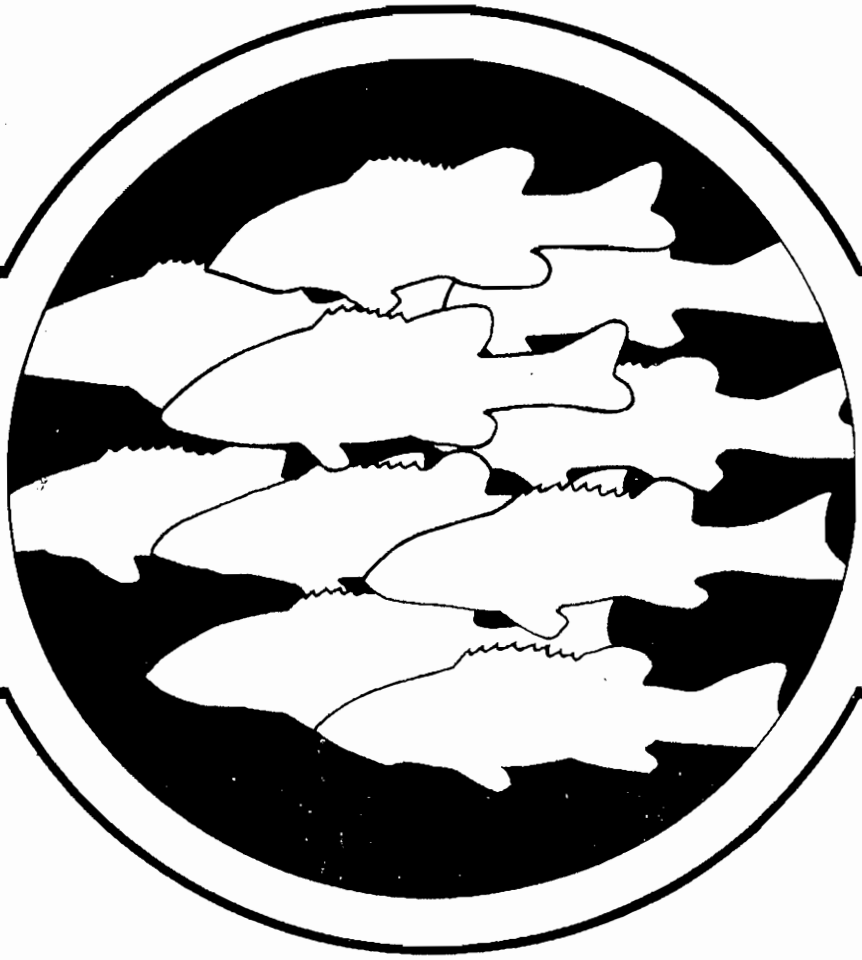

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# Muskellunge Streams Investigation in Red River, Station Camp Creek, and Sturgeon Creek

*Lewis E. Kornman*

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Kentucky
Department of Fish and Wildlife
Resources
Don R. McCormick, Commissioner

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Peter W. Pfeiffer, Director

# Muskellunge Streams Investigation

in

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by

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*ABSTRACT*

*Three muskellunge streams (Red River, Station Camp creek, and Sturgeon Creek) were studied during 1982 and 1983, primarily to determine the existing muskellunge population, what management potential exists that may enhance the muskellunge fishery, and evaluate past stockings of muskellunge fingerings. Additional data was gathered regarding associated fish species. Bottom fauna and selected chemical characteristics were gathered seasonally, and pertinent physical features were recorded at each study pool. Eight muskellunge were collected from Red River during the 2 years of sampling; for an overall catch rate of 0.3 muskellunge per hour. Mean annual growth of muskellunge at Red River was 10.8, 17.2, 23.1, and 28.0 inches long at ages 1-4, respectively. Muskellunge were better represented by year classes from years that muskellunge were stocked, as reported through the mail-in survey, than based on muskellunge collected during this study. A total of 11 muskellunge were collected in Station Camp Creek for a catch rate of 0.8 muskellunge per hour. Age groups 1-4 muskellunge had a mean length of 11.4, 18.0, 23.2 and 27.9 inches, based on back-calculated lengths. Five of the 11 muskellunge were from the 1979 year class, a year in which muskellunge were stocked. Only one muskellunge was collected from Sturgeon Creek for a catch rate of 0.2 fish per hour. This fish was from the 1979 year class, a year in which muskellunge were stocked, and was 30.0 inches long and 6.78 pounds in weight. This fish was harvested from the same pool 25 months later. The known Red River fish fauna is represented by 85 species when including those species of fish collected during this study. A total of 55 species are now recorded from Station Camp Creek and 56 species are now known from Sturgeon Creek. Ten species from these streams have been given conservation status. Golden redhorse were the most abundant fish taken by electrofishing from each of the streams. Spotted bass was the most abundant black bass species collected from Red River and Sturgeon Creek, but spotted bass and largemouth bass were taken with equal frequency from Station Camp Creek. Except in isolated cases, chemical parameters and benthos sampling indicated the presence of good water quality at all three streams. All three streams should be protected from any degradation that would alter habitat or water quality. Red River from ca mile 30 to the downstream junction of the Wild and Scenic portion and Station Camp Creek above the junction of Red Lick Creek should be protected as Outstanding Resource Waters. Sturgeon Creek should be closely monitored so that no further degradation occurs as a result of strip mining. Muskellunge fingerlings should be stocked annually into the Red River from mile 20-60 (every other year from mile 0-20), that portion of Station Camp creek above Middle Fork Creek every other year, and the lower 10 miles of Sturgeon Creek every year.*

## INTRODUCTION

Muskellunge investigations in Red River, Station Camp Creek, and Sturgeon Creek are part of an on-going study of Kentucky's native muskellunge streams. The native muskellunge in Kentucky is discussed by Trautman (1981) as that form found in Ohio outside of the Great Lakes region. Crossman (1978) discussed this form further. This form or possible variation of Esox masquinongy is considered the Ohio River system form and has been studied in Ohio (Clark 1964), Pennsylvania (Buss 1960), Tennessee (Parsons 1959, Riddle 1975, Garavelli 1977), and West Virginia (Miles 1978).

In 1967, D-J Project F-31-R (Musky Studies) was initiated and carried out by Brewer (1975 and 1980), who completed his field work in 1971. Prior to this study, little fish management work on muskellunge had been accomplished within Kentucky. Axon (1978, 1981) reported on the development of the muskellunge fishery at Cave Run Lake, an impoundment on the Licking River that flooded several important native muskellunge streams once reported by Brewer. From Brewer's study, important life history information on Kentucky's native muskellunge population was determined.

Brewer recommended to supplementally stock large muskellunge fingerlings annually into pool habitat areas of selected native muskellunge streams. The goal of such stockings was to bring the number of young-of-year muskellunge to a level that would have naturally occurred without detrimental effects of certain environmental conditions (i.e., high discharge rates and low temperatures) that were found to occur during the spawning periods in most years. Stream stockings began in 1973 in response to Brewer's recommendations and were completed in 1979. Stockings at Red River, Station Camp Creek, and Sturgeon Creek are shown in Table 1. Another recommendation was that supplemental stockings should be evaluated to determine whether such stockings have resulted in stronger year classes and if future stockings are justified.

Table 1. Muskellunge stockings in Red River, Station Camp Creek, and Sturgeon Creek from 1973-1985.

| Year | Red River | Station Camp Creek | Sturgeon Creek |
|---|---|---|---|
| 1973 | 400 | | |
| 1974 | | 50 | 40 |
| 1976 | 536 | 98 | 82 |
| 1979 | 270 | 49 | 41 |
| Stockings since the study has been completed: | | | |
| 1984 | 357 | 60 | 50 |
| 1985 | 357 | 60 | 50 |

In 1980, a muskellunge streams study was initiated as part of D-J Project Number F-50 and has since been expanded to determine (1) the fish population structure in muskellunge streams, (2) age and growth of muskellunge, (3) the exploitation rate and harvest of muskellunge, (4) the contribution of muskellunge stockings to the existing population, (5) physical and chemical determinations as they relate to muskellunge habitat and water quality, respectively, (6) the population of macroinvertebrates as indicators of water quality, and (7) the management potential for developing the muskellunge fishery in native muskellunge streams.

Since 1980, several studies have been completed. Kornman (1983) reported on findings from Kinniconick and Tygarts creeks, Jones and Stephens (1984) reported on muskellunge streams in the South Fork Kentucky River drainage, and Axon and Kornman (in press) reported on characteristics of native muskellunge streams in Eastern Kentucky. Prather reported on muskellunge investigations at North Fork Kentucky River and its tributary Troublesome Creek, Middle Fork Kentucky River, and the Licking River above Cave Run Lake in 1985. Laflin (personal communication) is currently investigating Barren and Green River muskellunge populations and Kornman is working on the Licking River below Cave Run Lake.

This study reveals findings from Red River (Clark, Estill, Menifee, Powell, and Wolfe counties), Station Camp Creek (Estill and Jackson counties), and that portion of Sturgeon Creek within Lee County. These streams are Kentucky River tributaries and were studied during 1982 and 1983.

## STUDY AREA

The Red River drainage is shown in Figure 1. Red River arises in eastern Wolfe County and flows in a westerly direction for roughly 96 mi through Wolfe and Powell counties while bordering on Menifee, Clark, and Estill counties, where it finally enters the Kentucky River just below Kentucky River 191 mi mark. The headwaters of Red River are at an elevation of around 1,200 ft msl, and the mouth of the stream where it flows into the Kentucky River is at 567 ft msl. The mean gradient of the stream is 6.6 ft/mi and the drainage area is roughly 460 $mi^2$. Brewer (1980) determined that there were 21 mi of muskellunge pool habitat within the Red River, primarily from mi 25-66. The historic muskellunge range is considered to be at stream mile 0-66, within which there are 33 miles of muskellunge pool habitat. Major tributaries include Hardwick Creek, Indian Creek, Lulbegrub Creek, Middle Fork Red River (South Fork Red River), Stillwater Creek, and Swift Camp Creek. The literature contains several references to North Fork Red River; however, topographic maps do not make this distinction. The author assumes that the portion of Red River above the junction of Middle Fork Red River is referred to as North Fork Red River (that point upstream of Red River mi 41.0). In this report, that portion of Red River above the Middle Fork Red River will be referred to as Red River, not North Fork Red River.

RED RIVER , STATION CAMP CREEK , and STURGEON CREEK DRAINAGES

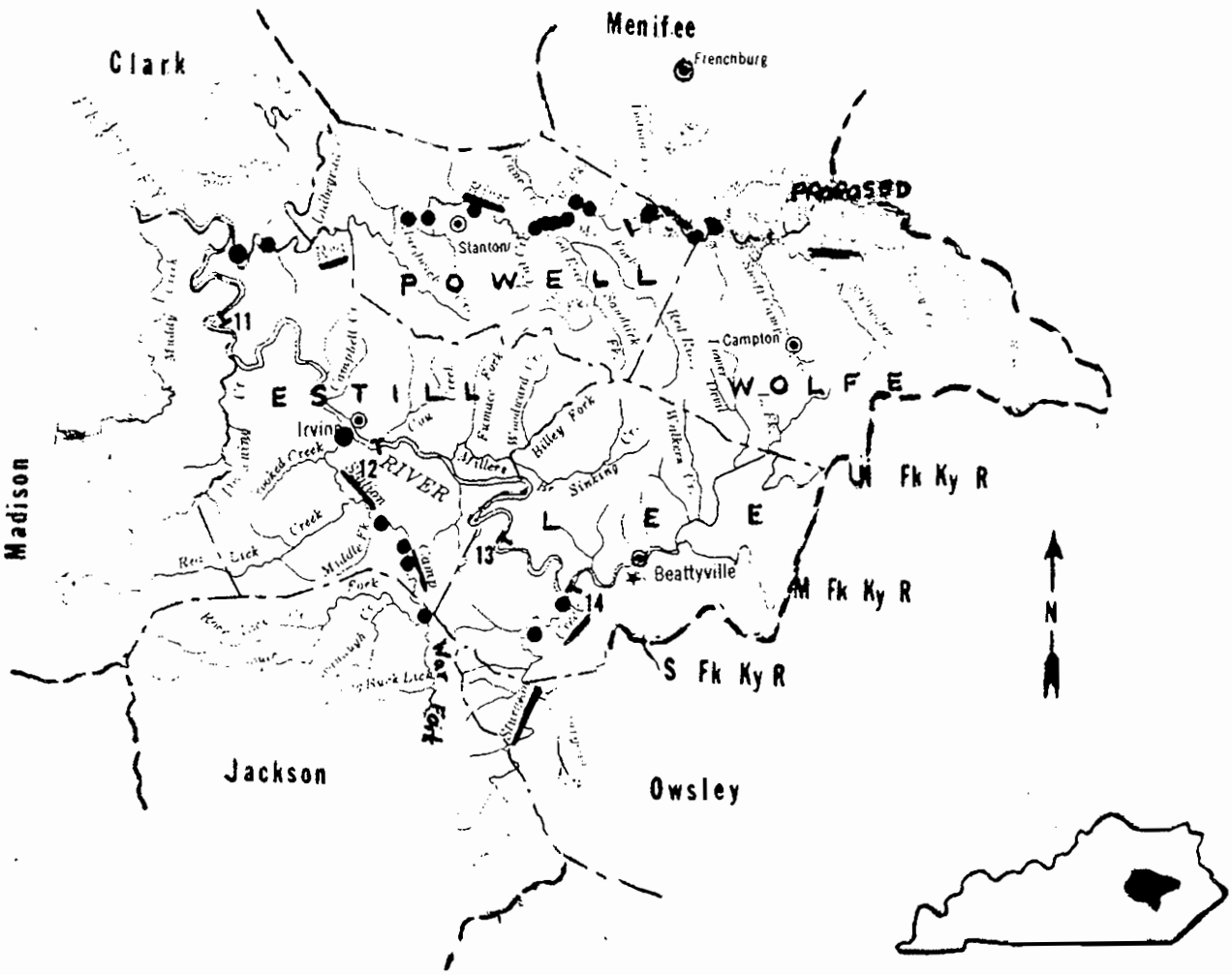


Figure 1. Stream map of Red River, Station Camp Creek and Sturgeon Creek Drainages.

Silviculture constitutes much of the land usage bordering the upper half of the Red River, while agriculture is the more common land usage in the lower reaches, primarily due to the much wider flood plain along this portion. Most of the Red River flows through the Cumberland Plateau of the Appalachian Plateaus Province, with the last few miles flowing into the Blue Grass section (Knobstone Escarpment and Knobs Subsection). The topography of this area is composed primarily of Pennsylvanian and Mississippian age deposits, with extreme lower reaches flowing over (through) Devonian, Silurian, and Ordovician age deposits.

An interesting area through which the Red River flows is the Red River Gorge Geological Area. This region lies on the edge of the Cumberland Plateau and is found mostly in the confines of the Daniel Boone National Forest. The river, 400 to 450 ft below the cliff line, flows roughly 20 mi through this area of cliffs, water falls, rock houses, chimney rocks, arches, etc. Sandstones and sandstone conglomerates predominate. Caves and springs are associated with this area and many small tributary streams exist. Within this corridor, between St Rt 715 crossing (ca river mi 61) upstream to St Rt 746 crossing (ca river mi 70), a 9.1 mi stretch of Red River has been designated as a Kentucky Wild River. An additional 10.3 mi of the Red River directly downstream from this segment warrants additional protection.

**Station Camp Creek**

Station Camp Creek is formed by the juncture of South Fork (24 mi in length) and War Fork (11 mi in length). These tributaries are found in Jackson County. From this point, Station Camp Creek flows 22 miles in a northerly direction through Estill County, where it enters the Kentucky River at Irvine (Kentucky River mi ca 218.5). The elevation at the juncture of South Fork and War Fork is 675 ft msl; at its juncture with the Kentucky River the elevation is 586 ft msl. The mean stream gradient is 4.0 ft/mi. Main tributaries include Red lick Creek, South Fork Station Camp, and War Fork. Headwater drainages lie within the confines of the Daniel Boone National Forest where silviculture is the primary land use. Lower reaches are primarily bordered by crop fields and pasture land, with riparian removal complete in some areas. Muskellunge range within the stream is considered to be from the mouth (mi 0) to mi 20, within which there are 8 mi of muskellunge pool habitat. The best reaches are upstream portions beginning just below the mouth of Middle Fork. Station Camp Creek flows through the Pottsville Escarpment (off of the Cumberland Plateau), Knobstone Escarpment, and Knobs Subsection of the Interior Low Plateaus Province. Primarily, Mississippian age deposits underlie the stream bed. Devonian age deposits can be found near the stream mouth; this deposit is known for its oil shale.

**Sturgeon Creek**

Sturgeon Creek has its headwaters in Jackson County and flows northeasterly through a corner of Owsley County and through Lee County

entering the Kentucky River just below Kentucky River mi 249. Kentucky River Lock and Dam No. 14 is located at this point as is Heidelberg, Kentucky. Sturgeon Creek is ca 33 mi in length, with the headwaters at 1,200 ft msl and the mouth at 621 ft msl; the mean stream gradient is 17.6 ft/mi. However, muskellunge generally range no more than up to mi 13, with a little more than 5 mi being muskellunge pool habitat. Little Sturgeon Creek is the major tributary. A relatively narrow flood plain has been formed by Sturgeon Creek, so most agricultural practices occur on upland sites. Silviculture and coal mining are also land uses within the drainage. Sturgeon Creek forms a portion of the eastern boundary of the Daniel Boone National Forest. This stream lies entirely within the Appalachian Plateaus Province (Cumberland Plateau), flowing over Pennsylvanian age deposits.

## METHODS

Study site locations (Table 2) were determined according to access and location of pools that had adequate depth and area for muskellunge to inhabit. These sites included those sampled by Brewer. The fish populations in both streams were sampled for 2 consecutive years with the use of a boat-type electrofishing unit. This unit consisted of a Homelite 5,000 watt, 60 cycle, single phase, 120/240 volt generator as a power source. The AC output was controlled by a Smith-Root type VI Electrofisher at 60HZ per second, with adjustable output voltage from 0-720 volts in 120 volt steps. The aforementioned gear was mounted on a 16-ft aluminum Polar Kraft boat. The output while electrofishing varied from 5-8 amps at 240-480 volts in Red River, 5-6 amps (8 amps at the mouth) at 240-360 volts in Station Camp Creek, and 4-6 amps (7 amps at mouth) at 240-360 volts within Sturgeon Creek.

Table 2. Locations of fish population sample stations at Red River, Station Camp Creek and Sturgeon Creek during 1982 and 1983.

| | Red River |
|---|---|
| Station 1 | From mouth (at Kentucky River near Dumford Hollow) upstream to just below HWY 89 bridge. 20 July 82 and 3 July 83. Clark/Estill County line, Palmer Quad. River mi 0-2.2 |
| Station 2 | From 0.2 mi above Log Lick Creek (Clark County) upstream 1.2 mi (0.4 miles below Woodward Creek, Estill County). 19 July 82 and 3 Aug 83. Near Vianna, Kentucky, Clark/Estill County line, Palmer Quad. River mi 5.5-6.7. |
| Station 3 | From 0.3 mile below Pompeii Rd. bridge upstream 1.5 mi to just below Pompeii Branch. 14 July 82 and 2 Aug 83. Near Clay City, Kentucky, Powell County, Clay City Quad. River mi 23.5-25.0. |
| Station 4 | From just above Hatton Creek upstream 1.5 mi to just above Beech Fork. 13 July 82 and 8 July 83. Near Stanton, Kentucky, Powell County, Clay City Quad. River mi 27.2-28.7. |

Station 5 From just below HWY 213 bridge upstream 0.9 mi to just below Ewen Branch. 12 July 82 and 6 July 83. Near Stanton, Kentucky, Powell County, Stanton Quad. River mi 31.6-32.5.

Station 6 From Hall Branch upstream 0.5 mi. 25 June 82. Near Bowen, Kentucky, Powell County, Stanton Quad. River mi 39.0-39.5.

Station 7 From HWY 613 bridge (near Bowen, Kentucky) downstream for 0.5 mi. 25 June 82 and 30 June 83. Powell County, Stanton Quad. River mi 40.0-40.5.

Station 8 From HWY 613 bridge (near Bowen, Kentucky) upstream 0.5 mi to mouth of Middle Fork Red River. Powell County, Stanton Quad. River mi 40.5-41.0. 25 June 82 and 30 June 83.

