Lewisa- 1937
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No. 2

BIOLOGICAL SURVEY

of the

BIG SANDY, TYGART, AND KINNICONICK DRAINAGE AREAS

1941

SURVEY REPORT NO.I

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Introduction

The biological survey is something new for Kentucky. Many of our leading states have had such a program in operation for a number of years and the question as to whether work of this type is useful in connection with the Division of Game and Fish has become a settled fact.

Kentucky's program began on April 1, 1937. Our present director, who has long been associated with survey work, upon his arrival in Kentucky saw the need of such studies here and began laying plans for the creation of a biological survey in Kentucky. It was the middle of July before all plans were made, equipment bought and received, and field work begun.

The federal government as well as the various states has carried on biological investigations in the national forests and in experimental wildlife areas over the country including many aquatic ones.

While the independent work of the states and the program of the bureau of Fisheries have done much to form a somewhat definite procedure in working out the biology of lakes and streams, each lake and each stream presents a new problem and must be studied as such. Therefore, it is impossible to follow rigidly any uniforn procedure by simply going about and collecting data blindly in all streams. This individuality of streams is at the same time the source of the sportsman's hope and despair, and of the interest and charm of any body of water.

Purpose of the Survey

A few of our fishermen would have us believe that all that is necessary to insure good fishing is for the Division of Game and Fish to stock any stream in sufficient numbers. The needed quanity of fish is released, thus converting a heretofore unproductive stream into a fisherman's paradise after allowing for a period of growth. If such were the case all that would be necessary is water. This is far from the truth as has been proven time and time again. Our fish are highly restricted in that the type of bottom, the amount of vegetation, the temperature, the amount and type of pollution present, etc., are all regulating factors as to whether reasonable success can be expected.

The first purpose of the survey is to formulate a systematic stocking policy with the proper species in accordance with the requirements of each stream of lake.

Another primary purpose of the survey is to determine the need for stream or lake improvement. The casual observer a given stream amy constitute a satisfactory environment, but after stocking, very disappointing results may be obtained. It is apparent then, after the money has been spent, that while conditions in general were favorable, the fish were unable to live and multiply owing to the fact that the stream was deficient in some essential feature. There may be a scaracity of pools or cover to which fish, when not feeding, can hide and find protection from their enemies. On the other hand, there may be an abundant number of fine pools and plent of cover but not enough food. Again, all of the above may be present, yet the temperature conditions may be so unsuited as to make it impossible for fish to live and flourish. Therefore, it is obvious that if some unfavorable conditions are present and can be improved even in part, the chances for a stream to provide good fishing will be raised considerably. Nothing less than perfect physical surrounding will give the maximum yield of game or fish in any environment. Anything short of that will give only a reduced production, no matter how much young stock you bring in from outside. The amount of fish life in a stream is a very direct measure of the fitness of that stream for the demands made on it. If it does not produce, there is certain to be something lacking as the environment which it is our business to learn.

Other purposes of the survey may be stated as follows:

To determine if the existing fishing regulations are suitable, and if not, to recommend proper changes.

To call attention to special problems which should receive more study.

Acknowledgments

Whatever success this survey may prove to be will, in a large measure, be due to those individuals who have given their helpful suggestions and other aid to the writer. The following deserve special mention: Major James Brown, Director of Game and Fish; Dr. W. R. Allen, Professor of Zoology, University of Kentucky, who has read and criticized this manuscript; Dr. H. S. Davis and Mr. Eugene Surber, of the Bureau of Fisheries; Dr. Carl L Hubbs, Curator of Fishes, University of Michigan.

DISCUSSION OF THE WATERSHED

THE BIG SANDY WATERSHED

The Big Sandy Drainage lies in the extreme Northeastern section of Kentucky. It is bounded on the south and southeast by the headwaters of the Kentucky River, on the east by the headwaters of the Licking, and on the northeast by the Little Sandy River. The Big Sandy and Tug Fork form the boundary line between Kentucky and West Virginia, the state line being in the middle of the streams. This river system drains all of Pike, Floyd, Martin, Johnson, and Lawrence Counties, and Parts of Letcher, Knott, Magoffin, Morgan, and Boyd Counties.

Levisa and Tug Fork, source streams of the Big Sandy River, rise in southwestern Virginia and flow in a general northerly direction, joining at Louisa, Kentucky, to from the Big Sandy River. The river flows north twenty-seven miles emptying into the Ohio River at Catlettsburg. The watershed has an area of about 4,280 square miles, approximately one-half of which is in Kentucky, one-quarter in West Virginia, and one-quarter in Virginia. The stream basin is shaped somewhat as a triangle with an apex at the mouth of the river and the base running approximately parael to the Ohio River.

The present Big Sandy River, according to geologists, is only the upper middle portion of a larger stream of former times. Certain types of boulders found in the Big Sandy and the upper waters of the Licking indicate the the ancient Big Sandy River had its headwaters in the Rowan Mountain region of western North Carolina and southwestern Virginia. The occurrence of quartzite boulders on the upper waters of the Licking River indicates that the Big Sandy flowed over the Licking to the northeast. Structural elevation, it is said, along the nearly north and south axis of Paint Creek has operated to bisect the Big Sandy, and to turn the waters to the northeast to join Tug Fork.

At the time the Big Sandy flowed in the course of the Lciking River it did not join the Ohio, for at this time there was no Ohio River since this latter stream is a product of Pleistocene glaciation. The original Big Sandy probably flowed to the northwest in the region of southwestern Ohio until it met major drainage which was the gulf of Mexico, then heading at Cairo, Illinois, or the Great Lakes basin, by way of Lake Erie.

Tthe topography of the Big Sandy Watershed is generally rugged. Nearly all the stream valleys are narrow and steep, especially in the headwater region where the stream flows through canyons or gorgeg. Between the mouths of the forks and the Ohio River, the valleys are wide with rounded hills. This is true for the Kentucky section of the watershed more than that of West Virginia. General elevations vary from 500 feet at the mouth of the river to 3,500 feet above sea level in the head-waters. There is practically no level upland surface on the entire shed. The ancient plateaux have had their softer strata cut away by erosion so that only sharp-crested ridges remain to indicate the former elevations. It is where the valleys are wide to form fertile bottom land that productive agricultural land is found. The hills, as a rule, are unproductive except for timber.

At one time nearly the whole watershed was thickly covered with hardwood forests. Trees native of the region are the black walnut, white oak, red oak, chestnut, beech, white ash, hickory, etc.; the most valuable being the black walnut and for that reason this wood has become rare. The extensive lumbering operations began before railroads had spread to this section and for amny years the rafting of timber on the river was an important industry. It was during this time that a considerable amount of timer was cut without any consideration for the young growth. As a result, it is only in a few places that a good second growth can be found. Besides timber, the central and upper portions of the basin contain extensive mineral resources of bituminous coal, petroleum, natural gas, and some iron ore. The mining of coal is by far the principal industry as over 25,000,000 tons are mined yearly. The only industrial concerns of importtance existing in the watershed are two oil refineries located above the mouth of the river near catlettsburg.

The bottom lands on the main section of the Big Sandy are flooded from the upper section of the basin and from the Ohio River as well. The Ohio River backwaters are the more frequent and may cause flood stages as far upstream as Louisa. Many more floods are experienced in recent years than formerly, a fact which may be accounted for in part by the removal of timber from the surrounding hills and from along the stream banks.

