

No.	Date	Calcium	Sodium	Chloride	Sulfate	ates	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	720	494	808	1522	173	3,717	8.10
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	21,102	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	192	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	7.52
32.	3/ 9/55	2593	1380	4750	2577	182	11,482	7.70
33.	7/19/54	27624	26026	88351	1059	125	143,186	7.70
	9/25/54	67956	33000	170090	1895	93	273,034	8.00
	1/31/55	8770	24550	51520	2503	135	87,478	7.70
34.	1/31/55	6745	10854	26980	2280	112	46,980	7.30
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
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

Locality No.	Date	Calcium	Sodium	Chloride	Sulfate	Carbonates	Total Salts	pH
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

The twelve permanent sample stations were named after nearby towns, geographic features or lakes. Their positions are shown on the accompanying map. Data for Lake Kemp and Lake Diversion were gathered during the 1953-54 period. Other data were collected during the 1954-55 investigation.

HACKBERRY STATION—Located at the small town of Hackberry, Cottle County, approximately 7 miles south-southwest of Paducah. Here the water is relatively "sweet," clear and cold. There is a large, deep, sand-bottomed pool and a long, swift, stony rapids.

**JOHNSON OIL FIELD STATION**—Located on the North Fork where it is crossed by Farm Road 567, about six 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, green pools. Surrounding country is barren hills of gypsum and sandstone with dominant vegetation of cedar and cacti.

**CROWELL STATION**—Located 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 and rills, and a few moderately deep pools.

**GUTHRIE STATION**—Located on the South Fork at the town of Guthrie, where the river is 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 to run, but the pools rarely dry out completely. 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**—Located 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 summer the river is often completely dry, exposing the hard, stone bed. In times of heavy rains the river bottom becomes a raging torrent, 100 feet across and six to ten feet deep.

**LAKE KEMP**—The bulk of the water samples were taken at Cara Blanca, at the southern and western (upper) end of the lake.

**KEMP DAM STATION**—Located in the plunge pool below the dam, at the eastern end of the lake. When water is released from the floodgates the river becomes broad, clear, swift and extremely cold at this station. At other times the deep pools become almost stagnant. Surrounding country is mesquite-covered hills.

**LAKE DIVERSION**—Water samples were taken in Crappie Creek Bay, on the northern side of the lake.

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

only a few gravel-bottomed rapids. Surrounding country is a broad valley where dominant vegetation is cottonwoods and elms. Surrounding the valley are mesquite-covered hills and flats.

LAKE WICHITA—Water samples were taken on the northern side of the lake.

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.

Table 3. 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	404	108	1522	173	3,717	8.10
2/4/55	766	491	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 4. 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

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 6. 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	5414	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 7. 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

8/25/53	852	1,960	7.7
9/29/53	834	1,890	7.6
10/ 1/53	852	1,750	7.9
10/23/53	639	1,470	7.1
11/12/53	444	1,050	7.2
12/ 3/53	674	1,400	7.5
12/30/53	710	1,540	7.6
1/22/54	781	1,454	7.6
1/26/54	852	1,890	8.1
3/16/54	1065	2,100	7.6
4/21/54	746	1,960	7.9

**Table 9. 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 10. Monthly Variation in Water Quality at Lake Diversion**

Date	Chloride	Total Salts	pH
7/24/53	1,366	3,185	7.9
7/30/53	1,402	3,500	8.0
8/31/53	1,242	2,520	7.5
9/10/53	1,278	2,800	8.1
9/20/53	1,242	2,520	7.9
10/18/53	1,207	2,100	7.5
11/ 5/53	869	1,820	7.4
11/23/53	923	1,960	7.5
12/16/53	823	1,890	7.6
1/ 7/54	869	1,750	7.4
2/ 4/54	834	1,420	7.6
2/23/54	852	1,610	7.8
3/10/54	781	1,820	8.1
4/22/54	710	1,820	7.9

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	8.31
12/ 9/54	274	423	692	505	116	2,010	7.90
1/17/55	276	402	675	486	119	1,958	8.15
2/22/55	266	411	666	495	115	1,953	.....
3/ 2/55	264	420	701	477	109	1,971	8.10
4/ 8/55	228	366	818	116	131	1,859	8.35
5/18/55	248	378	723	292	125	1,771	.....
5/25/55	180	306	568	211	110	1,375	7.95

**Table 12. Monthly Variation in Water Quality at Deadman Bridge Station**

Date	Calcium	Sodium	Chloride	Sulfate	Carbonates	Total Salts	pH
6/24/54	631	651	1642	471	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 13. 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	482	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	368	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

6/21/54	43	34	83	3	84	247	7.65
7/14/54	59	100	160	54	96	472	8.20
8/12/54	259	444	786	381	98	1,986	7.70
8/17/54	252	518	825	470	104	2,181	7.75
9/ 9/54	89	159	293	97	55	693	8.56
9/22/54	119	168	327	108	104	826	8.43
10/ 6/54	116	196	337	139	108	896	8.81
10/19/54	115	198	342	133	113	901	7.78
11/25/54	122	208	350	156	122	958	8.23
12/15/54	336	198	387	121	135	1,177	7.78
12/21/54	114	222	364	149	113	962	8.15
1/12/55	103	222	355	130	122	932	8.20
1/26/55	132	216	360	187	122	1,017	7.80
2/ 1/55	154	252	426	221	128	1,181	7.60
2/25/55	220	192	384	215	120	1,131	7.90
3/ 4/55	248	204	375	413	125	1,365	7.85
4/20/55	128	258	462	116	159	1,123	8.50
5/ 9/55	128	264	476	89	152	1,109	8.49
5 25/55	64	76	142	43	98	423	7.70

#### FISHES OF THE BIG WICHITA RIVER AND ITS IMPOUNDMENTS

A total of fifty species of fish have been established as occurring in the Big Wichita River and its impoundments, including several forms known or suspected to have been introduced. Specimens of most of these species have been examined by us and examples preserved in the collection of lower vertebrates at Midwestern University. A few records have been taken from the literature.

##### *Annotated Checklist of Species*

##### Family *Acipenseridae*

*Scaphirhynchus platyrhynchus*: shovelnose sturgeon. Definitely recorded from the Big Wichita River only once, near its mouth, on May 13, 1948. For details see Bonn and Kemp (1952). We have heard of others taken in past years from the lower river but there seem to be no records for the last two years.

##### Family *Lepisosteidae*

*Lepisosteus platostomus*: shortnose gar. The relationship between this form and the next species are rather confusing. Both species are present in most of the Big Wichita River system, but neither is abundant. In Lake Wichita, the shortnose gar outnumbers the spotted gar but elsewhere the reverse is true. Both the shortnose gar and the spotted gar may be important predators of the sunfishes and may be desirable in moderate numbers.

*Lepisosteus productus*: spotted gar. In Lake Kemp, the spotted gar is the dominant gar. Elsewhere it is only moderately common, or

gether, the longnose gar always outnumbered both the spotted and shortnose gars, at least in these waters.

*Lepisosteus osseus*: longnose gar. The longnose gar is the most abundant and successful gar in our waters, except in Lake Kemp and the upper river. Questioning commercial fishermen and old residents indicates that this gar never did occur in Lake Kemp. It is possible that no longnose gars were present in the area when the Lake Kemp dam was constructed. The longnose gar is a swift, predacious species that destroys many gizzard shad and sunfishes, and often is a highly beneficial fish. We suspect that the complete absence of goldfishes in the Big Wichita River system is largely the result of the predacious habits of this gar. Some white bass, and perhaps other game fishes, are also eaten. In large numbers, the longnose gar is a pest that drives fishermen to distraction by stealing bait minnows, almost never becoming hooked.