Station 9 From Mountain Parkway Bridge (just above Junct. Middle Fork Red River) 0.8 mi upstream to Catron's Ford (1.0 mi E. of HWY 613/599 Junct., near Bowen, Kentucky, off of HWY 613). 25 June 82 and 30 June 83. Powell County, Stanton Quad. River mi 41.2-42.0.

Station 10 From a ford located 1.5 mi E. of HWY Junct. 613/599 (near Bowen, Kentucky), off of HWY 613, upstream 0.9 mi to just above Dunwoody Branch. 24 June 82 and 29 June 83. Powell County, Stanton and Slade Quad. River mi 42.8-43.7.

Station 11 From the mouth of Short Creek upstream 1.1 mi to the mouth of Spaas Creek. 24 June 82. Powell County, Slade Quad. River mi 44.4-45.5.

Station 12 From the mouth of Indian Creek upstream 0.7 mi to low water ford (off Hwy 1067). 21 June 82 and 28 June 83. Powell County, Slade Quad. River mi 49.3-50.0.

Station 13 From just below Wolfpen Creek (Menifee County) upstream 0.2 mi to low water ford (located off of HWY 715, 1.5 mi E of Junct. HWY 77 and 715). 23 June 82 and 1 July 83. Powell/Wolfe/Menifee County lines, Slade Quad. River mi 55.0-55.2.

Station 14 From low water ford (described above) upstream 0.4 mi (see Chimney Top Creek). 23 June 82 and 1 July 83. Menifee/Wolfe County line. Slade Quad. River mi 55.2-55.6.

Water quality stations: Lower - July - below HWY 82 bridge in Powell County; October - below HWY 89 bridge in Estill County. Middle - Station 5; Upper - Station 12. These were seined 16 July 82.

Middle Fork Red River - just above its Junction with S. Fork Red River. South Fork Red River - at HWY 11/15 Bridge.

Water quality was taken 16 July and 14 October 1982. Water quality and benthos was taken 3 June, 4 August, and 20 October 1983.

Station Camp Creek

Station 1 From mouth (located at Irvine, Kentucky) upstream for 1.7 mi. 21 July 82 and 21 June 83. Estill County, Irvine Quad. Stream mi 0-1.7.

Station 2 From mouth of Middle Fork Creek (0.2 mi above HWY 89 bridge) upstream to just above Scrivner Creek. 15 June 82 and 20 June 83. Estill County, Leighton Quad. Stream mi 11.0-12.0.

Station 3 From Searcy Branch upstream 0.6 mi to low water concrete ford at Alumbaugh, Kentucky (off HWY 1209). 14 June 82 and 10 June 83. Estill County, Leighton Quad. Stream mi 14.4-15.0.

Station 4 From low water concrete ford at Alumbaugh, Kentucky, upstream 0.5 mi (off HWY 1209) 14 June 82 and 10 June 83. Estill County, Leighton Quad. Stream mi 15.0-15.5.

Station 5 From a point 0.2 mi above the Estill/Jackson County line upstream 0.8 mi (off HWY 1209). 21 May 82 and 6 June 83. Jackson County, Leighton Quad. Stream mi 19.4-20.2.

Two water quality stations (a) off HWY 89, 0.6 mi S. of South Irvine and (b) at Station 5. Also seined (15 July 82). Water quality was sampled 15 July and 13 October 1982. Water quality and benthos were sampled 19 April, 22 July, and 18 October 1983.

Sturgeon Creek

Station 1 From the mouth (located just below Kentucky River Lock and Dam No. 14) upstream 0.5 mi. 18 May 82 and 2 June 83. Near Heidelberg, Kentucky, Heidelburg Quad. Stream mi 0-0.5.

Station 2 From ford just above Upper Sinking Creek, upstream 0.8 miles. 19 May 82 and 2 June 83. Heidelburg Quad. Stream mi 4.2-5.0.

One water quality station on stream - located at ford at Station 2. Also seined 15 July 82. Water quality were sampled 15 July and 13 October 1982. Water quality and benthos were sampled 19 April, 22 July, and 18 October 1983.

Upstream seine collection:

Ca 2.4 mi above HWY 587 bridge, vic Lee/Owsley County line, near Earnestville, Kentucky. Sturgeon Quad. 15 July 82. Ca River mi 12.0.

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Fish population sampling on Red River was conducted from 21 June-20 July 1982 along 12.9 mi of stream that included 14 pool areas. Stations were again sampled during 1983 (from 28 June-03 August); 12 pools were sampled representing 11.3 mi of pool habitat. Station Camp Creek was surveyed during a period from 21 May - 21 July 1982 and 6 June - 21 June 1983; five pools were sampled as was a total of 4.6 stream mi each year. Two pools, representing 1.3 mi within Sturgeon Creek, were sampled during 18-19 May 1982 and 2 June 1983

Both shorelines of each pool-sampling area were usually electrofished twice, once during initial tagging efforts and again during re-capture efforts. The exception was on pools that were narrow and one round of electrofishing effort was considered sufficient. Recapture efforts were not carried out during 1983. Captured muskellunge and other species were measured to the nearest 0.1 in and weighed to the nearest 0.01 lb. Scale samples were taken from each muskellunge and a representative sample from other selected species. Legal size muskellunge ($\geq$30 in) were tagged on the anterior basal edge of the dorsal fin with a numbered, monel self-piercing, jaw tag identified as belonging to the Kentucky Department of Fish and Wildlife Resources. Sub-legal muskellunge were marked by clipping one of their pelvic fins. Self-addressed scale envelopes were made available to fishermen at country stores and tackle shops within the area. Envelopes were also provided by local conservation officers and through the Kentucky Silver Musky Club. Fishermen were asked to fill out the questionnaire on the envelopes upon catching a legal-size muskellunge, insert a few scales and any tags recovered, and return the envelope by mail. A certificate and clutch-back pin, depicting a muskellunge, were given by the Department for information on the first fish returned, and a clutch-back pin was given for any subsequent returns.

Age and growth determinations were made by reading scales that were dampened and mounted between glass slides and projected by a Bausch and Lomb Tri-Simplex Microprojector. Back-calculations of growth were determined by utilizing a modification of the Lee Method (Lagler 1956, Everhart and Youngs 1981), using a correction factor determined by Brewer. This correction factor was obtained by extrapolation of the regression line represented by plotting the scale measurement against body length. The body-scale relationship determined by Brewer was based on 152 muskellunge collected from nine streams in eastern Kentucky. The relationship between body length and scale length, as determined by Brewer, was expressed in the equation $L=4.5 + 3.6s$, which has a correction factor of 4.5 in. This factor was somewhat high compared to Miles' (1978) determination of West Virginia muskellunge from a nomograph adjusted to a length of 2.5 in at the time of scale formation. It was also high when compared to Erickson's

(1967) proposed correction factor of 2.6 in for Ohio River muskellunge. Brewer's (1980) correction factor was substituted into the formula $L' = C + \frac{s'}{s}(L-C)$ where:

L' = length of fish at annulus
C = correction factor
S' = length of scale radius at annulus
S = length of total scale radius
L = total length of fish at capture

The total fish population was sampled during part of the first round of electrofishing. Captured fish were sorted to species, counted, measured to the nearest inch group, and released. Any fish not readily identified in the field was preserved in 10% formalin and later identified in the laboratory. Seining was conducted in 1982 on riffles at water quality stations; these collections often included species not collected by electrofishing. Fish were identified using fish keys by Clay (1975) and Pfleiger (1975). Scientific and common names were assigned according to Robins et al. (1980). Some of the uncommon species have been deposited at one of the following localities: Eastern Kentucky University, Richmond; Morehead State University, Morehead, or Minor Clark Fish Hatchery, Morehead.

Pool dimensions were measured by using topographic maps and a cartometer for length, a 100-ft plastic tape for width, and a Tom Mann, Bird Trap, Hummingbird Super Sixty depth sounder for depth. General physical characteristics were recorded on stream survey forms for each pool sampled (i.e. fish shelter, bottom type, pool-riffle ratio, vegetation, pollution, land usage, etc.). Gradient was determined by measuring mileage and reading elevations from topographic maps.

Water quality was taken seasonally during 1982 and 1983 from lower, middle, and upper stations in the Red River, one station each from Middle Fork and South Fork Red River, lower and upper stations in Station Camp Creek, and one station from Sturgeon Creek. See Table 2 for locations and actual sample dates. Water quality determinations consisted of temperature, dissolved oxygen, total alkalinity, turbidity, and pH during 1982. In 1983, salinity and conductivity were collected in addition to the above. Temperature and dissolved oxygen were determined using a YSI Model 54 oxygen meter. Total alkalinity (high range - methyl orange) was determined using a HACH Model AL-AP Alkalinity Test kit using Brom Cresol Green - Methyl Red as an indicator. Total alkalinity in grains per gal as $CaCO_3$ is equal to the total drops of Sulphuric Acid Standard Solution; grains/gal was converted to mg/l by multiplying by 17.1. In 1982, turbidity (FTU) was determined using a HACH Turbidity Meter Scale and 4445 color filter. In 1983, turbidity (NTU) was measured using an H.F. Instruments DRT-15, Series "A" portable battery operated turbidimeter. In 1982, hydrogen iron concentration was measured using an Analytical Measurements pH meter. A HACH digital pH meter (Model 19000) was used to determine pH in 1983. Salinity (ppt) and conductivity (umhos) were measured by using a YSI Model 33 S-C-T meter.

Benthic macroinvertebrates were collected by employing the "kick" method of dislodging benthic organisms from the substrate of a square meter area above a D-framed (34 mesh per inch) aquatic net. Two square meter samples were taken at each of the stations on each stream as mentioned in Table 2 during the spring, summer, and fall and preserved in 80% ethanol for later sorting and identification in the laboratory. Specimens were identified using: Bednarik and McCafferty (1979), Brigham et al. (1982), Burch (1982), Edmunds et al. (1976), Merritt and Cummins (1984), McAlpine et al. (1981), Pennak (1978), Usinger (1956), and Wiggins (1977).

Benthic macroinvertebrates were collected as a means of determining levels of degradation (or lack of) rather than obtaining macroinvertebrate species composition. The Shannon-Weaver (1949) function, using the machine formula presented by Lloyd, Zar, and Karr (1968) was utilized in calculating mean diversity ($\bar{d}$) where $\bar{d} = \frac{C}{N}$ ($N \log_{10} N - \sum n_i \log_{10} n_i$), C is a constant (3.321928), N = total number of individuals, and $n_i$ = total number of individuals in the ith species. Studies have shown that $\bar{d}$ lacks the sensitivity to demonstrate slight or moderate levels of degradation; thus Lloyd and Ghelardi (1964) devised a formula for determining equitability ($e = \frac{s}{S}$) by comparing the number of species (s) in the sample with the number of species (s') based on $\bar{d}$ (as discussed in Weber 1973).

Wilhm (1970) found that in unpolluted water, $\bar{d}$ was generally between 3 and 4 and in polluted water, $\bar{d}$ was generally less than 1 (1 to 3 = moderately polluted). Equitability (e) generally ranged between 0.6 and 0.8 in most southeastern streams. Equitability generally ranges from 0 for polluted conditions and 1 for clean water, except for the case where there are relatively few species with several taxa (Weber 1973). Slight degradation generally results in e being 0 to 0.3.

## RESULTS AND DISCUSSION

### Muskellunge Population Characteristics

**Red River**

Fourteen pools representing 12.9 stream mi were electrofished in Red River during 1982; 12 pools that totaled 11.3 mi of stream were electrofished in 1983. While sampling in 1982, 6 muskellunge were captured that represented 0.4 fish/hour and 0.5 fish/mi (Tables 3 and 4). Legal-sized muskellunge ($\geq$30 in) were collected at a rate of 0.2 fish/mi while sub-legal muskellunge were sampled at a rate of 0.3 fish/mi. Only two sub-legal muskellunge (no legal sized fish) were collected during 1983. These muskellunge were collected at rates of 0.2 fish/hour and mi. The mean catch rates from both years of sampling was 0.3 muskellunge/hour and mi. The catch per unit effort (fish/hour) was well below the mean of 0.6 fish/hour found within 14 muskellunge streams sampled in Eastern Kentucky (Axon and Kornman in press).

Table 3. Sampling effort and muskellunge captured (by section and year) in the Red River during 1982-1983.

| Section | Stations | | Hours electrofished | | Length of sampled area (mi) | | Number of muskellunge actually captured | | Muskellunge observed | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 |
| Lower (mi 0-30) | 1-4 | 1-4 | 6.4 | 5.6 | 6.4 | 6.4 | 0 | 0 | 3 (1 legal) (2 sub-legal) | 0 |
| Middle (mi 30-60) | 5-14 | 5,7, 10-12, 12-14 | 7.4 | 5.5 | 6.5 | 4.9 | 6 (2 legal) (4 sub-legal) | 2 (2 sub-legal) | 6 (all sub-legal) | 7 (3 legal) (4 sub-legal) |
| Upper (mi 60-96.1) | No stations located within this reach. | | | | | | | | | |
| Total | 14 | 12 | 13.8 | 11.1 | 12.9 | 11.3 | 6 | 2 | 9 | 7 |

Table 4. Catch per unit effort while electrofishing for muskellunge within the Red River during 1982-1983.

| | Fish per hour | | | Fish per mile | | |
|---|---|---|---|---|---|---|
| | Lower section | Middle section[c] | Total | Lower section | Middle section | Total |
| 1982 | | | | | | |
| Legal | 0 | 0.27 | 0.14 | 0 | 0.31 | 0.16 |
| Sub-legal | 0 | 0.54 | 0.29 | 0 | 0.62 | 0.31 |
| Combined | 0 | 0.81 | 0.40 | 0 | 0.93 | 0.47 |
| 1983 | | | | | | |
| Legal | 0 | 0 | 0 | 0 | 0 | 0 |
| Sub-legal | 0 | 0.36 | 0.18 | 0 | 0.41 | 0.18 |
| Combined | 0 | 0.36 | 0.18 | 0 | 0.41 | 0.18 |

[a] ≥30 in long.

[b] <30 in long.

[c] No stations within upper reaches.

Muskellunge were not sampled in the upper third of the Red River where there is little adult muskellunge habitat. The best section for muskellunge is the middle reach from approximately mile 30-60. As a general range, adult muskellunge can be found from the mouth up to ca river mile 64, as our sampling showed muskellunge sporadically scattered throughout this range. Desirable habitat for muskellunge appears to decrease as one moves downstream from ca mile 30, based on the fewer fish captured or seen below this point.

An attempt was made to estimate the population of muskellunge from each stream by using the Peterson formula, with modifications by Ricker (1975), and expanding the numbers on a per mile basis. However, based on the number of recaptures of marked fish following completion of the studies, population estimates could not be made (Table 5). According to Robson and Regier (1964), population estimates were found to be highly inaccurate when fewer than four recaptures were made. Looking at both years combined, a total of three fish were collected during initial marking efforts (1st round), four unmarked fish were captured during the second (recapture round), and two marked fish were recaptured during this round. Due to time restraints, our method of recapture (a second sample round within the same pool, the same day), and our lack of recapture success, these efforts were discontinued after 1982.

Table 5. Muskellunge mark and recapture results at Red River in 1982-1983.

| Year | Marking effort Number of fish | Recapture effort Number of unmarked fish | Recapture effort Number of marked fish |
|---|---|---|---|
| 1982 | 2 | 4 | 1 |
| 1983 | 1 | * | |

*Did not conduct recapture rounds in 1983.

Obviously not all muskellunge that were sighted were captured. Limitations of success at capture were those normally experienced and expected when electrofishing. Table 6 shows the number of muskellunge captured, additional fish sighted (but not captured), and percent success at capturing muskellunge within Red River. Success rate at capture was fairly high for legal sized fish but somewhat poor for sub-legal fish. The primary reason for such a low success rate at capture within the Red River was due to the immense amount of in-stream cover (fallen trees, logs, brush, etc.) found within most sampled portions of the stream. The largest muskellunge sighted, but not captured, was observed at Station 1, ca mi 2.

Table 6. Muskellunge captured, additional muskellunge sighted (but not captured), and percent success of capture from Red River.

| Year | Number captured: Legal | Number captured: Sub-legal | Number captured: Total | Number sighted - not captured: Legal | Number sighted - not captured: Sub-legal | Number sighted - not captured: Total | Capture rate(%): Legal | Capture rate(%): Sub-legal | Capture rate(%): Total |
|---|---|---|---|---|---|---|---|---|---|
| 1982 | 2 | 4 | 6 | 1 | 8 | 9 | 67 | 33 | 40 |
| 1983 | 0 | 2 | 2 | 3 | 4 | 7 | 0 | 33 | 22 |
| Total | 2 | 6 | 8 | 4 | 12 | 16 | | | |
| Mean | | | | | | | 33 | 33 | 33 |

Muskellunge captured in 1982 averaged 24.7 in long and 3.80 lb in weight; lengths ranged from 19.5 - 30.6 in long and weights ranged from 1.58-6.84 lb. Data from only two muskellunge was obtained in 1983; these fish were 15.4 and 27.3 in long and weighed 0.70 and 4.47 lb, respectively. The combined average size of the eight muskellunge captured during 1982 and 1983 was 23.8 in long and 3.50 lb in weight.

Table 7. Length frequency of muskellunge captured and estimated length of those observed while electrofishing for a total of 24.9 hours and 24.2 stream mi during 1982 (13.8 hours and 12.9 mi) and 1983 (11.1 hours and 11.3 mi) at Red River.

| Year | Inch group | | | | | | | | | | | | Total | Fish/hour | Fish/mi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 12 | 15 | 19 | 20 | 21 | 24 | 25 | 27 | 28 | 30 | 31 | 40 | | | |
| 1982 | | | | | | | | | | | | | | | |
| Captured | | | | 2 | 1 | | | 1 | | 1 | 1 | | 6 | 0.4 | 0.5 |
| Observed | | | 2 | 3 | | 2 | 1 | | | | | 1 | 9 | 0.7 | 0.7 |
| 1983 | | | | | | | | | | | | | | | |
| Captured | | 1 | | | | | | 1 | | | | | 2 | 0.2 | 0.2 |
| Observed | 1 | | | 1 | | | 1 | | 1 | 2 | 1 | | 7 | 0.6 | 0.5 |
| Total[a] | | | | | | | | | | | | | | | |
| Captured | | 1 | | 2 | 1 | | | 2 | | 1 | 1 | | 8 | 0.3 | 0.3 |
| Observed | 1 | | 2 | 4 | | 2 | 2 | | 1 | 2 | 1 | 1 | 16 | 0.6 | 0.7 |

[a]Both years combined.

Table 7 presents the length distribution of the muskellunge captured and the estimated length of those muskellunge observed but not captured during 1982 and 1983, separately and combined. Catch per unit effort, in hours and mi, is also provided. Muskellunge were represented within the 12-31 inch groups. No muskellunge were captured or observed over 31 inches in length, except for the large muskellunge in Station 1 (ca 40 in long).

Mean back-calculated lengths for the eight muskellunge collected from Red River were 10.8, 17.2, 23.1, and 28.0 at ages 1-4, respectively (Table 8). These growth rates were similar to that found at Kinniconick and Tygarts creeks (Kornman 1983), Licking River (above Cave Run Lake), and Middle Fork Kentucky River (Prather 1985) but somewhat faster than muskellunge captured from the South Fork Kentucky River drainage (Jones 1984). Brewer (1980) showed slightly faster growth rates after age 1 from the average muskellunge sampled in nine Kentucky streams.

Table 8. Mean length (in) at each age for eight muskellunge collected during 1982 and 1983 from Red River.

| Year class | Year collected | No. | Age 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|
| 1982 | 1983 | 1 | 12.9 | | | |
| 1980 | 1982 | 3 | 9.6 | 17.0 | | |
| | 1983 | 1 | 12.1 | 18.4 | 24.5 | |
| 1979 | 1982 | 1 | 11.0 | 16.8 | 22.1 | |
| 1978 | 1982 | 2 | 10.9 | 17.0 | 22.9 | 28.0 |
| Total | | 8 | | | | |
| Mean | | | 10.8 | 17.2 | 23.1 | 28.0 |

Too few muskellunge were captured in order to make any significant comparisons regarding length-weight relationships or regression equations.