The Federal Government has improved the river for navigation by the construction of three locks and movable dams on the main river and one lock each on the two forks. The locks have a minimum chamber width of 52 feet and a length of 158 feet. Those on the Big Sandy proper were completed in 1905, while those on the forks were completed five years later. When built, the locks were designed to afford a six foot slack-water depth; however, heavy sand deposits in the pools occasionally reduce the available depth to about four feet. At the present time the locks and dams, especially on the forks, are in poor condition, but likely meet all the demands for navigation as this type of stream improvement does not extend into the coal fields.

Again, according to the geologist, most of the rock formation present in the basin belongs to the Pottsville group of the Carboniferous age with a small representation of the subcarboniferous limestones. There are three subdivisions appearing most often; these are the Lee conglomerate which is nearly 1000 feet in thickness, the

Norton formation of about 1,100 feet in thickness and the Wise formation of which about 300 feet of its lower members cap some of the ridges. Although coal measures are found in several formations, the better coal seams are found in the Norton formation. All of the formations consists mostly of layers of sandstone and shales and are similar in type to those found through the Appalachian strata.

Natural gas is found in large quantities along the entire basin, and it is from this region that a large amount of gas, used in cities such as Cincinnati, Louisville, and Pittsburg, is obtained. The gas is delivered to the cities by an intricate system of interconnected pipe-lines. Petroleum does not have the wide distribution of natural gas. While some oil is to be found in all parts of the Big Sandy Watershed including both forks of the river, the principal oil field at present is in the upper section of Blaine Creek in Lawrence County. The oil is transported by pipe lines to two refineries located near the mouth of the main river.

The watershedis rather sparsely settled and has no large cities. Large areas of both forks, as well as of the main stream, support but few inhabitants. In those sections where coal mining is most extensive are found the principal settlements. These settlements have had a fairly rapid growth of the mining industry.

Blaine Creek

This stream is naturally subject to extreme fluctuations which have no doubt been intensified by the removal of timber from the drainage area. The past summer was marked by more high water in the creek than for many years. While the shade along the stream bank in the central and upper sections is fairly heavy, the surrounding hills have been largely fenude of all timber, both young and old. The valleys are wider, in general, for this watershed than are usually found in a mountainous country. This accounts in part for the clearing of timber, as a moderate amount of agriculture is practiced.

Blaine Creek, with its source in the northwest corner of Johnson County, drains about two-thirds of Lawrence County, through which it flows northeast to empty into the Big Sandy near Catalpa, Kentucky . The stream is about 50 miles long.

There are a number of small tributaries of Blaine Creek, but none produce a significant amount of fishing. Upper and Lower Laurel and Hood Creeks were suggested to the writer for special study by sportsmen of Lawrence County as possible trout streams. A series of temperatures recorded during the month of July, at the most favorable stations located on the creeks mentioned above, showed the streams to be too warm. Futhermore, it was found that the streams are too heavily inhabited by warm-water species and that the water-level becomes too low durning the summer months. While a few good pools are found between the overhanging cliffs, they are too few in number to warrant listing the streams for stocking purposes. Fishing in the region is relatively light and natural spawning is adequate for the species found.

Located in this system is the only oil field of any importance at present in the entire Big Sandy region. Oil wells are fairly well distributed over the Blaine Creek watershed with the main producing center being found above Blaine, Kentucky. Before the time of oil drilling in this section, the creek is said to have abounded in amny fine fishes. Now this stream is classed as a poor fishing stream due to pollution from oil wells more than any other factor. As the oil is taken from the wells it is pumped into small storage tanks were the good and waste oils are allowed to separate. This waste oil is drained from the bottom of the tanks along with salt wa ter and allowed to flow into the creek. In the month that was spent on this creek, oil was seen on the water as far down stream as Fallsburg every day. On every bush and tree below the high water mark oil covers that portion which has been touched by the water.

Fishing is light in Blaine Creek as might be expected, and about the only fishing done is at Fallsburg in the large pool below the falls. These fish in the lower section near the Big Sandy probably come in from that river as it is unlikely that any fish could live in the creek for any length of time due to the pollution.

Figure 1.

Oil Well and Storage Tanks Located in Head of Blaine Creek

As oil is taken from the well it is placed in the tanks shown on the hill. Here the waste oil and salt water are separated and allowed to drain from the tanks to the creek

Levisa Fork System

The Levisa Fork rises in southwestern Virginia from two sources, the second being the headwaters of Russell Fork which river empties into Levisa at Millard, Kentucky. Levisa is 160 miles ong and flows in a general northerly direction across eastern Kentucky. This stream enters the state in Pike County, flowing on through Floyd, Johnson, and Lawrence to empty into the Big Sandy at Louisa, Kentucky.

In the region known as The Breaks, which is just above the Kentucky line in Virginia, is found some of the most scenic beauty of the entire basin. This section with some of the surrounding territory will undoubtedly one day be made into a national park. Already many tourists are attracted to this spot yearly throughout the summer and fall months. The road which leads from Elkhorn City to The Breaks has recently has some repair and in dry weather this drive is an outstanding one for scenic beauty. In Kentucky from below the Virginia line to Elkhorn City, a distance of four miles, the valleys are very narrow and steep; the stream frequently flowing through canyons or gorges. To all appearances this particular section should provide small-mouthed bass fishing unsurpassed by any in Kentucky. At the present time however, the upper part of Levisa is considered a better fishing stream. Some pollution entering Russell Fork above and just below Elkhorn City may account for the fact that the stream has very little good fishing waters.

In the upper section of Levisa Fork, that is, the section just below the Virginia line in Kentucky, the valleys are wider and not nearly so steep as those found on Russell Fork. The entire section from the state line down to the mouth of Russell Fork is one of the best fishing streams to be found in Kentucky as far as general appearances go. While fishing is good in this section, it could and should be better.

The gradient of the two streams is moderately steep. Levisa, from the state line to Millard, a distance of approximately 29.5 miles, falls about seven feet per mile. Russell Fork, between the same points, falls 13.1 feet per mile but flows for a distance of only 14.5 miles. From Millard on down the river to about fifteen miles below Paintsville the decline is more gradual and it is here at this point near the Johnson-Lawrence County line that the stream becomes of a more sluggis nature.*