#### Family *Clupeidae*

##### Herrings and Shads

*Dorosoma cepedianum*: gizzard shad. The gizzard shad is extremely abundant in the Big Wichita River system, ranging from the mouth of the river to and well into the upper river. Gizzard shad reach a large size in Lake Kemp and Lake Diversion but especially in Lake Wichita where specimens of four pounds or more in weight are not uncommon. Young gizzard shads are extensively fed upon by game and predacious fishes, but are often so abundant that the game fishes refuse bait minnows and artificial baits. Because the numbers of gizzard shad cannot be kept in control by natural means, it quickly outbreeds and crowds out desirable fishes. The gizzard shad is not itself edible. However, it is one of our most important forage species.

#### Family *Hiodontidae*

##### Mooneyes

*Hiodon alosoides*: goldeye. This highly predacious but almost inedible fish is moderately common in the lower river. We took a single specimen in Lake Diversion. Fishermen's accounts of catching shad on a fishhook pertain to the goldeye.

#### Family *Characidae*

##### Tetras

*Astyanax fasciatus*: Rio Grande tetra. The tetra does well in our water in the summer. It is often sold by local bait dealers and commonly

and are taken in a feral state shortly thereafter.

#### Family *Catostomidae*

##### Suckers and Buffalofishes

*Ictiobus cyprinellus*: bigmouth buffalo. This large fish does not do well in the Big Wichita River system. It is, and apparently always has been, absent from Lake Kemp. It is rare in Lake Diversion and the lower river. Only in Lake Wichita is this species even fairly common. Commercial fishermen eagerly seek this fish for its large size and ready market. Rarely, however, is it sought by sport fishermen.

*Ictiobus bubalus*: smallmouth buffalo. The smallmouth buffalo is absent from Lake Kemp and the upper river but is common to abundant elsewhere. It constitutes the principal commercial fish of the area and finds a ready market. Rarely it is sought or taken by sport fishermen.

*Carpoides carpio*: river carpsucker. This small sucker is the most common sucker in the Big Wichita River system. It is the most serious menace to the sport fisheries at present, because it is abundant, difficult to kill, widespread, and apparently generalized in food and breeding habits. It is ordinarily too small to be taken in the nets of the commercial fishermen and has no good market. It is almost never taken by sport fishermen, even by accident.

#### Family *Cyprinidae*

##### Shiners and Minnows

*Cyprinus carpio*: European carp. The carp is widespread in the Big Wichita River system, even extending into the upper river at times. It is most common in lakes but, at best, constitutes but a small percentage of the large-fish population. In some areas the carp is extremely common, but in these waters it apparently cannot compete successfully with the native suckers.

*Notemigonus crysoleucas*: golden shiner. The golden shiner seems unable to exist in the more saline parts of the Wichita River system. At least we failed to find it anywhere except in Lake Wichita and Holliday Creek, and there it is only moderately common.

*Hybopsis storeriana*: silver chub. This fish is extremely rare. We took but a single specimen, in the lower river.

*Hybopsis aestivalis*: speckled chub. This tiny fish is moderately common in riffles and rapids of clear water, where the bottom is sand

Creek.

*Phenacobius mirabilis*: suckermouth minnow. This widespread minnow is not common anywhere. Its tolerance to salinity and turbidity are striking. We found it from headwater streams of extreme salinity to relatively "sweet" waters, and from clear to extremely turbid waters. Although it is primarily a stream fish, numerous specimens were taken in Lake Diversion.

*Notropis bairdi*: Red River shiner. This saline-water shiner is common from the headwaters of the river to the mouth of the river. It is present in Lake Kemp but apparently absent from other lakes, as well as turbid streams, like Beaver Creek and Holliday Creek.

*Notropis buchanani*: ghost shiner. This small, transparent shiner is common in all three major lakes and at the stations below Lake Kemp dam and Lake Diversion dam, but absent from the moving parts of the river and its tributaries. Current, rather than salinity or turbidity, seems to determine the distribution of this form.

*Notropis deliciosus*: sand shiner. The distribution of this shiner is spotty. It appears occasionally where the water is swift and shallow, or over sandy shallows of lakes, but is absent from hundreds of seemingly identical habitats. Further, established colonies vanish after a few months. Possibly the colonies result from the release of bait minnows. The sand shiner is a fairly common bait minnow, usually seen offered for sale in midsummer. The colony at Diversion dam station has been present there for at least two years, in contrast to the other localities known to us.

*Notropis lutrensis*: red shiner. This form is, by far, the most abundant forage fish in the watershed of the Big Wichita River. Only in the extremely saline waters of the headwater streams of the upper river is it uncommon. It seems to prefer waters where the total salts are less than 5,000 parts per million.

*Notropis oxyrhynchus*: sharpnose shiner. In the past, the sharpnose shiner has been considered endemic to the Brazos River. It is widespread and obviously native to the Big Wichita River also. The headwaters of the South Fork of the Big Wichita River and the Salt Fork of the Brazos are close together. We suppose that floods have joined the waters in the past and allowed the spread of this shiner from one system to the other. The sharpnose shiner has a high tolerance to salinity and reaches its greatest abundance in the saline upper river. It is absent from the lakes but is present, though rare, in the lower river.

in Lake Diversion. Apparently, it does not occur above the Lake Kemp dam, though we found it just below the dam. The plains shiner seems to be strictly a stream fish.

*Notropis potteri*: chub shiner. The relationship between this shiner and the Red River shiner is close. The two forms are usually found together, and often in association with the sharpnose shiner. The chub shiner is usually less common than the Red River shiner.

*Notropis venustus*: spottail shiner. A colony of this shiner existed in Deadman Creek for several years but vanished in 1955. Since the species was not found elsewhere in the river system, we suppose the established colony resulted from the release of bait minnows. The spottail shiner is quite often offered for sale on bait stands, and it is surprising that the species has not become established in the lakes.

*Hybognathus placita*: plains minnow. The plains minnow is the most valuable commercial minnow in the river system. Most efforts of commercial bait seiners are directed to its capture. It is abundant in spite of this, from the headwater streams to the Red River and has a great range of tolerance to salinity and turbidity. Although not a lake form, it is common and apparently breeds in Lake Kemp. In the other lakes it is only of casual occurrence, probably introduced as released bait. It is a highly prolific species, and when spawning occurs, countless thousands of tiny minnows of this species may be taken in a single seine haul.

*Pimephales vigilax*: parrot minnow. The parrot minnow is a widespread and common minnow with an extremely broad range of tolerance to environmental conditions. It occurs in both streams and lakes, from headwaters to the river mouth. It lives in both still and swift, saline and "sweet" and turbid and clear waters. A decided preference is shown for moderately saline, cold, swift and clear water.

*Pimephales promelas*: fathead minnow. The fathead has a rather puzzling distribution in the Big Wichita River system. It seems to be principally a species of river pools and sluggish tributaries, absent or scarce where the water flows swiftly, and absent from the impoundments. Its range of tolerance to environmental conditions is much smaller than that of the related and superficially similar parrot minnow.

*Campostoma anomalum*: stoneroller. The single record of this minnow, from Lake Diversion, is doubtless the result of released

## Catfishes

*Ictalurus punctatus*: channel catfish. The channel catfish is one of the most sought-after sport fishes of the Big Wichita River system. It ranges from Lake Kemp downstream to the mouth of the river. We have taken individuals up to 14 pounds in weight, although the average fish caught by sport fishermen probably weighs less than three pounds.

*Ictalurus furcatus*: blue catfish. A single fish, recorded at the time as a blue catfish, was taken in Lake Kemp in the early part of this study. We have taken no others and now wonder if the early record might not have been an error. Although local fishermen often refer to blue catfish from the Big Wichita River system, all those so called and examined by us were large channel catfish. The absence of spotting is almost always the basis for fishermen's identification of blue catfish, and most fishermen are not aware that the spotted channel catfish in our waters loses all spots when fish reach a weight of four to six pounds. We now doubt that the blue catfish exists in the Big Wichita drainage area, except, perhaps, where stocked in private lakes.

