A PRELIMINARY SURVEY OF CHAPMAN CREEK

by

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TABLE OF CONTENTS

INTRODUCTION

This survey was undertaken to obtain some qualitative and quantitative data bearing upon the environmental conditions of a small permanent stream in Kansas, to enumerate some of its physical characteristics; to determine some of the species of fish and their relative abundance; to appraise its recreational value and to suggest possible steps to be undertaken in an effort to increase its productiveness.

The periods of drought and torrid summers from 1934 to 1937 inclusive had a deleterious effect on much of the flora in central Kansas and in addition many small streams dried up with enormous destruction of aquatic life. Any restorative program must of necessity begin with the environmental conditions as they now exist.

REVIEW OF LITERATURE

An examination of current literature dealing with the ecology of fresh waters reveals a voluminous amount of material devoted to complicated chemical analyses of both lakes and streams. Such factors as oxygen content; alkalinity; hydrogen-ion concentration and acidity have received a great deal of attention in various lakes and their limiting effects on aquatic species are well known. Systematic

studies of the fauna of streams have been made in only a very few restricted areas outside the state of Illinois. In 1876 Stephen A. Forbes initiated an investigation of the Illinois River which continued under his direction for over fifty years. The work is being continued and from an ecological viewpoint the Illinois River is probably the best known river in the world. European investigators have surpassed those in America in studies concerning lotic environments, but within the last few years much has been attempted here on the improvement of streams, especially for trout. There is a paucity of literature dealing with lotic environments in the plains of west central United States and more specifically Kansas. Several sporadic studies of reservoirs, lakes or marshes are recorded for Kansas but no stream studies. Canfield and Wiebe (1931) in a survey of the Blue River system of Nebraska recommended an increase of backwaters and the planting of black bass and bluegills. Sullivan (1929) published some notes on the aquatic life of the Niangua River in Missouri which recorded the species of insects available for fish food.

MATERIALS AND METHODS

A minnow seine four feet wide and eighteen feet long, with six meshes to the inch was used for the collection of

specimens. Three persons were required to operate the seine, one following behind to release it from obstructions which were encountered during each haul. Five stations were arbitrarily selected for seining and observation. (See Map Fig. 1). Station "A" was in the channel subjected to back-water from the Smoky Hill River; station "B" was an exposed area due to the removal of trees along the bank; station "C" was wider and deeper than either A or B and was shaded which made it popular among fishermen. Station "D" consisted of pools interspersed with lodgments of drift and station "E" which was well toward the source of the stream had a sandy bottom and clear shallow water.

From six to eight hauls were made at each station where a few specimens of each species were placed at once in formalin solutions (1:10) and the rest were released where caught. At each station observations were made concerning the width, depth, and length of the areas; the fish food present; predators; type of bottom; shade and bank flora. An automobile was used to survey the Chapman Creek watershed which was observed for its geological formation and topography relative to effects on mineral content, food content, and turbidity of the water.

Studies of precipitation and temperature ranges covering the ten year period from January 1, 1930 to December 31,

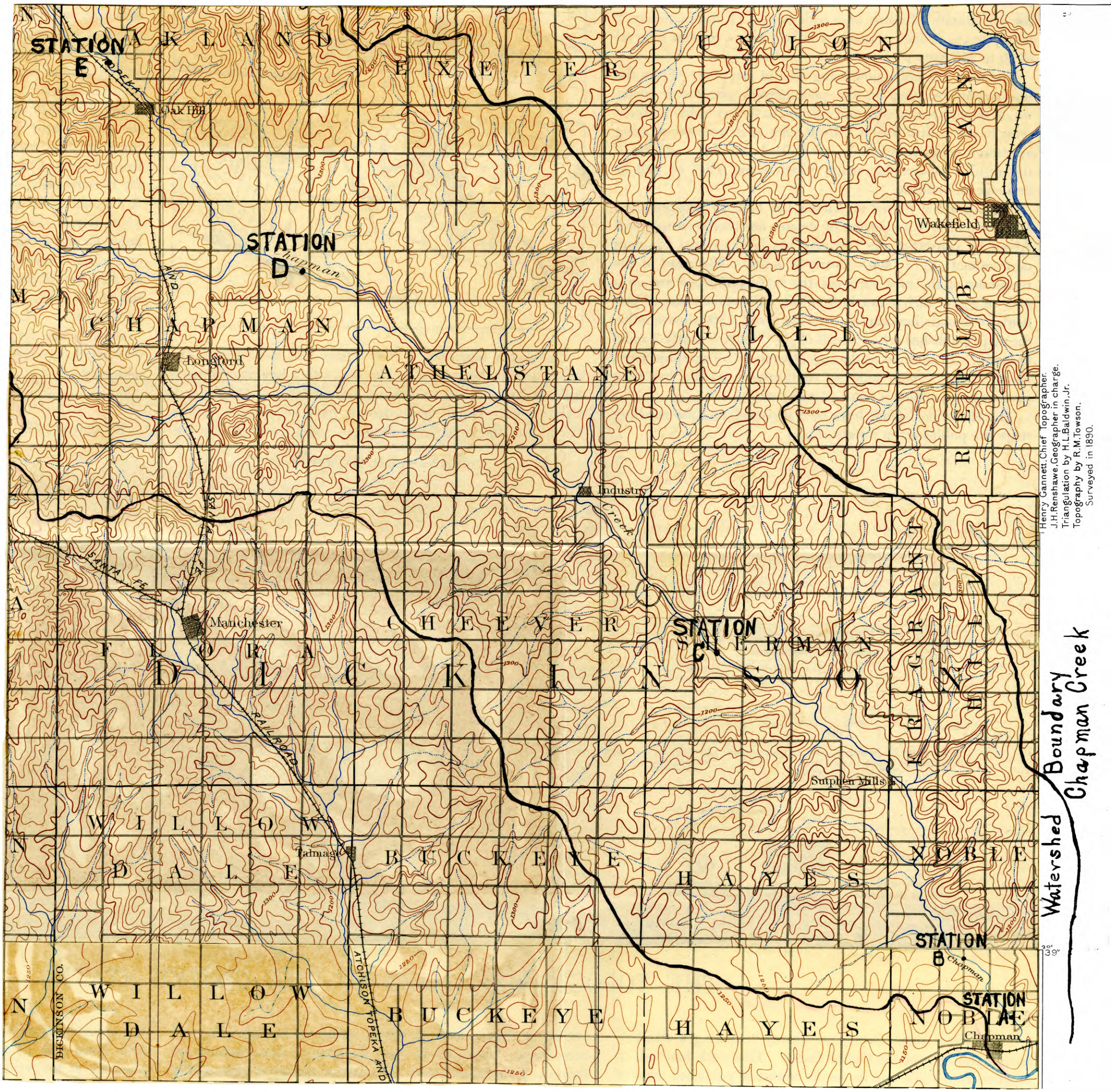

Fig. 1. **A topographical map of the lower basin of Chapman Creek showing the location of stations.**

1939 inclusive were made from the files of the Cooperative Observers Meterological Station at Chapman, Kansas.