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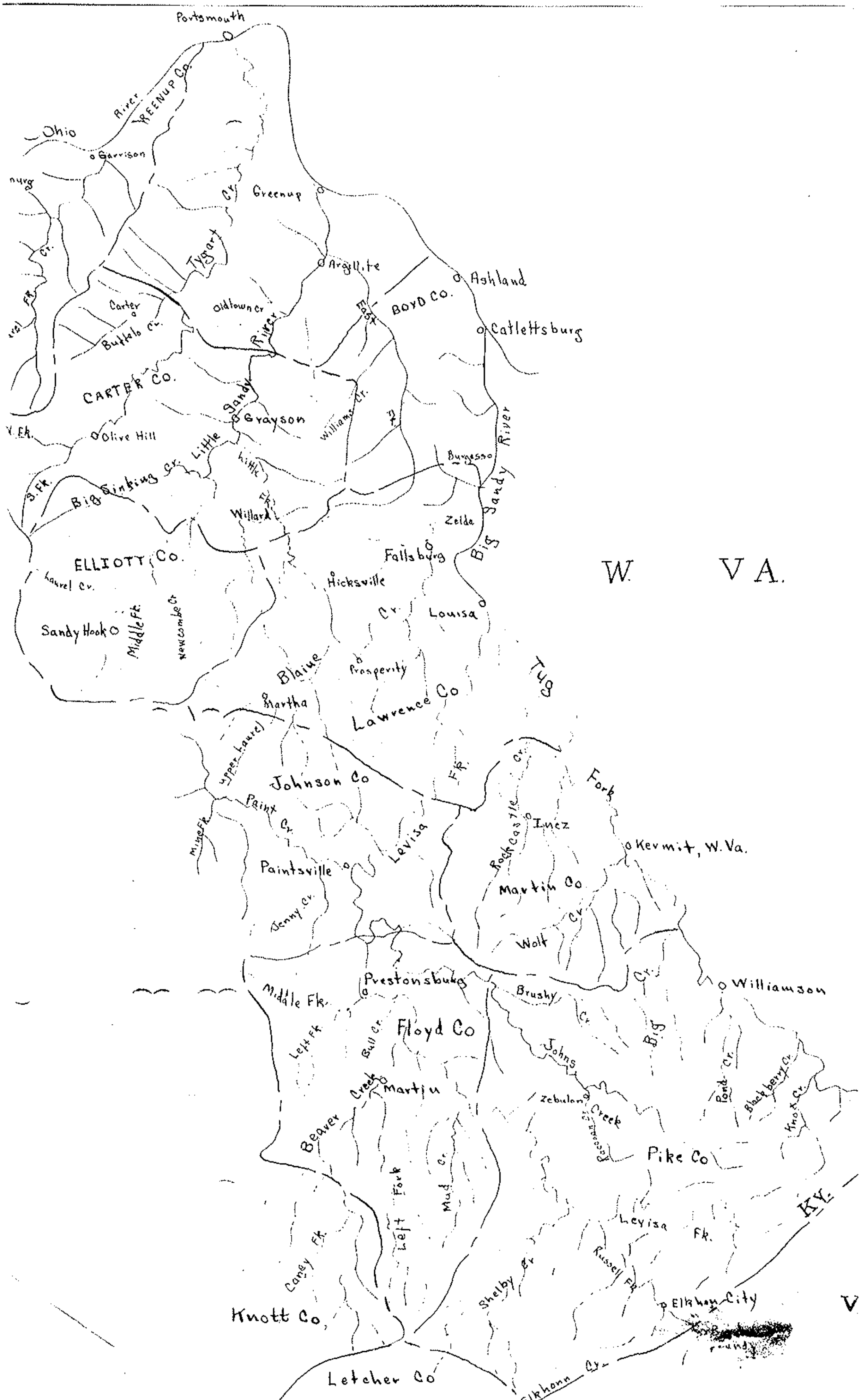
* For a more detailed account of the gradient refer to the maps and stream profiles.


Portsmouth
Ohio
River
Greenup Co.
Garrison
Greenup
Tygart
Argillite
Ashland
Boyd Co.
Catlettsburg
Carter
Buffalo Cr.
Oldtown Cr.
Carter Co.
Grayson
Olive Hill
Big Sinking Cr.
Willard
Burgess
Zelda
Big Sandy River
Fallsburg
Elliott Co.
Laurel Cr.
Sandy Hook
Middle Fk.
Newcombe Cr.
Hicksville
Louisa
W. VA.
Tug
Blaine
Prosperity
Martha
Lawrence Co.
Upper Laurel
Johnson Co
Paint Cr.
Fork
Inez
Rockcastle Cr.
Kermit, W. Va.
Levisa
Paintsville
Martin Co.
Jenny Cr.
Wolf Cr.
Prestonsburg
Middle Fk.
Brushy
Williamson
Floyd Co
Left Fk.
Bull Cr.
Johns
Martin
Beaver Creek
Zebulon
Creek
Pond Cr.
Blackberry Cr.
Knox Cr.
Pike Co
Left Fork
Mud Cr.
Caney Fk.
Levisa Fk.
Russell Fk.
Shelby Cr.
Elkhorn City
KY.
V
Knott Co.
Letcher Co
Elkhorn Cr.

In some cases the gradient is one foot or less per mile.

Practically no virgin timber is to be found on the Levisa Fork drainage area and it is only above Pikeville where a good second growth is to be found. Little timber of any size is found along the stream bank in the central and lower section of this basin. Young timber which gets a start is soon cut away by the owners, so that the flooded streams pick up sand from the unprotected banks, causing the stream to widen out, and the pools to silt up with the sand. Before the time of the oil wells and the extensive coal mine and lumbering operations, a handsome string of fish could be caught in a short time with a pole and line. Levisa at that time had many deep pools which were shaded by heavy timber causing the water to remain at a moderate temperature even in mid-summer. The water was clear and practically unpolluted at this time, except moderately from the few homes scattered along its banks. Timber was rafted down the river with little difficulity. Municipalities and industrial concerns of all types are here to stay and a "working agreement" between these and conservation interests will have to be accomplished before " the good old fishing days" known to the Kentucky pioneer will again, in some localities, be seen.

From below Pikeville down stream to Gallup, very few fishes are taken. However, in this large section there are two or three small portions of Levisa Fork from which a fair catch might be expected

The Larger Tributaries of Levisa Fork

Levisa Fork has several large tributaries but not one of these may beclassed as an excellent fishing stream. This is due primarily to two causes which are pollution and the filling in of the creek with silt. So far Johns Creek is the least effected by these two factors and is the best fishing stream. Beaver Creek has suffered most from pollution and silt and thus, supports fishes of little ecomomic value except in the small headwater regions of some of its tributaries which are above the sources of pollution.

A discussion of each of these tributaries follows.

Elkhorn Creek

ElkhomCreek rises in the northeast section of Letcher County and flows northest through Pike County where it empties into Russell Fork at Elkhorn City . The main stream has a length of about twenty-eight miles, the section of its watershed between Shelby Gap and Elkhorn City forming the boundary of Kentucky and Virginia. The creek contains far too few pools to think of stocking it in its present condition. The average gradient for the entire stream is something like 25.4 feet per mile.

The central and lower section of the stream has narrow, steep valleys which contain a fairly good stand of second growth timber.

The creek receives pollution from the twon of Jenkins as well as from other small settlements and coal mines located in the headwaters. The amount of pollution is relatively small however, and apparently has little effect on the stream. Located on the creek, one mile above its mouth, are the Pikeville Fish Ponds. These were built by the Fish and Game Club of Pike County. Here young small and large-mouthed bass are reared to the fingering stage before being liberated in the various streams of Pike County. When these pools were visited by the writer, they contained an excessive amount of algae which did more harm than good. It was suggested that much of the vegetation be eliminated by sending men into the ponds with pitch forks to roll the plants out to the bank where they could easily be removed. This was done.

Shelby Creek

Shelby Creek rises in the southeastern part of Pike County and flows through a rather narrow valley to its junction with Levisa Fork near Shelby, Kentucky. It is approximately thirty miles long and maintains a fairly good flow of water throughout the year. In the lower portion of this watershed shade is very good along the stream. In this section between Robinson Creek and the mouth of Shelby, the water flows through a moderately wooded country and is characterized by long, deep pools with abundant shelter alternating with riffles rich in food. This part of the creek is fished heavily during the spring and early summer months and although natural spawning is good, it is not adequate. In former times many of the fishes in this stream were killed by pollution, but now the amount entering the stream seems to be so small that it has only local effect, which is confined to the upper section.