Numbers of muskellunge collected (by year class) from Brewer, the mail-in survey, and from this study are shown in Table 9. Mail-in returns were very poor from this area. Most returns received through this program were from Kinniconick Creek, Licking River, and Tygarts Creek areas where Kentucky Silver Muskie Club Members are active and fishermen are more aware of our program. Most muskellunge returns via the mail-in survey were from a year class in which the Red River was stocked. Actually, it is difficult to assess the stocking success because no muskellunge were captured in any of our stream studies (Axon and Kornman in press) that proved to be older than 6 years of age. Therefore, by the time this study (F-50 Muskellunge Streams Investigation) was underway, the 1973 year class had probably been

drastically reduced or eliminated by angler harvest, natural mortality, and other natural, legal, or illegal methods. The 1976 year class was also disappearing for the same reasons and the 1979 year class was just becoming of legal harvest size (30 in long) by the time this study was complete. Looking at Table 9, 1980 apparently was a good year for natural reproduction; but this is just an assumption since there were very few muskellunge data from Red River.

Only two muskellunge were tagged during this study, with none (to our knowledge) being caught by anglers to date. Therefore, no information is available regarding angler exploitation. One muskellunge that Brewer tagged in Red River was harvested 27 months later; it is not known how many muskellunge Brewer tagged in Red River.

When comparing the three (four in some years) study sites that Brewer sampled from Red River (which were sampled for 4 years) with the same sites that were sampled for 2 years during this study, there were 1.9 muskellunge/mi taken during Brewer's study and 1.6 muskellunge/mi captured during this study. The above includes 7.4 mi of stream sampling, with 14 muskellunge being sampled or observed by Brewer. During this study, 5.6 of the same stream mi sampled by Brewer were sampled and nine muskellunge were captured or observed. Based on the above, the muskellunge population does not appear to have increased (at any significant level) due to stocking at Red River. Mail-in returns suggested that numbers of muskellunge from stocked years (1976 and 1979) did contribute to the catch when compared to the other years. Red River can only be considered fair as a muskellunge fishery when compared to other muskellunge streams. When one only looks at stream mi 20-60, the angling outlook is much better as this is where most muskellunge are located within Red River.

**Station Camp Creek**

Only one study has been conducted on Station Camp Creek by this agency (Carter 1970). This was one of the few native muskellunge streams in eastern Kentucky that Brewer did not sample.

Five muskellunge were captured during 1982 and six during 1983 while electrofishing 5 pools representing 4.6 stream mi each year. Table 10 exhibits sampling effort at each section and how many muskellunge were collected and observed from each section. Overall catch rates for muskellunge during 1982 and 1983 were 0.8 fish/hour and 1.2 fish/mi. The catch per unit effort (0.8 fish/hour) was above the mean CPUE for 14 muskellunge streams as reported by Axon and Kornman (in press). Table 11 shows catch per unit effort separately for both years and compares legal and sub-legal sized muskellunge CPUE at three stream reaches. The middle section (mi 7-15) had the best catch rate for muskellunge.

Table 9. Year-class frequency of muskellunge captured at Red River by Brewer, mail-in survey returns, and efforts from this study.

| | Year class | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1982 | 1980 | 1979[a] | 1978 | 1977 | 1976[a] | 1969 | 1968 | 1966 | 1965 | 1963 |
| Brewer (1967-1971) | | | | | | | 1 | 4 | 1 | 5 | 1 |
| Mail-in Survey (1975-1985) | 1 | 2 | 5 | 1 | 1 | 3 | | | | | |
| Red River study (1982-1983) | 1 | 4 | 1 | 2 | | | | | | | |
| Total | 2 | 6 | 6 | 3 | 1 | 3 | 1 | 4 | 1 | 5 | 1 |

[a]Year in which Red River was stocked.



Table 10. Sampling effort and muskellunge captured and observed by section in Station Camp Creek during 1982 and 1983.

| Section (mi) | Stations | | Hours electrofished | | Length of sampled area (mi) | | Muskellunge actually captured | | Muskellunge observed | |
|---|---|---|---|---|---|---|---|---|---|---|
| | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 | 1982 | 1983 |
| Lower (0-7) | 1 | 1 | 2.0 | 1.9 | 1.7 | 1.7 | | | 1 (legal) | |
| Middle (7-15) | 2-3 | 2-3 | 3.4 | 3.5 | 1.6 | 1.6 | 5(sub-legal) | 4 (1 legal) (3 sub-legal) | 4 (2 legal) (2 sub-legal) | 2 (1 legal) (1 sub-legal) |
| Upper (15-22) | 4-5 | 4-5 | 1.5 | 1.7 | 1.3 | 1.3 | --- | 2 (1-legal) (1-sub-legal) | 1 (1 sub-legal) | -- |
| Total | | | 6.9 | 7.1 | 4.6 | 4.6 | 5 | 6 | 6 | 2 |

Table 11. Catch per unit effort for muskellunge captured while electrofishing in Station Camp Creek during 1982 and 1983.

| | Fish per hour | | | | Fish per mile | | | |
|---|---|---|---|---|---|---|---|---|
| | Lower | Middle | Upper | Total | Lower | Middle | Upper | Total |
| 1982 | | | | | | | | |
| Legal | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Sub-legal | 0 | 1.47 | 0 | 0.72 | 0 | 3.13 | 0 | 1.08 |
| Combined | 0 | 1.47 | 0 | 0.72 | 0 | 3.13 | 0 | 1.08 |
| 1983 | | | | | | | | |
| Legal | 0 | 0.29 | 0.58 | 0.28 | 0 | 0.63 | 0.77 | 0.43 |
| Sub-legal | 0 | 0.86 | 0.58 | 0.56 | 0 | 1.88 | 0.77 | 0.87 |
| Combined | 0 | 1.15 | 1.16 | 0.84 | 0 | 2.51 | 1.54 | 1.30 |

Table 12 shows efforts of mark-recapture results at Station Camp Creek. As with Red River, too few recaptures were made to enable accurate estimates of the population size. Looking at both years combined, nine muskellunge were tagged during the initial marking effort, two unmarked muskellunge were captured and tagged during recapture efforts, and two tagged fish were recaptured during the recapture period.

Table 12. Muskellunge mark and recapture results at Station Camp Creek in 1982-1983.

| | Marking effort | Recapture effort | |
|---|---|---|---|
| Year | Number of fish | Number of unmarked fish | Number of marked fish |
| 1982 | 5 | -- | 1 |
| 1983 | 4 | 2 | 1 |

Overall success rate at capturing sighted muskellunge at Station Camp Creek was 58% (Table 13). A total of 19 muskellunge were observed; of these, 11 were captured. The success rate at capturing sub-legal muskellunge was better during both years than was the success of capturing legal-size fish.

Table 13. Muskellunge captured versus additional fish sighted, but not captured, and percent success at capture in Station Camp Creek in 1982-1983.

| | Number captured | | | Muskellunge sighted but not captured | | | Capture rate (%) | | |
|---|---|---|---|---|---|---|---|---|---|
| Year | Legal | Sub-legal | Total | Legal | Sub-legal | Total | Legal | Sub-legal | Total |
| 1982 | 1 | 4 | 5 | 2 | 4 | 6 | 33 | 50 | 45 |
| 1983 | 2 | 4 | 6 | 1 | 1 | 2 | 66 | 80 | 75 |
| Total | 3 | 8 | 11 | 3 | 5 | 8 | | | |
| Mean | | | | | | | 50 | 62 | 58 |

Twice as many hours were electrofished and 2.5 times as many miles were sampled on Red River versus Station Camp creek. The overall success rate of capturing all muskellunge was better at Station Camp Creek (58%) than at Red River (33%). This is misleading, however, due to the immense amount of cover found within the majority of pools sampled at Red River; the wider average width at Red River probably was an additional factor. Red River had a low population density of muskellunge, based on the number of fish captured and observed per mile.

The capture rate for muskellunge was greater at Kinniconick and Tygarts creeks (Kornman 1983), streams with wider mean widths, than at Station Camp Creek (69% at Tygarts Creek and 64% at Kinniconick Creek). This is due to those streams having better muskellunge habitat and a better population of muskellunge. Nevertheless, it is easier to capture muskellunge, if they are present, in shorter pools having a narrow width. For example, in the relatively narrow pools of the streams within the South Fork Kentucky River drainage (except for South Fork Kentucky River) Jones (1984) experienced a capture rate of 78%. There is a point, however, when length and width directly affect capture success. Therefore, it is not truly known whether muskellunge do not commonly inhabit longer, deeper, and wider pools or that muskellunge are just too difficult to sample in such areas. I suspect that fewer muskellunge do inhabit such areas because of the sluggish nature of these large pools. On the other hand, muskellunge do seem to avoid certain minimum physical characteristics as well (such as pools being to narrow, too shallow, too swift, etc.). Axon and Kornman (in press) found that muskellunge were most often found in pools that had mean depths of 3.5-4.0 ft, maximum depths of at least 5 ft, mean widths of more than 25 ft, lengths of 1.8 mi or less, and where the stream gradient was 3.0-6.9 ft/mi.

The mean length and weight of muskellunge collected at Station Camp Creek during both study years was 26.1 in and 5.36 lb. The five muskellunge captured from Station Camp Creek in 1982 averaged 23.6

Table 14. Length frequency of muskellunge captured and estimated length for those observed (but not captured) while electrofishing a total of 14.0 hours in 9.2 stream mi at Station Camp Creek in 1982 (6.9 hour and 4.6 mi) and 1983 (7.1 hour and 4.6 mi).

| Year | Inch group | | | | | | | | | | | Total | Fish/ hour | Fish/ mi |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 3 | 20 | 22 | 23 | 25 | 28 | 29 | 30 | 31 | 32 | 33 | | | |
| 1982 | | | | | | | | | | | | | | |
| Captured | 1 | 1 | 1 | 1 | | | 1 | | | | | 5 | 0.7 | 1.1 |
| Observed | | 1 | | | 2 | | | 1 | | 1 | 1 | 6 | 0.9 | 1.3 |
| 1983 | | | | | | | | | | | | | | |
| Captured | | 1 | | | 1 | 1 | 1 | | 1 | 1 | | 6 | 0.8 | 1.3 |
| Observed | | | | | 1 | | | 1 | | | | 2 | 0.3 | 0.4 |
| Total[a] | | | | | | | | | | | | | | |
| Captured | 1 | 2 | 1 | 1 | 1 | 1 | 2 | | 1 | 1 | | 11 | 0.8 | 1.2 |
| Observed | | 1 | | | 3 | | | 2 | | 1 | 1 | 8 | 0.6 | 0.9 |

[a]Both years.

inches in length (19.7-29.5 in) and 3.46 lb (1.56-6.62 lb); this does not include a 3.0 in long muskellunge that was collected. In 1983, the mean length from the six muskellunge sampled was 27.7 in (20.2-32.5 in) and the mean weight was 6.63 lb (1.76-10.38 lb). Length distribution for those muskellunge actually collected and estimated length for those muskellunge that eluded capture are shown in Table 14.

Muskellunge within Station Camp Creek grew at a rate comparable to fish in Kinniconick Creek, Tygarts Creek, and Red River. Determinations for age and growth are shown in Table 15. Mean calculated lengths were 11.4, 18.0, 23.2, and 27.9 for ages 1-4, respectively. One age 0 muskellunge was collected. The age 0 muskellunge collected on 15 June 82 was 3.0 in long. Little data is available from native muskellunge from birth to age 1 from Kentucky streams. Brewer (1980) provided the following from various muskellunge streams.

| Date collected | Number | Length (in) |
|---|---|---|
| May 25, 1970 | 1 | 1.0 |
| May 28, 1969 | 2 | 0.8-1.0 |
| May 29, 1969 | 3 | 0.9-1.2 |
| June 2, 1971 | 1 | 1.5 |
| June 25, 1969 | 1 | 4.5 |
| July 25, 1968 | 1 | 6.5 |
| August 7, 1968 | 1 | 6.5 |
| September 11-18, 1968 and 1969 | 3 | 8.0-10.3 |
| October 9-29, 1968 and 1969 | 8 | 9.3-11.0 |

Table 15. Mean length (in) at each age for 11 muskellunge collected during 1982 and 1983 within Station Camp Creek.

| Year class | Year collected | No. | Age 0 | 1 | 2 | 3 | 4 |
|---|---|---|---|---|---|---|---|
| 1982 | 1982 | 1 | * | | | | |
| 1981 | 1983 | 1 | | 13.2 | 18.8 | | |
| 1980 | 1982 | 3 | | 10.8 | 18.6 | | |
| | 1983 | 1 | | 11.1 | 18.0 | 23.0 | |
| 1979 | 1982 | 1 | | 10.2 | 17.4 | 25.8 | |
| | 1983 | 4 | | 11.8 | 17.5 | 22.6 | 27.9 |
| Total | | 11 | | | | | |
| Mean | | | | 11.4 | 18.0 | 23.2 | 27.9 |

*3.0 in long, collected 15 June 82.

Too few muskellunge were collected in Station Camp Creek to determine the length-weight relationship.

Year classes of muskellunge at Station Camp Creek from the 1982 and 1983 sampling consisted of: 1982 (1), 1981 (1), 1980 (4), and 1979 (5). To the author's knowledge, no angler returns have been received from Station Camp Creek through the mail-in survey. In view of this, none of the four tagged muskellunge have reportedly been harvested to date. As was revealed fromm Tygarts Creek and Red River, the 1980 year class was well represented considering the paucity of muskellunge data. Even better represented was the 1979 year class, a year in which muskellunge were stocked.

The fishery at Station Camp Creek is somewhat unique. Good fishing can be expected (above Middle Fork) for largemouth and spotted bass, with smallmouth bass entering the creel more so in the upper portion; bluegill and longear sunfish are well represented, and an occasional muskellunge or rainbow trout may enter the creel. However, access is poor.

**Sturgeon Creek**

Access for electrofishing was only found at two pools on Sturgeon Creek. These pools were electrofished in 1982 for a total of 2.5 hours and in 1983 for 2.1 hours. Both pools totaled 1.3 stream mi. No muskellunge were collected or observed during 1982. In 1983, one muskellunge was collected that was 30.0 in long and weighed 6.78 lb. This fish was captured during the recapture round. The muskellunge was tagged on 2 June 83 and was harvested from the same pool by an angler on 26 July 85. At that time, the fish was reportedly 33 in long and weighed 9 lb. To the author's knowledge, this is the only muskellunge data ever received via the mail-in survey from Sturgeon Creek. This fish was from the 1979 year class, a year when Sturgeon Creek was stocked. Back-calculated lengths for this fish at each age group was age 1 - 12.3 in, 2 - 18.0 in, 3 - 23.6 in, and 4 - 27.8 in.

Electrofishing effort in 1982 resulted in a catch of no muskellunge; in 1983 the CPUE was 0.4 muskellunge/hour and 0.8 muskellunge/mi. Combined efforts for the 2 years resulted in a total of 4.6 hours being spent electrofishing Sturgeon Creek. The overall catch rate was 0.2 muskellunge/hour. A total of 2.6 mi of stream was sampled for a catch of 0.4 muskellunge/mi. This CPUE is well below the average of 0.6 muskellunge/hour reported by Axon and Kornman from 14 Kentucky muskellunge streams. Both of the fish sampling stations at Sturgeon Creek were in the lower section within mile 0-5. Muskellunge probably range no more than up to ca mi 13.5.

In 1971, Brewer sampled the same two stations at Sturgeon Creek. He collected two muskellunge and observed a third. During this study, only one muskellunge was captured or observed while sampling both stations for 2 years.

Table 16. Fishes collected from the Red River, Station Camp Creek and Sturgeon Creek during 1982 (top number) and 1983 (bottom number). Numbers represent actual numbers of fishes collected during a timed subsample period within each pool; x represents species taken from that pool but not during timed period.

| | Stations | | | | | | | | | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Red River | | | | | | | | | | | | | | Station Camp Creek | | | | | Sturgeon Creek | | | | |
| Species | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 1 | 2 | 3 | 4 | 5 | 1 | 2 | c | | |
| Lamprey ammocoetes | | | | | | | | x | 1 | 1 | | x | | | | | | | | | x | | | |
| Longnose gar | 2 | x | x | x | | 2 | x | 1 | 1 | 2 | x | x | x | x | 1 | 2 | 2 | | | x | | | | |
| (Lepisosteus osseus) | 1 | 1 | | 3 | x | | | 1 | | x | | 3 | 1 | x | x | 2 | 2 | 4 | x | x | | | | |
| American eel | | x | 1 | x | 1 | | x | x | x | x | x | x | | | x | | x | | x | | | | | |
| (Anguilla rostrata) | x | | x | 2 | x | | 1 | x | x | 1 | | x | | | | x | x | | | | x | | | |
| Gizzard shad | 2 | 5 | x | 1 | 1 | | 2 | | | | 2 | | | | 1 | 5 | 10 | 1 | | | | | | |
| (Dorosoma cepedianum) | 2 | 19 | 46 | 11 | 10 | | 3 | 2 | | x | | 14 | | | x | 1 | | | | x | | | | |
| Mooneye | 1 | | x | | 1 | 3 | | | | | 1 | | | x | | 1 | | | | | | | | |
| (Hiodon tergisus) | | 2 | | x | x | | | x | | x | | | | 1 | | x | | x | | | x | | | |
| Rainbow trout (Salmo gairdneri) | | | | | | | | | | | | 1 | | | | x | 2 | x<br>3 | x | | | | | |
| Muskellunge | * | | * | * | x | x | x | * | 1 | * | | 1 | * | 1 | * | 2 | x | * | | | | | | |
| (Esox masquinongy) | | | | | * | | | * | * | x | | * | 1 | * | | | 1 | x | | | x | | | |
| Central stoneroller | | | 2 | | | | | | | | | | | | | | | | 2 | | b | | | |
| (Campostoma anomalum) | | | 2 | x | 4 | | | x | | | | 4 | | | | | 12 | 1 | x | | | x | | |
| Carp[a] | x | x | 1 | x | 2 | | 1 | 2 | 2 | 5 | x | x | | x | x | x | | | | | x | | | |
| (Cyprinus carpio) | 2 | | 3 | 6 | 5 | | 1 | 11 | x | x | | | | 4 | | 1 | | | | | | | | |
| Silverjaw minnow | | | 1 | | b | | | | | | | | | | | | | | | | | | | |
| (Ericymba buccata) | | | 1 | | | | | | | | | | | | | | | | | | | x | | |
| Silver chub | | | | | 2 | | 2 | | 2 | | | | | | | | | | | | | | | |
| (Hybopsis storeriana) | | | | | | | | | | | | | | | | | | | | x | | | | |
| River chub | | | x | 2 | | | | | 1 | | | 1 | | 1 | | | | | 2 | | b | | | |
| (Nocomis micropogon) | | | 1 | 1 | 1 | | | 1 | x | | | 7 | 1 | | | | 1 | 2 | | | | x | | |
| Rosefin shiner | | | | | | | | | | 1 | | | | | | | | | | | | | | |
| (Notropis ardens) | | | | | | | | | | | | | | | | | 1 | | | | | | | |
| Emerald shiner | | | 2 | x | 3 | | | | 2 | 1 | 2 | 3 | x | | 2 | 2 | | | | | | | | |
| (N. atherinoides) | | | 6 | 7 | 2 | | | | | | | 4 | | 1 | x | | | | | | | x | | |
| Striped shiner | | | x | 1 | 1 | | | | 2 | | | 2 | 1 | 3 | b | | | 3 | 2 | | b | | | |
| (N. chrysocephalus) | | | | x | 2 | | | | | | | 11 | 15 | 4 | | | 7 | 2 | x | | 9 | x | | |
| Silver shiner | | | x | | | | | | 1 | x | | 1 | | 1 | | | | | 1 | | 1 | | | |
| (N. photogenis) | | | | x | 2 | | | | | | | | 1 | 4 | | | 2 | 1 | 1 | | 1 | | | |
| Rosyface shiner | | | | | | | | | 2 | 1 | x | b | 2 | | b | 2 | | | 1 | | b | | | |
| (N. rubellus) | | | | | 1 | | | | x | | | 4 | 7 | 6 | | | 2 | 1 | | | | x | | |
| Spotfin shiner | 1 | | | 1 | 1 | | | | 4 | | | b | | | 1 | x | | | | | 1 | | | |
| (N. spilopterus) | | | 1 | x | | | | | x | | | 1 | | | | | | 1 | | | | | | |
| Sand shiner (N. stramineus) | | | | | | | | | | | | b | | | | | | | | | | | | |
| Mimic shiner | | | | | b | | | | 3 | | | | | 2 | | | | | | | | | | |
| (N. volucellus) | | | 3 | | | | | 3 | | | | | 14 | | | | | | | | | | | |
| Bluntnose minnow | | x | 2 | x | b | | | | 2 | x | | 13 | | 4 | b | x | 1 | 2 | 1 | | b | | | |
| (Pimephales notatus) | x | 8 | | | 2 | | 1 | | | | | 4 | 15 | 8 | | | 9 | 3 | | | 2 | x | | |
| Creek chub | | | | | | | | | | | | b | | | b | | | | | 1 | b | | | |
| (Semotilus atromaculatus) | | | | | | | | | | | | | 1 | | | | 6 | | | | | x | | |
| Quillback | | | | | | 2 | | | | | | | | | | | | | | | | | | |
| (Carpiodes cyprinus) | | | 1 | | | | | | | | | | | | | | | | | | | | | |
| White sucker (Catostomus commersoni) | | | x | | | | | | | | | | | | | | | | | | | | | |
| Northern hog sucker | | 2 | x | 4 | 6 | 1 | | 1 | 10 | 1 | 4 | 1 | 1 | 1 | 1 | | | 2 | 1 | | | | | |
| (Hypentelium nigricans) | | | 2 | 3 | 4 | | | | | x | | 6 | 3 | 2 | | 1 | 3 | 4 | | | 5 | | | |

