7.95
8.	1/28/55	3441	10100	18327	4448	134	36,450	7.71
9.	1/28/55	2282	5353	9140	4112	216	21,103	7.87
10.	1/22/55	794	12462	21080	14100	134	48,570	7.90
11.	1/22/55	1916	11457	19037	2656	140	35,206	7.66
12.	1/22/55	2608	12563	20725	4378	119	40,393	7.30
13.	1/22/55	1942	9191	15220	3158	124	29,635	7.90
14.	7/19/54	617	3723	5991	1001	179	11,517	7.75
15.	1/24/55	1612	5100	8742	2535	192	18,181	7.85
16.	1/24/55	616	765	1376	1060	;92	4,009	7.85
17.	1/24/55	1290	4998	8032	2516	188	17,024	7.90
18.	1/24/55	423	1556	2263	1010	244	5,496	7.55
19.	1/24/55	348	988	1429	830	166	3,761	8.00
20.	2/12/55	540	988	1598	998	260	4,384	8.40
21.	2/12/55	2710	7070	13135	2488	266	25,669	8.30
22.	2/12/55	320	468	692	620	220	2,326	8.45
23.	2/12/55	408	468	861	590	257	2,584	8.40
24.	2/12/55	262	420	524	600	250	2,056	8.30
25.	2/12/55	320	321	426	677	240	1,984	8.20
26.	2/13/55	284	276	231	682	330	1,803	8.15
27.	2/13/55	612	364	666	1150	228	2,970	8.10
28.	2/13/55	1340	4794	7810	2515	153	16,612	8.00
29.	2/13/55	667	30	116	1483	38	2,334	8.30
30.	2/13/55	1636	4641	7900	2505	540	17,222	8.70
31.	1/29/55	1065	4848	7455	2430	200	15,996	7.82
32.	3/9/55	2593	1380	4750	2577	182	11,482	7.80
33.	7/19/54	27624	26026	88351	1059	125	143,186	7.20
	9/25/54	67956	33000	170090	1895	93	273,034	8.10
	1/31/55	8770	24550	51520	2503	135	87,478	7.40
34.	1/31/55	6745	10854	26980	2280	112	46,980	7.63
35.	1/31/55	1403	4998	8343	2391	165	17,300	7.70
36.	1/31/55	7234	12060	29368	2730	103	51,495	7.80
37.	1/31/55	1628	4945	8432	2699	165	17,869	7.75
38.	2/26/55	1090	5094	7544	2832	160	16,720	7.75
39.	3/9/55	1307	2295	3860	2607	173	10,242	-
40.	2/26/55	1346	4794	7633	2805	142	16,720	7.95
41.	2/26/55	1084	2550	3684	2640	112	10,076	7.85
42.	2/26/55	1552	3009	5280	2675	154	12,640	7.95
43.	2/26/55	462	90	222	912	104	1,790	7.80
44.	2/26/55	1440	4029	6610	2805	153	15,037	7.75
45.	2/26/55	860	520	468	2125	190	4,343	8.05
46.	2/26/55	1444	4208	6524	3310	140	15,626	7.95
47.	7/19/54	1548	8888	15691	904	139	27,181	7.60
48.	1/16/55	933	598	925	2064	110	4,630	8.00

no.	date	calcium	sodium	chloride	sulfate	carbonates	total salts	pH
49.	4/23/55	1724	6565	11893	1642	144	21,968	7.49
50.	4/23/55	1552	5049	8387	2785	165	17,938	7.60
51.	3/5/55	1370	3825	6346	2592	122	14,255	7.95
52.	3/5/55	1562	3060	5858	2112	130	12,722	7.90
53.	3/5/55	1580	3417	6213	2424	125	13,759	7.80
54.	3/13/55	1556	3315	5982	2453	137	13,443	7.70
	4/8/55	800	2268	3949	1205	137	8,359	8.21
	4/28/55	1048	3825	5902	2402	134	13,317	8.16
55.	6/14/55	250	495	764	480	82	2,071	7.75
56.	6/14/55	242	501	773	438	139	2,093	7.85
57.	6/14/55	252	529	817	495	134	2,227	7.90
58.	6/14/55	52	55	85	19	128	339	7.75
59.	7/13/55	66	9	14	-	320	409	7.60
60.	7/13/55	218	435	670	432	104	1,859	7.90
61.	7/13/55	148	260	401	259	112	1,180	8.00
62.	3/5/55	434	15	18	860	185	1,510	8.05
63.	3/5/55	180	12	22	284	185	683	8.35
64.	7/26/54	71	0	9	30	144	254	8.40
65.	7/26/54	206	252	675	1	130	1,264	7.15
66.	4/30/55	415	759	1722	111	171	3,178	8.10
67.	4/30/55	386	583	1120	314	403	2,706	8.12
68.	4/30/55	400	671	1322	437	171	3,001	8.22
69.	4/30/55	218	396	675	327	118	1,734	8.25
70.	4/30/55	278	522	906	384	180	2,270	8.41
71.	4/30/55	238	426	710	373	155	1,902	8.35
72.	4/30/55	334	616	1295	203	165	2,610	8.31
73.	4/30/55	220	390	674	327	125	1,736	8.30
74.	4/30/55	214	402	693	297	140	1,746	8.25
75.	4/30/55	268	480	807	408	171	2,134	8.41
76.	5/1/55	332	572	1216	195	180	2,495	8.31
77.	7/13/54	271	318	621	352	125	1,701	8.35
	5/1/55	378	605	1181	376	238	2,778	8.29
78.	5/1/55	232	390	683	312	164	1,781	8.30
79.	5/1/55	294	558	604	914	161	2,531	8.39
80.	5/1/55	226	402	675	351	134	1,788	8.31
81.	5/1/55	232	396	719	299	140	1,786	8.31
82.	5/1/55	230	444	755	317	159	1,905	8.31
83.	5/1/55	330	576	968	500	229	2,603	8.39
84.	5/1/55	224	450	692	428	131	1,925	8.12
85.	5/1/55	300	484	1030	206	152	2,172	8.25
86.	7/26/54	157	12	195	8	137	509	6.95
87.	7/20/54	47	20	49	19	81	216	7.70
88.	7/20/54	273	84	351	147	255	1,110	7.50
89.	4/12/55	264	484	1075	80	140	2,043	8.16
90.	4/12/55	180	363	736	60	152	1,491	8.23
91.	4/12/55	63	126	144	66	201	601	8.10
92.	4/12/55	68	126	144	76	201	615	8.30
93.	4/12/55	204	318	563	250	162	1,497	8.40
94.	4/12/55	412	637	1296	473	158	2,986	8.36
95.	4/12/55	240	378	674	353	101	1,746	8.30
96.	4/12/55	272	351	710	178	315	1,826	8.51
97.	4/12/55	472	546	1322	338	186	2,864	8.31
98.	4/12/55	312	585	914	636	125	2,572	8.30
99.	4/12/55	120	806	914	175	448	2,592	8.21
100.	4/13/55	180	56	20	59	573	888	8.32