Davis (1938) cited a formula for determining the approximate flow of a stream derived by Embody (1927).

$$R = \frac{W D a L}{T}$$

In which R is equal to the rate of flow in cubic feet per second: W is average width: D is average depth in feet: L is the length of the section measured: "a" is a constant for correction of stream velocity: and T is the average time in seconds, of three trials, required for a float to traverse the distance L. If the bottom is rough and strewn with rocks, a is taken as 0.8; if the bottom is smooth (of mud, sand or bedrock) 0.9 is used for the constant.

Data were secured upon the sale of fishing licenses over a period of five years ending 1939 in Dickinson and Clay Counties.

The first data for this survey were collected in August, 1937, and the final observations were made in July, 1940.

OBSERVATIONS

Chapman Creek is a typical, permanent small stream of central Kansas. It is a tributary of the Smoky Hill River, which after its junction with the Republican River at a point about fifteen miles east of the mouth of Chapman Creek is known as the Kansas River. The Kansas River with

tributaries drains the major portion of the State of Kansas, into the Missouri River.

The source of Chapman Creek is in the vicinity of 97° 30' west longitude and 39° 25' north latitude and its mouth is situated at approximately 97° west longitude and 39° north latitude. Included in its basin are the southeastern corner of Cloud County, the northeast part of Ottawa County, the Southwest portion of Clay County, and most of northern Dickinson County. This watershed is between the lower basins of the Solomon and Republican Rivers. The valley of Chapman Creek slopes toward the southeast for a distance of forty-two miles and has an average width of ten miles, thus it embraces an area of four hundred-twenty square miles. The volume of water traversing the creek originates in numerous springs near the source and is periodically augmented by surface drainage whenever a heavy rainfall occurs. Since all run-off precipitation from this area must make its escape through Chapman Creek, one or more times per year this reaches considerable proportions filling the channel with a raging torrent. On several occasions since the occupation of the valley by the white man, it has inundated its flood plain, which in many places is nearly a mile in width.

The geology of the valley, is much the same as that of east central Kansas. The lower reach is characterized by the Fort Riley limestone formations, the central portion by the Herington limestone outcroppings and the upper valley as it approaches the divide is of the Dakota sandstone formation. Thus, an abundance of calcium in the water is assured.

The elevation of the source as given by the United States Geological Survey map is 1620 feet and that of its mouth is 1100 feet, making a total decline 520 feet. In the upper nine miles of the basin the decline is 320 feet leaving a fall of 200 feet for the lower thirty-three miles or an average of about six feet per mile air line measurement. The stream meanders considerably, thus it is estimated that the channel decline would be near three feet per mile.

The whole watershed might be classified as rolling prairie. The broad flood plain is bordered by low hills with which the channel frequently makes contact. This rough incline quickly gives way to a smooth, fertile upland which is well suited to agricultural needs. The drainage of the upland is well developed and numerous flat-bottomed ravines connect it with the creek channel.

The upland soil is a black loam with a tendency to be sandy in some areas.

The margins of the deeper ravines and the slopes along the flood plain, support a growth of native bluestem and buffalo grasses, which are used for the pasturage of livestock. The cultivated crops are wheat, oats, barley, sorghums, corn, and legumes. It is estimated that about 60 percent of the land in the lower half of the valley is planted to wheat, about 15 to 20 percent is in native grass, and the remainder is devoted to corn, oats, and forages. In the upper reach, as one ascends the valley there is a gradual increase in the area of native grass land until it approximates one-half or slightly more. This might be accounted for in two ways: A tendency toward steeper slopes and less depth to the soil as the subsoils of white, red or yellowish clay were exposed frequently in the higher fields and along the roadsides. Wheat continued to be the principal crop cultivated with generous acreages of oats and sorghums.

The banks of the stream were well wooded throughout its entire length, and many times this arboreal growth extended along the larger tributary ravines for several miles. In a few places small areas of three to ten acres or more along the stream were still in native trees. In the lower valley some of these wood lots were oak almost exclusively,

others were comprised mostly of elms, and others were a mixture of a dozen or more species. As the source was approached, box-elder, willow, and cottonwood became dominant types with a diminishing frequency of oak, black walnut and elms. The stumps remaining in the wood lots indicated that the surviving species may be largely the result of artificial selection.

The town of Chapman, Kansas, is situated about one-half mile northwest of the mouth of Chapman Creek where the flood plains of the Smoky Hill River and Chapman Creek converge at the foot of Indian Hill. Its population in the 1940 census was 782. Although it is the shipping point of a large agricultural community, being located on the Union Pacific Railway, it is also distinguished as the location of the Dickinson County Community High School with an enrollment of 480 in 1940. At this point the United States Department of Agriculture located a cooperative observers meterological station about 1900. At first, the records kept were incomplete, but since October 21, 1913, very few days have passed without recordings of precipitation, if any, and maximum and minimum temperatures being made. From these records, over the decade from January 1, 1930, to December 31, 1939, inclusive, it was found (Fig. 2) that a maximum high temperature of 116° F occurred on July 18, 1936