Table 16 continued.

| Species | Stations: Red River 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | Station Camp Creek 1 | 2 | 3 | 4 | 5 | Sturgeon Creek 1 | 2 | c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Smallmouth buffalo | 3 | | 2 | | x | | | | | | | | | | 1 | | | | | | | |
| (Ictiobus bubalus) | 5 | | | | | | | | | | | | | | | 2 | | | | | | |
| Spotted sucker | | | 2 | 2 | 2 | | | | | | | | | | 17 | 2 | 1 | | | 1 | | |
| (Minytrema melanops) | 2 | | 2 | 3 | 2 | | | | | | | | | | | 2 | 4 | x | | 2 | 1 | |
| Silver redhorse | | 3 | 4 | 10 | 24 | 13 | 32 | 5 | 14 | 4 | 5 | 14 | 5 | 3 | | | 1 | | 1 | | 1 | |
| (Moxostoma anisurum) | 2 | 5 | 15 | 7 | 10 | | 8 | 9 | | | | 6 | 1 | 7 | | x | | | | | | |
| River redhorse | | x | 1 | 2 | | 2 | x | | | | 2 | | | x | x | x | | | | | | |
| (M. carinatum) | | 1 | 2 | 1 | 1 | | | | | x | | | | 1 | | | | | | | | |
| Black redhorse | | 4 | 4 | 1 | 3 | | 2 | 1 | 2 | | | 1 | | | 1 | | 1 | 1 | | | | |
| (M. duquesnei) | | 1 | | | 1 | | 5 | | | | | 8 | 2 | 7 | | 8 | 1 | 6 | x | | | |
| Golden redhorse | 8 | 39 | 11 | 23 | 28 | 25 | 34 | 13 | 35 | 20 | 34 | 26 | 23 | 17 | 31 | 7 | 8 | 10 | 19 | 17 | 15 | |
| (M. erythrurum) | 6 | 46 | 24 | 46 | 38 | | 28 | 12 | | | | 23 | 15 | 23 | | 13 | 13 | 22 | | 5 | 10 | |
| Shorthead redhorse | | 1 | 1 | 2 | | | | | 2 | 2 | | 1 | | | | | | | | 3 | 1 | |
| (M. macrolepidotum) | | 1 | 7 | 4 | 3 | | | 2 | | | | 1 | | | | | | | | | | |
| Black bullhead | | | | | | | | | | | | | | | | | | | | x | | |
| (Ictalurus melas) | | | | | | | | | | | | | | | | | | | | | x | |
| Yellow bullhead | | | | | | | | | | | x | | | | | | | | | | | |
| (I. natalis) | | | | | | | | | | | | | | | | | 1 | | | | | |
| Channel catfish | | 1 | | | | 1 | 1 | x | | | x | | | | | | | | | | 2 | |
| (I. punctatus) | x | 2 | | x | | | x | 1 | x | | | x | 3 | x | | | | | | | 2 | |
| Stonecat | | | | | | | | | | | | | | | | | | | | | | |
| (Noturus flavus) | | | | | | | | | | | | | | | | | | | | | | x |
| Brindled madtom | | | | | b | | | | x | | | b | | 1 | | | | | | | | |
| (N. miurus) | | | | 1 | | | | | x | | | 1 | | 2 | | | | | | | | |
| Flathead catfish | 1 | 1 | x | | | | | | | | | | | | | | | | | | | |
| (Pylodictis olivaris) | x | 1 | | | x | | | 1 | | | | | 1 | 1 | | | | | | | | |
| Mosquitofish | d | | | | | | | | | | | | | | | | | | | | | |
| (Gambusia affinis) | x | | | | | | | | | | | | | | | | | | | | | |
| Brook silverside | 1 | | | | | | | | | | | | | | 1 | x | 1 | x | 1 | | 1 | |
| (Labidesthes sicculus) | | | | | | | | | | | | | | | x | | | 1 | x | | | |
| Rock bass | | 1 | x | | 1 | | | 1 | 1 | 3 | 2 | 1 | 1 | 1 | | x | | | 7 | | 5 | |
| (Ambloplites rupestris) | | 1 | 1 | 1 | | | 4 | x | x | | | x | 2 | 1 | | 1 | 1 | 3 | x | | x | x |
| Green sunfish | | 1 | 1 | | | | | | | | 2 | 1 | | | | | | | | | 2 | |
| (Lepomis cyanellus) | | 1 | | | | | | | | | | | | | | | | 1 | | | | x |
| Warmouth | | | | | | 1 | | | | | | | | | 1 | x | | | | | | |
| (L. gulosus) | | | | | | | | | | | | | | | x | 1 | | | | | | |
| Bluegill | 10 | 1 | 2 | x | 1 | | 2 | | 1 | 1 | 3 | | | | 9 | 1 | 1 | 1 | | 5 | 4 | |
| (L. macrochirus) | 5 | 6 | 1 | 6 | 5 | | 2 | 1 | x | | | | 2 | 2 | x | 4 | | | | 1 | 4 | |
| Longear sunfish | 1 | 2 | 7 | 10 | 18 | 2 | 3 | 6 | 9 | 8 | 13 | 3 | 6 | 9 | 9 | 24 | 5 | 12 | 3 | 6 | 4 | |
| (L. megalotis) | x | 9 | 5 | 31 | 5 | | 13 | 5 | x | | | 8 | 24 | 26 | | 25 | 4 | 14 | x | 1 | 1 | |
| Hybrid sunfish | | | | | | x | x | | | x | | | x | | x | | | | | | | |
| Smallmouth bass | | x | | x | x | | 2 | 1 | | x | 1 | 4 | x | | | | | | 1 | | 1 | |
| (Micropterus dolomieui) | | | 1 | x | 1 | | | | x | | | | 3 | 1 | | | | | x | | | x |
| Spotted bass | 2 | 1 | 2 | 2 | 1 | 1 | 2 | 2 | 1 | 2 | 3 | 2 | | x | x | x | 3 | 3 | | 3 | 3 | |
| (M. punctulatus) | x | 6 | 2 | 4 | 2 | | 2 | 3 | x | x | | x | | 4 | x | 2 | 1 | 2 | x | x | 5 | |
| Largemouth bass | 5 | 1 | x | | x | | | 2 | 1 | | | | 1 | | 2 | 1 | 1 | 1 | 1 | x | 1 | |
| (M. salmoides) | 3 | 1 | 1 | 1 | 1 | | | 1 | x | x | | | | | x | 3 | 2 | x | | x | 1 | |
| White crappie | x | | | x | | | | | | | x | | | | | | | | | | x | |
| (Pomoxis annularis) | | | | | | | | | | x | | | | | | | | | | | x | |
| Black crappie | | | | | | | | | | | | | | | | | | | | | | |
| (P. nigromaculatus) | | x | | | | | | | | | | | | | | | | | | | | |
| Eastern sand darter | | | | | 2 | | | | | | | | | | | | | | | | | |
| (Ammocrypta pellucida) | | | | | | | | | | | | | | | | | | | | | | |

Table 16 continued.

| Species | Stations: Red River 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | Station Camp Creek 1 | 2 | 3 | 4 | 5 | Sturgeon Creek 1 | 2 | c |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Emerald darter | | | | | | | | 1 | x | 1 | | b | | 1 | | | | | | | b | |
| (Etheostoma baileyi) | | | | | | | | | | | | 1 | | | | | | | | | | x |
| Greenside darter | | | 1 | | b | | | | | 1 | | x | | 1 | b | | | | | | b | |
| (E. blennioides) | | | | 2 | | | | | x | | | | | 1 | | | x | | | | 1 | |
| Rainbow darter | | | | | | | | | | | | | | | | | | | 1 | | b | |
| (E. caeruleum) | | | | | | | | | | | | | 3 | | | | x | 1 | | | | x |
| Fantail darter | | x | | x | | | | | | | | | | | b | | | | | | b | |
| (E. flabellare) | | | | | | | | | | | | | | | | | | | | | | x |
| Johnny darter | | | | | b | | | | | | | | | | | | | | | | x | |
| (E. nigrum) | | | | | | | | | | | | | 2 | 1 | | | 2 | | | | 1 | |
| Variegate darter | | | | | | | | | | x | | b | | | | | | | | | b | |
| (E. variatum) | | | | | | | | | | x | | 1 | 3 | | | | | | | | | x |
| Banded darter | | | 1 | | b | | | | | | | | | 1 | | | | | | | b | |
| (E. zonale) | | | | | | | | | | | | | 1 | x | | | | | | | | x |
| Logperch | x | 2 | x | 3 | 3 | | | x | | | x | 2 | | 1 | 2 | | | x | 2 | 1 | 3 | |
| (Percina caprodes) | | 4 | 4 | 1 | | | | x | | | | x | 3 | 4 | x | | | 1 | | | | |
| P. (Odontopholis) | | | | | | | | | | 1 | 1 | | 1 | | | | | | 2 | | | |
| sp. | | | | | | | | | | | | x | | 1 | | | | | | | | x |
| Blackside darter | 1 | | 2 | x | 2 | | | 6 | 4 | 7 | 2 | 3 | 3 | 4 | | x | | 4 | 1 | | 4 | |
| (P. maculata) | | | 1 | 9 | 5 | | 1 | 1 | x | | | 2 | 8 | 7 | | | 2 | 2 | x | | 2 | |
| Dusky darter | | | 1 | | | 1 | 2 | | 1 | | | 1 | | | | | | | | | | |
| (P. sciera) | | 1 | 1 | 2 | | | 3 | 3 | x | x | | | | | | | 1 | | | | | |
| Freshwater drum | 5 | 8 | x | | 2 | 1 | | 1 | | | x | | | | 6 | | | | | x | | |
| (Aplodinotus grunniens) | 4 | 6 | 3 | 1 | 1 | | | x | | x | | | | | x | | | | | | 1 | |
| Mottled sculpin | | | | | | | | | | | | | | | | | | | | | | |
| (Cottus bairdi) | | | | | | | | x | | 1 | | 1 | | | | | 1 | | | | | |
| Total no. species[e] from each station | 24 | 26 | 39 | 35 | 41 | 14 | 19 | 30 | 31 | 32 | 24 | 37 | 28 | 31 | 27 | 26 | 31 | 26 | 23 | 14 | 39 | 18 |

*Observed but not collected.

[a]Many more carp were observed than is indicated by numbers actually collected.

[b]Seine only at all water quality stations at Red River (16 July 82), Station Camp Creek (15 July 82), and Sturgeon Creek (15 July 82).

[c]Upstream seine collection; see locality table.

[d]Collected with benthos net. Abundant at mouth of unnamed tributary below St Rt 89 bridge in Estill County.

[e]Hybrid sunfish not included.

-Stations 6 and 11 at Red River only sampled in 1982; Stations 9 and 10-no timed data in 1983 (also only picked up selected species).

-Stations 1 and 5 at Station Camp Creek in 1983; there was no timed data, only selected species recorded.

## Associated Fish Species

Fish collected in addition to muskellunge from Red River, Station Camp Creek and Sturgeon Creek are shown in Table 16. The fish fauna of the Red River drainage has been well documented. Branson and Batch (1974) published the most in-depth study of the Red River fish fauna. Brewer (1980), Carter (1970), Clay et al. (1971), Harker et al. (1979), and Hannan et al. (1984) gave accounts of fish collected from the Red River and/or its tributaries. Greenburg and Steigerwald (1981) and Kuehne (1984) provided information regarding new species records from the Red River (to be discussed later in this report); Branson (1970) discussed 2 lamprey species from the drainage and Warren (1981) discussed the eastern sand darter distribution in Red River.

Carter (1970) and Branson and Batch (1983) listed fish they collected from Station Camp Creek and some of its tributaries.

Harker et al. (1979), Jones (1973), and Branson and Batch (1984) published reports that included fish sampling from Sturgeon Creek and/or its tributaries.

### Red River

During this study, 62 species of fish were collected from the main stem of Red River. In conducting cursory back-pack electrofishing studies in Red River tributaries, an additional six species of fish were collected that were not collected during this study from the main stem of Red River. Sampling site locations can be found in Table 17 and a list of fish found are included in Table 18. Several noteworthy records are included.

Table 17. Sample site locations for Red River tributaries in 1985.

MENIFEE COUNTY, KENTUCKY

(1) Clifty Creek - sampled ca 100 yd above confluence with Red River (just above 1st small fall); Menifee/Wolfe Co. line; 30 July 85; 25 min/245 ft; backpack electrofish sample.

(2) Clifty Creek - sample ca 200 yd upstream from where Osborne Branch enters; Meniffe/Wolfe Co. line; 16 July 85; 20 min/255 ft; backpack electrofish sample.

(3) Osborne Branch - sampled ca 75 yd above confluence with Clifty Creek. Menifee Co; 16 July 85; 15 min/150 ft; backpack electrofish sample.

(4) Gladie Creek - sampled just below confluence with Cane Branch; Menifee Co; 05 Aug 85; 25 min/205 ft; backpack electrofish sample.

(5) Dry Fork - sampled ca 100 yd above confluence with Gladie Creek; Menifee Co; 31 July 85; 30 min/265 ft; backpack electrofish sample.

(6) Laurel Fork - sampled ca 100 yd above confluence with Gladie Creek; Menifee Co; 31 July 85; 20 min/200 ft; backpack electrofish sample.

(7) Salt Fork - sampled ca 200 yd above confluence with Gladie Creek; Menifee Co; 03 July 85; 25 min/175 ft; backpack electrofish sample.

(8) Indian Creek - sampled ca 100 yd upstream of Leatherwood Creek; Menifee Co; 05 Aug 85; 15 min/190 ft; backpack electrofish sample.

(9) Leatherwood Fork (Indian Creek tributary) - sampled just below where Smallwood Branch enters; Menifee Co; 31 July 85; 20 min/270 ft; backpack electrofish sample.

(10) East Fork Indian Creek (Indian Creek tributary) - sampled ca 0.9 mi above junction with Indian Creek; Menifee Co; 05 July 85; 20 min/263 ft; backpack electrofish sample.

(11) East Fork Indian Creek (Indian Creek tributary) - sampled between Blackstand Branch and Hall Sink Branch; Menifee Co; 30 July 85; 20 min/270 ft; backpack electrofish sample.

(12) Powell Branch - sampled just above confluence with East Fork Indian Creek; Menifee Co; 30 July 85; 25 min/215 ft; backpack electrofish sample.

(13) Wolfpen Creek - sampled ca 200 yd above St Rt 715 bridge; Menifee Co; 02 July 85; 20 min/160 ft; backpack electrofish sample.

WOLFE COUNTY

(14) Chimney Top Creek - sampled ca 100 yd above where Rough Trail 221 first crosses creek; Wolfe County; 05 July 85; 20 min/230 ft; backpack electrofish sample.

(15) Right Fork Chimney Top Creek - sampled ca 100 yd above confluence with Chimney Top Creek; Wolfe County; 05 July 85; 20 min/260 ft; backpack electrofish sample.

(16) Parched Corn Creek - sampled vic Rough Trail 221 crossing; Wolfe County; 03 July 85; 25 min/220 ft; backpack electrofish sample.

(17) Rockbridge Fork - sampled ca 0.4 mi above confluence with Swift Camp Creek; just above where unnamed tributary enters along with boundary of Rockbridge Trail; Wolfe County; 03 July 85; 25 min/245 ft; backpack electrofish sample.

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Table 18. Fishes collected from Red River tributaries utilizing a backpack electrofisher (cursory sampling).

| Species | Sample site 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Lamprey ammocoetes | | | | | | | | | | | | | | | 2 | | |
| Brook trout *Salvelinus fontinalis* | | | | | | | | | | | | | | | | 27 | |
| Central stoneroller *Campostoma anomalum* | 8 | 21 | | 7 | | 2 | | 12 | 18 | 21 | 84 | 3 | | 1 | | | |
| Redside dace *Clinostomus elongatus* | | | | 1[a] | 22 | 2[b] | 4 | | | | | 1 | | 1 | | | |
| Silverjaw minnow *Ericymba buccata* | | | | | | | | | | | | | | | | | 2 |
| Bigeye chub *Hybopsis amblops* | | | | | | | | | | 1 | | | | | | | |
| River chub *Nocomis micropogon* | | | | | | | | | | | 2 | | | | | | |
| Rosefin shiner *Notropis ardens* | | | | | | | | 1 | | | | | | | | | |
| Striped shiner *N. chrysocephalus* | | | | | | | 2 | 20 | | 15 | 26 | 4 | | 1 | | | |
| Rosyface shiner *N. rubellus* | x | | | | | | 1 | 21 | | 9 | | | | | | | |
| Sand shiner *N. stramineus* | | | | | | | | | | 2 | | | | | | | |
| Mimic shiner *N. volucellus* | | | | | | | | | | 3 | | | | | | | |
| Southern redbelly dace *Phoxinus erythrogaster* | | 3 | | 13 | 28 | 2 | 6 | | 28 | | | 68 | 11 | 4 | 3 | | |
| Bluntnose minnow *Pimephales notatus* | | | | | | | | x | | 2 | 4 | | | | | | |
| Blacknose dace *Rhinichthys atratulus* | 2 | | 4 | 2 | 9 | 2 | 3 | | 15 | | | 8 | 8 | 11 | 26 | | |
| Creek chub *Semotilus atromaculatus* | 40 | 73 | 40 | 39 | 19 | 2 | 30 | 26 | 41 | 21 | 21 | 29 | 65 | 35 | 62 | 16 | 180 |
| White sucker *Catostomus commersoni* | | 3 | | 4 | 7 | 2 | | 1 | 6 | 1 | 1 | | | 2 | x | | 4 |
| Northern hog sucker *Hypentelium nigricans* | | | | x | | | | 2 | | 7 | 3 | | | | x | | |
| Rock bass *Ambloplites rupestris* | | | | 1 | | | | 3 | | 9 | 2 | 1 | | | | | |
| Longear sunfish *Lepomis megalotis* | | | | | | | | | | 1 | | | | | | | |
| Smallmouth bass *Micropterus dolomieui* | | | | | | | 1 | x | | 6 | 2 | | | | | | |
| Emerald darter *Etheostoma baileyi* | | | | | | | | 2 | | 6 | | | | | | | |
| Greenside darter *E. blennioides* | | | | | | | | 7 | | 1 | | | | | 2 | | |
| Rainbow darter *E. caeruleum* | 1 | 4 | | 1 | 12 | 6 | 45 | 23 | 3 | 1 | 8 | 17 | 2 | 3 | 9 | | |
| Fantail darter *E. flabellare* | 1 | | | | | | 4 | | 2 | | 2 | 3 | 4 | | 1 | | 4 |
| Johnny darter *E. nigrum* | 1 | | | 7 | | | 6 | | 1 | 4 | | 4 | | 1 | | | 14 |
| Arrow darter *E. sagitta spilotum* | | | | | | | | | | | | | | | | | 3 |
| Variegate darter *E. variatum* | | | | | | | | 4 | | | | | | | | | |
| Logperch *Percina caprodes* | | | | | | | | | | 3 | | | | | | | |
| Blackfin darter *P. (Odontopholis) sp.* | | | | | | | 2 | 2 | 2 | 1 | | | | 2 | 2 | | |
| Blackside darter *P. maculata* | | | | | | | | x | | | | | | | | | |
| Mottled sculpin *Cottus bairdi* | 3 | 3 | 4 | 18 | 12 | 10 | 20 | 17 | 8 | 2 | 8 | 5 | 28 | 15 | 14 | | |

x - Collected, but not during timed period.