The amin tributaries are Long Fork which empties near Virgie and Robinson Creek which empties near Robinson, Kentucky. These streams fluctuate rapidly after rains, and during dry seasons become very low.

Beaver Creek

The upper end of Beaver Creek is quite inacessible as the road on the Right Fork is practically impassable above Wayland and on the Left Fork nearly as bad. At the present time however, the state has under construction a part of the road up Left Fork.

The source of Beaver Creek is in the northeastern part of Knott County. It flows in a general northerly direction across Floyd County to enter Levisa Fork at Allen. For the most part the valleys are wide and a fair amount of bottom land is found for a mountainous county such as Floyd. Surface run-off is extreme and has been accelerated by the growth of settlements. Excessive cutting of timber and repeated burning has greatly reduced the effectiveness of much of the forest cover in checking the run-off. The occupation of our hill land in some sections has been accompanied by seemingly persistent efforts to remove surface water from the land just as rapidly as possible, with consequent losses in soil and water. The amin part of Beaver and the Right Fork have for the most part sandy bottoms while that of the Left Fork has more gravel and rubble. Pools are more numerous on the Right Fork, these being wider, longer and deeper than those on the other forks. There is practically no fishing in any section of the entire creek since most of the fish have been driven out or destroyed by pollution from coal mines, gas pumping stations, and small towns. Oil, although in small quanities, occurs widely in Floyd County and has been produced on Right Beaver for a number of years. Pollution for this source is negligible though, as compared to that from the source mentioned above. Beaver Creek is more heavily polluted per mile of stream than any other water of the entire Big Sandy Basin found in Kentucky. Water entering Levisa from Beaver causes that river to be polluted for some miles below its point of Entrance.

It is recommended that Beaver Creek, which is approximately fifty miles in length be freed of pollution before it is ever stocked for fishing.

John Creek

The mountains of the John Creek drainage are of the rolling type, while the valleys are in general quite narrow. A large part of the creek is almost inacessible since that part between Meta and Gulnare, Kentucky, has the only road that can be traveled at any season of the year. The road in the upper and lower sections are only passable during dry weather. It is only in those sections which are served by comparatively good roads that much fishing is done, since here are found the better pools, and riffles are richer in food. During hot weather the stream the stream gets quite low but since most of it is well shaded, it remains fairly cool. The stream flows down a moderate gradient over a bottom composed of boulders, rubble, and sand and gravel for the upper and central sections and gravel, sand, and rubble for the lower section. The type of bottom mentioned first is encountered more frquentely than the second type, etc. Shelter is abundant as well as several types of vegetation. As a whole, food is very plentiful and many small bass were seen, but there is a complaint of a scarcity of legal size fish. Small fingerling bass are abundant, indicating that natural spawning is keeping up the supply. An abundance of good spawning grounds exists over the entire length of the stream. The scarcity of large bass is probably due to the illegal practice of dynaniting and to a lesser extent to seining which occurs at various times . While this creek does have adequate spawning grounds, abundance of shelter and food, there is a definite lack of pools for a stream of this size. This factor exerts its influence on the production of fish.

Practically no virgin timber remains on this watershed but the slopes and streams are protected by a good second growth timber as the forest in this region have suffered little injury from fire and agriculture. Since the banks are fairly well protected by trees, the streams on this particular basin do not tend to spread excessively as in some other sections of the main Big Sandy drainage area.

The region is sparsely settled and contains only two or three villages of four or five houses. The coal seams have not been opened except in one or two places for private use. Due to the lack of development in this section, Johns Creek is nearly unpolluted except by some chance drainage from a toilet or from cattle pastured on the slopes. This stream receives less pollution than does any other of the Big Sandy. The main tributary of Johns Creek is Brushy Creek. It contains no pools of any size and consequently goes dry for the most part in hot weather.

In the headwaters, above Lawson's School, an old mill dam is said to keep fish from passing upstream except on very rare occasions during high w ater. Due to the presence of this dam,a large pool has formed below the barrier which would immediately fill were the structure removed. The height of this dam is only four feet and since there is practically no pool area anyway above the dam, it is recomended that it not be torn away. While working in this section the water level arose twice over this structure, allowing an opportunity for the passage of fish. It is evident to the writer that this is a frequent occurrence rather than a rare one.

Paint Creek

Paint Creek rises from two sources, one of which is Little Paint Creek with its headwaters in the southwestern corner of Johnson County, and the second, Open Fork which has its source in the northeastern part of Morgan County. Little Paint and Open Fork, when taken together, are in reality a unit and according to geologist, these were an integral part of the drainage of the Elk Fork of Licking River in not too remote geologic time.

The physical aspect of the country-side is that of a maturely dissected plateau. Meandering drainage encompassed by usually steep, forest-covered, winding ridges is characteristic of the region. The central and upper waters of Paint Creek are deeply entrenched as a whole and present atruly scenic beauty. Shade along the creek bank is relatively good and many fine pools are distributed along the stream.

The only town of any size found in this area is paintsville, which is located at the junction of the creek with Levisa Fork. The creek is heavily polluted in this lower region by Paintsville sewage. Above this section the inhabitation of the watershed is light and the upper part is parctically inaccessible due to the lack of roads.

Some coal, oil, and gas are found in this region. Before the day of the development of mineral resources in Johnson County, Paint Creek contained many fine fish. At the present itme however, due mainly to oil pollution, this stream has little fishing of any kind. No particular place can be pointed out as a spot where pollution enters, since most of the damage comes from a break in the line carrying the oil. When this happens, practically every fish in the creek is destroyed except those which are lucky enough to escape by entering a tributary. The creek has several small tributaries, Jenny and Mudlick Creeks bing the largest. Those are of little importance, as in hot weather they become low and have too few pools to be stocked.

Tug Fork

Tug Fork rises in southwestern Virginia and flows generally north throughout the 154 miles of its length. For about 95 miles, it forms the boundary between West Virginia and Kentucky and for 5 miles, the boundary between West Virginia and Virginia. The stabe line follows the center of the stream for its entire length where it forms the boundary of the states mentioned above. The country-side found in the headwaters of this fork is much the same as that on the Levisa Fork with the exception that the valleys are not quite so steep. As the stream enters Kentucky it flows through an alomst undeveloped wilderness which contains few roads, and these in a very poor condition. The hillsides are better wooded than those in the central and lower section.

Tug Fork has far fewer inhabitants lining on its watershed than does Levisa, but the stream is much more polluted. The washing of coal in West Virginia causes the entire stream to contain coal dust which keeps the water in a blackened condition for the most of the year. When the clear waters of Levisa mix with the waters from Tug at Louisa, it seems that a stream of clear water is being added to a stream of ink. It is on rare occasions that Tug Fork runs clear.