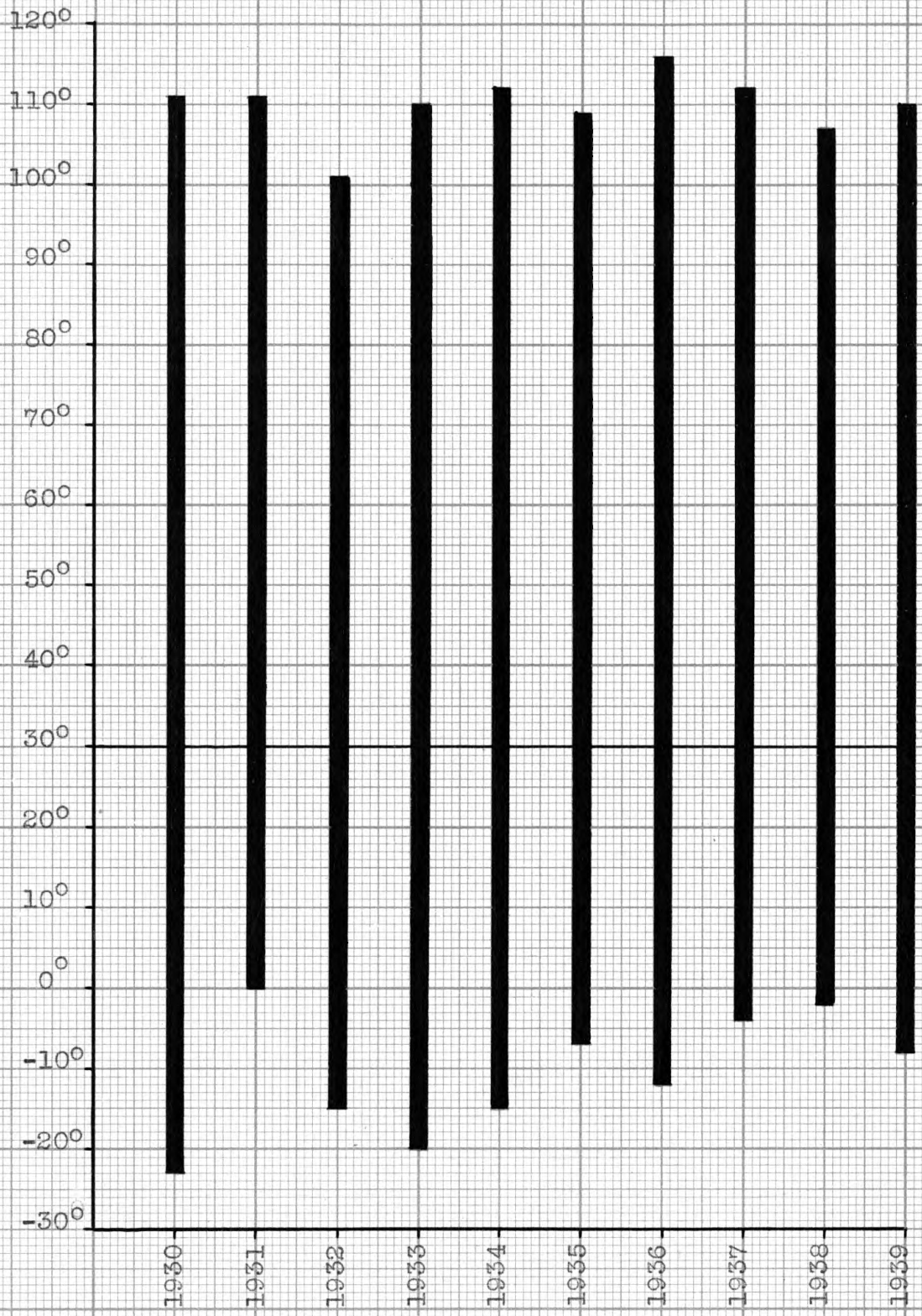

Fig. 2. Showing the extreme range of temperature each year during the years 1930 to 1939 inclusive, as revealed by the records of the meterological station at Chapman, Kansas.

and a minimal low temperature of minus 23° F occurred on January 18, 1930 making an extreme range of 139° F. The average of the mean temperatures of the ten years is 60° F. The average mean temperature of the winter months, November to April inclusive, was 40.9° F., and of the summer months, May to October inclusive, was 71.5° F.

During the same decennium (Fig. 3) the mean number of days per year having a minimal temperature of 32° F or lower was 126.2. The year 1936 had the greatest number, or 143, while 1931 had only 110.

The same ten year interval (Fig. 4) there was an average of 54.1 days per year when the temperature was 95° F or above. The year 1936, while having the greatest number of cold days, also had the largest number of hot days, or 73, and the year 1932 attained this high temperature only 29 times.

The average rainfall per year (Fig. 5) from January 1, 1930 to December 31, 1939, as recorded at Chapman, Kansas, was 26.096 inches. A variation from 21.35 inches in 1936 to 33.76 inches in 1938 was shown. The years 1934 and 1937 were also below 22 inches, but at no observation made had the creek ceased to flow, indicating that subterranean sources contribute a fair volume of water to the stream.

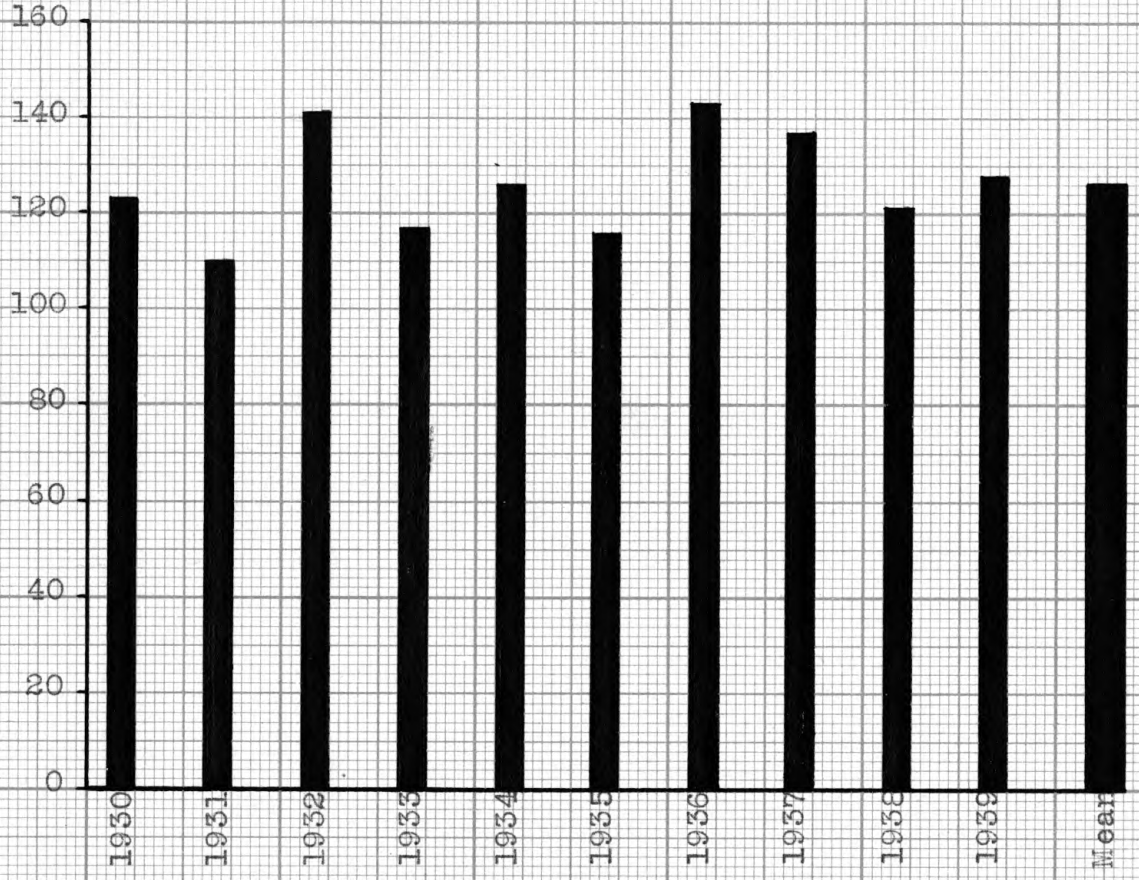

Fig. 3. Showing the total number of days each year, and the mean over a ten year period, with a minimal temperature of or below 32° F. as obtained from the files of the meterological station at Chapman, Kansas.