TABLE II. VOLUME OF WATER IN THE BIG WICHITA RIVER AT WICHITA FALLS, OCTOBER, 1952 TO SEPTEMBER, 1953

Mean daily discharge in October	83.0
Mean daily discharge in November	78.0
Mean daily discharge in December	58.1
Mean daily discharge in January	38.6
Mean daily discharge in February	35.0
Mean daily discharge in March	103.0
Mean daily discharge in April	54.3
Mean daily discharge in May	98.4
Mean daily discharge in June	109.0
Mean daily discharge in July	155.0
Mean daily discharge in August	168.0
Mean daily discharge in September	71.4
16-year average discharge	322
Total runoff in October	5,100
Total runoff in November	4,640
Total runoff in December	3,570
Total runoff in January	2,370
Total runoff in February	1,950
Total runoff in March	6,360
Total runoff in April	3,230
Total runoff in May	6,050
Total runoff in June	6,490
Total runoff in July	9,530
Total runoff in August	10,360
Total runoff in September	4,250
Total annual runoff	63,910

Note: All discharge is given in cubic feet per second; runoff is in acre feet.

INVENTORY OF SPECIES

Ecological factors so greatly influence the distribution of fishes in the Big Wichita River that almost every part of the river has a distinct fish fauna. Thus, large fishes are absent from the saline upper river. Large fishes are abundant in Lake Kemp, but some forms that are abundant in the middle river are absent from that lake (longnosed gar, smallmouth buffalo). Qualitatively, the lower river is most like the middle river but such species as the killifish and red river pupfish are absent while the goldeye and silvery dace are present.

We have made a generalized, areal summary of fish distribution and numbers in the Big Wichita River and its tributaries in the following pages. A total of thirty-eight species are definitely recorded as taken by us in the past year. A hypothetical list included eleven other species.

A careful, quantitative and qualitative analysis of the fish populations was carried out by making collections monthly at each of nine stations located at strategic places along the length of the river. Details of seasonal distribution of species, and numbers taken each month, as well as water analyses from the stations, are given in tables 3 to 20. Note the increase in species but not in individuals as the river is traversed downstream.

Tables 21 and 22 give details on the population of larger and more important fishes found in the river. Rough fishes greatly outnumber and also outweigh the game fishes. However, the discrepancy may not be as great as would appear from the tables. Because of the current of the river, we had great difficulty in setting our gill nets effectively, and we suspect that for this reason the nets took fewer game fishes that they should have. Most of the game fishes taken were small, and we know that large individuals were present.

We have named our nine fisheries stations after nearby towns or other geographic features, as follows:

HACKBERRY STATION, located at the tiny town of Hackberry, approximately 7 miles south-southeast ofPaducah, Cottle County. Here the water is relatively "sweet," clear and cold. There is a large, deep, sand-bottomed pool and a long, swift, stony rapids. The surrounding country is sandy river floodplain, quite arid and desert-like.

JOHNSON OIL FIELD STATION, on the North Fork where it is crossed by Farm Road 567, about 6 miles east of Hackberry Station. At this point the river is extremely salty, having been joined by Salt Creek and Cottonwood Creek as well as many salt springs. The water is clear and cold. There are sandy shallows, swift rapids and deep, still, green pools. Surrounding country is barren hills of gypsum and sandstone with dominant vegetation cedar and cacti.

CROWELL STATION, where the North Fork is crossed by State Highway 283, south of the town of Crowell, Foard County. The river valley is broad and sandy. There are numerous shallow pools, rills, and a few moderately deep holes.

GUTHRIE STATION, on the South Fork at the town of Guthrie where crossed by U. S. Highway 83. Here, in an ordinary fall and spring, there is but a small stream, rarely more than two feet wide and two inches deep, running between broad, deep pools. In summer and winter the streams cease but the pools rarely go completely dry. After heavy rains the river may become waist-deep in the shallows. Surrounding country is sandy floodplain in a broad valley in arid, cedar-covered hills.

BENJAMIN STATION, on the South Fork north of the town of Benjamin, Knox County, at the site of the bridge on State Highway 283. The river is usually shallow, about ten feet wide and six inches deep, in a broad valley in mesquite flats and hills. In midsummer the river is often completely dry, exposing the hard, rock bed. In times of heavy rain the river becomes a raging torrent, 100 feet across and six to ten feet deep.

KEMP DAM STATION, in the plunge pool below the Lake Kemp Dam, Baylor County. When water is being released from the floodgates the river here is broad, clear, swift and extremely cold. At other times the deep pools become almost stagnant. Surrounding country is mesquite-covered hills.

DIVERSION DAM STATION, in the plunge pool beneath the Lake Diversion Dam, Archer County. Water passes here only when the lake floods over the spillway after heavy rains. At such times the river is broad and swift. Usually the large plunge pool is still, sometimes almost stagnant. Surrounding country is mesquite-covered hills.

DEADMAN BRIDGE STATION, located on the lower river about seven miles west of Wichita Falls, Wichita County. The river is shallow with a firm sand bottom. It flows swiftly in a belt of meanders without especially deep pools and only a few gravel-bottomed rapids. Surrounding country is a broad valley where the dominant vegetation is cottonwoods and elms, bounded by mesquite-covered hills.

BYERS STATION, located where the Old Charlie Road crosses the river one mile north of the town of Byers, Clay County. This is about three miles from the junction of the Wichita and the Red. The river varies from swift to rather sluggish, is turbid and deep, with broad meanders and oxbow lakes. The bottom is principally of mud, with some sandbars in the shallows. Surrounding country is forested with cottonwoods, willows and oaks, and the hills back from the river are grassy prairie.

DISTRIBUTION OF FISHES IN THE WATERSHED OF THE BIG WICHITA RIVER

Lepisosteus osseus (Longnosed Gar).-- Abundant in deeper parts of the river, and in pools beneath Lake Kemp Dam and Lake Diversion Dam, but not present in Lake Kemp or the river above that lake.

Lepisosteus platostomus (Shortnosed Gar).-- Rare. We took but two specimens, both in the lower part of the river, near its confluence with the Red.

Dorosoma cepedianum (Gizzard Shad).-- Abundant throughout the river from Lake Kemp to the river mouth. Occasional in the headwater streams as far west as Crowell Station, on the North Fork, and Guthrie Station on the South Fork.

Hiodon alosoides (Goldeye).-- Uncommon in the lower river, as far west as Diversion Dam Station. When Lake Diversion floods over its spillway after heavy rains, goldeyes sometimes ascend the Wichita River from the Red River in large numbers and dozens are taken by sports fishermen.