Mnay of the tributaries coming in from West Virginia are acid due to mining operations. Some few tributaries from the Kentucky side are also acid, and acid water drains from some mines in both states directly into the main stream

Before mining began good springs were plentiful and waterseeped through coal without being harmful. Since operations began in the coal fields , the mines have given out a great quantity of acid and mineral salts which were empties into streams, killing many fishes, and keeping others moving because of the constancy of the flow of the mine water

The production of acid caused by mining may be explained as follows:

Ferrous Sulfide	Oxygen	Wa ter	Ferrous Sulphate	
$2FeS_2$	$7O_2$	$2H_2O$	$2FeSO_4$	$2H_2SO_4$

the reaction then continues;

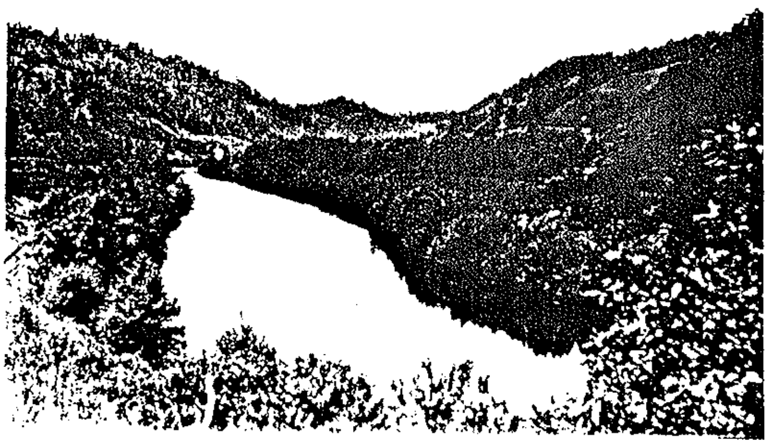
	Sulfuric Acid		Ferric Sulphate	
$4FeSO_4$	$2H_2SO_4$	O_2	$2Fe(SO_4)_3$	$2H_2O$

It is noted in the above equations that air (oxygen)

Figure 2

TUG FORK

Near Martin Lawrence-County Line



has to be present before the reaction can take place. Before the seams were opened, there was no way for oxygen to be present, hence there was no acid formed.

Two alternatives of the problem are, to remove the acid and acid salts from the mine water by chemical treatment before it enters the stream or to prevent the formation of acid and acid salts by some means. The aicd many be removed by adding lime to the water- one pound of lime to a pound of acid. This would be too expensive and a sludge would be formed in the stream. Research has been directed towards finding some by-pnoduct from mine water which would pay for its treatment. Several paint pigments were found, but there are more satisfactory and less expensive sources of these, and futhermone, it was found that enough of the product could be recovered from a few mines to supply the world market.

Since the discovery that oxygen had to be present for the formation of acid, theU. S. Public Health Service has been active in sealing a number of abandoned mines. These acid factories have been sealed in amny places on the Big Sandy Drainage. After mines are sealed, made air-tight, they gradually cease to make acid and the water flowing from them often becomes good alkaline water. If every abandoned mine were sealed the problem would not be solved however, since acid also comes from those mines in operation. But the sealing of all possible mines would eliminate more than fifty percent of the trouble, which would be a good start in the right direction.

It is recommende that no part of Tug For be stocked with any fish until it has received more study. Up to the present time very little research has been done on the effect of mining pollution on fish life. It is known that fish can not tolerate much change in the pH valute of water. Since acid is being poured into the stream for almost its entire length, and since the stream becomes low during the hot weather, the acidity would be expected to change enough in certain sections to affect the available food supply, or even destroy fishes.

As was stated earlier in this paper, Tug Fork contains a heavy concentration of coal dust due to the washing of coal. The small particles of coal in the water adhere to the gills and other portions of the body causing a heavy secretion of mucus. As the mucus is secreted, more coal dust attaches itself to the fish and death finally results from asphyxiation. Young fishes are more readily affected by the presence of coal dust than older fishes with the possible exception of the sucker family. The dust will not only destroy fishes but will also prevent the eggs from hatching. As the coal settles to the bottom of the stream, bottom organisms are destroyed. Too, the roily condition of the water cuts off light from the plankton, therefore limiting its growth. It is further recommended that this and other problems be given adequate study before any fish are placed in the stream for stocking purposes. An experimental section should be designated and a series of tests and experiments made before money is spent in stocking such a stream as this. While an occasionally good fish is taken from Tug Fork, this by no means demonstrates that the stream is worth stocking and that money would not be lost in so doing.

The Larger Creeks of Tug Fork

There are six creeks, Knox, Peter, Pond, Big, Wolf, and Rockcastle Creeks, which are worthy of special discussion. All except Knox Creek are classed as poor fishing streams since pool areas are entirely to few in number. Each of these streams have three or more fairly good pools but the rest of the stream, in each case, is shallow water.

Knox Creek

Knox Creek, the first tributary of any size to enter Tug Fork as this latter stream flows into Kentucky, rises in the southwestern part of Virginia and flows generally north to its mouth in Kentucky near Okeeffe, West Virginia. Only the lower section (eight and half miles) of this creek lies in Kentucky. Its watershed is rugged. Valleys are steep and narrow, with only a small amount of bottom land. The slopes are protected by virgin or good second growth timber.

The creek is reached by traveling on the West Virginia side up Tug Fork as far as Delorme. Here one crosses to Freeburn, drives on to Turkey Creek of Knox by way of Majestic. Travel is possible about a mile up stream from the mouth of Turkey - there is no road in the section below.

Knox Creek is the only stream of importance that flows into Tug Fork from Kentucky, so far as fishing is concerned, at the present. The stream bed is composed of gravel, rubble, boulder, and some sand. Shade is moderately abundant, food is plentiful, and deep pools are numerous. Vegetation is common as well as

Blackberry Creek

Showing an example of what road building has done to some of our streams in Kentucky.

an abundance of cover. Many small-mouthed bass were seen and the Kentucky bass was found to be common. It was reported that the yellow bass is present in this stream but no specimens were taken in the collections made from the creek.

Sportsmen living at Majestic say that they have made up money at different times which was used in purchasing fish for stocking this creek and that meanwhile most of the stream has been posted by landpwners of the section. The writer,found while he was there , that most of the creek in Kentucky was posted. Of course if this condition remains, no more fish should be planted by the state until the stream is opened to the public.

Peter Creek

Peter Creek rises in the northeastern section of Pike County and empties into Tug Fork at Freeburn. A large part of the timber has been cut away so that only a poor second growth remains. Thus the run-off is accelerated. The run-off in turn has been speeded up as the absorptive topsoil was removed. Most subsoil is highly unabsorptive and will not hold a large amount of water or retain its flow. Gullies are set up when the top-soil has been removed and in a short time **many** new tributaries are formed to natural drainageways. All tributaries concentrate run-off and discharge it with maximum velocity into the main stream. Immediately after a heavy rain every stream has to take care of an enormously increased volume of water rushing from all the surrounding acres of eroded land. In avery short time one of the best streams may be made practically useless. Pools are filled in. During the dry summer months the stream becomes low, due to the fact that most of the water has been carried away immediately following a rain.

Peter Creek serves as an example of the foregoing description. Only seven pools of moderate value are found in the entire creek at this time. In years gone by the creek is said to have abounded in any number of good deep pools, and many fishes. The stream flows over a bottom of gravel, sand, and boulder, down a moderate gradient. A fair amount of shade is present along the lower part, which accounts for the fact that in this section the channel has not widened out appreciably.

Coal mines located in this drainage area have been said to turn their acid water into the creek killing many fishes. At the time of our examination on June 15, no acid was found in any of the tests made at the several stations on Peter Creek. However all species of fish life were relatively scarce in this stream, which fact is most likely accounted for by mine water present at times in lethal amounts.

Pond Creek

This creek, which is approximately fifteen and half miles long, is by far the most densely settled territory of the entire Big Sandy Watershed. Only second gorwth timber remains in this section and this is extremely scarce.