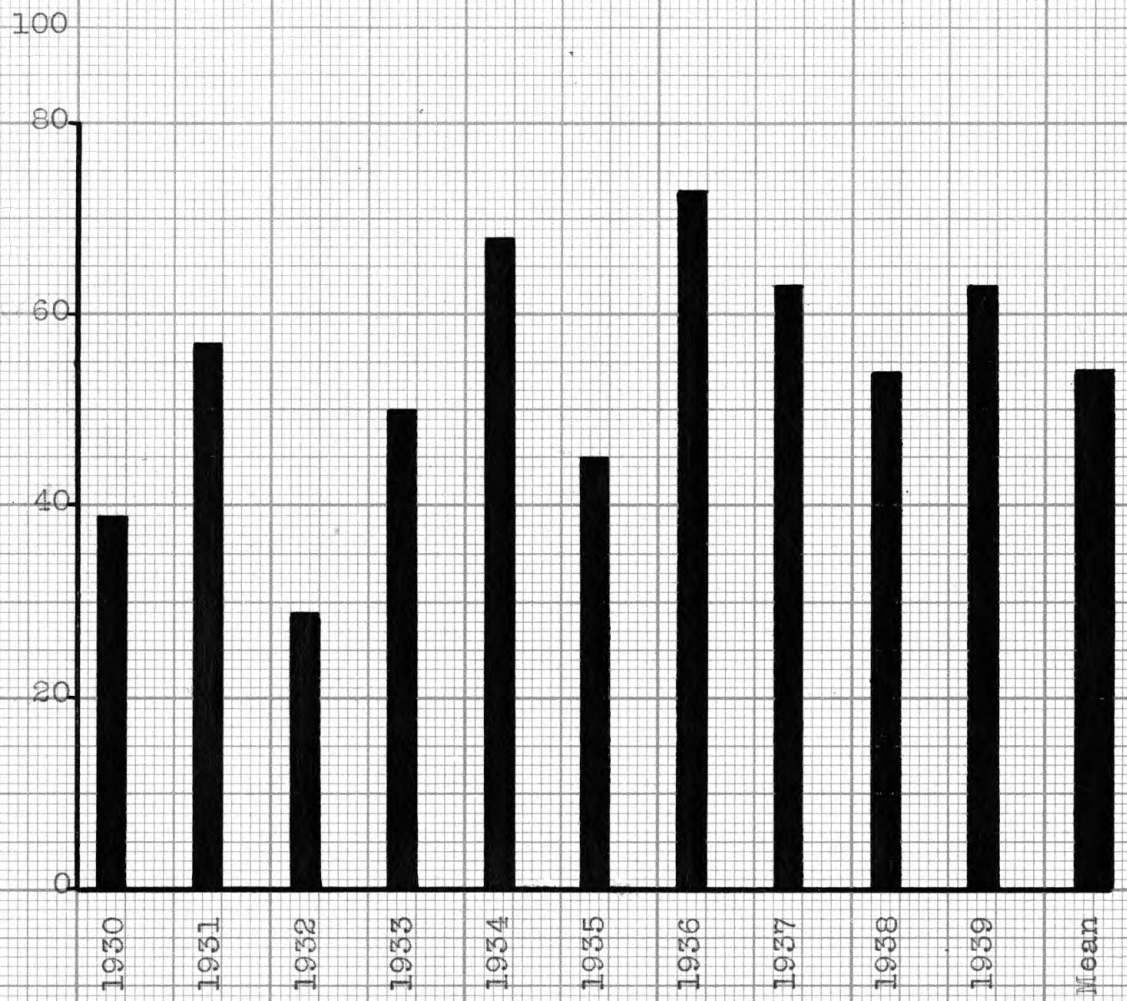

Fig. 4. Showing the total number of days each year, and the mean over the decade 1930 to 1939 inclusive, with a maximal temperature of or above 95° F. as recorded in the files of the meterological station at Chapman, Kansas.

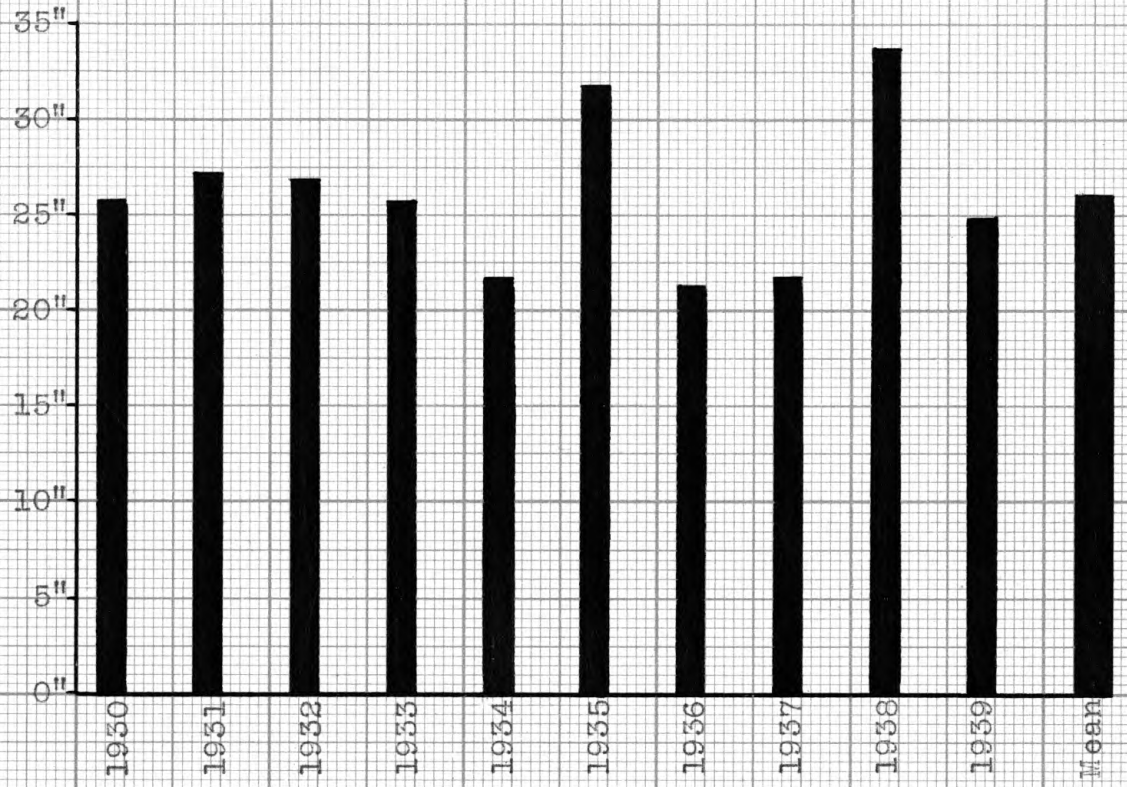

Fig. 5. Showing the rainfall in inches per year and the mean for the decennium 1930 to 1939 inclusive, as measured at the meterological station at Chapman, Kansas.

Analyzing the rainfall by months (Fig. 6) revealed that May and June were the two wettest months of the year, while September and August followed in order named. The least precipitation occurred in the months of December, January and February.