Ictiobus bubalus (Smallmouth Buffalo).-- Common in the lower river and the middle river, as far west as Kemp Dam Station, but not present in Lake Kemp or the upper river.

Carpiodes carpio (River Carpsucker).-- Common to abundant in the lower and middle rivers, including Lake Kemp, but apparently completely absent from the upper river, where salinity is high.

Cyprinus carpio (European Carp).-- Moderately common to abundant in the river from Kemp Dam Station to the river mouth. One small individual taken at Crowell Station shows that the species can stand high salinity.

Hybopsis storeriana (Silvery Dace).-- Previously recorded from the Red River but the single specimen we obtained at Byers Station is our only record.

Hybopsis aestivalis (Speckled Dace).-- Common in riffles in the river above Lake Kemp and in some sandy-bottomed tributaries of the lower river. It is scarce in the more sluggish waters of the lower river itself. This species thrives in some extremely saline waters.

Notemigoneus crysoleucas (Golden Shiner).-- Rare in the Big Wichita

River but moderately common in Lake Wichita. We took specimens in Holliday Creek near its junction with the river.

Pimephales promelas (Fathead Minnow).-- In the river this is a "pool" fish, sometimes moderately common but very local in its distribution. It seems to be absent from the river below Lake Kemp. It is found in some of the tributaries of the lower river.

Pimephales vigilax (Parrot Minnow).-- A common to abundant species throughout the length of the river. It is especially abundant in riffles and rapids where the water is cold, but was found in almost every ecological niche. It is capable of living in quite salty water.

Hybognathus placita (Silvery Plains Minnow).-- Common to abundant throughout the length of the river, including some extremely saline streams of the upper river. This species is much sought by commercial minnow dealers for it is the favorite bait minnow of the region.

Phenacobius mirabilis (Suckermouth Minnow).-- Uncommon but widespread through the length of the river. The species is capable of living in quite saline waters.

Notropis bairdi (Baird Shiner).-- Abundant in the headwaters of the river, and less common elsewhere throughout the length of the river. Of all of the species of Notropis found in the Big Wichita River, this form and N. oxyrhynchus are best able to stand excessively saline water.

Notropis buchanani (Ghost Shiner).-- This lake minnow is found sporadically in deeper pools and calm waters from Lake Kemp downstream.

Notropis deliciosus (Sand Shiner).-- Uncommon and restricted to shallow, swift water with sand bottom. Taken only in the lower river where salinity is only moderate.

Notropis lutrensis (Red Shiner).-- The most abundant shiner of the river from Lake Kemp downstream, and in the upper river above the sources of natural salt pollution. In the extremely saline waters of the upper river, the red shiner is rare and scattered. We suppose that most of the specimens from salty water were washed there by rains.

Notropis oxyrhynchus (Sharpnosed Shiner).-- A common species in the upper river, especially in riffles, and capable of standing high salinity. This form is less common in the middle river and the lower river but is widespread. Previously oxyrhynchus was thought to be endemic to the Brazos River system but it is widespread and obviously native to the Wichita River also. Suggestions that this species has been introduced to the Wichita River as bait may be discounted. It is widespread through the entire river system where salinity is high, and is most abundant in the upper river where there are no game fishes nor fishermen. There is no more reason to think that oxyrhynchus was introduced from the Brazos to the Wichita than to believe the reverse. For lack of earlier records from the lower river, see the account of N. fumeus in the hypothetical list.

Notropis percobromus (Plains Shiner).-- A common to abundant species below Lake Kemp but not recorded from Lake Kemp or the upper river.

Notropis potteri (Broadhead Shiner).-- Though rarely common, this shiner is widespread. We found it the entire length of the river from swift, saline headwater streams to the slow, turbid lower river. Occasional individuals reach a large size.

Notropis venustus (Spottail Shiner).-- We had long been aware that there was a small population of this shiner living in Deadman Creek near its junction with the Big Wichita River, and we therefore expected to find the species elsewhere on the watershed. To our surprise, it was not found anywhere except at the mentioned locality. Apparently the local population has resulted from released bait minnows.

Pilodictus olivaris (Flathead Catfish).-- Uncommon in the lower river. We took no specimens but, after many fish were killed by industrial pollution from Wichita Falls, many sick flathead catfish were washed into the Red River and picked up by Oklahoma fishermen. We were told of one pickup truck loaded with catfish, probably all from the Wichita River, seen at Waurika, Oklahoma. We noted a dead catfish on the bank of the Big Wichita River near its mouth that might have weighed 40 pounds.

Ictalurus punctatus (Spotted Channel Catfish).-- Common in the river from Lake Kemp to the river mouth. Apparently this species cannot stand high salinity for it was never found in the upper river. The channel catfish is one of the most sought fishes in the river as far as sports fishermen are concerned.

Ameiurus melas (Black Bullhead Catfish).-- We took two specimens of this fish at Guthrie Station, one sick and one dead. They were probably washed to Guthrie by rains, from the non-saline upper reaches of the South Fork, and were unable to survive in the salty water at Guthrie. In the lower river the bullhead is common and we have seen fishermen with large strings. However we took but one specimen in our nets, at Kemp Dam Station.

Fundulus kansae (Plains Killifish).-- Abundant in the upper river where it is one of the commonest species in excessively saline waters. This form and the pupfish survive and thrive in water too salty to support other fishes. We have taken both forms in Johnson Oil Field Creek, where salinity (total salts) tested 87,000 to 273,000 parts per million (8.7% to 27.3%). Below Lake Kemp Dam the killifish is scarce. It seems to be absent from the lower river.

Cyprinodon rubrofluviatilis (Red River Pupfish).-- An abundant form in the saline headwater streams, rare below Lake Kemp, a few records from Diversion Dam Station, and apparently absent from the river below Diversion Dam. The pupfish is also present in some tributary streams of the lower river when these are swift, clear and salty.

Gambusia affinis (Mosquitofish).-- Widespread and locally abundant through the entire length of the river, from the salty headwater streams to the river mouth, as well as in tributary streams and impoundments.

Morone chrysops (White Bass).-- Locally abundant from Lake Kemp downstream to the river mouth, but absent from the upper river. The white bass breeds in the Big Wichita River in great numbers.

Micropterus salmoides (Black Bass).-- Present or said to be present in deeper pools and tributaries of the upper river where salinity is low. It is a common species from Lake Kemp downstream to the mouth of the river.

Lepomis cyanellus (Green Sunfish).— A common to abundant species from the saline waters of the upper river throughout the entire length of the river and its tributaries.

Lepomis humilus (Orange-spotted Sunfish).— This small, brilliantly-colored fish is widespread but uncommon from Lake Kemp downstream to the river mouth.