As might be expected, most of the shade along the stream has been cut away, leaving the stream to widen out and to become warn in hot weather. Practically the entire stream is no more than a riffle, which contains little vegetatinn . Nor is it capable of supporting any of the game fishes.

Although there are many mine located on this particular watershed, there is little mine water entering the creek, and this seemed when examined to have no effect on the fish life of the stream. Many types of forage fishes are present in this water, all of which are relatively abundant.

Pond Creek rises in the north central part of Pike County and flows almost directly north to enter Tug Fork near Williamson,West Virginia. In the upper part of the creek, the valleys are narrow and steep while those in the lower section are wider.

Big Creek

Big Creek has its source in the central part of Pike County and flows north through a rather narrow valley to its junction with Tug Fork near Nolan, West Virginia. The upper part of the waterhsed contains but little timber while below there is fairly good second growth. Shade is poor but this will improve within the next few years if the young trees now growing along the banks are not cut away.

Roads in the central and lower section on the creek are passable only when dry. Due to this fact fishing is comparatively light. The stream flows down a moderate gradient over a bottom composed of sand, gravel, and rubble. There are many long riffle areas and many of the pool are shallow. Vegetation is common and food conditions are very good, with the exception of the lower section.

Water from a mine opening on Chatin Branch causes the creek to be acid for a mile and half below the mouth of the branch. Two saw mills located in the headwaters allow sawdust to enter the stream. The effect of this pollution is minor however, as only small amounts of saw dust enters the stream.

The central section is characterized by a fair number of good pools, an abundance of shade, vegetation common, a bottom made up of gravel, rubble and sand. Excellent spawning grounds and other conditions over a considerable area of the stream favor bass. Many young small-mouthed bass were seen and it is believed that natural spawning is adequate for the present.

There are no tributaries of Big Creek of any importance.

Wolf Creek

Wolf Creek rises in the south central part of Martin County and flows north to its junction with Tug Fork near Lovely, Kentucky. This stream is naturally subject to extreme fluctuations of flow which have been intensified by loss of timber and topsoil. Very little timber of any size is found in the drainage due to the extensive lumbering operations of some years ago. Much of the stream bed has been used for road building. Because of this and the fact that shade and other timber has been removed from the slopes so throughly, there remain practically no pool areas of any value in the stream.

Wolf Creek flows through a narrow valley down a moderate gradient over a bottom composed of sand, gravel and some rubble. Vegetation is scarce, food is present in moderate amounts, and long stretches of the stream is made up of shallow pools of little value. In the lower region a number of spawning places are found which serve fishes coming in from Tug Fork. Yet, all species of young game fish were relatively rare when this creek was studied in early summer, while there was still plenty of water.

As yet the creek receives little pollution except from two small sawmills located near the headwaters of the creek. The country-sideis sparsely settled, and no coal seams have been opened so far for operation. A small amount of gas and oil is produced from this section with a number of wells just being drilled this past summer. (1938)

The tributaries of Wolf Creek are small and do not warrant a discussion.

Rockcastle Creek

The source of Rockcastle Creek is in southwestern Martin County across which it flows in a general northerly direction to its junction with Tug Fork at Clifford. The valley bottoms are restricted in size, narrow, and meandering, while the hills are steep and winding. Most of the virgin timber has been cut away but a fair growth is to be found as well as a good amount of shade along the stream as a whole. The creek divided into three main parts which are Rockhouse, Middle, and Coldwater Forks. Rockhouse Fork does not maintain a good flow of water nor does it have pools of value. The stream is well shaded however, vegetation is abundant, and the food is above average. At Inez, Rockcastle divides again to form Middle and Coldwater Forks. Several private mines have been opened on Middle Fork. While chemical tests did not show any large amount of acid to be present in this fork, it is evident that at times the flow of water from the mines is great enough, and contains enough acid to be harmful. In the lower section of this fork are found a few well shaded pools containing an abundance of food and vegetation. The bottom is mostly snad. Fishes are scarce in this fork with the Creek Chub being the only member present in any numbers. Coldwater Fork is much the same as Middle Fork except that it is more heavily shaded. The bottom is composed mostly of snad, food is below average, and vegetation is not so common.

For the stream as a whole, there is a scarcity of good pools and vegetation and food are present in moderate amounts. Much of the bottom is made up of sand while in the central part more gravel and rubble are found. The gradient if moderate. Very few game fishes were taken in collections made from the creek but suckers were relatively abundant. The section near Grassy, should be stocked with a few small-mouthed bass and sunfishes.

The creek is seined heavily which accounts in part for the fact that this is not a good fishing stream.

KINNICONICK CREEK

Kinniconick Creek

The source of Kinniconick Creek is in the extreme south central section of Lewis County across which it flows about fourty-four miles to its junction with the Ohio River near Garrison, Kentucky. Water to the south of this drainage flows into Licking and Little Sandy Rivers, to the East into Tygart Creek, and to the West into the Ohio and North Fork of Licking Rivers. Kinniconick drains approximately two hundred square miles and ofr its size, probably is second to none in Kentucky in its possibilities as a fine fishing stream. As a whole the slopes are well wooded by second growth timber. The upper part, from Kinniconick, Kentucky, to the headwaters, is surrounded by more open land than any other section of the stream. Here much of the timber has been removed from the hills but a good amount of shade remains along the stream. In the more central and lower regions there is practically no bottom lands, as the valleys are narrow and steep.

With the exception of the region above Stricklett, the stream is characterized by excellent pools containing much vegetation in the more shallow areas and by a very good supply of food. These pools are from fifteen to twenty feet deep and remain cool even in midsummer. The gradient of Kinniconick is fairly moderate and it flows over a bottom composed of gravel, rubble, and boulders and sand. There is an abundance of water lilies under the pads of which Pike, which are so plentiful, linger during the warmer days while awaiting their chance to dart out after some animal as it passes by. The creek draws many out-of-state fishermen each year, and fishing is heavy. Scattered along the stream are a number of camps, both private and for rent. At Kinniconick, there is Kinniconick Inn which accomodates mnay people the entire year who come to the region for fishing and hunting.

The country-side is lightly is lightly settled and the stream as a whole receives little pollution. The only considerable sources of contamination are seven sawmills which dump sawdust on the stream bank and chance pollution from farm homes along the stream. Mill waste will be taken up later on in this paper.

There are several good tributaries of this creek which furnish excellent places for spawning. Indian Creek, which is the first main tributary to enter from the upper region, contains a few pools which are deep, well shaded, and provided with plenty of shelter. Food conditions are good, making this a fine nursery stream. The slopes are particularly weal wooded and the main stream maintains a fair flow of water which clears as rapidly as it becomes turbid. The bottoms of the pools as deep as six feet can be seen as clearly as those of one foot elsewhere.

Straight Fork too serves as a nursery stream for Kinniconick. While the flow of water in this fork is not maintained as well as from Indian, nor does it contain pools which are deep, the stream is rich in food and its hills are will wooded with second growth timber.

The best tributary of the drainage is Laurel Creek which drains the southeastern part of the county. The lower part of this creek is characterized by a pool-riffle ratio of a 50-50 per-cent, an abundance of food, and well shaded water. The stream has a moderate gradient and flows over a bottom composed mostly of gravel. Grassy Fprk, which is a tributary of Laurel, has a few good pools in the lower area which contains small-mouthed bass in abundance as well as suckers and minnows. It is believed however that the sawdust from the two sawmills on this fork will eventually create such unfavorable conditions that the fishes present will be killed or driven out, unless some check is made on these sources of pollution. At Laurel Point, another sawmill is dumping sawdust on the very edge of the water. At times of large run-off it is carried down stream.