*Ictalurus melas*: black bullhead catfish. Bullheads are uncommon in the Big Wichita River system, though they are widespread. All taken have been the above species, which in the adult form in our waters is usually olive yellow in color. The true yellow bullhead is uncommon in North-central Texas and apparently absent from the saline waters of the Big Wichita River system.

*Pylodictus olivaris*: flathead catfish. The flathead catfish, like the black bullhead, is uncommon in the drainage area of the Big Wichita River. We have heard of individuals taken in Lake Kemp and have ourselves taken a few in Lake Diversion. In Lake Wichita, a "sweet-water" lake, the species is fairly common. Trotline fishermen regularly take a few specimens in the lower river and we saw a dead specimen on the shore near Byers Station that we estimated would weigh 40 pounds.

## Family Cyprinodontidae

## Killifishes and Topminnows

*Fundulus notatus*: blackstripe topminnow. Oddly enough, we have failed to take this small fish in the "natural" waters of the Big Wichita River system, though the area is well within the presumed range of the species. We have taken numerous specimens in drainage ditches and irrigation ditches, however, in water with its source in Lake Diversion.

It is also found locally in some shallow, sand-bottomed bays in Lake Kemp and Lake Diversion. A small colony lives in the shallows at the foot of the plunge pool at Diversion Dam Station but none was found elsewhere in the lower river. Plains killifish were abundant in Lake Wichita when the lake was at its low level, in 1953, but vanished when normal water levels were restored and have not again been found there.

*Cyprinodon rubrofluviatilis*: Red River pupfish. The distribution of the pupfish is quite similar to that of the plains killifish. The two forms, together, constitute the bulk of the fish population of the upper river. We did not find the pupfish in Lake Wichita but it is common in Deadman Creek, a small tributary of the lower river west of Wichita Falls.

#### Family *Poeciliidae*

##### Mosquitofishes

*Gambusia affinis*: mosquitofish. The mosquitofish is ubiquitous, ranging from the springs at the headwaters of the river through the length of the river to its mouth, including the impoundment lakes and most tributaries. Neither salinity nor turbidity seem to govern its distribution, though it is not common where salinity is excessive.

#### Family *Serranidae*

##### Basses

*Roccus chrysops*: white bass. This game fish is abundant in the lower river and the impoundment lakes but is absent from the upper river. It is one of the most popular sport species, even though it rarely reaches more than three pounds in weight in local waters.

#### Family *Centrarchidae*

##### Black Basses and Sunfishes

*Micropterus punctulatus*: spotted bass. This bass was introduced into Lake Kemp several years ago, and was at one time fairly common. It did not spread to other parts of the river system and has steadily declined in numbers until, at present, it is uncommon. Sport fishermen often report taking this fish, usually termed "Kentucky jumper," but most specimens proved, on examination, to be highly colored largemouth bass.

*Micropterus salmoides*: largemouth black bass. Although a few black bass live in the "sweet-water" pools at the sources of the river, none is found in the more saline parts of the upper river be-

impoundment lakes, and the larger tributaries, the black bass is moderately common and greatly sought by fishermen. Indeed, it is the most prized game species in the Big Wichita River system. Black bass weighing seven pounds and more are not rare in the impoundment lakes, but the average fish taken by anglers probably weighs little more than one pound.

*Chaenobryttus gulosus*: warmouth. The warmouth is a sluggish-water fish and is not common in the clear, saline waters of the Big Wichita River system. We found one colony in the plunge pool beneath the Lake Kemp dam, another in the plunge pool beneath the Lake Diversion dam, and another large colony in Holliday Creek and Lake Wichita. A few individuals of one pound or more in weight are taken in Lake Wichita by sport fishermen.

*Lepomis auritus*: yellowbelly sunfish. This species is apparently not native to the drainage area of the Big Wichita River. Our only record is of a fish taken in a routine seine haul in Lake Diversion. We can only imagine that it was accidentally introduced to the lake in some way, perhaps with some hatchery-raised black bass.

*Lepomis cyanellus*: green sunfish. The green sunfish has a broad range of tolerance to environmental conditions, broader than that of any other predacious fish in the Big Wichita River system. It is able to live in waters showing considerable variation in temperature, salinity and turbidity. Indeed, it is almost ubiquitous, and is found from the headwater springs through the river system, including impoundment lakes and most tributaries. It is usually considered a pest by anglers, for its large mouth and voracious habits make it a great bait thief. The usual cost of minnows is three to five cents each, and the depredations of green sunfish can reach considerable cost in a short time. The sunfish itself rarely exceeds three inches in length in these waters and is not large enough to be considered food by most anglers.

*Lepomis humilis*: orangespotted sunfish. This small, brightly-colored sunfish is rarely seen by sport fishermen. It is usually uncommon in the Big Wichita River system, but is widespread. It seems to be absent from the upper river but we took a few specimens in almost every other part, including the impoundment lakes and major tributaries.

*Lepomis macrochirus*: bluegill sunfish. A few bluegills of small size were found in the "sweet-water" pools at the head of the North

individuals of a pound or so in weight are taken by fishermen. Except for these rare specimens, the bluegills of the impoundment and the river are small, the average large specimen weighing less than a quarter-pound. The bluegill is not a sport species in local waters.

*Lepomis megalotis*: longear sunfish. The distribution and habits of this sunfish are similar to those of the bluegill. A few specimens were taken in the "sweet-water" pools at the river source, but none were found elsewhere in the upper river. From Lake Kemp downstream through the river, impoundment lakes, and unpolluted tributaries, it is common to abundant. It usually outnumbers the bluegill wherever the two species occur together. One longear sunfish from Lake Diversion weighed almost a pound, but no others were seen that measured more than four inches in length.

*Lepomis microlophus*: redear sunfish. Our few records of this sunfish are all of large fishes and are from scattered localities. We found no young specimens. Probably all taken were released hatchery stock and it would seem that the species does not reproduce successfully in our waters.

*Pomoxis annularis*: white crappie. Except for a small population isolated in Cottonwood Creek, the upper river is free of crappie. From Lake Kemp downstream, the crappie is common to abundant, especially in the impoundment lakes. The crappie is one of the most important game fishes in the area and great numbers are taken by sport fishermen, especially in winter. Some crappie weighing more than four pounds come from the impoundment lakes, though the average "keeper" crappie weighs little more than one pound.

#### Family *Percidae*

#### Perches and Darters

*Percina caprodes*: logperch. This is the only member of the widespread darter group to occur in the drainage area of the Big Wichita River. The species seems unable to stand high salinity and occurs only in Holliday Creek and Lake Wichita. This population, isolated by the saline waters of the main river, has evolved into a strongly marked local race. The species is of no economical importance. Some fishermen who have tried to use logperch for bait remarked that the fish was "too tough to stick the hook through."

*Aplodinotus grunniens*: freshwater drum. The drum is absent from the upper river but is abundant from Lake Kemp downstream, in the river, the impoundment lakes and major tributaries. In spite of its abundance it is not taken in corresponding numbers by sport fishermen. Anglers rarely seek the drum, even though it attains a weight of more than 40 pounds on occasion. Most drum are caught incidental to "catfishing." The drum is a fine foodfish, and most fish taken are eaten.

*Sciaenops ocellata*: redbfish. Experimental introduction of this popular salt water game fish was begun in 1954, when a small number were placed in Lake Kemp. Results of this stocking remain to be determined.

*Cynoscion nebulosus*: speckled trout or spotted weakfish. Small numbers of this excellent food and sport fish were introduced from the Gulf of Mexico to Lake Kemp in 1955. Results of the experimental stocking remain to be determined.

#### HYPOTHETICAL LIST

*Notropis blennioides*: river shiner. Recorded from the Red River, and might therefore be expected in at least the lower Big Wichita River. We searched for this fish and failed to find it.

*Notropis boops*: bigeye shiner. Another form recorded from the Red River (by Knapp, 1953) which we failed to find in the Big Wichita River.