Lepomis macrochirus (Bluegill Sunfish).— Recorded from Hackberry Station on the North Fork, above the source of natural salt, and common to abundant from Lake Kemp downstream.

Lepomis megalotis (Longeared Sunfish).— The distribution of this species in the Big Wichita River system is almost identical to that of the bluegill sunfish. In general, the longear is more common, usually much more common, than the bluegill.

Lepomis microlophus (Redear Sunfish).— The redear sunfish is rare in the Big Wichita River and we suspect that those individuals found were released hatchery fishes.

Chaenobryttus coronarius (Warmouth).— An uncommon form of slow, muddy waters of the lower river and some tributary streams.

Pomoxis annularis (White Crappie).— Common to abundant in the lower part of the river, from Lake Kemp downstream, but never taken in the river above Lake Kemp.

Aplodinotus grunniens (Freshwater Drum).— Common to abundant in the river from Lake Kemp downstream. We would have expected this species to have a high resistance to salinity but we did not find it above Lake Kemp.

HYPOTHETICAL LIST

Scaphirhynchus platorynchus (Shovelnose Sturgeon).— This species has been recorded from the Wichita River but we failed to take any specimens.

Lepisosteus productus (Spotted Gar).— Present in the impoundment lakes, including Lake Wichita and Lake Diversion, but we took no specimens in the river.

Astyanax fasciatus (Rio Grande Tetra).— This species is often found in a feral state as a result of the release of bait minnows. We did not find it in the river but did take specimens in Lake Wichita during the past year.

Notropis fumeus (Southern Ribbon Shiner).— Recorded from the Wichita River but not found by us. We wonder if the old records might not have been based on specimens of the sharpnosed shiner, a superficially somewhat similar species.

Notropis boops (Bigeye Shiner).— Recorded from "The Red River between Oklahoma and Texas," and thus by inference from the Wichita River also. We did not find this shiner, even though we were alert for it.

Notropis blennius (River Shiner).-- Another form recorded from the Red River, which we failed to find in the Wichita River.

Ictalurus furcatus (Blue Catfish).-- Reported by fishermen but probably as a result of mistaking large channel catfish for blue catfish. Large channel catfish lose their spots and are easily confused with the blue catfish by fishermen.

Anguilla rostrata (American Eel).-- This species once occurred in the river and in some tributary streams but we suppose that the construction of Denison Dam blocked this fish from ascending the river from the sea. However, there are persistent reports of their occurrence, although we have seen no specimens.

Fundulus notatus (Blackstripe Killifish).-- This species occurs in the Wichita Valley, although not commonly. However, to date we have found it only in irrigation ditches and never in the natural watershed of the Wichita River.

Micropterus punctulatus (Spotted Bass).-- Introduced into Lake Kemp and possibly occurs in the river on occasions.

Percina caprodes (Logperch).-- Our only specimens come from Lake Wichita but this fish doubtless occurs in the river also.

Sciaenops ocelata (Redfish).-- Introduced into Lake Kemp in 1954 and 1955. This species may ascend the saline waters of the upper river.

TABLE III. MONTHLY VARIATION IN SPECIES AND NUMBERS OF FISHES AT HACKBERRY STATION

species	7/19	8/5	9/11	9/25	10/21	11/26	1/6	2/4	3/4	4/17	5/7
Hybopsis	1								1		
Phenacobius					2			2	4		
N. bairdi	12	16			23	7	26	28	7	7	5
N. lutrensis	102	32	140	66	223	58	117	222	21	91	61
N. oxyrhynchus		11	1	2			3	2		4	1
N. potteri		2			10			2	2		1
Hybognathus	13				27	37	2	1	6		
P. promelas	98		37			1			3	66	3
P. vigilax	44	38		104	66	40	15	18	10		19
Ameiurus		2									
Fundulus	14	16	36	32		16	4	7	21	31	22
Cyprinodon	1	11		9	5	6	2	9	6	14	7
Gambusia	5	3	14	4	19				3		
Micropterus				1							
L. cyanellus	27	8	14	26	82	12		11	2	6	14
L. macrochirus		3	4	1	7						
L. megalotis	2	4	13	1	4						

TABLE IV. MONTHLY VARIATION IN WATER QUALITY AT HACKBERRY STATION

date	calcium	sodium	chloride	sulfate	carbonates	total salts	pH
7/19/54	724	312	932	999	154	3,127	7.65
8/5/54	1190	65	905	1628	137	3,946	7.75
9/11/54	535	806	911	1564	204	4,020	7.95
9/25/54	727	520	852	1577	122	3,798	8.64
10/21/54	762	559	1482	1633	209	4,042	7.78
11/26/54	780	495	861	1574	195	3,905	8.28
1/6/55	720	494	808	1522	173	3,717	8.10
2/4/55	766	494	870	1575	214	3,919	8.00
3/9/55	873	416	834	1614	198	3,935	7.95
3/12/55	814	528	888	1677	225	4,132	7.70
4/17/55	604	525	888	1192	195	3,414	7.50
5/3/55	562	512	799	1145	232	3,250	8.00
5/9/55	546	576	906	1112	204	3,334	8.19

TABLE V. MONTHLY VARIATION IN SPECIES AND NUMBERS OF FISHES TAKEN AT JOHNSON OIL FIELD STATION

species	7/19	8/5	9/11	9/25	10/21	11/26	1/6	2/4	3/12	4/17	5/7
Hybopsis		1	4	1		8	2	3	7	9	3
N. *bairdi*	7	24	10	10	30	31	263	492	61	9	28
N. *lutrensis*	6	9	1	1	2	4	2			1	
N. *oxyrhynchus*	13	1				16	3	3	2	1	
N. *potteri*			13	11			2	3		2	3
Hybognathus	5	10	28	38	5		7		1	16	11
P. *vigilax*		1				11			3		
Fundulus	4	49	393	262	216	119	30	221	121	62	41
Cyprinodon	33	49	99	103	113	64	16	4	88	31	18
Gambusia	4	5	6	1	4	14		3			
L. *cyanellus*	1										

TABLE VI. MONTHLY VARIATION IN WATER QUALITY AT JOHNSON OIL FIELD STATION

date	calcium	sodium	chloride	sulfate	carbonates	total salts	pH
7/19/54	747	4590	7588	997	125	14,058	7.25
8/4/54	2734	3434	8121	2643	122	17,060	7.80
9/11/54	517	5858	8653	1654	136	16,818	7.85
9/25/54	7114	4845	17883	2733	337	32,912	8.53
10/21/54	4773	1479	8653	2743	124	17,782	7.78
11/26/54	1426	4718	7854	2506	158	16,662	8.20
1/7/55	1266	4645	7544	2400	161	16,016	8.10
1/29/55	867	5000	7322	2453	198	15,840	7.81
2/4/55/	1208	4386	7145	2256	172	15,167	8.40
3/9/55	1205	4845	7590	2588	192	16,420	7.85
3/12/55	1618	4896	8343	2684	171	17,712	7.60
4/17/55	980	5050	8653	1084	137	15,904	7.55
5/3/55	800	4335	7189	1167	138	13,629	8.15
5/9/55	884	5100	8140	1662	128	15,914	8.21