Figure 3

A View of Kinniconick Creek, Central Section

TYGART CREEK

Tygart Creek

Tygart Creek rises in the southwestern corner of Carter County, flows east, then north, entering Greenup County, across which it flows north to its junction with the Ohio River near McCall, Kentucky. Waters to the south of this drainage flow into Licking adn Little Sandy Rivers, to the east into Little Sandy, and to the west into Kinniconick Creek. Tygart is approximately 82 miles long, has a moderate gradient, and is well shaded as a whole. The bottom of the upper part of the stream is composed mostly of gravel and rubble, while in the lower section more sand bottom is found. While some good pools are found in the Carter County portion of Tygart Creek, the better part of the stream lies in Greenup County. Pools are more numerous, shelter is abundant, and food conditions are better.

From Olive Hill to the Greenup County line the creek flows through a narrow valley which is a gorge in places. Above and below this point the valleys are wider, the slopes are not so abrupt, and a large part of the timber has been removed from the watershed..

In the upper section high grade flint fireclays are produced. Sands occur in residual deposits at various depths in the region suitable for general construction, glass making and metal molding purposes. Limestones suitable for building purposes, highway construction and iron fluxing are found. Glacial deposits in the form of metamorphic pebbles are occasionlly picked up in this region.

In contrast with Kinniconick Creek which clears rapidly, Tygart Creek remains turbid for a large part of the year. At the time the creek was studied (October-November) the water was a dark brown which could be accounted for in part by the large number of leaves which had fallen from the trees lining the bank. However, even in midsummer the water is never clear and white.

Located within the drainage between Olive Hill and Grayson are Carter Caves and Cascade Caves. One of the carter Caves was used for saltpeter manufacturing during the war of 1812. Many interesting formations are to be seen in these fantastic caves. Collections were made from the waters of the two caves. These contained the same species of fish as found in the main creek.

Impurities enter the creek from Ollive Hill, the only settlement of any size in the basin, from limestone

Figure 4

Tygart Creek Near Red Hot, Ky

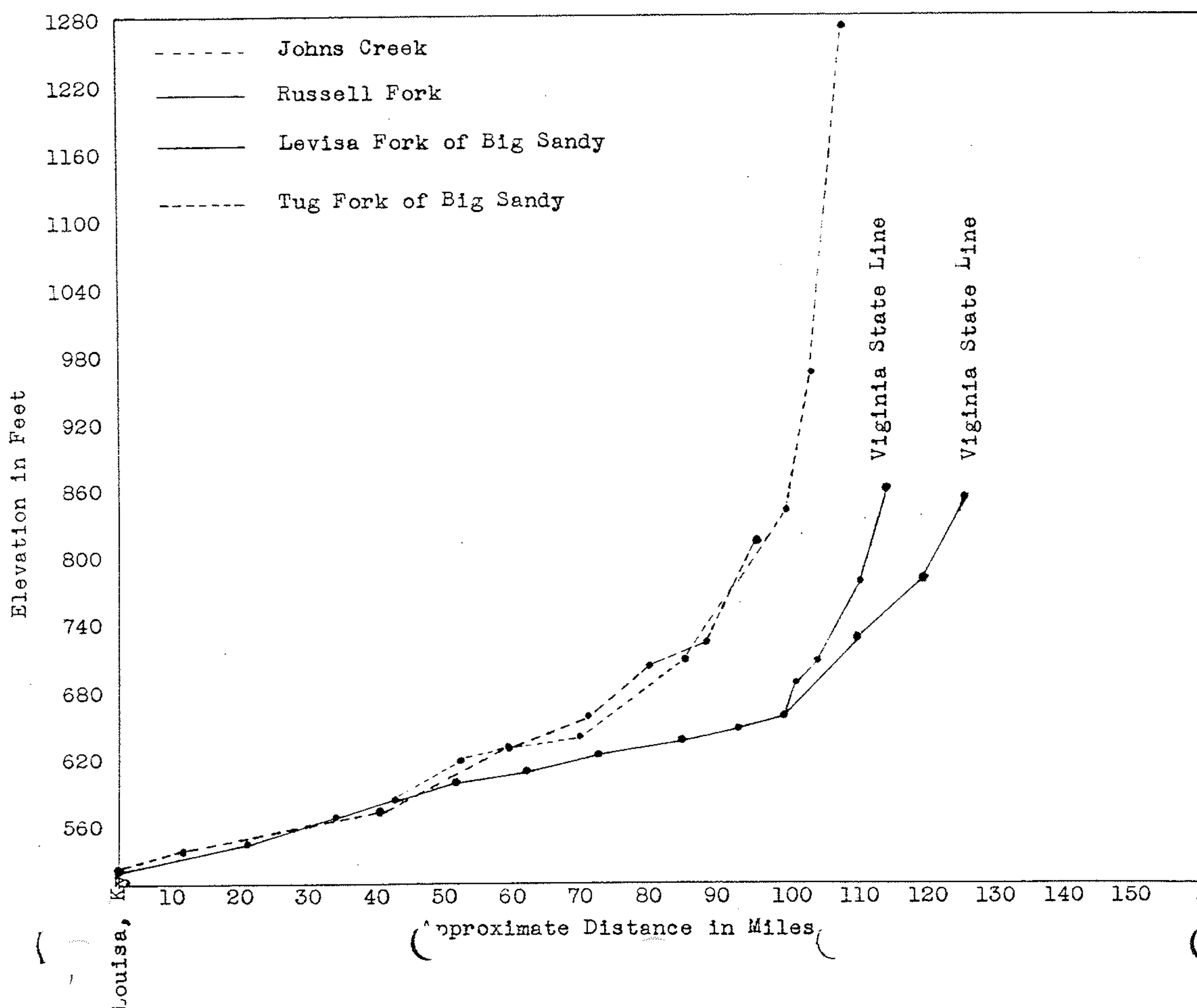
quarries, and fire brick plants. Sewage from Olive Hill causes the greatest amount of damage.