*Notropis fumeus*: ribbon shiner. Recorded from the Red River by Knapp (1953) and earlier (unpublished MS.) from the Big Wichita River. We believe the old reports were based on specimens of the superficially similar *Notropis oxyrhynchus*, which is present in the Big Wichita River but apparently was overlooked by earlier workers.

*Ictalurus natalis*: yellow bullhead. This species is present locally in non-saline waters of North-central Texas, but we found none in the waters of the Big Wichita River system.

*Schilbeodes gymnotus*: tadpole madtom. Like the yellow bullhead, this tiny catfish is resident in North-central Texas but apparently avoids the saline waters of the Big Wichita River system.

*Anguilla rostrata*: American eel. We have received persistent reports of eels taken by fishermen in waters of the Big Wichita River system but have been unable to verify these reports. It is not at all impossible that an occasional eel might ascend the Red River and so enter the Big Wichita system.

Quantitative studies of the fish populations of various parts of the Big Wichita River system were made by several means. At the nine stations along the river itself, fish samples, taken monthly, are presented in detail so that seasonal distribution and possible migratory tendencies might be shown. Elsewhere, the fishes are separated into "large and important" forms, which classification includes rough fishes and game species together, and "forage fishes," or fishes of the minnow or sunfish type. Forms of rare or casual occurrence are excluded.

Table 15. Monthly Variation in Species and Numbers of Fishes at Hackberry Station, 1954-55

Species	7/19	8/5	9/11	9/25	10/21	11/26	1/6	2/4	3/4	4/17	5/7
<i>Hybopsis aestivalis</i>	1	0	0	0	0	0	0	0	1	0	0
<i>Phenacobius mirabilis</i>	0	0	0	0	2	0	0	2	4	0	0
<i>Notropis bairdi</i>	12	16	0	0	23	7	26	28	7	7	5
<i>Notropis lutrensis</i>	102	32	140	66	223	58	117	222	21	91	61
<i>Notropis oxyrhynchus</i>	0	11	1	2	0	0	3	2	0	4	1
<i>Notropis potteri</i>	0	2	0	0	10	0	0	2	2	0	1
<i>Hybognathus placita</i>	13	0	0	0	27	37	2	1	6	0	0
<i>Pimephales promelas</i>	98	0	37	0	0	1	0	0	3	66	3
<i>Pimephales vigilax</i>	44	38	0	104	66	40	15	18	10	0	19
<i>Ictalurus melas</i>	0	2	0	0	0	0	0	0	0	0	0
<i>Fundulus kansae</i>	14	16	36	32	0	16	4	7	21	31	22
<i>Cyprinodon rubrofluvialtilis</i>	1	11	0	9	5	6	2	9	6	14	7
<i>Gambusia affinis</i>	5	3	14	4	19	0	0	0	3	0	0
<i>Micropterus salmoides</i>	0	0	0	1	0	0	0	0	0	0	0
<i>Lepomis cyanellus</i>	27	8	14	26	82	12	0	11	2	6	14
<i>Lepomis macrochirus</i>	0	3	4	1	7	0	0	0	0	0	0
<i>Lepomis megalotis</i>	2	4	13	1	4	0	0	0	0	0	0

Table 16. Monthly Variation in Species and Numbers of Fishes Taken at Johnson Oil Field Station, 1954-55

Species	7/19	8/5	9/11	9/25	10/21	11/26	1/6	2/4	3/4	4/17	5/7
<i>Hybopsis aestivalis</i>	0	1	4	1	0	8	2	3	7	9	3
<i>Notropis bairdi</i>	7	24	10	10	30	31	263	492	61	9	28
<i>Notropis lutrensis</i>	6	9	1	1	2	4	2	0	0	1	0
<i>Notropis oxyrhynchus</i>	13	1	0	0	0	16	3	3	2	1	0
<i>Notropis potteri</i>	0	0	13	11	0	0	2	3	0	2	3
<i>Hybognathus placita</i>	5	10	28	38	5	0	7	0	1	16	11
<i>Pimephales vigilax</i>	0	1	0	0	0	11	0	0	3	0	0
<i>Fundulus kansae</i>	4	49	393	262	216	119	30	221	121	62	41
<i>Cyprinodon rubrofluvialtilis</i>	33	49	99	103	113	64	16	4	88	31	18
<i>Gambusia affinis</i>	4	5	6	1	4	14	0	3	0	0	0
<i>Lepomis cyanellus</i>	1	0	0	0	0	0	0	0	0	0	0

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
<i>Dorosoma cepedianum</i>	0	1	0	0	0	0	0	0	0	0	0	0
<i>Cyprinus carpio</i>	0	0	1	0	0	0	0	0	0	0	0	0
<i>Hybopsis aestivalis</i>	7	5	6	12	5	14	2	17	7	17	3	11
<i>Notropis bairdi</i>	13	22	14	1	6	11	26	41	27	28	26	14
<i>Notropis lutrensis</i>	22	77	16	2	9	3	4	9	0	0	4	0
<i>Notropis oxyrhynchus</i>	23	59	21	30	30	9	7	2	5	11	19	42
<i>Notropis potteri</i>	0	4	1	7	2	2	0	0	0	3	4	11
<i>Hybognathus placita</i>	26	7	32	19	28	35	41	39	0	3	4	16
<i>Pimephales promelas</i>	0	0	8	0	0	0	0	0	0	0	0	0
<i>Pimephales vigilax</i>	0	0	0	0	0	0	0	0	0	9	0	0
<i>Fundulus kansae</i>	166	203	61	131	92	75	67	167	185	87	31	39
<i>Cyprinodon rubrofluvialtilis</i>	27	24	25	17	20	34	191	59	33	22	14	40
<i>Gambusia affinis</i>	0	1	0	0	0	0	0	0	0	0	0	0
<i>Lepomis cyanellus</i>	3	0	1	0	0	0	0	0	0	0	0	0

Table 18. Monthly Variation in Species and Numbers of Fishes at Guthrie Station, 1954-55

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
<i>Dorosoma cepedianum</i>	0	0	0	6	0	0	0	0	0	0	0	0
<i>Notropis bairdi</i>	0	3	0	0	0	9	5	0	6	7	11	0
<i>Notropis lutrensis</i>	59	35	46	104	18	23	11	13	12	2	4	14
<i>Notropis oxyrhynchus</i>	0	0	0	0	0	2	1	0	0	0	0	0
<i>Notropis potteri</i>	0	0	0	0	0	2	0	0	0	0	0	0
<i>Hybognathus placita</i>	0	16	1	4	0	0	14	3	6	0	14	4
<i>Pimephales promelas</i>	64	87	165	122	32	27	21	43	145	67	38	28
<i>Ictalurus melas</i>	0	0	2	0	0	0	0	0	0	0	0	0
<i>Fundulus kansae</i>	71	56	20	75	418	18	23	6	5	21	61	36
<i>Cyprinodon rubrofluvialtilis</i>	27	21	6	15	276	53	321	121	212	81	20	9
<i>Gambusia affinis</i>	0	3	0	0	0	0	1	0	0	0	0	0
<i>Lepomis cyanellus</i>	21	9	11	7	26	0	1	0	0	0	0	0

Table 19. Monthly Variation in Species and Numbers of Fishes at Benjamin Station, 1954-55

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
<i>Dorosoma cepedianum</i>	0	0	1	0	1	0	0	0	0	0	0	0
<i>Hybopsis aestivalis</i>	0	2	1	0	0	0	0	0	0	0	0	0
<i>Notropis bairdi</i>	5	167	56	25	2	0	0	1	34	35	22	5
<i>Notropis lutrensis</i>	0	0	5	0	0	0	0	0	0	0	0	0
<i>Notropis oxyrhynchus</i>	1	0	11	7	0	0	0	0	0	0	0	0
<i>Notropis potteri</i>	0	0	0	46	0	0	0	0	0	0	3	0
<i>Hybognathus placita</i>	26	4	19	55	407	429	46	1	0	24	9	0
<i>Pimephales vigilax</i>	0	0	3	0	0	0	0	0	0	0	0	0
<i>Fundulus kansae</i>	51	118	50	14	63	39	14	14	17	4	31	9
<i>Cyprinodon rubrofluvialtilis</i>	47	20	32	32	66	54	21	3	0	0	9	0