TABLE VII. MONTHLY VARIATION IN SPECIES AND NUMBERS OF FISHES AT CROWELL STATION

species	6/18	7/23	8/4	9/4	10/10	11/9	12/5	1/16	2/6	3/7	4/23	5/8
Dorosoma		1										
Cyprinus			1									
Hybopsis	7	5	6	12	5	14	2	17	7	17	3	11
N. bairdi	13	22	14	1	6	11	26	41	27	28	26	14
N. lutrensis	22	77	16	2	9	3	4	9			4	
N. oxyrhynchus	23	59	21	30	30	9	7	2	5	11	19	42
N. potteri	—	4	1	7	2	2				3	4	11
Hybognathus	26	7	32	19	28	35	41	39		3	4	16
P. promelas			8									
P. vigilax										9		
Fundulus	166	203	61	131	92	75	67	167	185	87	31	39
Cyprinodon	27	24	25	17	20	34	;91	59	33	22	14	40
Gambusia		1										
L. cyanellus	3		1									

TABLE VIII. MONTHLY VARIATION IN WATER QUALITY AT CROWELL STATION

date	calcium	sodium	chloride	sulfate	carbonates	total salts	pH
6/18/54	1314	2275	4726	2275	148	9,858	8.00
7/23/54	3022	2424	6825	2978	124	15,378	7.50
8/4/54	1675	4590	7562	3261	98	17,210	7.80
9/4/54	1133	2933	5396	1450	110	11,022	7.70
10/10/54	5506	4743	14777	3048	96	28,170	8.54
11/9/54	3653	2609	6653	3136	125	16,176	8.00
12/5/54	1496	4335	7190	2794	146	15,961	8.13
1/16/55	1100	3927	6213	2320	146	13,706	8.05
2/6/55	776	1326	2441	1258	95	5,896	8.30
3/7/55	594	4335	5592	2818	122	13,461	7.80
4/23/55	1040	4945	7765	2205	132	16,087	7.61
5/8/55	1006	4998	7420	2715	115	16,254	7.98

TABLE IX. MONTHLY VARIATION IN SPECIES AND NUMBERS OF FISHES AT GUTHRIE STATION

species	7/19	8/5	9/11	9/25	10/21	11/26	12/10	1/6	2/4	3/12	4/17	5/7
Dorosoma				6								
N. bairdi		3				9	5		6	7	11	
N. lutrensis	59	35	46	104	18	23	11	13	12	2	4	14
N. oxyrhynchus						2	1					
N. potteri						2						
Hybognathus		16	1	4			14	3	6		14	4
P. promelas	64	87	165	122	32	27	21	43	145	67	38	28
Ameiurus			2									
Fundulus	71	56	20	75	418	18	23	6	5	21	61	36
Cyprinodon	27	21	6	15	276	53	321	121	212	81	20	9
Gambusia		3					1					
L. cyanellus	21	9	11	7	26		1					

TABLE X. MONTHLY VARIATION IN WATER QUALITY AT GUTHRIE STATION

date	calcium	sodium	chloride	sulfate	carbonates	total salts	pH
7/19/54	1783	1428	3532	2346	111	9,211	7.80
8/5/54	2438	1377	4127	3013	145	11,112	7.50
9/11/54	1185	3366	5434	2436	143	12,544	7.65
9/25/54	5589	2958	11715	3649	114	24,512	8.49
10/21/54	3844	1122	5860	3456	230	14,512	7.33
11/26/54	1661	2958	5148	2972	240	12,979	8.19
12/10/54	95	60	120	136	70	481	7.69
1/6/55	1469	2397	4172	2717	210	10,965	8.15
2/4/55/	1272	1581	2751	2453	232	8,289	8.00
3/12/55	1840	2444	4615	3097	213	12,209	7.49
4/17/55	1236	2448	4482	1857	201	10,224	7.25
5/7/55	1384	2856	5184	2160	172	11,720	8.29

TABLE XI. MONTHLY VARIATION IN SPECIES AND NUMBERS OF FISHES AT BENJAMIN STATION

species	6/18	7/23	8/4	9/4	10/10	11/9	12/5	1/16	2/6	3/7	4/23	5/8
Dorosoma			1		1							
Hybopsis		2	1									
N. bairdi	5	167	56	25	2			1	34	35	22	5
N. lutrensis			5									
N. oxyrhynchus	1		11	7								
N. potteri				46							3	
Hybognathus	26	4	19	55	407	429	46	1		24	9	
P. vigilax			3									
Fundulus	51	118	50	14	63	39	14	14	17	4	31	9
Cyprinodon	47	20	32	32	66	54	21	3			9	

TABLE XII. MONTHLY VARIATION IN WATER QUALITY AT BENJAMIN STATION

date	calcium	sodium	chloride	sulfate	carbonates	total salts	pH
6/18/54	1018	2163	3741	1794	133	8,849	7.95
7/23/54	2994	5610	11272	3512	150	23,553	7.75
8/4/54	3380	5050	11183	3459	69	23,153	7.60
9/4/54	2071	4590	9541	1553	116	17,871	7.20
10/10/54	6447	4770	15750	4030	116	31,113	8.42
11/9/54	4532	5444	11630	3874	116	25,596	8.00
12/5/54	2686	7929	14245	3586	149	28,595	8.10
1/16/55	2661	6161	3106	2928	140	14,996	7.95
2/5/55	1120	6010	10073	1512	124	18,839	8.15
3/7/55	3266	6767	13580	3504	122	27,239	7.80
4/23/55	1896	8585	14777	2380	144	27,782	7.59
5/8/55	884	3060	5192	1370	137	10,643	8.20