Station "A" was located approximately one mile north from the mouth of the creek, measured in a straight line, but were all the meanderings taken into account the distance possibly would be doubled. A rock outcropping, known locally as Erwin's Riffle, crosses the stream bed at this point, thus the water is aerated as it races over this area of loose rocks. In times of high water a pool was scooped out just below the riffle. The channel of the creek from the mouth to about one-half mile above this riffle may be partially filled with backwater from the Smoky Hill River during periods of high water levels, thus the riffle during these periods may be covered to a depth of three to six feet

On June 15, 1940, the water being at normal level, the flow was calculated using the formula (Page 5) given by Embody (1927). It was found to be three and three-fourths cubic feet per second.

When at normal height, the stream for a distance of 210 yards above and 420 yards below Erwin's Riffle was 15 to 20 feet in width. Twice in this distance the current

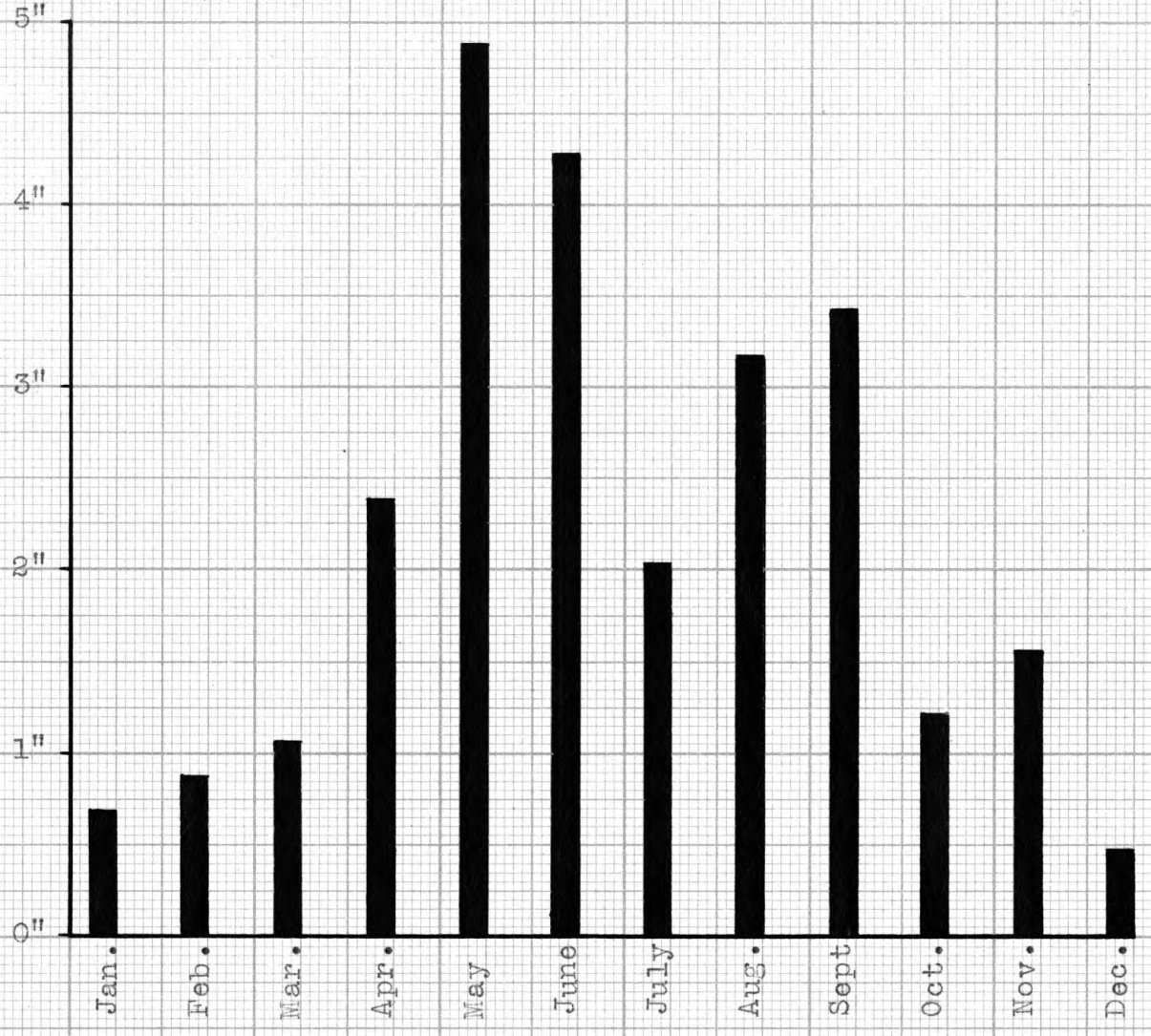

Fig. 6. Showing the average rainfall each month of the year over the decade 1930 to 1939 inclusive, as found in the records of the meterological station at Chapman, Kansas.

was obstructed by a fallen tree or a lodgment of drift wood. For the most part the bottom was of soft mud, from which volumes of gas, due to decaying vegetation, arose whenever the mud was disturbed. Drift wood was embedded in the mud to such an extent that at no place could our net be drawn a reasonable distance without encountering one or more obstructions. While this submerged drift afforded shelter and nesting areas to the different species it undoubtedly had its effect on the showing of the catch, as it was necessary at every haul to lift the bottom of the seine to free it from either rocks or submerged vegetation.

The wide banks of the creek were well planted to trees, the tops of which extended over the channel so that for a large portion of the day the water was shaded. Underneath this boundary of trees were found weeds which extended to within a few feet of the water's edge. Smart weeds and horse weeds made up the majority of this annual vegetation with patches of prickly lettuce, lambs quarter and nettle weeds at intervals. Slightly over half of the trees were elms, oak and black walnut together made up about one-fourth, and the remaining fourth included sycamores, ash, cottonwood, hackberry, honey locust, coffee-bean trees and mulberry. The bottom land adjacent to the stream was under cultivation

excepting the small areas partially encircled by the winding stream, which were still woodlands. Numerous stumps indicated many trees had been removed. Bordering the creek bottom the landscape rises abruptly to moderate hills which show frequent rocky protrusions near their tops. This sloping land occupied by native grasses is used for pasturage.

The area seined below the riffle was 130 feet in length and averaged 21 feet in width and 33 inches deep. The bottom was coarse gravel with a few large rocks scattered about. It is a favorite point for collecting bait by the local fishermen, as its location is about one-half mile from town on a graveled highway. In our net we found large numbers of crayfish, hundreds of them less than an inch in length. Common shiners Luxilus cornutus (Mitchill), and red fins Cyprinella lutrensis (Baird and Girard), were quite numerous and a few bullheads Ameiurus melas (Raf.), spotted channel catfish Ictalurus punctatus (Raf.), pumpkin-seed sunfish Eupomotis gibbosus (L.), and carp suckers Carpiodes carpio (Raf.), were taken.

A number of large clams were found here and great numbers of small ones up to 15 mm in width.

Above the riffle large tracks were observed in the mud, which from their size were likely those of a great blue heron

EXPLANATION OF PLATE I

Fig. 7. Erwin's Riffle facing upstream.

Fig. 8. The pool and stream below Erwin's Riffle.