<i>Dorosoma cepedianum</i>	80	2	2	0	1	6	8	8	12	48	17
<i>Ictiobus bubalus</i>	4	0	2	0	0	6	3	2	9	2	0
<i>Carpiodes carpio</i>	2	0	0	10	1	4	2	1	4	15	0
<i>Cyprinus carpio</i>	0	0	0	0	2	2	0	1	0	0	0
<i>Phenacobius mirabilis</i>	0	0	0	1	0	0	0	0	0	0	0
<i>Notropis bairdi</i>	1	0	0	0	0	0	0	0	0	16	0
<i>Notropis buchmanii</i>	11	0	0	0	4	0	0	7	3	40	17
<i>Notropis deliciosus</i>	0	0	0	0	1	0	18	0	2	0	0
<i>Notropis lutrensis</i>	121	36	65	38	81	0	46	2	20	23	61
<i>Notropis oxyrhynchus</i>	0	0	17	0	4	0	1	0	0	0	0
<i>Notropis percobromus</i>	3	0	0	6	43	0	0	0	0	0	3
<i>Notropis potteri</i>	0	0	0	2	1	0	0	0	0	0	0
<i>Pimephales vigilax</i>	57	21	37	22	60	0	12	72	17	19	30
<i>Ictalurus punctatus</i>	12	11	3	0	0	0	0	1	0	1	0
<i>Fundulus kansae</i>	39	1	1	0	0	0	0	0	0	0	8
<i>Cyprinodon rubrolineatus</i>	5	0	5	0	0	0	2	0	0	0	0
<i>Gambusia affinis</i>	15	21	4	0	33	0	0	0	10	0	0
<i>Roccus chrysops</i>	0	0	20	9	5	1	3	0	1	3	0
<i>Micropterus salmoides</i>	0	1	1	1	3	6	0	1	3	7	0
<i>Chaenobryttus gulosus</i>	1	0	0	0	0	0	0	0	0	0	0
<i>Lepomis cyanellus</i>	1	0	6	6	0	0	0	0	1	0	0
<i>Lepomis humilis</i>	0	0	0	3	0	0	0	0	5	0	0
<i>Lepomis macrochirus</i>	46	0	8	8	0	0	0	2	36	21	0
<i>Lepomis megalotis</i>	59	3	11	30	0	0	0	0	9	0	1
<i>Pomoxis annularis</i>	11	0	8	16	2	2	0	0	0	1	0
<i>Aplodinotus grunniens</i>	16	0	0	0	0	0	0	0	0	0	0

Table 21. Monthly Variation in Species and Number of Fishes at Diversion Dam Station, 1954-55

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
<i>Lepisosteus osseus</i>	25	0	0	11	8	5	6	0	0	1	0	0	0
<i>Dorosoma cepedianum</i>	1	93	0	10	45	11	0	3	1	12	4	0	0
<i>Hiodon alosoides</i>	0	1	0	0	0	0	0	0	0	0	0	0	0
<i>Ictiobus bubalus</i>	1	0	0	0	0	0	0	0	0	0	0	0	0
<i>Carpiodes carpio</i>	11	0	0	3	0	0	1	1	0	0	0	0	0
<i>Cyprinus carpio</i>	0	0	0	2	0	0	0	1	0	0	0	0	0
<i>Phenacobius mirabilis</i>	0	0	0	4	0	0	0	0	0	0	0	0	0
<i>Notropis buchmanii</i>	0	0	0	0	0	0	0	0	0	0	0	0	2
<i>Notropis deliciosus</i>	0	0	0	5	7	14	0	3	0	2	0	0	0
<i>Notropis lutrensis</i>	0	84	0	34	28	55	0	11	0	26	58	36	26
<i>Notropis percobromus</i>	0	2	0	0	7	3	0	0	0	0	0	0	1
<i>Notropis potteri</i>	0	0	0	0	0	2	0	0	0	0	0	0	0
<i>Hypognathus placita</i>	0	0	0	0	0	12	0	0	0	0	3	1	0
<i>Pimephales vigilax</i>	0	4	0	11	212	68	0	1	0	1	0	20	0
<i>Ictalurus punctatus</i>	0	0	4	6	0	4	0	0	0	0	0	0	0
<i>Fundulus kansae</i>	0	6	0	4	0	3	0	0	0	0	3	0	0
<i>Gambusia affinis</i>	0	2	0	2	0	0	1	1	0	0	9	0	0
<i>Roccus chrysops</i>	1	1	1	0	3	0	0	0	1	0	0	0	0
<i>Micropterus salmoides</i>	0	7	5	5	1	1	3	0	0	4	1	0	1
<i>Chaenobryttus gulosus</i>	0	0	0	0	0	0	0	0	0	0	4	1	0
<i>Lepomis cyanellus</i>	4	17	8	16	4	26	0	9	0	1	0	1	0
<i>Lepomis humilis</i>	0	2	0	2	0	0	3	0	0	0	10	0	0
<i>Lepomis macrochirus</i>	5	9	35	15	21	1	22	3	0	1	1	2	0
<i>Lepomis megalotis</i>	1	4	6	63	37	17	6	12	0	1	2	0	0
<i>Lepomis microlophus</i>	0	0	0	2	0	1	0	0	0	0	0	0	0
<i>Pomoxis annularis</i>	1	0	6	4	0	1	0	5	0	0	0	0	0
<i>Aplodinotus grunniens</i>	0	0	19	37	2	1	0	0	1	0	0	0	0

Species	6/24	7/13	8/3	9/27	10/19	11/16	12/7	1/7	2/17	3/8	4/19
<i>Dorosoma cepedianum</i>	2	9	5	1	0	0	0	0	0	0	0
<i>Carpiodes carpio</i>	0	0	1	0	0	1	0	0	0	0	0
<i>Cyprinus carpio</i>	0	0	1	0	0	0	0	0	0	0	0
<i>Phenacobius mirabilis</i>	0	0	0	1	0	0	0	0	0	0	0
<i>Notropis bairdi</i>	1	1	0	1	2	7	0	0	0	0	1
<i>Notropis lutrensis</i>	201	128	330	80	128	16	11	66	78	34	63
<i>Notropis oxyrhynchus</i>	0	0	0	13	0	0	0	0	0	0	0
<i>Notropis percobromus</i>	14	0	15	17	14	21	33	10	11	7	6
<i>Notropis potteri</i>	0	0	4	0	1	0	7	2	0	0	0
<i>Notropis venustus</i>	2	0	4	0	0	0	0	0	0	0	0
<i>Hybognathus placita</i>	2	1	242	1	6	0	6	0	3	0	0
<i>Pimephales promelas</i>	0	1	0	0	0	0	0	0	0	0	0
<i>Pimephales vigilax</i>	15	12	27	31	14	14	19	14	12	9	30
<i>Ictalurus punctatus</i>	0	1	1	0	4	0	0	0	0	0	1
<i>Cyprinodon rubrofluvialis</i>	0	1	6	6	3	16	0	0	0	0	0
<i>Gambusia affinis</i>	0	3	0	61	26	5	0	8	0	0	0
<i>Roccus chrysops</i>	0	0	4	11	4	0	3	0	0	0	0
<i>Lepomis cyanellus</i>	0	0	1	0	0	0	0	0	0	0	0
<i>Lepomis megalotis</i>	1	0	2	2	1	0	0	0	0	0	0
<i>Pomoxis annularis</i>	0	1	0	0	0	0	0	0	0	0	0
<i>Aplodinotus grunniens</i>	0	3	0	0	0	0	0	0	0	0	0

Table 23. Monthly Variation in Species and Numbers of Fishes at Byers Bridge Station, 1954-55