TABLE XIII. MONTHLY VARIATION IN SPECIES AND NUMBERS OF FISHES TAKEN AT LAKE KEMP DAM STATION

species	6/13	8/10	9/1	10/26	11/18	12/23	1/6	2/21	3/1	4/11	5/18
Dorosoma	80	2	2		1	6	8	8	12	48	17
I. bubalus	4		2			6	3	2	9	2	
Carpiodes	2			10	1	4	2	1	4	15	
Cyprinus					2	2		1			
Phenacobius				1							
N. bairdi	1									16	
N. buchanani	11				4			7	3	40	17
N. deliciosus					1		18		2		
N. lutrensis	121	36	65	38	81		46	2	20	23	61
N. oxyrhynchus			17		4		1				
N. percobromus	3			6	43						3
N. potteri				2	1						
P. vigilax	57	21	37	22	60		12	72	17	19	30
Ictalurus	12	11	3					1		1	
Fundulus	39	1	1								8
Cyprinodon	5		5				2				
Gambusia	15	21	4		33				10		
Morone			20	9	5	1	3		1	3	
Micropterus		1	1	1	3	6		1	3	7	
Chaenobryttus	1										
L. cyanellus	1		6	6					1		
L. humilus				3					5		
L. macrochirus	46		8	8				2	36	21	
L. megalotis	59	3	11	30					9		1
Pomoxis	11		8	16	2	2				1	
Aplodinotus	16										

TABLE XIV. MONTHLY VARIATION IN WATER QUALITY AT LAKE KEMP DAM STATION

date	calcium	sodium	chloride	sulfate	carbonates	total salts	pH
6/13/54	198	255	448	339	79	1,319	7.80
7/9/54	284	438	772	475	87	2,062	8.10
8/10/54	283	432	786	381	98	1,986	7.70
9/1/54	271	294	577	404	104	1,650	7.60
9/12/54	171	390	538	416	96	1,611	8.00
10/9/54	245	348	586	438	96	1,713	8.72
10/26/54	279	312	577	438	128	1,734	8.14
11/18/54	252	360	604	454	98	1,768	8.27
12/9/54	270	351	612	432	124	1,789	6.99
12/13/54	263	360	621	433	106	1,783	7.93
1/6/55	270	360	639	436	119	1,824	8.20
2/21/55	243	411	630	485	120	1,889	-
3/1/55	268	396	666	475	122	1,927	8.10
3/13/55	267	384	648	461	128	1,888	7.75
4/11/55	240	366	673	272	137	1,689	8.31
5/18/55	272	378	763	282	162	1,857	7.50

TABLE XV. MONTHLY VARIATION IN SPECIES AND NUMBERS OF FISHES AT DIVERSION DAM STATION

species	6/1	6/6	7/7	8/2	9/16	10/7	11/17	12/9	1/17	2/22	3/2	4/6	5/25
L. osseus	25			11	8	5	6			1			
Dorosoma	1	93		10	45	11		3	1	12	4		
Hiodon		1											
I. bubalus	1												
Carpiodes	11			3			1	1					
Cyprinus				2				1					
Phenacobius				4									
N. buchanani													2
N. deliciosus				5	7	14		3		2			
N. lutrensis		84		34	28	55		11		26	58	36	26
N. percobromus		2			7	3							1
N. potteri						2							
Hybognathus						12						3	1
P. vigilax		4		11	212	68		1		1		20	
Ictalurus			4	6		4							
Fundulus		6		4		3						3	
Gambusia		2		2			1	1			9		
Morone	1	1	1		3					1			
Micropterus		7	5	5	1	1	3			4	1		1
Chaenobryttus											4	1	
L. cyanellus	4	17	8	16	4	26		9		1		1	
L. humilis		2		2			3					10	
L. macrochirus	5	9	35	15	21	1	22	3		1	1	2	
L. megalotis	1	4	6	63	37	17	6	12		1	2		
L. microlophus				2		1							
Pomoxis	1		6	4		1		5					
Aplodinotus			19	37	2	1			1				

TABLE XVI. MONTHLY VARIATION IN WATER QUALITY AT DIVERSION DAM STATION

date	calcium	sodium	chloride	sulfate	carbonates	total salts	pH
6/1/54	168	329	520	314	91	1,422	7.90
7/8/54	191	245	411	278	90	1,224	8.00
8/2/54	232	342	586	351	139	1,662	7.75
9/16/54	299	468	834	485	93	2,179	8.45
10/7/54	258	468	763	484	90	2,063	8.60
11/17/54	233	450	784	478	91	2,036	8.60
12/9/54	274	423	692	505	116	2,010	8.31
1/17/55	276	402	675	486	119	1,958	7.90
2/22/55	266	411	666	495	115	1,953	8.15
3/2/55	264	420	701	477	109	1,971	-
4/8/55	228	366	818	116	131	1,859	8.10
5/18/55	248	378	728	292	125	1,771	8.35
5/25/55	180	306	568	211	110	1,375	-
							7.95

TABLE XVII. MONTHLY VARIATION IN SPECIES AND NUMBERS OF FISHES AT DEADMAN BRIDGE STATION

species	6/24	7/13	8/3	9/27	10/19	11/16	12/7	1/7	2/17	3/8	4/19
Dorosoma	2	9	5	1							
Carpiodes			1			1					
Cyprinus			1								
Phenacobius				1							
N. bairdi	1	1		1	2	7					1
N. lutrensis	201	128	330	80	128	16	11	66	78	34	63
N. oxyrhynchus				13							
N. percobromus	14		15	17	14	21	33	10	11	7	6
N. potteri			4		1		7	2			
N. venustus	2		4								
Hybognathus	2	1	242	1	6		6		3		
P. promelas		1									
P. vigilax	15	12	27	31	14	14	19	14	12	9	30
Ictalurus		1	1		4						1
Cyprinodon		1	6	6	3	16					
Gambusia		3		61	26	5		8			
Morone			4	11	4		3				
L. cyanellus			1								
L. megalotis	1		2	2	1						
Pomoxis		1									
Aplodinotus		3									

TABLE XVIII. MONTHLY VARIATION IN WATER QUALITY AT DEADMAN BRIDGE STATION

date	calcium	sodium	chloride	sulfate	carbonates	total solids	pH
6/24/54	631	651	1642	47;	231	3,626	7.60
7/13/54	506	312	1012	389	125	2,250	8.00
8/3/54	822	195	1369	496	162	3,070	8.00
9/27/54	391	819	1411	628	139	3,338	8.69
10/19/54	500	744	1482	604	174	3,505	7.83
11/16/54	242	715	1012	579	152	2,700	8.02
12/7/54	529	754	1527	613	198	3,621	7.81
1/7/55	427	689	1429	375	182	3,102	8.30
2/12/55	1380	975	2166	2175	294	6,990	-
3/8/55	714	803	1962	556	232	4,267	7.89
4/7/55	524	714	1908	12	207	3,365	8.21
4/19/55	386	741	1411	704	186	3,428	7.80
5/1/55	332	572	1216	195	180	2,495	8.31
5/17/55	100	165	355	8	113	741	7.75