[a] One specimen collected during timed sample, 4 others not collected during timed sample.

[b] Two specimens collected during timed sample, 4 others not collected during timed sample.

Branson and Batch (1974) reported 74 species of fish from the Red River and its tributaries which they collected. They discounted Brewer's (1968) identification of the dusky darter which Hannan et al. (1984) reported from the drainage. The dusky darter was collected at nine stations while electrofishing the Red River during this study in 1982 and 1983. Greenberg and Steigerwald (1981) added the arrow darter Etheostoma saqitta spilotum to the Red River fauna in 1981. They collected a single specimen from Rockbridge Fork; in 1983, the author collected 3 specimens from Rockbridge Fork (Table 18). Kuehne (1984) added another species to the fish fauna in Red River - the redside dace Clinostomus elongatus from Edward Branch. Les Meade (personal communication) collected this fish from Salt Fork (Gladie Creek tributary); in 1985 it was collected here and in five other tributaries by the author and his crew (see Table 18).

Carter (1970) collected 45 species which included several species not found during this study. They were slenderhead darter Percina phoxocephala, bullhead minnow Pimephales vigilax, and streamline chub Hybopsis dissimilis. The bullhead minnow and streamline chub will not be considered further due to lack of verification, although they may exist within the drainage.

Fish (44 species) that were collected from the Red River by Brewer (1980) but not collected during this study included least brook lamprey Lampetra aepyptera, highfin carpsucker carpiodes velifer, and redear sunfish Lepomis microlophus. Additional fish not mentioned above nor collected during this study that were collected by Branson and Batch (1974) were: silver lamprey Ichthyomyzon unicuspis, American brook lamprey Lampetra lamottei (L. appendix as listed by Robins et al. 1980 as Lethenteron wilderi as changed by Vladykov and Kott 1982), golden shiner Notemigonus crysoleucas, bigeye shiner Notropis boops, steelcolor shiner N. whipplei, fathead minnow Pimephalles promelas, bigmouth buffalo Ictiobus cyprinellus, river carpsucker Carpiodes carpio, stonecat Noturus flavus, white bass Morone chrysops, and river darter P. shumardi.

During this study (listed in Tables 16 and 18), the following species of fish were collected which, to the author's knowledge, have not been reported previously from the Red River: mooneye (10 stations), brook trout (1 tributary), blacknose dace (11 tributary sites), quillback (2 stations), river redhorse (9 stations), and black crappie (1 station). This brings the total (known) number of species reported from the Red River drainage to 85.

Two of the fish found within the Red River have been introduced. Rainbow trout are currently stocked into Swift Camp Creek, East Fork Indian Creek, and Middle Fork Red River. They are annually stocked during several months by the U.S. Forest Service. Brook trout found in Parched Corn Creek were stocked by a private individual who said he no longer stocked the stream in the past several years. If this is true, then natural reproduction is taking place. We collected 69 (2-3 in long) brook trout on 11 September 80 and 20 (1.8-2.4 in long) brook trout on 03 July 85 from Parched Corn Creek. The only additional species we collected from this stream was creek chub. In addition, this agency has plans to stock several tributary streams

within the Red River drainage with brown trout.

## Station Camp Creek

During this study, 44 species of fish were sampled while electrofishing for muskellunge in Swift Camp Creek (Table 16). Carter (1970) reported 29 species while sampling the Station Camp Creek drainage - primarily South Fork and War Fork. Branson and Batch (1983) sampled Station Camp Creek and several tributaries within the drainage (mainly the tributary streams) and identified 43 fish species.

Several species of fish were reported by Carter that we did not collect during this study. They included: silverjaw minnow, southern redbelly dace, brindled madtom, flathead catfish, speckled darter (Etheostoma stigmaeum) (Clay 1975 and Burr 1980 do not report this fish as being found in the Kentucky River drainage; therefore, it will not be considered further), and banded darter. Branson and Batch (1983) reported additional species of fish from Station Camp Creek drainage not mentioned previously. These were: bigeye chub, sand shiner, mimic shiner, fathead minnow, western blacknose dace, white sucker, shorthead redhorse, emerald darter, variegate darter, and banded sculpin Cottus carolinae. The single specimen of Cottus collected during this study (Kornman) from Station Camp Creek was identified as bairdi. This specimen superficially resembled the banded sculpin but had an incomplete lateral line with 18 pores on one side and 21 on the other.

During 1982 and/or 1983, the following species of fish were collected from the main stem of Station Camp Creek that were not mentioned in any previous published account: longnose gar, American eel, mooneye, muskellunge (assumed but not actually collected by any investigator), carp, smallmouth buffalo, spotted sucker, silver redhorse, river redhorse, yellow bullhead, warmouth, largemouth bass, dusky darter, freshwater drum, and mottled sculpin. With the above listed species, the fish fauna found within the Station Camp Creek drainage totals at least 55 species.

Species found in Red River and Sturgeon Creek but not yet reported by any investigator from Station Camp Creek are: lamprey species, silver chub, steelcolor shiner, channel catfish, black bullhead, stonecat, white crappie, and arrow darter. The lack of records for the channel catfish is surprising. All of the above species, with the possible exception of the arrow darter, should be expected to occur in this drainage.

## Sturgeon Creek

While sampling for muskellunge, data from 46 other species of fish was gathered from two stations in Sturgeon Creek proper. Investigators who have provided information from Sturgeon Creek relating to fish sampling were Jones (1973) who sampled Sturgeon Creek and Little Sturgeon Creek and revealed 34 species (2 of which are

questionable). Harker et al. (1979) provided information on 27 species of fish from a site they sampled within Sturgeon Creek, and Branson and Batch (1984) in discussing the fish of the Middle Fork of the Kentucky River, included references to 37 species of fishes collected from three sites at Sturgeon Creek and one site in Little Sturgeon Creek.

Jones (1973) listed several species of fish from Sturgeon Creek that were not sampled during this study. These fish were: brindled madtom, white sucker, and rosefin shiner. He also listed orangespotted sunfish Lepomis humilis and orangethroat darter Etheostoma spectabile, both of which are probable mis-identifications and will not be considered further. Harker et al. (1979) reported the mimic shiner and Gilbert (1887) reported the arrow darter Etheostoma sagitta spilotum from Sturgeon Creek at Travelers Rest in Owsley County, Kentucky (Kuehne and Bailey 1961) - Harker et al. also collected it from Sturgeon Creek. Species listed by Branson and Batch (1984) from Sturgeon Creek but not listed in the above studies or this study were: steelcolor shiner, southern redbelly dace, fathead minnow, flathead catfish, and channel darter Percina copelandi. Another species of fish not collected by any of the investigators is the rainbow trout. This fish is stocked into Sturgeon Creek at mi 9 by this agency as part of a put-and-take trout fishing program.

With these species accounts, coupled with the 46 species collected during this study (Table 16), the known fish fauna of Sturgeon Creek stands at 56 species.

Species of fish collected by the author during this study but not mentioned by any of the above investigators include: lamprey ammocoetes, longnose gar, American eel, gizzard shad, mooneye, carp, silver redhorse, black bullhead, largemouth bass, white crappie, and freshwater drum.

Species of fish which were found (includes all investigators) in the Red River and Station Camp Creek drainages that were not found in the Sturgeon Creek drainage included: bigeye chub, sand shiner, blacknose dace, smallmouth buffalo, river redhorse, black redhorse, warmouth, dusky darter, and mottled sculpin. Fish such as the smallmouth buffalo and river redhorse would not be expected except at the mouth of Sturgeon Creek. Further collecting in headwater areas or in tributary streams may reveal the presence of the blacknose dace and mottled sculpin.

Species of fish that have been reported from the Red River drainage but not within the Station Camp Creek and Sturgeon Creek drainages were: silver lamprey, least brook lamprey, American brook lamprey, brook trout, redside dace, streamline chub, golden shiner, bigeye shiner, bullhead minnow, river carpsucker, quillback, highfin carpsucker, bigmouth buffalo, black bullhead, mosquitofish, white bass, redear sunfish, black crappie, eastern sand darter, slenderhead darter, and river darter. Carpsucker and buffalofishes would not be expected within these streams except in the vicinity of the stream mouth. White bass probably occur ocassionally at the mouth of most of the larger streams of the Kentucky River; they are caught by anglers in the spring and fall below nearly all locks and dams on the river.

Of the three drainage systems discussed in this report, the banded sculpin was only reported from Station Camp Creek (Branson and Batch 1983) and the channel darter was only found in Sturgeon Creek (Branson and Batch 1984).

Over the last 5 years (1981-1985), sauger Stizostedion vitreum were introduced into North, South, and Middle forks of the Kentucky River. All were stocked above lock and dam 14. It is possible if they move downstream, that they may show up in one or all of the streams mentioned in this report.

Table 19 reveals a listing of fish given conservation status by Branson et al. (1981a), which were found in one or more of the three streams investigated in this report. Branson (1977[a]) provided probable reasons for certain species declines within Kentucky and Branson (1977b) gave a review of those fish he felt were threatened within the Daniel Boone National Forest where portions of all three streams in this study are located.

Table 19. Conservation status (according to Branson et al. 1981[a]) of 10 species of fish found within the drainages of one or more of the following streams - Red River, Station Camp Creek and Sturgeon Creek.

| Species | Status | Drainage where reported |
|---|---|---|
| *Ammocrypta pellucida* | Threatened | Red River |
| *Clinostomus elongatus* | Undetermined (peripheral) | Red River |
| *Esox masquinongy* | Special concern | Red River, Station Camp Creek, Sturgeon Creek |
| *Etheostoma sagitta* | Threatened (endomic) | Red River, Sturgeon Creek[a] |
| *Icthyomyzon unicuspis* | Special concern (peripheral) | Red River[b] |
| *Lamptera appendix* | Special concern | Red River[c] |
| *Percina copelandi* | Special concern | Sturgeon Creek |
| *P. (Odontopholis) sp.* | Special concern | Red River, Station |
| *P. phoxocephala* | (endemic) | Camp and Sturgeon |
| *P. shumardi* | | creeks |
| | Special concern[d] | Red River[d] |
| | Threatened | Red River[d] |

a Collected from Red River by Greenberg and Steingerwald (1981) and from Sturgeon Creek by Gilbert (1887) and Harker et al. (1979).

b Branson and Batch (1974).

[c] Branson and Batch (1984).

[d] Recommended for de-listing by Warren and Cicerello (1983).

[e] Warren and Cicerello (1983) believe that further collecting will reveal new populations and the fish will eventually be removed from the threatened category.

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Since the Branson et al. (1981) report, collecting for fish in Kentucky has intensified. New locality and distribution records, the re-discovery of other fish, etc. has shed new light on the abundance and distribution of many species of fish found in Kentucky. The list of endangered plants and animals of Kentucky is currently being revised. No doubt the conservation status for many fish will change and some fish will probably be removed from the conservation status list as additional collecting shows their populations more commonly occur than previously thought. On the other hand, the status of some fish species may be elevated for the opposite reasons.

## Species Catch Per Effort (CPUE) Based on Electrofish Results

Timed sub-sample periods were carried out at least once during the study period (1982-1983) at each study pool. During this period, an attempt was made to pick up all fish observed. Tables 20, 21, and 22 show the length distribution, catch rate (fish/hour), and % of total species composition of the fish collected during these timed samples from Red River, Station Camp Creek, and Sturgeon Creek.

Based on percent of occurrence, the five most frequently sampled species, taken by electrofishing with each stream were:

| Species | Percent |
|---|---|
| Red River | |
| Golden redhorse | 30 |
| Longear sunfish | 11 |
| Silver redhorse | 10 |
| Gizzard shad | 6 |
| Bluntnose minnow, northern hog sucker, bluegill, blackside darter | 3 |
| Station Camp Creek | |
| Golden redhorse | 25 |
| Longear sunfish | 20 |
| Spotted sucker | 5 |
| Gizzard shad | 4 |
| Black redhorse | 4 |

| Species | Percent |
|---|---|
| Sturgeon Creek | |
| Golden redhorse | 32 |
| Bluegill | 9 |
| Longear sunfish | 8 |
| Spotted bass | 7 |
| Striped shiner | 6 |

Of 14 muskellunge streams reported (which include the three streams above) by Axon and Kornman (in press), the golden redhorse was the number 1 species by number collected from 11 of the streams, number 2 from 2 streams, and number 3 from 1 stream. The longear sunfish was one of the top three most numerous species in 10 of the 14 streams. Another stream which is currently being studied by Kornman, the Licking River below Cave Run dam, showed the following three species, taken while electrofishing, to be most abundant (1984 sampling): longear sunfish (19%), gizzard shad (18%), and golden redhorse (8%). The three most abundant species Prather (personal communication) found in the Licking River above Cave Run Lake were: gizzard shad (35%), carp (16%), and golden redhorse (11%). Laflin (Axon 1985) found the following to be the most abundant species (based on percent of total numbers) when sampling 41 pools in the Green River: gizzard shad (33%), golden redhorse (12%), and carp (10%).

Harrison and Hadley (1979), in a study of the biology of muskellunge in the Niagara River (NY), reported that they "suspected that the extremely rapid growth of West Virginia, Kentucky, and Niagara River fish during the first years of life reflects a very abundant food source of appropriate size, presumably small cyprinids in the Niagara River." They further stated "the growth decline in later years may then result from a decreased forage base of larger prey species such as Moxostoma spp.". Contrary to this assumption, within the muskellunge streams studied thus far, catostomids are represented by 14 different species, of which 5 species are of the genus Moxostoma. Obviously, all 14 species of catostomids are not found within each stream, but based on percent of occurrence, most of these streams have an abundant population of golden redhorse. Therefore, some other factor is limiting muskellunge growth in later years; perhaps inter- or intraspecific competition for some environmental need other than food. Perhaps it is just the nature of the beast in relatively small, somewhat infertile, streams in Kentucky. From all available data on muskellunge collected from native muskellunge streams in Kentucky (Brewer, Kornman, Axon and Kornman, Jones, Prather, and Laflin); the stream muskellunge does not appear to be very long-lived. Very few, large (40 plus inch long) muskellunge have been reported from Kentucky streams. They do reach these larger sizes in Kentucky reservoirs where they have been stocked. The author believes harvest mortality (legal

Table 20. Species, length distribution, and catch rate of fish collected during a timed subsample from study pools at Red River, 1982 and 1983 combined (1982 - 14 pools, 3.9 hours; 1983 - 10 pools, 4.5 hours).

| Species | Inch group | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | Total number | No./ hour | % of total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 30 | 31 | 39 | | | |
| Lamprey/ ammocoetes | | | | | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 0.4 | t |
| Longnose gar | 3 | | | | 1 | 1 | | | | | | | | | | | 2 | | | 2 | | 1 | 3 | 2 | 1 | 2 | | | | | | 18 | 2.1 | 1 |
| American eel | | | | | | | | | | | | | | | | | | | | | | 1 | 2 | | | 1 | | | | 1 | 1 | 6 | 0.7 | t |
| Gizzard shad | | | | | | | 11 | 21 | 25 | 14 | 8 | 15 | 16 | 10 | | | | | | | | | | | | | | | | | | 120 | 14.3 | 6 |
| Mooneye | | | | | | | | 4 | 4 | | 1 | | | | | | | | | | | | | | | | | | | | | 9 | 1.1 | t |
| Rainbow trout | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | 1 | 0.1 | t |
| Muskellunge | | | | | | | | | | | | | | | 1 | | | | 1 | | 1 | | | | | | | | 1 | | | 4 | 0.5 | t |
| Central stoneroller | | 3 | 8 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 12 | 1.4 | 1 |
| Carp | | | | | | | | | | | 1 | 1 | 1 | | 3 | 2 | 1 | 4 | 4 | 4 | 5 | 1 | 5 | 4 | 2 | 2 | 2 | 2 | 1 | | | 45 | 5.4 | 2 |
| Silverjaw minnow | | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 0.2 | t |
| Silver chub | | | 1 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 0.7 | t |
| River chub | | 1 | 3 | 3 | 4 | 5 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 17 | 2.0 | 1 |
| Rosefin shiner | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0.1 | t |
| Emerald shiner | | 1 | 16 | 15 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 32 | 3.8 | 2 |
| Striped shiner | | 1 | 21 | 14 | 6 | | | | | | | | | | | | | | | | | | | | | | | | | | | 42 | 5.0 | 2 |
| Silver shiner | | | 2 | 5 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | 10 | 1.2 | t |
| Rosyface shiner | | | 22 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 23 | 2.7 | 1 |
| Spotfin shiner | | 2 | 6 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 9 | 1.1 | t |
| Mimic shiner | | 22 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 25 | 3.0 | 1 |
| Bluntnose minnow | 3 | 30 | 26 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 59 | 7.0 | 3 |
| Creek chub | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0.1 | t |
| Quillback | | | | | | | | | | | | | | 2 | 1 | | | | | | | | | | | | | | | | | 3 | 0.4 | t |
| Northern hog sucker | | 1 | 6 | 9 | 11 | 6 | 9 | 5 | | 2 | | | 1 | | | | | | | | | | | | | | | | | | | 50 | 6.0 | 3 |
| Smallmouth buffalo | | | | | | | | | 1 | 1 | | | 1 | 1 | | 1 | | | | 1 | 1 | 1 | | 2 | | | | | | | | 10 | 1.2 | t |
| Spotted sucker | | | | | 1 | | 3 | 3 | 3 | 3 | | | | | 1 | 1 | | | | | | | | | | | | | | | | 15 | 1.8 | 1 |
| Silver redhorse | | | | 1 | 9 | 16 | 15 | 20 | 22 | 14 | 20 | 22 | 16 | 17 | 8 | 4 | 10 | 1 | 7 | 2 | 1 | 1 | | | | | | | | | | 206 | 24.5 | 10 |
| River redhorse | | | | | | | | | | | 3 | | | | 1 | | | 2 | | | 3 | 3 | 1 | | | | | | | | | 13 | 1.5 | 1 |
| Black redhorse | | | 1 | 1 | 3 | 3 | 9 | 3 | 7 | 11 | 2 | 2 | | | | | | | | | | | | | | | | | | | | 42 | 5.0 | 2 |
| Golden redhorse | | | 3 | 4 | 17 | 34 | 89 | 82 | 71 | 66 | 85 | 79 | 38 | 13 | 7 | 1 | | 3 | 1 | 2 | | | 1 | | | | | | | | 596 | 71.0 | 30 |
| Shorthead redhorse | | | | | | | 1 | 2 | 4 | 12 | 6 | 1 | 1 | | | | | | | | | | | | | | | | | | | 27 | 3.2 | 1 |
| Channel catfish | | | | | | | 1 | 1 | | 2 | | 1 | 2 | 1 | | | | | | | 1 | | | | | | | | | | | 9 | 1.1 | t |
| Brindled madtom | | 1 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 5 | 0.6 | t |
| Flathead catfish | | . | | | | | | | | | 3 | 2 | | | | 1 | | | | | | | | | | | | | | | | 6 | 0.7 | t |
| Brook silverside | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0.1 | t |
| Rock bass | | 1 | | 1 | 4 | 10 | 5 | 1 | | | | | | | | | | | | | | | | | | | | | | | | 22 | 2.6 | 1 |
| Green sunfish | | | 2 | 1 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 0.7 | t |
| Warmouth | | | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0.1 | t |
| Bluegill | | 1 | 8 | 11 | 18 | 12 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 51 | 6.1 | 3 |
| Longear sunfish | 1 | 21 | 66 | 73 | 49 | 15 | | | | | | | | | | | | | | | | | | | | | | | | | | 225 | 26.8 | 11 |
| Hybrid sunfish | | | | 1 | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 0.2 | t |
| Smallmouth bass | | | 5 | 1 | | 1 | | | 1 | 3 | 1 | | | 1 | 1 | | | | | | | | | | | | | | | | | 14 | 1.7 | 1 |
| Spotted bass | 1 | | 6 | 3 | 2 | 7 | 7 | 5 | 8 | 2 | 2 | 1 | | | | | | | | | | | | | | | | | | | | 44 | 5.2 | 2 |
| Largemouth bass | | 2 | | 1 | | 1 | | | 3 | 3 | 4 | 2 | 1 | 1 | | | | | | | | | | | | | | | | | | 18 | 2.1 | 1 |
| Eastern sand darter | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 0.4 | t |
| Emerald darter | | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | 0.5 | t |

Table 20 continued.

| Species | Inch group 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 | 28 | 30 | 31 | 39 | Total number | No./ hour | % of total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Greenside darter | | 2 | 4 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 0.7 | t |
| Rainbow darter | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 0.4 | t |
| Johnny darter | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 0.4 | t |
| Variegate darter | | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | 0.5 | t |
| Banded darter | | 3 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 3 | 0.4 | t |
| Logperch | | 1 | 9 | 16 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | 27 | 3.2 | 1 |
| Percina (Odontopholis) sp. | | 3 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 4 | 0.5 | t |
| Blackside darter | | 23 | 38 | 2 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | | | 68 | 8.1 | 3 |
| Dusky darter | | 5 | 9 | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | 16 | 1.9 | 1 |
| Freshwater drum | | | | | | | 6 | 8 | 2 | 3 | 2 | 2 | 3 | 2 | 1 | | | 1 | 1 | | | | 1 | | | | | | | | | 32 | 3.8 | 2 |
| Mottled sculpin | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 0.2 | t |

[a]Many more observed but not recorded.

t = < 0.5.