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
<i>Lepisosteus osseus</i>	1	0	11	0	0	0	0	0	0	0	119	4	
<i>Lepisosteus platostomus</i>	0	0	1	0	0	0	0	0	0	0	1	0	
<i>Dorosoma cepedianum</i>	69	138	19	10	7	0	4	1	0	0	0	2	0
<i>Hiodon alosoides</i>	0	0	0	0	0	0	0	0	0	0	0	2	0
<i>Ictiobus bubalus</i>	0	0	6	0	0	0	0	0	0	0	13	1	
<i>Carpiodes carpio</i>	0	4	34	0	0	0	1	0	0	0	15	20	
<i>Cyprinus carpio</i>	0	0	1	0	0	0	0	0	0	0	0	0	0
<i>Hybopsis aestivalis</i>	0	1	0	0	0	0	0	0	0	14	0	0	
<i>Hybopsis storeriana</i>	0	0	0	0	0	0	0	0	0	1	0	0	
<i>Phenacobius mirabilis</i>	0	0	2	0	0	0	0	0	0	0	0	0	
<i>Notropis bairdi</i>	0	4	9	0	1	0	16	3	53	0	6	0	0
<i>Notropis lutrensis</i>	35	86	131	6	136	59	110	41	28	0	0	0	9
<i>Notropis oxyrhynchus</i>	0	50	114	3	2	0	8	1	0	1	0	0	4
<i>Notropis percobromus</i>	0	0	18	2	16	7	26	11	0	2	26	0	14
<i>Notropis potteri</i>	0	0	11	0	0	0	1	1	17	5	0	0	0
<i>Hybognathus placita</i>	0	318	253	326	23	112	143	77	14	5	33	0	7
<i>Pimephales vigilax</i>	0	0	0	13	0	0	0	3	6	3	9	0	5
<i>Ictalurus melas</i>	0	0	0	0	0	0	0	0	0	0	1	0	0
<i>Ictalurus punctatus</i>	0	1	3	0	6	5	0	0	0	1	0	0	1
<i>Gambusia affinis</i>	0	0	21	40	141	0	21	11	0	0	0	4	2
<i>Roccus chrysops</i>	0	0	22	5	9	3	0	0	0	0	0	3	2
<i>Lepomis cyanellus</i>	0	2	0	0	0	0	0	0	0	0	0	0	0
<i>Lepomis humilis</i>	0	1	0	1	0	0	0	0	0	0	0	0	0
<i>Lepomis macrochirus</i>	0	1	0	0	3	0	1	0	0	1	0	0	0
<i>Lepomis megalotis</i>	1	3	2	3	3	2	0	0	0	0	0	0	0
<i>Pomoxis annularis</i>	0	0	0	0	1	1	0	0	0	0	0	0	0
<i>Aplodinotus grunniens</i>	0	0	7	3	1	1	1	0	0	0	0	0	0

Species	Number	% of Total Number	% Males	% Females
<i>Lepisosteus osseus</i>	193	23.1	59	41
<i>Dorosoma cepedianum</i>	240	28.7	57	43
<i>Hiodon alosoides</i>	3	.3	..	100
<i>Ictiobus bubalus</i>	50	6.0	54	46
<i>Carpiodes carpio</i>	95	11.4	52	48
<i>Cyprinus carpio</i>	11	1.3	55	45
<i>Ictalurus punctatus</i>	50	6.0	58	42
<i>Roccus chrysops</i>	60	7.2	38	62
<i>Micropterus salmoides</i>	31	3.7	34	66
<i>Pomoxis annularis</i>	38	4.5	47	53
<i>Aplodinotus grunniens</i>	65	7.8	34	66
Totals	836	100.0	..	..

**Table 25. Percentage Composition and Sex Ratios of Large and Important Species of Fishes from Lake Kemp, as Determined from Gill Nets Only, June 15, 1953 through May 31, 1954**

Species	Number	% of Total Number	% Males	% Females
<i>Lepisosteus productus</i>	40	4.0	37	63
<i>Dorosoma cepedianum</i>	222	22.1	36	64
<i>Carpiodes carpio</i>	428	42.7	52	48
<i>Cyprinus carpio</i>	61	6.1	50	50
<i>Ictalurus punctatus</i>	39	3.9	44	56
<i>Roccus chrysops</i>	79	7.9	47	53
<i>Micropterus salmoides</i>	15	1.5	37	63
<i>Pomoxis annularis</i>	111	11.0	43	57
<i>Aplodinotus grunniens</i>	8	0.8	87	13
Totals	1,003	100.0	..	..

**Table 26. Percentage Composition and Sex Ratios of Large and Important Species of Fishes from Lake Diversion, as Determined from Gill Nets Only, June 15, 1953 through May 31, 1954**

Species	Number	% of Total Number	% Males	% Females
<i>Lepisosteus osseus</i>	73	4.9	44	56
<i>Lepisosteus platostomus</i>	5	0.3	60	40
<i>Lepisosteus productus</i>	6	0.4	33	67
<i>Dorosoma cepedianum</i>	443	29.9	51	49
<i>Ictiobus bubalus</i>	185	12.5	71	29
<i>Carpiodes carpio</i>	287	19.4	60	40
<i>Cyprinus carpio</i>	42	2.8	51	49
<i>Ictalurus punctatus</i>	38	2.6	37	63
<i>Roccus chrysops</i>	206	13.9	52	48
<i>Micropterus salmoides</i>	41	2.8	22	78
<i>Pomoxis annularis</i>	107	7.2	49	51
<i>Aplodinotus grunniens</i>	49	3.3	37	63
Totals	1,482	100.0	..	..

Species	Number	Number	% of Total	% Males	% Females
<i>Lepisosteus osseus</i>	105	9.8	75	25	
<i>Lepisosteus platostomus</i>	36	3.3	53	47	
<i>Lepisosteus productus</i>	9	.8	44	56	
<i>Dorosoma cepedianum</i>	178	16.5	33	67	
<i>Ictiobus cyprinellus</i>	7	.7	100	..	
<i>Ictiobus bubalus</i>	226	21.0	84	16	
<i>Carpionotus carpio</i>	173	16.1	57	43	
<i>Cyprinus carpio</i>	40	3.7	60	40	
<i>Ictalurus punctatus</i>	4	.4	75	25	
<i>Ictalurus melas</i>	14	1.3	50	50	
<i>Roccus chrysops</i>	121	11.2	46	54	
<i>Micropterus salmoides</i>	32	3.0	34	66	
<i>Pomoxis annularis</i>	86	8.0	42	58	
<i>Aplodinotus grunniens</i>	45	4.2	33	67	
Totals	1,076	100.0	..	..	

Table 28. Rough Fishes Taken in Survey Gill Nets from Lake Wichita, June 1, 1954 through May 31, 1955

Species	Number	% of Total Number	Weight (lbs.)	% of Total Weight	Average Wt. (lbs.)
Gars (all species)	150	19.4	431.9	22.8	2.2
Gizzard Shad	178	23.0	292.6	15.4	1.6
Buffalos (2 species)	233	30.1	731.4	38.5	3.1
River Carpsucker	173	22.3	383.7	20.2	2.2
European Carp	40	5.2	58.2	3.1	1.5
TOTALS	774	100.0	1,897.8	100.0	....

Table 29. Rough Fishes Taken by Commercial Fisherman C. E. Walston in Lake Wichita, February 1, through April 30, 1955

Species	Number	% of Total Number	Weight (lbs.)	% of Total Weight	Average Wt. (lbs.)
Gars (all species)	387	3.6	2,309	6.6	6.0
Gizzard Shad	3,649	33.4	7,936	22.7	2.2
Buffalos (2 species)	3,282	30.0	13,947	39.9	4.3
River Carpsucker	3,534	32.3	10,062	29.1	2.8
European Carp	75	.7	645	1.7	8.6
TOTALS	10,927	100.0	34,899	100.0	....