TABLE XIX. MONTHLY VARIATION IS SPECIES AND NUMBERS OF FISHES AT BYERS BRIDGE STATION

species	6/24	7/23	8/6	9/14	9/21	10/13	11/16	12/8	1/7	2/17	3/8	3/30	4/6
L. osseus	1		11									119	4
L. platostomus			1									1	
Dorosoma	69	138	19	10	7		4	1				2	
Hiodon												2	
Ictiobus			6									13	1
Carpiodes		4	34					1				15	20
Cyprinus			1										
H. aestivalis		1									14		
H. storeriana											1		
Phenacobius			2										
N. bairdi		4	9		1		16	3	53		6		
N. lutrensis	35	86	131	6	136	59	110	41	28				9
N. oxyrhynchus		50	114	3	2		8	1		1			4
N. percobromus			18	2	16	7	26	11		2	26		14
N. potteri			11				1	1	17	5			
Hybognathus		318	253	326	23	112	143	77	14	5	33		7
P. vigilax				13				3	6	3	9		5
Ameiusus												1	
Ictalurus		1	3		6	5				1			1
Gambusia			21	40	141		21	11				4	2
Morone			22	5	9	3						3	2
L. cyanellus		2											
L. humilus		1		1									
L. macrochirus		1			3		1			1			
L. megalotis	1	3	2	3	3	2							
Pomoxis					1	1							
Aplodinotus			7	3	1	1	1						

TABLE XX. MONTHLY VARIATION IN WATER QUALITY AT BYERS BRIDGE STATION

date	calcium	sodium	chloride	sulfate	carbonates	total salts	pH
6/24/54	183	295	520	214	171	1,383	8.10
7/9/54	306	510	976	373	113	2,289	8.15
7/23/54	651	26	852	385	90	2,010	8.05
8/6/54	761	91	1057	468	127	2,519	7.95
9/14/54	171	793	1074	508	119	2,665	8.77
10/13/54	35	884	967	497	143	2,526	8.00
11/16/54	1122	552	582	518	161	1,935	8.06
12/8/54	470	682	1322	592	201	3,267	8.12
1/7/55	338	832	1429	456	192	3,247	8.35
2/17/55	490	546	1207	490	207	2,940	-
3/8/55	532	803	1669	504	210	3,728	8.20
3/30/55	268	286	869	120	186	1,729	8.45
4/6/55	384	468	1242	72	189	2,355	8.42
4/12/55	337	546	1242	112	198	2,435	8.41
5/23/55	72	90	186	32	91	471	7.70

TABLE XXI. PERCENTAGE COMPOSITION AND SEX RATIOS OF THE LARGER FISHES TAKEN IN THE BIG WICHITA RIVER

species	number taken	% of total	% males	% females
Lepisosteus osseus	193	23.3	59	41
Dorosoma cepedianum	240	29.0	57	43
Hiodon alosoides	3	.3	-	100
Ictiobus bubalus	50	6.0	54	46
Carpiodes carpio	95	11.4	52	48
Cyprinus carpio	11	1.2	55	45
Ictalurus punctatus	50	6.0	58	42
Morone chrysops	60	7.1	38	62
Micropterus salmoides	31	3.8	34	66
Pomoxis annularis	38	4.6	47	53
Aplodinotus grunniens	65	7.7	34	66
totals	826	100.4		

TABLE XXII. WEIGHTS, PERCENTAGE COMPOSITION BY WEIGHT AND MEAN WEIGHTS OF LARGER FISHES TAKEN IN THE BIG WICHITA RIVER

species	weight taken	% of total weight	mean weight
Lepisosteus osseus	710.8 lbs.	61.6%	3.7 lbs.
Dorosoma cepedianum	144.0	12.4	.6
Hiodon alosoides	2.1	.2	.7
Ictiobus bubalus	88.1	7.6	1.7
Carpiodes carpio	86.4	7.5	.9
Cyprinus carpio	23.2	2.0	2.1
Ictalurus punctatus	34.7	2.9	.7
Morone chrysops	14.9	1.3	.2
Micropterus salmoides	21.7	1.9	.7
Pomoxis annularis	7.2	.6	.5
Aplodinotus grunniens	20.3	1.8	.3
totals	1153.4	99.8	

SALINITY TOLERANCE OF FISHES IN THE BIG WICHITA RIVER

Marked differences are apparent in the resistance of the various species of fishes that occur in the Big Wichita River. Some kinds can stand salinities much greater than that of the sea. Others, though basically fresh-water forms, are able to exist in waters that range from a third as salty as the sea to slightly more salty than the sea (assuming 3% salinity as normal sea water). Still other forms are strictly restricted to low salinities and do not normally occur in water exceeding one-tenth of the salinity of the sea.

Topping the list in salt-resistance are the killifish (*Fundulus kansae*) and the pupfish (*Cyprinodon rubrofluviatilis*). Both species were found in the Johnson Oil Field Creek, where total salts ranged from a minimum of 87,000 ppm. to a maximum of 273,000 ppm (10,000 ppm. equals 1%). It is probably significant that both genera are salt-water types, and both of our representatives have close relatives in the Gulf of Mexico. However, the same might be said of the white bass and freshwater drum, but neither of these fishes was taken in waters of high salinity.

The second group of fishes includes those that we found naturally common in waters ranging from 10,000 to slightly more than 30,000 ppm. These are:

Hybopsis aestivalis (Speckled Dace)
Notropis bairdi (Baird Shiner)
Notropis oxyrhynchus (Sharpnosed Shiner)
Notropis potteri (Broadhead Shiner)
Hybognathus placita (Silvery Plains Minnow)
Pimephales vigilax (Parrot Minnow)

It is possible that the mosquitofish (Gambusia affinis) and the green sunfish (Lepomis cyanellus) also belong in this group for both occur often but not regularly in highly saline waters. If the upper limit were set at 20,000 instead of 30,000 ppm., we would unhesitatingly include both.

A few species have been taken casually in waters in the 10,000 to 30,000 ppm. total salts range. This indicates that these species can stand such high salinity but do not like it and leave it for fresher water. We include here the gizzard shad (Dorosoma cepedianum), European carp (Cyprinus carpio), fathead minnow (Pimephales promelas) and the red shiner (Notropis lutrensis). We took this latter species quite often within the high salinity waters but in every instance we had reason to think the specimens had been swept downstream from waters of lower salinity, where the species is the most common or almost the most common fish.

We would set the lethal-salinity limit of the black bullhead catfish (Ameiurus melas) at or near 12,000 ppm. On September 11, 1954, we took two emaciated bullheads, one dead and one still living, at Guthrie Station when the total salts tested at 12,500 ppm.

Other species occurring in the drainage area of the Big Wichita River seem not to occur naturally in waters where the total salts measure more than 4,000 ppm. Game fishes, such as the black bass, crappie and white bass, are usually found in waters of less than 3,000 ppm. total solids and less than 1,000 ppm. chloride.