PLATE I

Fig. 7

Fig. 8

Two common gars Lepisosteus osseus (L.) each twenty-three inches in length were taken from the water; also a medium sized snapping turtle Chelydra serpentina (L.), and a small soft shell turtle Amyda spinifera (Le Suer).

Many insect larvae were found in the net and seen swimming in the water. Euglena were so numerous on the surface on June 15, 1940, that at a little distance the water appeared greenish. The water was turbid for at no place could objects be discerned more than a few inches beneath the surface.

Station "B" was located about two miles north from the western boundary of Chapman, at a point known as Stafford's Ford. The stream bed at this place is composed of rock ledges for a distance of about 150 feet. Loose rocks 12 to 24 inches in their greatest measurement are heaped up to a depth of about three feet and taper off down stream for about 60 feet. The water impounded by this rocky obstruction was four to five feet deep for a distance of over 200 yards and averaged about 30 to 35 feet wide. The banks were steep and overgrown with weeds and brush almost to the water's edge. The bottom was covered to a depth of several inches with silt. Below the ledges were numerous pools 15 to 20 feet in width and 30 to 50 feet or more in length, being separated by lodgments of brush and other

EXPLANATION OF PLATE II

Fig. 9. A view of part of Stafford's Ford and the pool it creates.

Fig. 10. Shallow pools below Stafford's Ford.

PLATE II

Fig. 9

Fig. 10

debris. They had muddy bottoms and the stream banks were sloping and weedy. Many of the large trees along the bank had been cut so that much of the water surface was exposed to the sun.

Among the rocks and weeds numerous cricket frogs Acris crepitans Baird and a few leopard frogs Rana pipiens Schreber were observed. In the pools were found many crayfish, tadpoles, insect larvae, and some algae. Chickens were feeding along the edges of the pools. A large snapping turtle was found in one of these pools. Hundreds of common shiners and red fins were taken in the ratio of about two of the former to one of the latter. Pumpkin-seed, and green sunfish Apomotis cyanellus (Raf.), bullheads, and channel catfish were also taken.

Station "C" was located five miles east and ten miles north of Abilene, Kansas, or twelve miles due north of Enterprise, at a point on the creek known as Scripter's Ford. Two riffles occur here about 200 feet apart enclosing a pool averaging 20 feet in width and about 32 inches deep. The upper riffle obstructs the stream for a distance of about forty feet while the lower one with its extended shallows reaches down about seventy-five feet. Above the upper riffle, the water is four or five feet deep for a distance exceeding 100 yards. It averaged four feet deep.

Some holes below this are from seven to ten feet deep. The bottom of the stream in this region is gravel, small rocks, and a few large stones with a deposit of sediment several inches deep in places. The width was between 20 and 30 feet and averaged about 25 feet. The banks were steep with few weeds and shrubs. This is a favorite fishing spot and during the summer, four or five car loads' per week fish here. At this point quite a large bend of the creek is occupied by an oak grove. Along the banks of the stream were found oaks, elms, cottonwood, box elder, and a few black walnut. The water is shaded most of the day with small patches of sunlight streaking its surface.

On the north side of the stream the flood plain extends out about a half mile, and is devoted to cultivation, while on the south side, the adjacent land is rough and used for grazing. Common shiners and red fin minnows were found here in great abundance being about equal in frequency. Also the pumpkin-seed sunfish, bullheads, channel catfish, carp, fat heads Pimephales promelas Raf., and stonerollers Campostoma anomalum (Rafinesque) were taken. In the riffles great numbers of snails were observed and in the deeper water clams were numerous. Many crayfish and tadpoles were present. On the bank cricket frogs were frequent and a few bull frogs Rana catesbeiana (Shaw) were seen. On June 17,

EXPLANATION OF PLATE III

Fig. 11. The deep pool above the upper riffle at Scripter's Ford.

Fig. 12. The crossing at Scripter's Ford.

PLATE III

Fig. 11

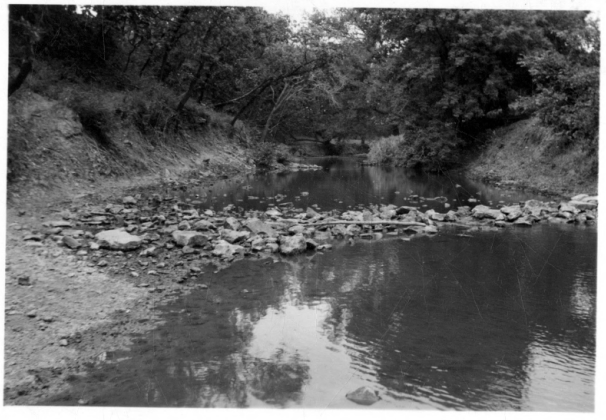

Fig. 12

1940, the surface of the water at a short distance above the riffles appeared greenish due to euglena. Pads of spirogyra were found floating on the water and in the riffles chara was seen. Many water striders and whirligigs were on the water surface, and in the air were dragon flies and butterflies. The water was murky, and schools of newly hatched shiners less than an inch in length were seen. On July 11, 1940, five schools, each of 200 to 300 or more, of bullhead fry were observed on the surface of one of the larger deep pools.

The yield of this section of the creek was quite high. One party took 33 bullheads on June 9, 1940; another on June 13, 1940, took 17 and a family group on June 16, 1940, was reported to have gathered "quite a sack full." These are only a few of the records of the fishing on those days.

Station "D" was located 3.5 miles east and 3.5 miles south of the village of Oak Hill where the north-south highway crosses Chapman Creek. Here the creek bed was soft mud with many pieces of drift wood embedded and projecting above the water. The stream averaged about 10 feet in width and 20 to 30 inches in depth. Along its borders were muskrat burrows. The banks, rising with a more or less steep slope to a top width of channel estimated at 35 or 40 feet, were overgrown with horse weeds, nettles, smart weeds, and

EXPLANATION OF PLATE IV

Fig. 13. Facing down stream at Station D.

Fig. 14. Pools and lodged drift at Station D.

PLATE IV

Fig. 13

Fig. 14

wild rye. Both banks were fringed with box elder, cottonwood, elm, ash, honey locust, willow, and black walnut. About one-half of the trees were box elder with elm and cottonwood next in frequency.

In the weeds were scores of dragon flies and grasshoppers. Many leopard frogs jumped from the vegetation into the water. A large number of common shiners and red fins, in about equal ratio, were taken in our net along with small numbers of pumpkin-seed and green sunfish, bullheads, fat heads, and chubs Semotilus atromaculatus (Mitchell). Tadpoles and small clams were abundant. On July 11, 1940, six medium sized to large snapping turtles were observed in one pool. Hundreds of newly hatched common shiners less than an inch long were seen in the water surface.

Station "E" was located about one mile north and one mile west of Oak Hill. The creek bed was composed of sand and the water was almost clear. The channel was about 25 or 30 feet wide with steep to vertical banks, topped with box elder, ash, elm, cottonwood, and honey locust trees. Sunny sand bars with shallow water overflowing, alternated with pools 20 to 30 inches deep and 10 to 12 feet wide and 50 to 200 feet long. From the algae and grass growing along the waters edge numerous tiny toads and grasshopper nymphs emerged. In the water were an abundance of crayfish,

EXPLANATION OF PLATE V

Fig. 15. Showing channel and steep banks at Station E.