Species	Weight (lbs.)	% of Total Weight	Average Wt. (lbs.)
<i>Lepisosteus osseus</i>	710.8	61.6	3.7
<i>Dorosoma cepedianum</i>	144.0	12.5	.6
<i>Hiodon alosoides</i>	2.1	.2	.7
<i>Ictiobus bubalus</i>	88.1	7.6	1.7
<i>Carpodes carpio</i>	86.4	7.5	.9
<i>Cyprinus carpio</i>	23.2	2.0	2.1
<i>Ictalurus punctatus</i>	34.7	3.0	.7
<i>Roccus chrysops</i>	14.9	1.3	.2
<i>Micropterus salmoides</i>	21.7	1.9	.7
<i>Pomoxis annularis</i>	7.2	.6	.5
<i>Aplodinotus grunniens</i>	20.3	1.8	.3
TOTALS	1,153.4	100.0	...

Table 31. Weights, Percentage Composition by Weight, and Average Weights of Large and Important Fishes from Lake Kemp, as Determined from Gill Nets, June 15, 1953 through May 31, 1954

Species	Weight (lbs.)	% of Total Weight	Average Wt. (lbs.)
<i>Lepisosteus productus</i>	99.74	10.7	2.49
<i>Lepisosteus platostomus</i>	8.14	.8	2.71
<i>Dorosoma cepedianum</i>	56.60	6.1	.24
<i>Carpodes carpio</i>	530.00	56.8	1.20
<i>Cyprinus carpio</i>	61.58	6.6	1.01
<i>Ictalurus punctatus</i>	33.30	3.6	.86
<i>Roccus chrysops</i>	43.31	4.6	.54
<i>Micropterus salmoides</i>	41.08	4.4	2.74
<i>Pomoxis annularis</i>	33.44	3.6	.30
<i>Aplodinotus grunniens</i>	26.15	2.8	3.27*
TOTALS	933.34	100.0	....

\*Includes one very large specimen, weight 25.5 lbs.

Table 32. Weights, Percentage Composition by Weight, and Average Weights of Large and Important Fishes from Lake Diversion, as Determined from Gill Nets, June 15, 1953 through May 31, 1954

Species	Weight (lbs.)	% of Total Weight	Average Wt. (lbs.)
<i>Lepisosteus osseus</i>	228.23	15.9	3.99
<i>Lepisosteus platostomus</i>	12.60	.7	2.52
<i>Lepisosteus productus</i>	11.27	.6	1.88
<i>Dorosoma cepedianum</i>	277.86	15.4	.63
<i>Ictiobus bubalus</i>	455.56	25.2	2.47
<i>Carpodes carpio</i>	360.94	19.9	1.27
<i>Cyprinus carpio</i>	81.44	4.5	1.94
<i>Ictalurus punctatus</i>	51.56	2.8	1.36
<i>Roccus chrysops</i>	150.62	8.3	.73
<i>Micropterus salmoides</i>	45.08	2.5	1.10
<i>Pomoxis annularis</i>	45.06	2.5	.42
<i>Aplodinotus grunniens</i>	31.09	1.7	.63
TOTALS	1,751.31	100.0	....

Species	Weight (lbs.)	% of Total Weight	Average Wt. (lbs.)
<i>Lepisosteus osseus</i>	356.5	16.7	3.4
<i>Lepisosteus platostomus</i>	63.1	3.0	1.6
<i>Lepisosteus productus</i>	12.3	.6	1.4
<i>Dorosoma cepedianum</i>	292.6	13.7	1.6
<i>Ictiobus cyprinellus</i>	26.5	1.2	3.8
<i>Ictiobus bubalus</i>	704.9	33.0	3.2
<i>Carpiondes carpio</i>	383.7	17.9	2.2
<i>Cyprinus carpio</i>	58.2	2.7	1.5
<i>Ictalurus punctatus</i>	9.4	.4	2.4
<i>Ictalurus melas</i>	20.4	1.0	1.5
<i>Roccus chrysops</i>	103.9	4.9	.9
<i>Micropterus salmoides</i>	26.1	1.2	.8
<i>Pomoxis annularis</i>	30.7	1.4	.4
<i>Aplodinotus grunniens</i>	49.8	2.3	1.1
TOTALS	2,138.1	100.0	...

Table 34. Percentage Composition of Forage Fishes from the Impoundment Lakes

Species	Lake Kemp	Lake Diversion	Lake Wichita
<i>Asryanax fasciatus</i>	.....	.....	.10
<i>Nolemigonus crysoleucas</i>	.....	.....	4.10
<i>Phenacobius mirabilis</i>	.....	.16	.....
<i>Pimephales vigilax</i>	.79	9.96	1.40
<i>Hybognathus placita</i>	22.15	1.85	.30
<i>Notropis bairdi</i>	1.20	.....	.....
<i>Notropis buchanaui</i>	10.12	5.64	5.00
<i>Notropis deliciosus</i>	.....	.20	.05
<i>Notropis lutrensis</i>	48.84	67.32	44.40
<i>Notropis oxyrhynchus</i>	11.23	.....	.....
<i>Hybopsis aestivalis</i>	.40	.....	.....
<i>Fundulus kansae</i>	2.24	.20	.....
<i>Cyprinodon rubrofluvialtilis</i>	.29	1.89	.....
<i>Gambusia affinis</i>	.46	1.11	10.80
<i>Chaenobryttus gulosus</i>	.....	.....	1.10
<i>Lepomis cyanellus</i>	.....	.25	5.50
<i>Lepomis humilis</i>	.17	.....	1.00
<i>Lepomis macrochirus</i>	1.61	5.35	16.10
<i>Lepomis megalotis</i>	.50	5.93	9.90
<i>Lepomis microlophus</i>	.....	.12	.....
<i>Percina caprodes</i>	.....	.....	.05
TOTALS	100.00	99.98	99.80

Based on random seine samples that included 2,412 fishes from Lake Kemp, 2,430 fishes from Lake Diversion and 2,008 fishes from Lake Wichita.

larger communities along the river have effective sewage treatment plants and the waters of the effluent ditches are of good quality. (Table 2, numbers 69, 91, 92). A few farms and small tourist courts may dispose of sewage directly into the river, but the amount of such material is slight and probably oxidizes rapidly. The garbage dump of the city of Iowa Park is located on the banks of the river in such a manner that rain water may percolate through the garbage and then drain into the river. A few individuals also dump trash beside or into the river when they think their actions will pass unnoticed. Hard objects such as tin cans, old automobile tires, etc., are unsightly and last a long time, but probably have little effect on the fish population.

The most serious domestic pollution results from emptying the "sludge," or materials removed in clarifying the drinking water of the city of Wichita Falls into Holliday Creek, a tributary of the river. This sludge is a gray muck that forms unsightly bars in the river below the mouth of Holliday Creek and creates conditions in which game fish do not live. The sludge contains little organic matter and, in small quantities, at least, does not seem to be toxic to fishes.

Industrial pollution in the form of oil field salt brine is a characteristic feature of the Big Wichita River and has continued for nearly fifty years. The great numbers of oil wells located on the drainage area of the Big Wichita River all produce a certain amount of salt water, in addition to petroleum. Qualitatively, these salts are quite similar to the salts of the natural springs emerging from the Blain Formation at the headwater streams of the river. As a result, the addition of the oil field brine to the already saline natural waters simply augments the salt burden of the river without changing the relative proportions of the salts present.

The relative amounts of salt contributed by natural springs, as compared with the amount of salts contributed by oil well brine, cannot be estimated in the upper river. Many of the oil wells on the upper river, such as those of the Johnson Oil Field, have injection systems, and the salt water is pumped back into the earth at the level from which it was withdrawn. This salt water will not again reach the surface of the earth in the foreseeable future. A great deal of salt from oil wells on the South Fork does reach the river, but, as explained elsewhere, much of the water and salt of the South Fork fails to reach the main river.