Table 21. Species, length distribution, and catch rate of fish collected during a timed subsample from study pools at Station Camp Creek, 1982 and 1983 combined (1982--5 pools, 2.6 hours; 1983--3 pools, 1.2 hours).

| Species | Inch group | | | | | | | | | | | | | | | | | | | | | | | | | | Total number | No./ hour | % of total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 27 | 31 | | | |
| Longnose gar | | | | | | | | | | | | | | | | | | 2 | 1 | | 3 | 2 | 2 | 1 | 1 | 1 | | 13 | 3.5 | 3 |
| Gizzard shad | | | | | 4 | 1 | | | | | 3 | 6 | | 1 | 3 | | | | | | | | | | | | | 18 | 4.9 | 4 |
| Mooneye | | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | 1 | 0.3 | t |
| Rainbow trout | | | | | | | 1 | | 3 | | 1 | | | | | | | | | | | | | | | | | 5 | 1.4 | 1 |
| Muskellunge | | | 1 | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 3 | 0.8 | 1 |
| Central stoneroller | | 14 | | 1 | | | | | | | | | | | | | | | | | | | | | | | | 15 | 4.1 | 3 |
| Carp | | | | | | | | | | | | | | | | | | | | | | | 1 | | | | | 1 | 0.3 | t |
| River chub | | 2 | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | 5 | 1.4 | 1 |
| Rosefin shiner | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0.3 | t |
| Emerald shiner | | 3 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 4 | 1.1 | 1 |
| Striped shiner | | 5 | 4 | 4 | 1 | | | | | | | | | | | | | | | | | | | | | | | 14 | 3.8 | 3 |
| Silver shiner | | 2 | 1 | 2 | | | | | | | | | | | | | | | | | | | | | | | | 5 | 1.4 | 1 |
| Rosyface shiner | | 3 | 3 | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 1.6 | 1 |
| Spotfin shiner | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 0.5 | t |
| Bluntnose minnow | 1 | 13 | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | | | 16 | 4.3 | 3 |
| Creek chub | | 5 | 1 | | | | | | | | | | | | | | | | | | | | | | | | | 6 | 1.6 | 1 |
| Northern hog sucker | | | 2 | 2 | 2 | 4 | | | 1 | | | 1 | | | | | | | | | | | | | | | | 12 | 3.2 | 2 |
| Smallmouth buffalo | | | | | | | | | | | | | 1 | | | | | 1 | | | | | | | | 1 | | 3 | 0.8 | 1 |
| Spotted sucker | | | | | | 1 | 11 | 4 | 3 | 2 | 2 | 1 | | 2 | | | | | | | | | | | | | | 26 | 7.0 | 5 |
| Silver redhorse | | | | | | | | | | | | | | 1 | | | 1 | | | | | | | | | | | 2 | 0.5 | t |
| Black redhorse | | | | | | 1 | 5 | 4 | | 3 | 4 | 1 | | | | | | | | | | | | | | | | 18 | 4.9 | 4 |
| Golden redhorse | | | 1 | | 1 | 13 | 16 | 11 | 11 | 20 | 23 | 16 | 6 | 2 | 1 | | 1 | | | | | | 1 | | | | | 123 | 33.2 | 25 |
| Moxostoma sp[a] | | 3 | 6 | | | | | | | | | | | | | | | | | | | | | | | | | 9 | 2.4 | 2 |
| Yellow bullhead | | | | | | | | | 1 | | | | | | | | | | | | | | | | | | | 1 | 0.3 | t |
| Brook silverside | | 1 | 2 | 1 | | | | | | | | | | | | | | | | | | | | | | | | 4 | 1.1 | 1 |
| Rock bass | | | 1 | | 4 | 2 | 4 | 1 | | | | | | | | | | | | | | | | | | | | 12 | 3.2 | 2 |
| Green sunfish | | | | 1 | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0.3 | t |
| Warmouth | | | | | 1 | 1 | | | | | | | | | | | | | | | | | | | | | | 2 | 0.5 | t |
| Bluegill | | 2 | 3 | 1 | 6 | 2 | 1 | 1 | | | | | | | | | | | | | | | | | | | | 16 | 4.3 | 3 |
| Longear sunfish | 1 | 4 | 13 | 24 | 32 | 22 | | | | | | | | | | | | | | | | | | | | | | 96 | 25.9 | 20 |
| Smallmouth bass | | | | | | | | | | | | | | | | | 1 | | | | | | | | | | | 1 | 0.3 | t |
| Spotted bass | | | | | | 1 | | 4 | 2 | 2 | 1 | 1 | | | | | | | | | | | | | | | | 11 | 3.0 | 2 |
| Largemouth bass | | | | | 1 | | 2 | 3 | 1 | | 3 | | | | | 1 | | | | | | | | | | | | 11 | 3.0 | 2 |
| Rainbow darter | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 0.5 | t |
| Johnny darter | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 0.5 | t |
| Logperch | | 1 | | 2 | 2 | | | | | | | | | | | | | | | | | | | | | | | 5 | 1.4 | 1 |
| Percina (Odontopholis) sp. | | 2 | | | | | | | | | | | | | | | | | | | | | | | | | | 2 | 0.5 | t |
| Blackside darter | | 4 | 5 | | | | | | | | | | | | | | | | | | | | | | | | | 9 | 2.4 | 2 |
| Dusky darter | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0.3 | t |
| Freshwater drum | | | | | | | 1 | | | | 1 | 1 | 1 | | | 1 | | | 1 | | | | | | | | | 6 | 1.6 | 1 |
| Mottled sculpin | | 1 | | | | | | | | | | | | | | | | | | | | | | | | | | 1 | 0.3 | t |

[a]Too small to accurately identify.
t < 0.5%.

Table 22. Species, length distribution, and catch rate of fish collected during a timed subsample from study pools at Sturgeon Creek, 1982 and 1983 combined (1982 - 2 pools, 0.6 hour; 1983 - 2 pools, 0.7 hour).

| Species | Inch group | | | | | | | | | | | | | | | | | | Total number | No./ hour | % of total |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | 13 | 14 | 15 | 16 | 18 | 27 | | | |
| Striped shiner | | 5 | | | 1 | 1 | 2 | | | | | | | | | | | | 9 | 7.5 | 6 |
| Silver shiner | | 1 | | 1 | | | | | | | | | | | | | | | 2 | 1.7 | 1 |
| Spotfin shiner | | | 1 | | | | | | | | | | | | | | | | 1 | 0.8 | 1 |
| Bluntnose minnow | | | 2 | | | | | | | | | | | | | | | | 2 | 1.7 | 1 |
| Creek chub | | | | | 1 | | | | | | | | | | | | | | 1 | 0.8 | 1 |
| Northern hog sucker | | | 4 | | | 1 | | | | | | | | | | | | | 5 | 4.2 | 3 |
| Spotted sucker | | | 1 | | | | | 2 | | | 1 | | | | | | | | 4 | 3.3 | 3 |
| Silver redhorse | | | 1 | | | | | | | | | | | | | | | | 1 | 0.8 | 1 |
| Golden redhorse | | | | | 2 | 8 | 8 | 8 | 5 | 3 | 4 | 6 | 3 | | | | | | 47 | 39.2 | 32 |
| Shorthead redhorse | | | | | | | | 2 | 1 | | | 1 | | | | | | | 4 | 3.3 | 3 |
| Moxostoma sp.[a] | | | 7 | | | | | | | | | | | | | | | | 7 | 5.8 | 5 |
| Channel catfish | | | | | | | | | 1 | | | | 1 | | 1 | | 1 | | 4 | 3.3 | 3 |
| Brook silverside | | | 1 | | | | | | | | | | | | | | | | 1 | 0.8 | 1 |
| Rock bass | | | | 1 | | 1 | 1 | | 1 | 1 | | | | | | | | | 5 | 4.2 | 3 |
| Green sunfish | | | | 1 | 1 | | | | | | | | | | | | | | 2 | 1.7 | 1 |
| Bluegill | | | | 4 | 4 | 5 | 1 | | | | | | | | | | | | 14 | 11.7 | 9 |
| Longear sunfish | | 1 | 3 | 5 | 2 | 1 | | | | | | | | | | | | | 12 | 10.0 | 8 |
| Smallmouth bass | | | | | 1 | | | | | | | | | | | | | | 1 | 0.8 | 1 |
| Spotted bass | | | 1 | | 2 | 1 | 2 | 1 | 3 | 1 | | | | | | | | | 11 | 9.2 | 7 |
| Largemouth bass | | | | | | | | | | | | 1 | | | | 1 | | | 2 | 1.7 | 1 |
| Greenside darter | | 1 | | | | | | | | | | | | | | | | | 1 | 0.8 | 1 |
| Johnny darter | | 1 | | | | | | | | | | | | | | | | | 1 | 0.8 | 1 |
| Logperch | | 1 | 2 | 1 | | | | | | | | | | | | | | | 4 | 3.3 | 3 |
| Blackside darter | | 2 | 4 | | | | | | | | | | | | | | | | 6 | 5.0 | 4 |
| Freshwater drum | | | | | | | | | | | | | | | | | | 1 | 1 | 0.8 | 1 |

[a]Too small to accurately identify.

or illegal) removes most muskellunge from streams before they have a chance to reach trophy size of 20 lb or more. Before the advent of more modern boats, tackle, and other fishing gear, and in areas where access was difficult, a few muskellunge were able to grow to trophy size.

## Black Bass Composition

Black bass made up the following percent composition, based on timed sub-sampling, as depicted in Tables 20-22.

| | Red River | | Station Camp Creek | | Sturgeon Creek | |
|---|---|---|---|---|---|---|
| Species | % of all fish | % of black bass | % of all fish | % of black bass | % of all fish | % of black bass |
| Spotted bass | 2 | 57 | 2 | 48 | 7 | 79 |
| Largemouth bass | 1 | 24 | 2 | 48 | 1 | 14 |
| Smallmouth bass | 1 | 19 | <0.05 | 4 | 1 | 7 |

Spotted bass were found to be the dominant black bass within 9 of the 12 streams where native muskellunge populations were found (Axon and Kornman in press). Smallmouth bass was of equal abundance with spotted bass in one stream, as was largemouth bass at another, and largemouth bass was the most abundant black bass within one of the streams studied; this included the three streams from this study. Looking at two muskellunge streams not included in the aforementioned studies (Licking River below Cave Run dam and a portion of the Green River), the percent abundance among the three species of black bass was: Licking River below Cave Run dam (Kornman) - spotted bass (60%), smallmouth bass (37%), and largemouth bass (3%). Prather found the following from the Licking River above Cave Run Lake: spotted bass (95%), largemouth bass (5%), smallmouth bass (0). Laflin (Axon 1985) found the following black bass composition in Green River: spotted bass (74%), largemouth bass (22%), and smallmouth bass (4%).

Black bass habitat within the Red River appears to be best suited for the spotted bass. Smallmouth bass was collected sporadically throughout the sample stations, with most being taken in the upper reaches as would be expected. Largemouth bass was also collected ocassionally throughout the sampled pools, being most abundant at the mouth. Largemouth bass and spotted bass were taken with the same frequency in Station Camp Creek. Spotted bass were collected at about the same rate at each study pool, while largemouth bass became less abundant upstream. The primary range of the smallmouth bass in Station Camp Creek drainage is probably where

preferred habitat is found within War Fork, South Fork, upper Station Camp Creek (probably within several miles of the junction of War Fork and South Fork), and Red Lick Creek. Only two pools were sampled on Sturgeon Creek, one being at the mouth so little can be gleaned from these findings. Smallmouth bass are probably more numerous above our sample sites. Largemouth bass are likely uncommon in Sturgeon Creek, except within the lower portion, with spotted bass occupying the middle and lower reaches of this stream.

## Physical Determinations

Selected physical characteristics at each study stream (Red River, Station Camp and Sturgeon creeks) are shown in Tables 23 and 24. A brief discussion of each characteristic at all three study streams follows:

Length: stream length, as measured from topographic maps, is 96.1 mi for Red River (approximately 2 mi of stream are above this length, but this section is intermittant). Station Camp Creek is 22.0 mi long to the junction of South Fork and War Fork. Sturgeon Creek is 33.0 mi long. The average length of the pools sampled at each stream was 0.9 mi at Red River and Station Camp Creek and 0.7 mi long at Sturgeon Creek. Red River is an order VI stream from the mouth to Middle Fork Red River; above this point Red River is order V. Both Station Camp Creek and Sturgeon Creek within the study area are order V streams.

Width: The average width of study pools were greatest at Red River (70.2 ft). The average width for pools sampled at Station Camp Creek was 54.2 ft, it was 63.8 ft at Sturgeon Creek. The widths determined from each stream probably do not reflect the average for the entire stream, as the upper, generally narrower, section of each stream was not sampled or measured. Only two pools located in the lower reaches were sampled at Sturgeon Creek. The upper two-thirds of the stream is much narrower and shallower and has a higher gradient.

Depth: Mean depth of study pools at Station Camp Creek and Sturgeon Creek were nearly the same at 4.4 and 4.3 ft, respectively. Red River study pools averaged shallower at 3.4 ft. Maximum depths ranged from 5.0-21.0 ft (x 10.5) at Red River, 9.0-15.0 (x 12.1) at Station Camp Creek, and 11 and 12 ft (x 11.5) at

Table 23. Selected physical characteristics from each pool sampled during 1982 and 1983 at Red River, Station Camp Creek and Sturgeon Creek.

| Station (no. muskellunge[a]) | Stream mile | Pool length (mi) | Average width (ft) | Acreage | Average depth (ft) | Maximum depth (ft) | Percent shade |
|---|---|---|---|---|---|---|---|
| Red River | | | | | | | |
| 1 (1) | 0[b] - 2.2 | 2.2 | 82.6 | 22.0 | 9.4 | 21.0 | 5-25 |
| 2 (0) | 5.5 - 6.7 | 1.2 | 60.4 | 8.8 | 3.4 | 9.0 | 50-75 |
| 3 (1) | 23.5 - 25.0 | 1.5 | 77.7 | 14.1 | 2.9 | 8.0 | 25-50 |
| 4 (1) | 27.2 - 28.7 | 1.5 | 69.0 | 12.5 | 1.9 | 12.0 | 25-50 |
| 5 (4) | 31.6 - 32.5 | 0.9 | 68.2 | 7.4 | 2.7 | 7.0 | 25-50 |
| 6 (2) | 39.0 - 39.5 | 0.5 | 75.2 | 4.6 | 2.6 | 7.0 | 25-50 |
| 7 (1) | 40.0 - 40.5 | 0.5 | 65.0 | 3.9 | 2.4 | 5.0 | 50-75 |
| 8 (2) | 40.5 - 41.0 | 0.5 | 58.2 | 3.5 | 3.7 | 8.0 | 50-75 |
| 9 (2) | 41.2 - 42.0 | 0.8 | n/d | n/d | n/d | n/d | 50-75 |
| 10 (2) | 42.8 - 43.7 | 0.9 | n/d | n/d | n/d | n/d | 25-50 |
| 11 (0) | 44.4 - 45.5 | 1.1 | 57.3 | 7.6 | 3.3 | 10.0 | 50-75 |
| 12 (2) | 49.3 - 50.0 | 0.7 | 69.4 | 5.9 | 2.4 | 11.5 | 50-75 |
| 13 (2) | 55.0 - 55.2 | 0.2 | 70.7 | 1.7 | 1.9 | 7.0 | 25-50 |
| 14 (4) | 55.2 - 55.6 | 0.4 | 88.3 | 4.3 | 4.4 | 21.0 | 50-75 |
| Total | | 12.9 | | 96.3 | | | |
| Mean | | 0.9 | 70.2 | 6.9 | 3.4 | 10.5 | |
| Station Camp Creek | | | | | | | |
| 1 (1) | 0 - 1.7 | 1.7 | 59.0 | 12.2 | 6.5 | 15.0 | 50-75 |
| 2 (11) | 11.0 - 12.0 | 1.0 | 59.9 | 7.3 | 4.0 | 15.0 | 5-25 |
| 3 (4) | 14.4 - 15.0 | 0.6 | 51.1 | 3.7 | 4.4 | 10.0 | 25-50 |
| 4 (3) | 15.0 - 15.5 | 0.5 | 53.0 | 3.2 | 4.1 | 11.5 | 50-75 |
| 5 (0) | 19.4 - 20.2 | 0.8 | 48.0 | 4.7 | 3.0 | 9.0 | 75-100 |
| Total | | 4.6 | | 31.1 | | | |
| Mean | | 0.9 | 54.2 | 6.2 | 4.4 | 12.1 | |
| Sturgeon Creek | | | | | | | |
| 1 (0) | 0 - 0.5 | 0.5 | 65.6 | 4.0 | 4.5 | 11.0 | 75-100 |
| 2 (1) | 4.2 - 5.0 | 0.8 | 62.1 | 6.0 | 4.1 | 12.0 | 75-100 |
| Total | | 1.3 | | 10.0 | | | |
| Mean | | 0.7 | 63.8 | 5.0 | 4.3 | 11.5 | |

[a]Number collected and observed combined for both years.

[b]0 is the stream mouth.

Table 24. Stream miles, gradient, corresponding sampling stations, and number of muskellunge (captured and observed, combined for both years) by stream section at Red River, Station Camp Creek, and Sturgeon Creek.

| Distance (stream mi) from mouth (mi 0) to headwater | Elevation msl(ft) | Gradient (ft/mi) | Corresponding sample stations | Number of muskellunge |
|---|---|---|---|---|
| Red River | | Lower section | | |
| 0 - 10 | 567[a] - 580 | 1.3 | 1,2 | 1 |
| 10 - 20 | 580 - 600 | 2.0 | --- | -- |
| 20 - 30 | 600 - 624 | 2.4 | 3,4 | 2 |
| | | Middle section | | |
| 30[b] - 40 | 624 - 641 | 1.7 | 5,6 | 6 |
| 40[b] - 50 | 641 - 670 | 2.9 | 7-12 | 9 |
| 50 - 60 | 670 - 710 | 4.0 | 13,14 | 6 |
| | | Upper section | | |
| 60[c] - 70 | 710 - 840 | 13.0 | | |
| 70 - 80 | 840 - 899 | 5.9 | | |
| 80 - 90 | 899 - 965 | 6.6 | | |
| 90 - 96 | 965 - 1,200 | 38.5 | | |
| Station Camp Creek | | Lower section | | |
| 0 - 7 | 586[d] - 600 | 2.0 | 1 | 1 |
| | | Middle section | | |
| 7 - 10 | 600 - 608 | 2.7 | --- | -- |
| 10 - 15 | 608 - 630 | 4.4 | 2,3 | 15 |
| | | Upper section | | |
| 15 - 22[e] | 630 - 675 | 6.4 | 3,4 | 3 |
| Sturgeon Creek | | Lower section | | |
| 0 - 5 | 621[f] - 665 | 8.8 | 1,2 | 1 |
| 5 - 10 | 665 - 715 | 10.0 | | |
| | | Middle section | | |
| 10[g] - 15 | 715 - 775 | 12.0 | | |
| 15 - 20 | 775 - 858 | 16.6 | | |
| | | Upper section | | |
| 20 - 25 | 858 - 940 | 16.4 | | |
| 25 - 33.0 | 940 - 1,200 | 32.5 | | |

[a] Based on normal pool elevation at KY Lock and Dam No. 10 (USCE 1978).
[b] Ca mi 41.0, Middle Fork Red River enters; river above this point referred to North Fork Red River (topographic map does not make this distinction).
[c] Ca mi 63.0, upper extent of general muskellunge range for stream.
[d] Based on normal pool elevation at KY Lock and Dam No. 11 (USCE 1978).
[e] Mi 22 junction of War Fork and South Fork; War Fork - length 11.0 mi, gradient 33 ft/mi; South Fork - length 24.0 mi, gradient 10 ft/mi (Carter 1970).
[f] Based on normal pool elevation at KY Lock and Dam No. 13 (USCE 1978).
[g] Ca mi 12.0, extent of general muskellunge range for stream.