Fig. 16. The sand and fine gravel showing through the clear water at Station E.

PLATE V

Fig. 15

Fig. 16

tadpoles, and larvae of various aquatic insects. Common shiners and red fins were present here in large numbers and about equal ratio. Pumpkin-seed sunfish and bullheads were also taken.

Several miles above station "E" the creek is joined by a number of small contributary branches. Each consisting of a broad shallow ravine with a tree-bordered streamlet in its center. Higher up in these ravines the vegetation and willow trees indicated springs and seepage.

Table 1. Approximate numbers of fish species taken per haul.

Station	A	B	C	D	E
Number of hauls	40	40	20	10	10
Common Shiner	125	100	100	75	75
Red Fin	50+	50	100	75	75
Bull Head	4	5	6	5	3
Spotted Channel Cat	3	2	2	--	--
Pumpkin-seed Sunfish	5	4	7	10	5
Fat Head Minnow	--	--	4	8	--
Chub	--	--	--	6	--
Carp Sucker	4	--	2	--	--
Stone Roller	--	--	1	--	--
Green Sunfish	--	2	--	5	--
Common Gar	.05	--	--	--	--

DISCUSSION

Chapman Creek, with its rather large drainage basin, of approximately 420 square miles, may be considered representative of other small streamsof central Kansas. Its geological formations are mostly of limestone making it quite favorable for aquatic life. Jordon (1911) observed that limestone streams were usually more favorable for fishes; and Canfield and Wiebe (1931) state that certain European workers claim lakes having hard water are more productive of plankton, a factor of prime importance in the food chain of fishes.

No towns of any consequence as to size are located on its banks, hence the stream is not polluted by sewage. Neither are there oil wells, mines, nor commercial enterprises dumping waste into its tributaries to interfere with aquatic organisms.

The soil of the valley, especially the lower two-thirds is indeed quite fertile as many fields were reported, the year 1940, to yield over 40 bushels and some as high as 52 bushels of wheat per acre. Forbes (1928) with respect to Illinois streams said:

> Most of our streams are remarkably productive because of the richness of the land from which they derive their organic content and because of their

> sluggish flow over a level surface by which ample time is given for the organization of their food materials into the forms fit for the maintenance of animal life and finally by means of this, for the life of man.

The cultivation of the valley has its negative effect in the quantity of silt carried into the stream and the consequent turbidity of the water. During the growing season the water in the lower channel is always turbid to some degree. After a freshet or heavy downpour the water has been observed to be quite muddy, to the extent that large fish, especially carp, were seen floating on the surface like driftwood. The bed of the stream was covered with sediment several inches deep in the quiet places. This deposit would undoubtedly have its drawbacks during the spawning seasons. The present emphasis given by the Federal Department of Agriculture on contour farming, terracing of hillsides, and gully control may bear fruit in diminished silt.

Another undesirable effect of these sudden torrential rises of the water, besides the washing down stream of the fish, is the carrying away and destruction of much of the fish food. The displacement downward of the fish is offset to some extent by the general habit of fishes of going up stream to spawn. Forbes (1876-1880) states: "No other

features of the environment affect an individual so powerfully, so intimately and so variously as the elements of its food." Mann (1921) speaks of the diatoms as the grass of the sea, the primary food upon which all marine life depends Diatoms are present in all water and none are known to be deleterious. Welch (1935) quotes the findings of Kofoid (1908) that within certain limits the plankton increased with the age of the waters. Shelford and Eddy (1929) found water in the Sangamon River, Illinois, at 9 days had practically no plankton. It was not abundant until the water was at least 20 days old. As the current decreased with low water, plankton became more abundant up streams. These same investigators also observed that impounded waters bore heavy plankton with attendant increase in the number of fish per unit area. Forbes (1928) concurs with the statement that the more fundamental elements of the nutrition of fishes are algae, protozoa, and animal plankton. Whenever these floating primary foods are swept from the channel, a period of time must elapse before the natural food chains can be reconstructed and productive.

No growths of sedges, cress, arrowroot or similar large aquatic plants were encountered in the portions of the stream investigated. Thompson and Hunt (1930-1932) observed that "The largest variety and greatest abundance

of fishes in individual collections in Illinois, were consistently found in situations with luxuriant growths of submerged aquatic plants." They expressed the abundance of fishes as three per square yard or about 150 pounds per acre with an annual increment not above 75 pounds per acre. No attempt was made to calculate the abundance of fishes in Chapman Creek, but the frequency with which fishermen were encountered and their reports of catches would indicate a generous supply of bull heads with a scattering of carp and channel catfish. The two largest catfish reported taken the spring of 1940 were nine and one-half pounds and nearly seven pounds respectively. It is reported that a few years ago sunfish were abundant but now one is seldom taken.

A moderately warm temperature seems to be a favorable factor for fish production. High temperatures tend to lower the available oxygen in the water but Welch (1935) stated that: "The oxygen supply of uncontaminated streams is usually high at all levels, often well toward saturation for the existing temperature." It would seem that the unusually hot summer of 1936, which had 73 days with a maximum temperature of 95° F or above, with 27 consecutive such days in July and later 21 consecutive days in August, had slight lethal effect on the existing species, due to the fact that the species were eurythermal.

Long continued cold spells, however, may be more deadly to the fish of a shallow stream. A coating of ice for a short duration would be of little consequence as bacterial action slows down with the falling of the temperature below 50° F, and much of the free oxygen in the water is ordinarily exhausted by their activity. The years 1936 had 143 days with a minimal temperature of 32° or lower and 1937 had 137 such days. From January 16, to February 21 inclusive, 1936, or for 37 days the maximum temperatures did not rise above freezing except on four occasions and the maximum temperature of the cold spell was only 46° F. Again in 1937 cold weather held sway for 29 days, from January 7 to February 4 inclusive, with 11 days whose maximum recordings were above 32° F with a period maximum of 41° F. During such prolonged cold weather ice forms on the creek to a great thickness. In shallow places it was frozen solid. In February, 1937, the ice was extremely thick. The fish wintering in shallow waters when such cold weather persists would suffer serious consequences. In the pools which were 30 inches or more in depth it is doubtful if any serious loss would be sustained.

The amount of precipitation and its distribution throughout the year are both of vital importance to the welfare of the aquatic animals. A deluge that drains quickly

into the stream may change the temperature so suddenly that deleterious effects accrue. Although the incoming surface waters bring in quantities of food organisms, if burdened with silt, however, it might clog the respiratory apparatus or foul the spawn in the nests. While the control of the rainfall is beyond human regulation, it is yet in man's power to manipulate the soil in such a way as to diminish the amount of run off. The average annual rainfall of 26.096 inches for the ten-year period considered is adequate for good agricultural yields. May and June, the normal periods of rapid growth of plants were the wettest, with August and September, the months when seed-bed preparations are made, were next high in moisture. The type of crop planted and the tillage of the soil in the most approved manner, by either terracing or contouring, restrain the run off and contribute their quota in the volume output of the springs and a stabilized height of water in the channel. The rainfall of the valley for the decade ending December, 1939, was so distributed that the least precipitation occurred during December, January, and February when the weather was the coldest and when aquatic animals were least active.