PRESENT UTILIZATION OF THE FISHES OF THE BIG WICHITA RIVER, EXCLUSIVE OF THE IMPOUNDMENT LAKES

The upper river is almost useless, at present, for game fishes. It is possible that a few fish are taken each year from the extreme headwaters where the water is not excessively salty. The upper river does, however, support a vast number of small fishes, suitable for bait. The favored bait species in north-central Texas is the silvery plains minnow, Hybognathus placita, and this fish abounds in the upper river. One of the most common species, the pupfish, is almost useless for bait; at least there is no market for it. It is unfortunate also that the killifish, Fundulus kansae, though we have found it to be excellent bait, finds no ready market because of local prejudice. The various species of shiners, especially when they are large, as they usually are in the upper river, are good and salable bait.

The upper river is not greatly utilized for bait minnows at present, in part because much of it is not easily reached by car and in part because local landowners refuse access to bait dealers. Some landowners go so far as to drive seiners from the river bed when they have reached the water by highway right-of-way and have a legal right to operate. Almost all of the upper river is, legally, a navigable stream and its bed therefore belongs to the state. We judge that a considerable resource in bait minnows is at present wasted each year in the upper river.

The middle river, especially in the extreme upper part, supports a heavy fishing pressure. Unfortunately here too landowners refuse access to fishermen through most of the length of the river. The lower part of the middle river can be reached by boat from Lake Diversion, but this part is shallow and not good fishing.

The lower river is the best fishing water of the entire river. Here again much of the banks are closed to access but there are some boat fishermen who enjoy excellent fishing. Where access to the river banks is permitted by the landowners, or where the river banks belong to a city or county, there is much fishing pressure.

In general, however, sports fishing in the river itself is far less important than it is in the impoundment lakes.

POSSIBILITIES OF IMPROVEMENT OF THE BIG WICHITA RIVER FOR FISHING

We have considered three factors in possible improvement of the BigWichita River for sports fishing. These are: (1), cutting down or eliminating the salt burden of the river; (2), stocking the river and impoundment lakes with salt water game fishes if elimination of the salt is impractical; (3), gaining more access to the river for fishermen.

In studying possible methods of cutting down or eliminating the salt of the river we have had the active cooperation of the Wichita County Water Improvement Districts. If a suitable method can be devised, they will be the agency to do the work and bear the cost. Several methods are here discussed.

Pollution by oil-well salt.-- Elimination of this industrial pollution should cut down by approximately one-half, the sodium chloride occurring in the river between Lake Diversion and the river mouth. Pollution abatement is continuing with marked success. See Completion Report, F-7-R-2, Job C-2, part 2).

Damming or blocking the salt springs of the upper river.-- Some experiments and consultations with geologists have convinced us that this is impossible.

Damming Salt Creek to back-pressure the salt springs.-- It is highly possible that this might result in stopping the flow of the principal offending springs. It would be expensive, however, and it is possible that it would only result in the salt water finding a new outlet further downstream, below the new dam. There are possibilities of this method in conjunction with the following suggestions.

Damming Salt Creek and pumping its water to the Pease River.-- Since the Pease River is extremely saline, usually dry, and has no game fishes, we would approve of this. The salt would reach the Red River sooner than it would at present, at the mouth of the Pease instead of the mouth of the Wichita. We judge that the salt in Lake Kemp could be cut in half by this method, and the salts of the lower river even more. The cost would be in the millions of dollars.

Damming Salt Creek and pumping the water onto or into an evaporation basin.-- This method would be cheaper than the above if a suitable basin area, of some impermeable rock, can be found closer than the divide of the Pease River. In time of extremely heavy rains, the basin might flood and allow the salt to reach the main river in high concentration.

Constructing a retaining dam across the river above Lake Kemp.-- The construction of a dam as large as would be required, if possible at all, would be almost prohibitively expensive. Further, it is doubtful that the gypsum rocks of this area would hold water if the dam were constructed.

Drilling disposal wells for pumping the salt water into the earth.-- Geologists consulted stated that the disposal wells would take the water only until the ground was saturated, and then refuse to accept more water. Flowage of the underground water is only ten to 100 feet per year, but eventually the underground salt water would find another outlet to the river, farther downstream.

Detouring the entire Wichita River around Lake Kemp and Lake Diversion.-- This practical method would leave Lake Kemp and Lake Diversion as sweet-water lakes but would seriously pollute the lower Wichita River. This, from the standpoint of fisheries management, might be worth the gains in removing the salt from the impoundment lakes. Estimated cost of this is about nine million dollars.

If the elimination of the salt is impractical, we have considered the utilization of the saline waters for the establishment of a sports fishery of salt-water game fishes introduced from the Gulf of Mexico. Experiments are now being carried out with the redfish (Scianops ocellata) and other species are being considered.

In general, access for fishermen to the lower river can be legally gained only at the highway rights-of-way, where bridges are constructed. There boats can be launched for "float-trips" downstream to another bridge. Unfortunately many landowners have fenced off and posted the highway right-of-way where a boat would have to be launched. We feel sure that increased popularity of the float-trips will eventually cause fishermen to determine their legal rights in the courts.

SUMMARY

The Big Wichita River of north-central Texas is the principal tributary of the Red River in Texas and, unlike most Texas rivers, drains northeastward into Oklahoma and Arkansas before turning southward to the Gulf. The river is approximately 165 miles from permanent-water headwaters to mouth, and drains approximately 4,000 square miles of land. The watershed is entirely in the red beds of the Texas Permian and the dissolved solids carried by the waters are of Permian origin. In its upper parts the river is shallow, swift, saline and flows through deep canyons in the desert-like cedar brakes. The middle river, between Lake Kemp and Lake Diversion, is dependent for flow on human agency. The river here is sinuous, shallow, and has a mud or quicksand bottom. The lower river, below Lake Diversion, is a mature stream of deep, slow, turbid water that reaches the Red River in a series of broad meanders. The entire drainage area is in the Mesquite Plains Biotic District but vegetation varies from desert-type shrubs on the headwaters to broad-leafed forest near the river mouth.

The most striking feature of the Wichita River is the dissolved salt burden.

Much of this salt comes from natural springs on the headwater streams. The upper third of the river is useless to game fishes because of this salt. Many small fishes of the minnow type do live in the saline waters of the upper river.

The chemical nature of the river and its tributaries is discussed in detail, and the fish fauna is discussed both arealy, quantitatively and qualitatively. Detailed chemical analyses, including calcium, sodium, chloride, sulfate, carbonates, total salts and pH, are listed for 100 sample localities of the river and its tributaries. Monthly listings of fishes and water chemistry is given for nine stations along the length of the river. An account of the species of fishes and their distribution in the river, and their tolerance to high salinity, is given. Methods of improving the fishing in the river are discussed.