Sturgeon Creek. Average depths of study pools at Red River, especially areas sampled from mi 25-26 that includes stations 4-14, fluctuate in depth on a regular basis due to the immense areas of shifting sand, shoals, and sand bars that continually change.

Gradient: The average gradient for the entire length of Red River was 6.6 ft/mi, 4.0 ft/mi at Station Camp creek (up to the junction of War Fork and South Fork), and 17.6 ft/mi at Sturgeon Creek. Gradients at sections of stream that include study pools ranged from 1.3-4.0 ft/mi at Red River, 2.0-6.4 ft/mi at Station Camp Creek, and 8.8 ft/mi at Sturgeon Creek.

Annual flow: The annual flow within the study streams is constant, with flow declining during late summer and fall of most years. During the dry or drought periods, riffles that may have a foot or more of water flowing over them have a reduced depth of a few inches or less.

Fish shelter: In-stream fish shelter was extremely abundant within much of Red River, particularly at Stations 5-10. Fish shelter here was basically in the form of fallen trees, logs, log jams, brush, stumps, and undercut banks. This cover was found to a lesser extent at other stations; in a few of the upper pools (Stations 13 and 14) cover in the form of boulders was found. Station Camp Creek had much cover at Station 1 in the form that mentioned above (excluding boulders) but was not near as abundant within upstream stations. There was a great deal of cover in the form of overhanging willows that grew to the stream edge and often their inter-tangled roots and limbs provided cover. One muskellunge at Station Camp creek was collected from under the shade of a wooden john-boat that was tied to the bank. Sturgeon Creek had much more in-stream cover at Station 1 than at Station 2. Boulders were present at both stations.

As mentioned by Kornman (1983), the presence of instream debris, particularly in the form of fallen trees (the more leaves retained the better), is very important in providing stream habitat for muskellunge.

Riparian zone: The riparian zone varied from site-to-site at Red River. In much of the lower section, the stream was bordered by fields and the riparian zone ranged from 0-60 ft. Small woodlots, especially along hillsides, allowed for a much wider riparian zone. The area just below and through the Red River Gorge Geological Area was bordered by woodlands. Station 1 at Station Camp Creek had a riparian zone of 30-60 ft. Riparian areas varied from 0-30 ft at sample pools 2-3 and portions of Station 4 (nearly all of the land bordering the stream in this area was in fields). Riparian habiatat became wider as one progressed upstream. In sections of Station Camp Creek that had no riparian habitat, the fish species composition was somewhat different than that typical of other study streams.

Here the dominant black bass was the largemouth bass and many species of fish taken were of harvestable size-largemouth bass up to 16 in long, spotted bass 14 in long, bluegill and rock bass 8 in long and several legal sized muskellunge. The smallest muskellunge that the author has collected to date from any study was a 3.0 in long specimen found just below a riffle (covered with Justicia americana) in an area that had no riparian vegetation. The riparian zone along most of Sturgeon Creek was woodlands and hillsides. Commonly found riparian vegetation in the form of trees at the study streams included sycamore, box elder, silver maple, river birch, ash species, alder species, and, particularly at Station Camp Creek, willow species. Portions of Red River and Sturgeon Creek were bordered by hemlock and rhododendron sp.

Shade: Present shade averaged 35-60% at sample stations along Red River (stream width was the greatest influence), 40-65% along areas having riparian zones at Station Camp Creek, and 70-100% at Sturgeon Creek.

Bottom type: Bottom type at pool areas varied considerably at Red River. Lower sites consisted primarily of clay, silt, sand, muck, and detritus. Middle sites were chiefly composed of sand, with lesser amounts of silt, some clay, muck, and detritus. There was ocassionally rubble and gravel, with very little exposed bedrock area being observed (a small portion of Stations 4 and 5 was bedrock). Pool areas at Station Camp Creek were composed chiefly of clay, silt, muck, and detritus at Stations 1 and 2, with gravel ocassionally in upstream areas. Bottom types at the mouth of Sturgeon Creek were mostly clay, silt, muck, and detritus. Station 2 had sand, gravel, rubble, some boulder, and bedrock as bottom types. Riffles at the study streams are primarily composed of large rubble to coarse gravel, intermixed with fine gravel and sand. The riffles are swept clean of silt, muck, and detritus, but these materials are often accumulated immediately below the riffle.

Pool/riffle ratio: Pool habitat was basically the habitat type sampled during our electrofishing efforts at these streams. Riffle areas included sandy shoals, raceways, and slightly deeper riffle habitat. Thirty percent of the area sampled in Red River was of this type of riffle habitat; 70% was pool habitat. In Station Camp Creek, 92% of the area sampled was pool habitat; 85% of Sturgeon Creek was pool habitat.

Aquatic vegetation: In-stream cover in the form of fallen trees, brush, and logs is important to muskellunge because aquatic vegetation is scarce to non-existent in most of these streams. Basically, the only in-stream vegetation found was Justicia americana. Beds of this plant were located in all study streams, usually within the margin of most riffle areas and on exposed stream margins. Dense stands of willow species growing from slightly below the stream edge up to and along the bank were present along many stretches at Station Camp

Creek. Willow and birch species were growing on exposed riffle margins ocassionally at each stream.

Aesthetic value: The Red River Gorge Geologic Area is no doubt one of the more picturesque, unique, and interesting areas of Kentucky, thus aesthetic values are highest at this stream. Station Camp Creek is somewhat unique, and portions above the confluence of Middle Fork remind the author of a large, meadow-type stream. The aesthetic value of this stream is highest above this point. Rainbow trout are stocked into the stream within this section and appear to spread-out and survive well even though the water temperature in the summer months is marginal for this species. Aesthetic values increase upstream and are excellent within the War Fork drainage. Aesthetic values at Sturgeon Creek are high; strip mining and oil well operations in the area may alter this value in the future.

## Water Quality

Water quality determinations taken during 1982 (Table 25) showed oxygen levels to be depressed in Station Camp Creek at the lower station in July and October. Alkalinity levels were highest at Station Camp Creek during both seasons sampled compared to the other streams, and lowest at Sturgeon Creek. Other parameters taken during 1982 did not reveal any major differences that would be of concern.

Results of water quality sampling during 1983 can be found in Table 26. Most of the parameters are considered suitable as warmwater habitat for fish (based on the criteria for warmwater fish habitat) and is not too dissimilar among streams. The dissolved oxygen was depressed at the lower station in the Red River and Station Camp Creek when the summer sample was taken. Oxygen was also low at the lower station at Station Camp Creek in the fall. Alkalinity readings seemed somewhat low for Station Camp Creek during spring when compared to the higher values obtained in summer and fall. Salinity levels were low, but detectable, at the middle stations in Red River and Middle Fork Red River, and somewhat high from the South Fork Red River (also revealed in the high conductivity readings at that time) when taken in the fall. This is no doubt due to the low flows and the presence of numerous oil wells in the South Fork Red River drainage. It should be noted that severe drought conditions were experienced throughout the late summer and early fall months in this region of Kentucky, resulting in below normal flows in most streams.

The following is a brief description of some of the potential or existing problems within the watershed of the study streams that may have an impact on water quality.

Table 25. Water quality determinations from Red River, Station Camp Creek and Sturgeon Creek during 1982.

| | Red River | | | Middle Fork | South Fork | Station Camp Creek | | |
|---|---|---|---|---|---|---|---|---|
| | Lower | Middle | Upper | Red River | Red River | Lower | Upper | Sturgeon Creek |
| Temperature (C) | | | | | | | | |
| July | 25.0 | 23.7 | 22.5 | 22.3 | 23.0 | 24.0 | 25.0 | 22.5 |
| October | 15.5 | 14.0 | 14.0 | 14.0 | 14.0 | 16.0 | 17.0 | 16.5 |
| Dissolved oxygen (mg/l) | | | | | | | | |
| July | 8.3 | 7.7 | 7.7 | 7.9 | 8.7 | 5.5 | 7.8 | 7.0 |
| October | 7.1 | 8.2 | 8.6 | 8.4 | 8.7 | 4.6 | 7.7 | 6.8 |
| Total alkalinity (mg/l) | | | | | | | | |
| July | 70 | 70 | 40 | 100 | 100 | 120 | 100 | 60 |
| October | 85 | 75 | 45 | 85 | 50 | 115 | 105 | 40 |
| Turbidity (FTU) | | | | | | | | |
| July | 15 | 30 | 15 | 10 | 10 | 21 | 9 | 10 |
| October[a] | n/d | n/d | n/d | n/d | n/d | n/d | n/d | n/d |
| pH | | | | | | | | |
| July | 7.6 | 7.2 | 7.2 | 7.9 | 7.6 | 7.3 | 7.6 | 7.0 |
| October | 7.3 | 7.4 | 7.2 | 7.5 | 7.3 | 7.0 | 7.4 | 6.9 |

[a]Hach Meter not working.

Table 26. Water quality determinations from Red River, Station Camp Creek, and Sturgeon Creek during 1983.

| | Red River | | | Middle Fork | South Fork | Station Camp Creek | | |
|---|---|---|---|---|---|---|---|---|
| | Lower | Middle | Upper | Red River | Red River | Lower | Upper | Sturgeon Creek |
| Temperature (C) | | | | | | | | |
| June | 15.3 | 16.0 | 1.65 | | | 8.0 | 8.0 | 7.5 |
| August | 25.5 | 24.5 | 23.0 | 23.0 | 23.8 | 27.0 | 27.5 | 26.5 |
| October | 14.0 | 14.0 | 14.0 | 13.5 | 13.5 | 15.0 | 15.5 | 14.5 |
| Dissolved oxygen (mg/l) | | | | | | | | |
| June | 8.6 | 8.8 | 8.9 | | | 11.6 | 11.7 | 11.2 |
| August | 4.7 | 6.2 | 6.5 | 7.2 | 7.3 | 3.4 | 7.0 | 6.6 |
| October | 5.8 | 7.4 | 8.5 | 9.2 | 8.3 | 4.4 | 8.3 | 6.2 |
| Total alkalinity (mg/l) | | | | | | | | |
| June | 119.7 | 102.5 | 85.5 | | | 70.0 | 45.0 | 20.0 |
| August | 119.7 | 119.7 | 85.5 | 136.8 | 102.6 | 136.8 | 136.8 | 85.5 |
| October | 102.6 | 85.5 | 85.5 | 136.8 | 119.7 | 188.1 | 136.8 | 68.4 |
| Turbidity (NTU) | | | | | | | | |
| June | 44.0 | 24.0 | 14.0 | | | 17.0 | 6.4 | 13.0 |
| August | 18.0 | 14.0 | 6.0 | 4.9 | 5.5 | 4.2 | 4.1 | 9.8 |
| October | 5.2 | 5.0 | 7.6 | 2.6 | 2.2 | 4.5 | 2.9 | 2.0 |
| pH | | | | | | | | |
| June | 7.0 | 6.7 | 6.5 | | | 8.1 | 8.2 | 7.4 |
| August | 6.7 | 6.7 | 7.1 | 6.8 | 6.4 | 6.7 | 6.7 | 6.9 |
| October | 7.6 | 7.6 | 8.2 | 7.5 | 6.9 | 6.5 | 6.6 | 7.3 |
| Salinity (ppt) | | | | | | | | |
| June | 0 | 0 | 0 | | | 0 | 0 | 0 |
| August | 0 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| October | 0 | 0.1 | 0 | 0.5 | 4.0 | 0 | 0 | 0 |
| Conductivity (umhos/cm) | | | | | | | | |
| June | 159 | 180 | 72 | | | 135 | 90 | 61 |
| August | 278 | 270 | 120 | 331 | 218 | 265 | 239 | 232 |
| October | 180 | 325 | 100 | 303 | 4,900 | 280 | 205 | 185 |

Red River

Two towns (Clay City and Stanton) downstream of the Red River Gorge Geological Area (RRGGA) may impact the water quality in Red River at various times from runoff and/or sewage discharge, although muskellunge were collected or observed within the vicinity of both towns. Above the RRGGA, Hazel Green and Lee City are the only towns that may have impacts on the water quality within the upper section. Headwaters of Swift Camp Creek flow through Campton and thus into Red River at the downstream end of the Wild and Scenic section. On several occasions pollution cases have been pinpointed in this drainage. Other sources of pollution may be from agricultural runoff (sediments, barnyard wastes, pesticides, herbicides, etc.) and sediments from the removal of timber operations. In several instances, small-scale saw-mill operations have polluted tributary streams. Runoff from a limestone crushing facility may impact the pH within a portion of the Red River during heavy rains. Waste from oil extraction, particularly in the form of salt brine, has been a persistent problem in the upper Middle Fork and especially South Fork Red River drainage. Some of the tributary streams sampled in the South Fork drainage had salinity levels (during low flow) that ranged from 100-24,000 ppm (19 sites on 15 Dec 1981). This is a serious issue that has generated much controversy. Another controversial issue that united many conservation groups arose in the late 1960's and early 1970's. This was a proposal to build a flood control dam that would back up water into a substantial portion of the RRGGA; this lake would cover 3,177 a. The project was placed in an "inactive" category in 1976 as a result of the Commonwealth of Kentucky withdrawing its support (USCE 1981). This agency, hopefully, will take a stand against construction of this dam if it is ever re-activated.

**Station Camp Creek**

Irvine and South Irvine at the vicinity of the mouth of Station Camp Creek are the only towns that could potentially have any impact on the water quality of the stream. Several oil wells occur in the flood plain and some occur in the Middle Fork drainage. Run-off from agricultural practices and timber operations are other potential sources of degradation to Station Camp Creek.

**Sturgeon Creek**

No towns are found along the main course of Sturgeon Creek. Quite a few oil wells are located along Duck Fork, a tributary of Sturgeon Creek. Small-scale coal extraction, in the form of stripping, occurs within the drainage and impact the stream, particularly with sediment, at times of heavy rainfall, although turbidity readings were not unusually high when taken. Little impact can be expected from agricultural practices, while run-off from timber operations may, at times, contribute to the sediment load.

## Bottom Fauna

### Red River

A limited amount of macroinvertebrate data exists on the Red River system. Carter (1970) reported on bottom fauna sampled from seven sites at Red River (his data only mentioned insect orders). Harker et al. (1979) studied the macroinvertebrate fauna at one location, KY 746 at beginning of the Wild River Section in Wolfe County, on North Fork of the Red River. Hannan et al. (1982) reported on the macroinvertebrate fauna collected from the Red River at KY 82 bridge (Powell County). The freshwater mussel fauna of the Kentucky Wild River section of Red River was surveyed by Houp (1980). Branson and Batch (1982) reported on the Gastropoda and Sphaeriacean clams of Red River. The Kentucky Division of Water (DOW) collects macroinvertebrate data yearly from the Red River near Hazel Green (DOW 1982).

All tabulated data (diversity $\bar{d}$, equitability e, density, and total number of taxa T.T.) from macroinvertebrates collected during this study in 1983 showed some seasonal fluctuation (Table 27) at all sampling sites. This can be explained by emergence patterns of the various groups of aquatic organisms and local weather conditions (i.e., spates and/or periods of low or no flow).

The macroinvertebrate community structure indicates that all three sites were located in areas with good water quality. All major groups of aquatic insects as well as crustaceans, mollusks, and annelids were taken from all sampling locations, indicating that the habitats were diverse and the water quality was good. Mayflies were well represented at each site. This is an additional indication that the sampling sites had good water quality because this group generally requires good water quality to flourish. A total (all seasons combined) of 50 macroinvertebrate taxa was collected at the lower station in Red River, 34 taxa from the middle section, and 35 taxa from the upper station.

While electrofishing on 3 August 83, Palaemonetes sp. (freshwater shrimp) were observed at fish sampling Station 2 but were not collected.

### Station Camp Creek

There is essentially no existing data on the macroinvertebrate fauna at Station Camp Creek. Carter (1970) made cursory bottom fauna analysis from five stations within the drainage and only mentioned numbers per order. The DOW has recently sampled two locations in the Station Camp creek drainage (this data should be published in 1986).

Values for $\bar{d}$, e, density, and T.T. were seasonally variable (Table 28). This is a normal phenomenon in eastern Kentucky streams and does not necessarily indicate degraded water quality.

The macroinvertebrate composition indicates that the two sampling sites were located in stream reaches which have good water quality. Annelids, mollusks, crustaceans, and all major groups of aquatic insects were recorded from both smapling stations. Also, both sites supported a diverse assemblage of mayflies. Both of these support the contention that these sites lie within regions of good water quality. A total of 49 taxa were sampled at the lower station and 41 taxa recorded at the upper station.

The freshwater shrimp Palaemonetes sp was observed at Station 2 on 16 June 1982.

Sturgeon Creek

Only limited macroinvertebrate data exists for Sturgeon Creek. Harker et al. (1979) studied the macroinvertebrate fauna from one site on Sturgeon Creek.

Species diversity, e, density, and T.T. fluctuated most drastically between the spring/summer samples on the fall sample (Table 29). The large population of the fingernail clam Sphaerium striatinum affected all the tabular data for the fall sample. Virtually all the S. striatinum observed in the October sample were young-of-year individuals. It is not uncommon to see seasonally elevated populations of a few macroinvertebrate species in good quality eastern Kentucky streams.

The community structure indicates that Sturgeon Creek at this sampling location is a good quality stream. Annelids, mollusks, and most major groups of aquatic insects were collected at this site. This stream reach also supported an excellent mayfly fauna. These are indications that this section of Sturgeon Creek has good water quality. Thirty-six taxa were found at this site during one season or the other.