There are no natural springs producing excessive salt water in the lower river, however, and there the pollution resulting from oil well brine can easily be determined. There are no salt springs between Diversion Dam Station and Deadman Bridge Station, but the Kaymay Oil Field is located between these stations. If the water quality at Diversion Dam Station (Table 11) is compared with the water

from the Kaymay Oil Field. Concentration by evaporation accounts for only a small amount of the increase.

The effect of salt pollution on fishes is difficult to determine. Since the Big Wichita River is naturally a saline stream, fishes native to it are adapted to saline conditions. Further, tolerance to salt varies in different species of fishes. Even some of the less-tolerant forms can endure a rather high salt concentration, but are unable to stand a sudden change in salt concentration. In general, it was found that in the Big Wichita River, small fishes of the "minnow" type are most resistant to salt. The pupfish (*Cyprinodon rubrofluvialis*) and plains killifish (*Fundulus kansae*) can stand astonishingly high salt concentration, several times higher than sea water. Plains minnows (*Hybognathus placita*), speckled chub (*Hybopsis aestivalis*) and several species of shiners (*Notropis*) thrive when the chloride content of the water is in excess of 10,000 parts per million. Of the larger fishes, only the gizzard shad (*Dorosoma cepedianum*) and European carp (*Cyprinus carpio*) naturally entered waters this salty. We did not find any of the popular game fishes, such as black bass, white bass, crappie, catfishes or drum in waters where the chloride content averaged as much as 2,000 parts per million. Occasionally, a light rain after a period of drought will gather accumulated salt from the watershed of the upper river and wash it into the head of Lake Kemp. This sudden influx of salt causes the death of great numbers of fish. These fish kills are marked by relatively great numbers of game species killed in comparison with the numbers of rough fishes. Thus it seems that the salt not only kills the game fishes and keeps them out of otherwise suitable waters, but it also may favor the undesirable rough fishes which have a naturally higher tolerance to salt.

There seems to be little industrial pollution of the Big Wichita River, other than that caused by oil field brine, except in and near the city of Wichita Falls. Even here, pollution is slight under most conditions. There is occasional surreptitious dumping of waste materials such as spoiled milk, etc., into the river or drainage channels leading to the river. More serious is the occasional accidental release or escape of detergents, petroleum products or by-products, from refineries, oil lines, business concerns, railroad roundhouses, etc. In instances where repetition of such accidents indicated lack of concern or inadequate facilities, court action has been brought or threatened by state game wardens. As a result, such accidental pollution is rare, but when some such instances do occur, the results are disastrous to the fish population of the lower river. In some cases, pollution decimated the fish population of the lower river and even extended into the Red River of Oklahoma.

Numerous crude oil pipe lines cross the Big Wichita River, and these sometimes break, causing a serious and long-lasting but subtle

the river. The oil ignited, or was ignited, and burned fiercely for several hours. Immediate damage was caused to fish life by the oil and fire, but greater damage, extending over a period of months, was caused by the floating blobs of oil. As the oil slowly oxidized, it gathered dust and debris until its specific gravity was greater than that of the water, and the blobs sank. There they adhered to the bottom mud or sand, smothering and killing animals and plant life under and near them. As the dead organisms decayed, bubbles formed and were trapped beneath the oil blobs until these were torn loose and floated to the surface again. The rise of the oil blobs through the water relieved the pressure on the bubbles on their undersides, and the blobs expanded until, at or near the surface, the expanding bubbles overturned the oil blobs causing them to spill their bubbles and give off a film of volatile oil before sinking again to repeat the process. At each rise and the following sinking, the oil blobs were floated a few yards downstream. Two months after the breaking of the pipe line, oil blobs were still rising and sinking at Petrolia Bridge Station. Eventually, the oil was oxidized to an asphalt, and the included dust and debris increased its weight until it remained on the bottom after approximately four months.

#### SILTATION AND EROSION OF THE WATERSHED OF THE BIG WICHITA RIVER

Study of the surface rocks and soils of the watershed of the Big Wichita River reveals a similar general pattern throughout the area. The underlying rocks are of Permian age, consisting of some shales and sandstones, but principally of soft red clays and silts with beds and stringers of gypsum. These are, in most areas, directly overlain by sands and gravels of Pleistocene age. These deposits contain, in some places, abundant remains of large mammals. The presence of mammoth bones, and absence of bison bones, indicates an early-middle Pleistocene age for these deposits. These older beds are directly overlain by Recent earth containing bones of buffalo and antelope, along with arrowheads and worked flints.

Interpretation of the described sequence indicates a brief period of deposition in the early-middle Pleistocene, followed by, perhaps, a period of a half-million years when no soils were deposited (except for local gravel beds that are terraces of the river and contain bones of later Pleistocene animals). The Recent seems to be the only other major period of deposition in later earth history.

Examination of these Recent deposits is also informative. The soils are "fluffy" and largely wind-deposited. Exposed on their surfaces are skeletal elements of buffalo and worked flints. Remains of cattle and other modern animals are not found in the ground except where actually buried by man or landslides. Thus, it would appear



Figure 15. Erosion on the headwaters of the South Fork of the Big Wichita River, in Knox County. As a result of overgrazing and poor land use, the prairie soils (dark upper layer) have eroded away, exposing beds of silt, sand and gravel of the Seymour Formation. As the soil washes away from the roots of the mesquite trees the mesquites die and are replaced by the more resistant cedars (green vegetation on left of photo). The silts contribute to the turbidity of the river and siltation of the basins of the reservoirs farther downstream.

and poor land use.

Wind erosion decreases or removes the vegetative cover, permitting swift water erosion of gullies and canyons. Most of the upper river furnishes striking examples of this. The cedar brakes are virtual "badlands," of barren spires, knife-edged ridges and naked basins. In many areas, the Recent and Pleistocene deposits have been removed, leaving the soft, barren, red Permian clays and silts exposed for dozens of square miles. Almost no vegetation will grow on the saline Permian soils.

The result of the rapid gulley erosion is extreme siltation of the river. After every heavy rain, the river flows red with silt. The dissolved salts cause rapid flocculation of the silt and its deposition in the bed of the slower-moving parts of the river and in the impoundment lakes. This soft mud bottom is unsuited to game fishes but can be utilized by the rough fishes, thus giving them an advantage in their competition with the game species.

In the arid watershed of the upper river, the value of the land is so low that there is a tendency to gain as much from its use as it possible. Reclamation of the erosion-damaged land is economically unfeasible for the landowners. In some areas, we have noted half-hearted attempts to stop headward erosion of gullies by placing brush or other debris in the arroyos. Only intensive effort and rigid control of grazing can restore the uplands and control the erosion.

#### RECOMMENDATIONS

The Big Wichita River is a naturally saline stream and will remain so. Nevertheless, much can be done to reduce the salinity of the water of the river, and the value of the river and its impoundments for sport fishing will be in proportion to this reduction. The major source of salts that can be eliminated is oil field pollution. Insistence that all oil wells have reinjection equipment, and forbidding the use of surface storage of brine in pits, along with strict enforcement of these regulations, would eventually result in the elimination of more than half of the salt in the lower river and a considerable, but undetermined amount, from the upper river and impoundment lakes.

Most of the salt and much of the gypsum can be kept from entering the impoundment lakes by diverting or detouring the upper river. The river might be canaled around the lakes to the lower river. This would ruin the lower river for sport fishing, but the resultant increase in the sport fisheries of the impoundment lakes would more than make up for this loss. The waters of the upper river might be pumped to another watershed or to a large evaporating basin. Such projects would be undertaken by agencies desiring to improve the water quality for agricultural or industrial use, or even as a

offer a fertile field for experimentation with the introduction of salt water game fishes into saline inland waters. If one or more of the popular salt water game fishes can be established and maintained in the river or its impoundments, it might prove even more popular than the native game species.

Lastly, good land management should be encouraged on the watershed of the river, to prevent siltation of the river and impoundment lakes.

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