The lower half of the channel presented a uniformity of characters. The bottom was silt generally, with large

amounts of drift anchored in the muddy banks or bottom. The stream varied from about 10 feet to over 30 feet in width, with an average of 12 to 15 feet. In depth, it was from 15 inches to 4 feet, or more where measured. In the shallower stretches it would average between 15 and 30 inches and in the pools from 4 to 10 feet or more in depth.

Using the above formula of Embody (1927) at station A, the flow was found to be about 3.75 cubic feet per second when the stream was at normal height. The frequency with which drift and rocks were encountered indicated that shelter was abundant throughout the length of the stream.

A number of predators were observed. Several large snapping turtles were captured in our seine and at numerous places turtle tracks were seen on the muddy banks. Several large gars were also taken from the water. A great blue heron was observed in the vicinity several times, also large bird tracks in the mud, and a grebe was seen. A few water snakes were observed, but none captured. Several localities gave evidence of the presence of muskrats.

In years gone by, a grist mill was located about midway between stations "A" and "B". A remanent of the dam still exists and impounds water to the depth of about four feet. The popularity of this deep water with the local fishermen indicated that a slight increase in water depth

has a decided bearing on the fish production. It is a common observation that older fishes and larger species seek the deeper waters.

For purpose of sport and recreation the creek waters are easily accessible to the residents of its valley and of the several towns in its vicinity. Surfaced State and County highways cross the valley at short intervals and most of the township roads cross the stream on the section line pattern. The number of fishermen encountered, the paths along the creek banks and discarded bait containers all indicated the large volume of fishing that took place. The reports of the County Clerks of Dickinson and Clay Counties also indicated that fishing is indulged in freely. The number of licenses purchased in the two counties for the past five years follows:

Year	1935	1936	1937	1938	1939
Dickinson	553	1315	1469	1384	1360
Clay	194	424	463	405	640

It is not implied that all these sportsmen fish only in Chapman Creek for the Smoky Hill River crosses Dickinson County and the Republican River flows through Clay County and Ottawa County State Lake is in an adjacent county.

Jordan (1911) stated that "the processes of natural selection have given to each kind of river or lake species of fishes adapted to the conditions of life which obtain there. Thompson and Hunt (1930-1932) when investigating the distribution of fishes in Champaign County, Illinois, reported their findings by ten types of habitats. Their habitat type number 8 very closely resembles Chapman Creek.

> Drainage basin 40 to 400 square miles, depth 1 to 4 feet: width 20 to 50 feet: current sluggish during periods of low water: bottom sand or gravel with mud: overhanging grass or weeds: commonly shaded by trees on the banks: tree roots often exposed: numerous drifts of brush, logs and stumps and some large trees fallen in: banks drop off steeply to a uniform depth: moderate amounts of a variety of animal foods: mussels of several species numerous.

By adding that much bottom is of mud and silt and the water is turbid the above description would apply to Chapman Creek. Thompson and Hunt found the following species in habitat 8:

Moxostoma aureolum (LeSueur)

Moxostoma breviceps (Cope)

Carpiodes velifer (Raf.)

Catostomus commersonii (Lacépède)

Catostomus nigricans Le Sueur

Micropterus dolomieu Lac.

Pomoxis annularis Raf.

Pimephales notatus (Raf.)

Notropis blennius (Girard)

Notropis whipplii (Girard)

Notropis cornutus (Mitchill)

Hybopsis kentuckiensis (Rafinesque)

Ictalurus punctatus (Raf.)

Lepomis cyanellus Rafinesque

Lepomis megalotis (Rafinesque)

Lepomis humilis (Girard)

The following food fishes were taken from Chapman Creek:

Ictalurus punctatus

Ameiurus melas

Lepomis cyanellus

Carpiodes carpio

Eupomotis gibbosus

It would seem advisable to increase the number of channel catfish by stocking some of the pools with fingerlings as an abundance of molluscs, snails and insect larvae were found. Since the large mouthed black bass Micropterus salmoides (Lacepede) is indifferent to warm and muddy waters, is a good game fish, and feeds freely on minnows and crayfish, it might be a profitable venture to plant it in Chapman Creek.

Nature may be considered almost lavish in her generous contributions to the wants of man. Since the early dawn of human history, man has assisted nature in the fruits of the land by cultivating the soil. To assure an adequate supply of flesh for his table he has domesticated, sheltered, and fed the animals of the field. But the yield of the waters, he has taken for granted, and for the major part, has depended entirely upon the wiles and whims of nature. Unless he assists in the production of the fishes, as earnestly and intelligently, as he tills his fields and tends his herds, they are doomed to extinction.

The first step in improvement of Chapman Creek would be the deepening of the water by the erection of numerous low water dams. Logs placed across the channel or rock walls properly placed would restrain the flow only slightly and increase the depth from a few inches to two or three feet, thus providing opportunity for more and larger fish and diminish the hazards of cold and heat. Retardation of the water, by increasing the depth and number of pools, would tend toward increased quantities of food and diminished turbidity. Planting of aquatic plants in selected places also would be a profitable enterprise.

The management of the land to retard the rate and amount of run off would decrease the destruction attendant

upon high waters and the quantity of silt carried in, as well as help maintain a more uniform and increased flow.

SUMMARY

1. A survey of Chapman Creek was conducted from August, 1937 to July, 1940 inclusive. Chapman Creek is one of the small permanent streams of central Kansas. At normal height, it carries about 4 cubic feet of water per second. It is free from pollution. The geological formations of its watershed of 400 square miles assure an adequate supply of calcium, which is an important factor in the production of fish foods.

2. Excessive silting, due to the agricultural pursuits in its valley, would be alleviated by improved systems of soil control, as terracing or contouring slopes and damming gullies.

3. Prolonged cold spells in the winter have a deleterious effect on the aquatic animals due to the stream freezing solid in shallow places.

4. A few common gars and a considerable number of snapping turtles were found.

5. Eleven species of fish were identified and their relative abundance determined.

6. Chapman Creek, with its frequent deep pools, is a suitable habitat for several species of food fishes. It abounds with such fish foods as plankton, algae, insect larvae, snails, clams, and crayfish.

7. Food fishes were taken from Chapman Creek as follows Bullheads in large numbers, channel catfish and carp with moderate frequency and some sunfish.

8. Chapman Creek is subject to heavy fishing: It furnishes recreational activities for a large number of citizens.

9. The general fish habitat could be improved greatly by construction of inexpensive low water dams, which would increase the depth of the water.

10. Stocking the creek with fingerlings of channel catfish and large-mouthed black bass would be desirable.

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