## Management Recommendations

As with all Kentucky streams of good water quality and healthy fish populations, Red River, Station Camp Creek, and Sturgeon Creek should be protected from any degradation that might occur. State and federal agencies involved in the responsibilities of water quality enforcement and/or habitat protection should see that any discharges into these streams do not exceed levels of established or future water quality standards for these streams. Also, any habitat alteration that may harm the aquatic biota of these streams should be closely monitored. The Kentucky Department of Fish and Wildlife Resources has recommended that Red River, Station Camp Creek, and Sturgeon Creek be designated as Outstanding Resource Waters in Kentucky on the merit of the muskellunge habitat and fishery. The author believes that mi 25 up to the headwaters at Red River and Station Camp Creek above the confluence of Middle Fork up to the headwaters (including War Fork and South Fork Station Camp) are the more critical areas in need of protection within these systems. Sturgeon Creek is a possible

Table 27. Number of Individuals per Taxa, Number of Taxa, Species Diversity ($\bar{d}$), and Equitability (e) Values for Benthic Macroinvertebrates Collected Seasonally at Three Stations in the Red River System. The Total Sample from Each Station is from Two Square Meter Riffle Areas.

| Taxa | | Stations | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Jun 1983 | | | Aug 1983 | | | Oct 1983 | | |
| | | Lower | Middle | Upper | Lower | Middle | Upper | Lower | Middle | Upper |
| Lumbriculida | Lumbriculus sp. | - | - | - | - | - | - | 50 | - | - |
| Haplotaxida | Branchiura sowerbyi | - | - | - | - | 1 | - | 1 | - | - |
| | Limnodrilus/Tubifex | - | - | 5 | - | - | - | 10 | - | - |
| Basommatophora | Ferrissia rivularis | - | - | - | 1 | - | 2 | 1 | - | 6 |
| | Gyraulus sp. | - | - | - | - | - | - | 1 | - | - |
| | Helisoma anceps anceps | - | - | - | - | - | - | - | - | 1 |
| | Physella integra | - | - | - | - | - | - | 5 | - | - |
| Mesogastropoda | Campeloma sp. | - | - | - | 1 | - | - | 1 | - | - |
| | Elimia sp. 1 | - | 1 | - | 1 | 234 | 54 | 1 | 89 | 85 |
| | Pleurocera canaliculatum | - | - | - | 4 | - | - | - | - | - |
| Heterodonta | Corbicula fluminea | - | 9 | - | - | 96 | 14 | - | 29 | 87 |
| | Sphaerium sp. | - | - | - | 8 | - | - | 1 | - | - |
| Isopoda | Lirceus fontinalis | 5 | - | - | - | - | - | 5 | - | - |
| Amphipoda | Crangonyx sp. | - | - | - | 1 | - | - | 1 | - | - |
| Decapoda | Orconectes putnami | - | - | - | 3 | - | 1 | - | 2 | - |
| Ephemeroptera | Baetis sp. | 1 | - | - | - | - | - | - | - | - |
| | Batisca rogersi | - | - | 1 | - | - | - | - | - | 125 |
| | B. sp. | - | - | - | - | - | - | - | 1 | - |
| | Caenis sp. | 1 | - | 1 | 3 | - | - | - | - | 7 |
| | Ephemera sp. | - | - | 1 | 1 | - | 1 | - | - | - |
| | Ephoron leukon | - | - | - | - | 3 | 2 | - | - | - |
| | Eurylophella temporalis gp. | - | - | 1 | - | - | - | - | - | - |
| | Heptagenia sp. | - | 3 | - | - | - | - | - | - | - |

Table 27 continued...

| Taxa | | Stations | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Jun 1983 | | | Aug 1983 | | | Oct 1983 | | |
| | | Lower | Middle | Upper | Lower | Middle | Upper | Lower | Middle | Upper |
| | Isonychia sp. | - | 13 | - | - | - | - | - | 3 | 9 |
| | Stenacron interpunctatum | 4 | - | 1 | 5 | 4 | - | - | 5 | 5 |
| | Stenonema femoratum | - | - | - | 4 | 1 | - | - | 1 | - |
| | S. mediopunctatum | 2 | 1 | 5 | - | 16 | 8 | 1 | - | 10 |
| | S. terminatum | 3 | - | - | - | - | - | - | - | - |
| | S. vicarium | 1 | 9 | 4 | - | 3 | - | - | 30 | 23 |
| | Tricorythodes sp. | - | - | - | 9 | 3 | - | - | - | 13 |
| Plecoptera | Beloneuria sp. | 1 | 4 | 5 | - | - | - | - | - | - |
| | Leuctra sp. | - | - | - | - | - | 1 | - | - | - |
| | Perlesta placida | 6 | - | - | - | - | - | - | - | - |
| Odonata | Argia sp. | 1 | - | - | 1 | - | - | 8 | 6 | - |
| | Boyeria vinosa | - | - | - | - | - | - | 1 | - | 1 |
| | Dromogomphus sp. | 1 | - | - | 3 | 2 | 1 | - | 14 | 6 |
| | Enallagma sp. | - | - | - | - | - | - | 1 | - | - |
| | Hagenius brevistylus | - | - | - | 2 | - | - | - | - | - |
| | Progomphus sp. | - | - | - | - | - | - | - | - | 6 |
| | Stylogomphus albistylus | - | - | 1 | - | 1 | 1 | - | 1 | - |
| Coleoptera | Dineutus sp. (larvae) | - | - | - | - | - | 1 | - | - | - |
| | Dubiraphia sp. | - | - | - | 1 | 2 | - | 1 | 2 | - |
| | Ectopria nervosa | - | - | - | 1 | - | - | - | - | - |
| | Helichus lithophilus | - | - | - | - | - | 1 | - | 9 | - |
| | Macronychia glabratus | 1 | - | - | - | - | 1 | - | - | - |
| | Microcara sp. (larvae) | - | - | - | - | - | - | 12 | - | - |
| | Optioservus sp. (larvae) | - | - | - | 1 | - | 1 | 3 | 1 | 1 |
| | Paracymus sp. | - | - | - | 1 | - | - | 1 | - | - |
| | Peltodytes sp. | - | - | - | 1 | - | - | 1 | - | - |
| | Psephenus herricki | - | - | - | - | - | - | - | 2 | 1 |
| | Stenelmis crenata | - | 5 | - | - | - | - | - | - | - |

Table 27. continued...

| Taxa | | Stations | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | Jun 1983 | | | Aug 1983 | | | Oct 1983 | | |
| | | Lower | Middle | Upper | Lower | Middle | Upper | Lower | Middle | Upper |
| | S. sexlineata | - | - | - | 1 | - | - | - | - | - |
| | S. sp. (larvae) | 2 | 1 | - | - | 2 | - | - | 5 | - |
| Hemiptera | Metrobates sp. | - | - | - | - | 1 | - | - | - | - |
| | Sigara sp. | - | - | - | - | - | - | 57 | - | - |
| Megaloptera | Corydalus cornutus | - | - | - | - | - | - | - | 1 | 3 |
| | Sialis sp. | - | - | - | 16 | - | - | - | - | - |
| Trichoptera | Cheumatopsyche sp. | 2 | - | - | - | - | 4 | - | 1 | 6 |
| | Ochrotrichia sp. | - | - | 1 | - | 13 | - | - | - | - |
| | Oecetis sp. | - | - | - | - | - | - | - | 1 | - |
| | Polycentropus sp. | - | - | - | 1 | - | - | - | - | - |
| Diptera | Anopheles sp. | - | - | - | - | - | - | 10 | - | - |
| | Bezzia/Palpomyia/ Johannsenomyia gp. | 1 | 1 | - | - | - | - | - | - | - |
| | Erioptera sp. | - | - | - | - | - | - | 6 | - | - |
| | Hemerodromia sp. | - | - | - | - | 1 | - | - | - | - |
| | Hexatoma sp. | - | 1 | - | - | - | - | 1 | - | - |
| | Tipula sp. | - | - | - | - | - | - | - | - | 3 |
| | Chironomidae | | | | | | | | | |
| | Group A | 2 | - | - | 50 | 2 | 3 | 2 | - | 1 |
| | Group B | - | - | - | - | 9 | 5 | 13 | - | 1 |
| | Group C | 16 | - | 19 | 250 | - | 200 | 3 | - | 1 |
| | Group D | 3 | - | 4 | 200 | 4 | - | - | - | 1 |
| Total Number of Organisms Collected | | 52 | 48 | 49 | 570 | 398 | 301 | 198 | 204 | 702 |
| Total Number of Taxa | | 18 | 11 | 13 | 26 | 19 | 18 | 27 | 20 | 23 |
| Species Diversity (d) | | 3.6590 | 2.9910 | 3.0530 | 2.2240 | 1.9940 | 1.7990 | 3.4200 | 2.8380 | 2.1590 |
| Equitability (e) | | 1.0054 | 1.0070 | 0.9554 | 0.5361 | 0.5369 | 0.4943 | 0.8141 | 0.7499 | 0.5427 |

Table 28. Number of Individuals per Taxa, Number of Taxa, Species Diversity ($\bar{d}$), and Equitability (e) Values for Benthic Macroinvertebrates Collected Seasonally at Two Stations in the Station Camp Creek System. The Total Sample from Each Station is from Two Square Meter Riffle Areas.

| Taxa | | Stations | | | | | |
|---|---|---|---|---|---|---|---|
| | | Apr 1983 | | Jul 1983 | | Oct 1983 | |
| | | Lower | Upper | Lower | Upper | Lower | Upper |
| Lumbriculida | Limbriculus sp. 1 | 3 | 3 | - | - | - | - |
| Haplotaxida | Branchiura sowerbyi | - | - | 1 | - | 50 | - |
| | Limnodrilus/Tubefix gp. | - | - | - | - | 2 | 1 |
| Basommatophera | Ferrissia rivularis | - | - | 6 | - | 2 | - |
| | Helisoma anceps anceps | - | - | 2 | - | 2 | - |
| | Physella integra | - | - | - | - | 18 | 4 |
| Mesogastropoda | Elimia sp. 1 | - | - | 10 | 39 | 21 | 23 |
| Limnophila | Fossaria sp. 1 | 1 | - | - | - | - | - |
| Heterodonta | Corbicula fluminea | - | 1 | 13 | 5 | 296 | - |
| Schizodonta | Elliptio dilatata | - | - | - | - | 1 | - |
| Isopoda | Lirceus fontinalis | 8 | - | 5 | - | 2 | - |
| Decapoda | Orconectes putnami | - | 1 | 2 | 1 | 1 | - |
| Ephemeroptera | Baetis sp. | 4 | 1 | - | - | - | - |
| | Batisca gibbera | - | - | - | - | - | 1 |
| | Caenis sp. | - | 18 | 10 | 1 | 4 | 2 |
| | Ephemera simulans | - | 2 | - | - | - | - |
| | Ephemerella sp. 1 | 1 | 5 | - | - | - | - |
| | Eurylophella temporalis gp. | - | - | - | - | - | 1 |
| | Heptagenia sp. | - | - | 2 | - | - | - |
| | Isonychia sp. | - | 16 | - | 320 | - | 210 |
| | Leptophlebia sp. | - | - | - | - | 25 | - |
| | Leucrocuta sp. | - | 18 | - | - | - | - |

Table 28 continued...

| Taxa | | Stations | | | | | |
|---|---|---|---|---|---|---|---|
| | | Apr 1983 | | Jul 1983 | | Oct 1983 | |
| | | Lower | Upper | Lower | Upper | Lower | Upper |
| | Pseudocloeon sp. | - | 11 | - | - | - | - |
| | Stenacron interpunctatum | 1 | 26 | - | 4 | 4 | - |
| | Stenonema femoratum | - | - | 10 | - | - | - |
| | S. mediopunctatum | - | - | 12 | 3 | - | - |
| | S. modestum | - | - | - | - | 1 | - |
| | S. terminatum | - | - | 18 | - | - | - |
| | S. vicarium | 4 | 5 | 16 | 122 | 3 | 152 |
| Plecoptera | Acroneuria abnormis | - | - | - | - | - | 7 |
| | A. evoluta | - | - | 8 | - | - | - |
| | Alloperla sp. | - | 1 | - | - | - | - |
| | Amphinemura sp. | - | 3 | - | - | - | - |
| | Strophopteryx sp. | - | 2 | - | - | - | - |
| Odonata | Argia sp. | - | 1 | - | - | - | 8 |
| | Dromogomphus sp. | - | - | - | | - | 2 |
| | Enallagma sp. | - | - | - | - | 2 | - |
| | Stylogomphus albistylus | - | - | 7 | - | - | - |
| Coleoptera | Dineutus sp. (larvae) | - | - | 1 | 2 | - | - |
| | Dubiraphia sp. | - | - | - | 1 | - | - |
| | Helichus basalis | - | - | - | 1 | - | - |
| | H. lithophilus | - | - | - | 2 | 11 | 17 |
| | Macronychus glabratus | - | - | 5 | - | 6 | - |
| | Psephenus herricki | - | 1 | 1 | - | 1 | 64 |
| | Stenelmis crenata | - | - | - | - | 1 | - |
| | S. humerosa | - | - | - | 1 | - | - |
| | S. sexlineata | - | - | - | 3 | 2 | - |
| | S. sp. (larvae) | - | - | 3 | - | - | - |

Table 28 continued...

| Taxa | | Stations | | | | | |
|---|---|---|---|---|---|---|---|
| | | Apr 1983 | | Jul 1983 | | Oct 1983 | |
| | | Lower | Upper | Lower | Upper | Lower | Upper |
| Megaloptera | Corydalus cornutus | - | - | - | 3 | - | 6 |
| | Nigronia serricornis | - | - | - | - | - | 4 |
| | Sialis sp. | - | 1 | 6 | - | 1 | - |
| Trichoptera | Cheumatopsyche sp. | - | 1 | - | 3 | 23 | 38 |
| | Chimarra sp. | - | 1 | - | - | - | 16 |
| | Hydropsyche sp. | - | - | - | - | - | 2 |
| Diptera | Anopheles sp. | - | - | - | - | 2 | - |
| | Chaborus sp. | - | - | - | - | 2 | - |
| | Hemerodromia sp. | - | 1 | - | - | 4 | - |
| | Hexatoma sp. | - | - | 1 | - | 1 | - |
| | Prosimulium sp. | - | - | - | - | 1 | - |
| | Simulium sp. | - | 1 | - | - | 23 | 1 |
| | Tipula sp. | - | - | - | - | 92 | 20 |
| | Chironomidae | | | | | | |
| | Group A | 5 | 5 | 8 | - | 3 | - |
| | Group B | 80 | - | 32 | - | 2 | - |
| | Group C | 1 | - | - | - | 1 | - |
| | Group D | 3 | - | 22 | - | 1 | - |
| | Group E | - | - | - | - | 15 | - |
| | Group F | - | - | - | - | 1 | - |
| | Group G | - | - | - | - | 1 | - |
| | Group H | - | - | - | - | 1 | - |
| Total Number of individuals | | 111 | 125 | 201 | 511 | 628 | 582 |
| Total Number of Taxa | | 11 | 23 | 24 | 16 | 38 | 21 |
| Species Diversity (d) | | 1.7320 | 3.6720 | 4.1230 | 1.6590 | 3.0100 | .8190 |
| Equitability (e) | | 0.5831 | 0.9231 | 1.0213 | 0.4770 | 0.6873 | .7318 |

Table 29. Number of Individuals per Taxa, Number of Taxa, Species Diversity ($\bar{d}$), and Equitability (e) Values for Benthic Macroinvertebrates Collected Seasonally at One Station in Sturgeon Creek. The Total Sample from the Station is from Two Square Meter Riffle Areas.

| | | Station | | |
|---|---|---|---|---|
| Taxa | | Apr 1983 | Jul 1983 | Oct 1983 |
| Haplotaxida | Limnodrilus/Tubifex gp. | 13 | 1 | 2 |
| Basommatophora | Helisoma anceps anceps | 3 | - | 1 |
| | Physella integra | - | - | 2 |
| Mesogastropoda | Elimia sp. 1 | 4 | 3 | 15 |
| Heterodonta | Corbicula fluminea | - | - | 50 |
| | Sphaerium striatinum | 1 | 19 | 400 |
| Ephemeroptera | Baetis sp. | 2 | - | - |
| | Batisca sp. | - | - | 19 |
| | Caenis sp. | 27 | 15 | 146 |
| | Ephemera simulans | 1 | 8 | 2 |
| | Ephemerella sp. 1 | 1 | - | - |
| | Eurylophella temporalis gp. | 4 | - | 6 |
| | Heptagenia sp. | - | 1 | - |
| | Isonychia sp. | - | - | 1 |
| | Stenacron interpunctatum | - | - | 2 |
| | Stenonema vicarium | 1 | 12 | 40 |
| Odonata | Argia sp. | - | - | 5 |
| | Boyeria vinosa | - | 1 | - |
| | Dromogomphus sp. | 1 | - | - |
| | Stylogomphus albistylus | 1 | 1 | 2 |
| Coleoptera | Dineutus sp. | - | 1 | 1 |
| | Helichus lithophilus | - | - | 2 |
| | Optioservus sp. (larvae) | - | - | 2 |
| Hemiptera | Rheumatobates sp. | - | 1 | - |
| Megaloptera | Corydalus cornutus | - | - | 1 |
| | Sialis sp. | - | - | 1 |
| Trichoptera | Cheumatopsyche sp. | 1 | - | 8 |
| | Chimarria sp. | - | - | 1 |
| | Polycentropus sp. | 2 | - | - |
| Diptera | Bezzia/Palpomyia/ Johannsenomyia gp. | 1 | - | 1 |
| | Hemerodromia sp. | - | - | 5 |
| | Tipula sp. | - | - | 82 |

Table 29. continued...

| Taxa | Station | | |
|---|---|---|---|
| | Apr 1983 | Jul 1983 | Oct 1983 |
| Chironomidae | | | |
| Group A | 10 | 10 | 29 |
| Group B | 31 | 18 | 8 |
| Group C | 20 | 12 | 33 |
| Group D | 11 | 8 | 24 |
| Total Number of Organisms Collected | 135 | 111 | 891 |
| Total Number of Taxa | 19 | 15 | 29 |
| Species Diversity (d) | 3.3470 | 3.3770 | 2.8780 |
| Equitability (e) | 0.9012 | 0.9962 | 0.6692 |

candidate for inclusion and certainly warrants close monitoring for protection against any degradation.

The Red River where it flows through the Red River Gorge Geological Area and Wild and Scenic portion is fairly well protected, but roughly 30 mi of Red River lie above this point. It is important that good water quality within this section be assured. Muskellunge and other fish populations are found in the vicinity of Clay City and Stanton, so any state monitored discharges from these towns should be strictly enforced to meet established or future water quality standards set forth for this stream. Operations relating to the extraction of oil need to be closely monitored in portions of the Red River, Station Camp Creek, and Sturgeon Creek drainages where these operations occur. Unfortunately, some of these operations continue to degrade the water quality within parts of these drainages. It is not necessarily the single operation causing the drainage, but the accumulative affect of so many operations in a relative small area. Coal mining within the Sturgeon Creek drainage should be monitored to assure state and federal reclamation requirements are being met.

Reports and physical evidence point to the illegal harvest of muskellunge is likely occurring. Untagged hoop nets of illegal dimensions were found and removed from two stations in Red River. Evidence of old gill and trammel nets were found at one site on the Red River and wire, basket-type traps were discovered at various locales on Red River, Station Camp Creek, and Sturgeon Creek. Probably not specifically aimed at taking muskellunge, the above forms of gear are capable of doing so. Local fishermen tell of muskellunge they sometimes catch using limb lines, bank (set) lines, float (jug) lines, and trot-lines baited with live fish (panfish, suckers, minnows, chubs, etc.). These lines frequently are not checked on a regular basis. Also, sub-legal muskellunge are caught and often cannot be released alive or these fish are already dead when checked. Fishing with the use of limb lines, bank (set) lines, and/or float (jug) lines are completely unregulated. Limb and bank lines dangle from the limbs of trees or from "cane poles" where most have been abandoned in nearly every pool sampled. If this is any indication of how many are fished, they surely have an impact on the sport fishery in these streams. Therefore, better enforcement is needed to protect against the illegal taking of sub-legal and legal-sized muskellunge. Also, better regulations pertaining to limb, pole, bank, and set lines are needed.

Of the three streams studied, Red River is better known for its muskellunge fishery. Past stocking rates recommended by Brewer were never properly inacted, and the results of this study indicate a possible decline, or at least no noticaeable change, in the muskellunge population as compared to Brewer's findings. However, numbers of muskellunge returned via the mail-in survey were greater from year classes belonging to years when muskellunge were stocked into Red River. Based on the above, the following management recommendations should be followed at Red River. Stocking of muskellunge should be concentrated in muskellunge pool habitat found within the Red River from mi 20-60 (roughly 170 a). At least 150, 7-9 inch long muskellunge should be stocked at a rate of one per acre annually in order to establish more consistent year classes.

Muskellunge populations at Station Camp Creek were never studied in the past and no mail-in returns have been received from this stream, so there is no information to compare data collected from this study to past muskellunge populations. The strongest year class was from a year muskellunge were stocked but was closely followed by a non stocked year. Based on its size, Station Camp Creek has a good muskellunge population. This population is probably in no danger from over harvest due to the inaccessibility to most of the stream; probably the same holds true for illegal harvest. There are roughly 60 acres of muskellunge pool habitat at Station Camp Creek. Sixty muskellunge (7-9 in long) should be stocked into Station Camp Creek every other year. Emphasis should be placed on stocking above the confluence of Middle Fork Station Camp Creek.

The muskellunge population has declined at Sturgeon Creek when compared to Brewer's studies. There is no data from the mail-in survey program except for the single fish that was tagged during this study. There are only about 40 acres of muskellunge pool habitat in Sturgeon Creek and these pools are easily accessible by anglers. This stream should be stocked at a rate of one muskellunge per acre of pool habitat (from mile 0-12) annually if a muskellunge fishery is to be maintained.

In order to determine if these stocking recommendations are successful at improving the muskellunge fishery, a few pre-selected pools should be sampled on a routine basis at each stream, beginning 4 years after the study has been completed and maintenance stockings have been carried out. Number, catch rate, and year-class strength of muskellunge should be compared with findings from this study within the same pools. Any important changes in species composition should also be noted.

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the macroinvertebrate community observed at each sampling location and a bibliography of taxonomic references used. Appreciation goes to Ron Cicerello (Kentucky Nature Preserves Commission) for confirming my identification of certain fish. Thanks are also extended to Karen Hukill for her fine job at typing this report.

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