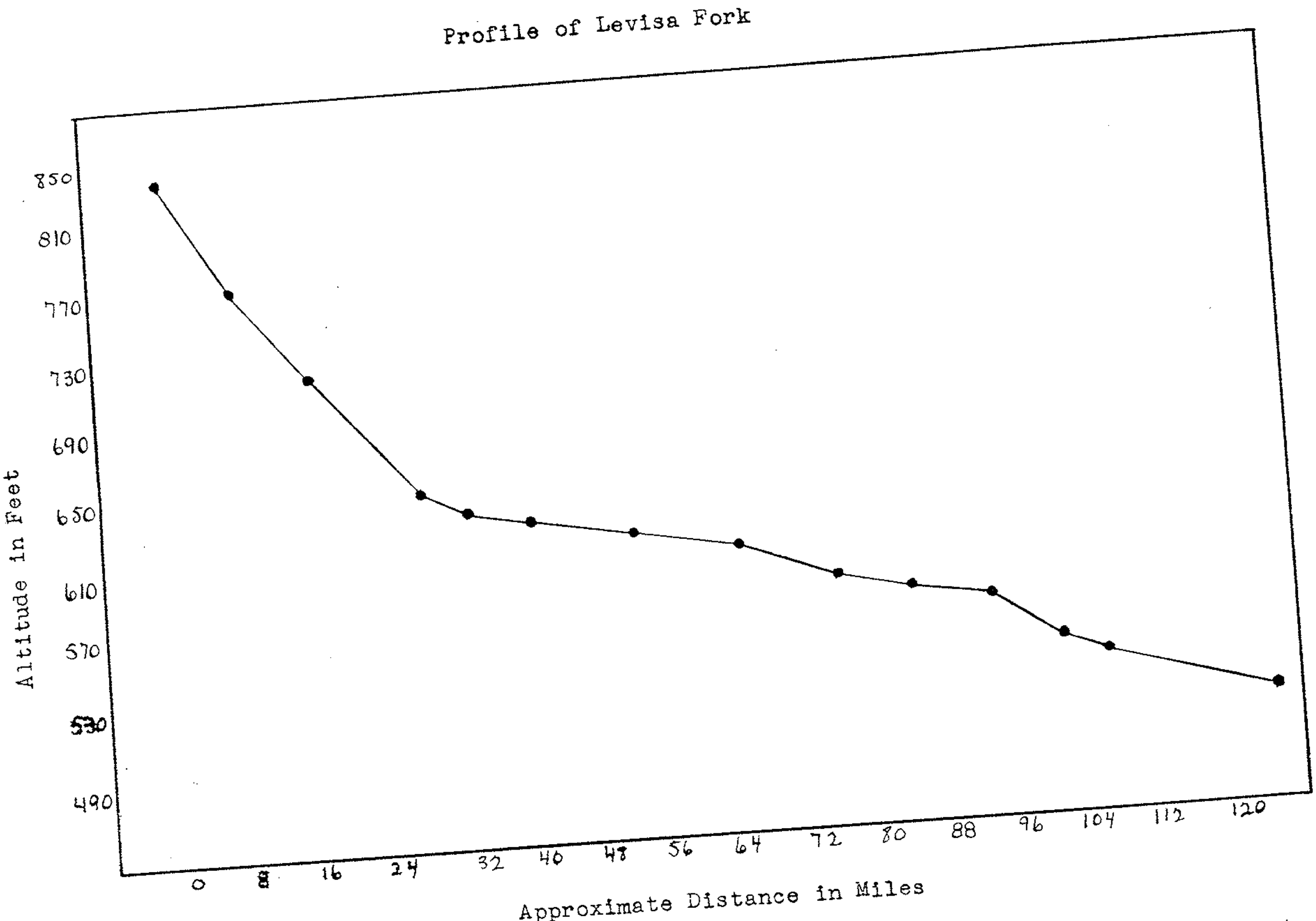
Stream Profiles

Stream profiles are made by determining the elevation at various points alonga stream. Knowing the distance between each point at which the readings were taken, it is then possible to graph the stream showing its approximate elevation at any one location. A slight error is to be expected at various points as the aneroid barometer, which was used in taking the readings, changes rapidly when once set. In some cases, bench marks were located several miles from a station on the stream. All readings were taken at the level of the water.

On the following page, the two forks of Big Sandy, Johns Creek,and Russel Fork have been drawn on the same graph for comparative studies of the profiles. Following this, each stream has been shown but not for use in comparative studies of the various streams. Thses are shown for use in studying one particular stream only. A scale was adapted to each which would show best the gradient of each stream

STREAM PROFILE




Profile of Levisa Fork
850
810
770
730
690
650
610
570
530
490
Altitude in Feet
0
8
16
24
32
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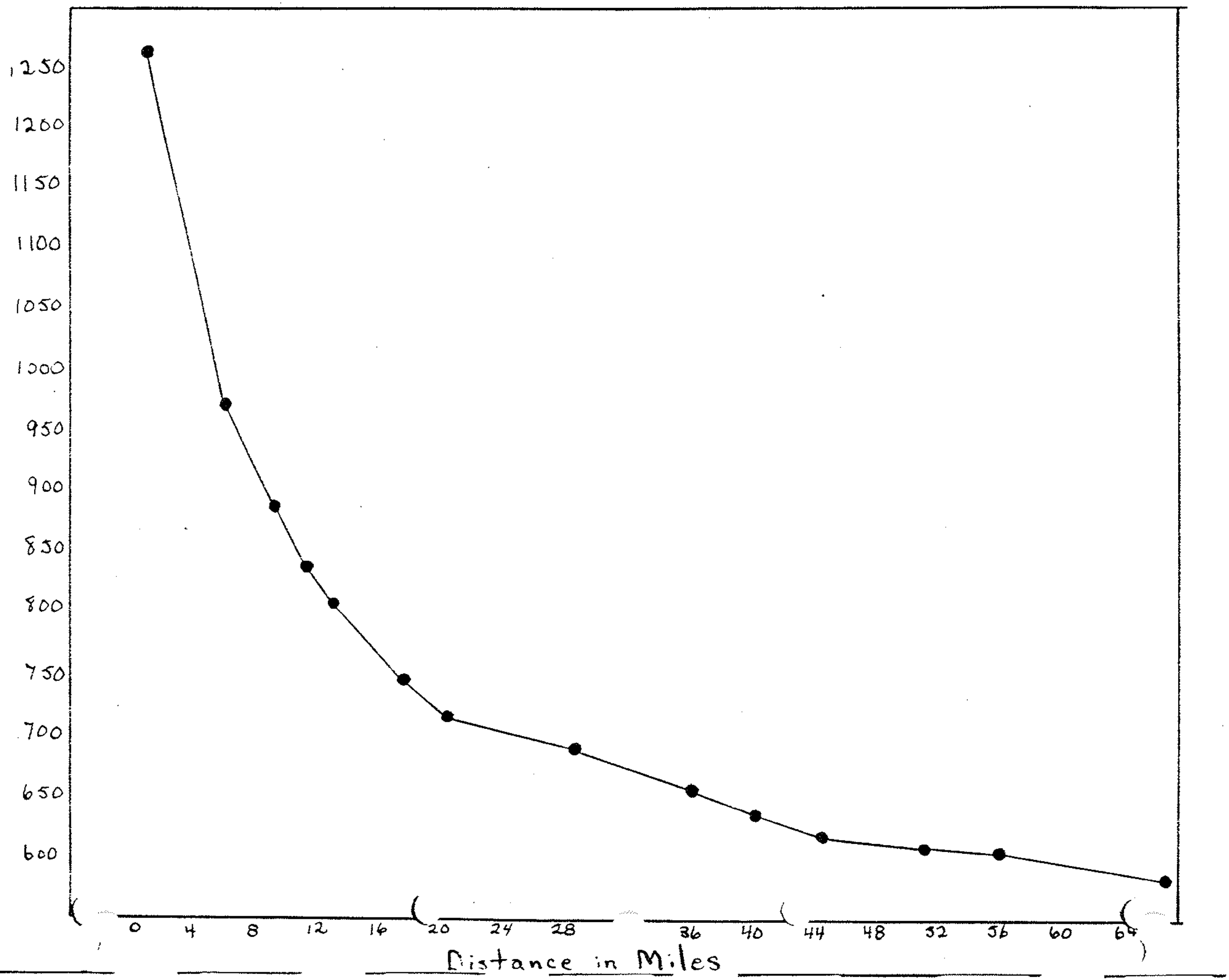
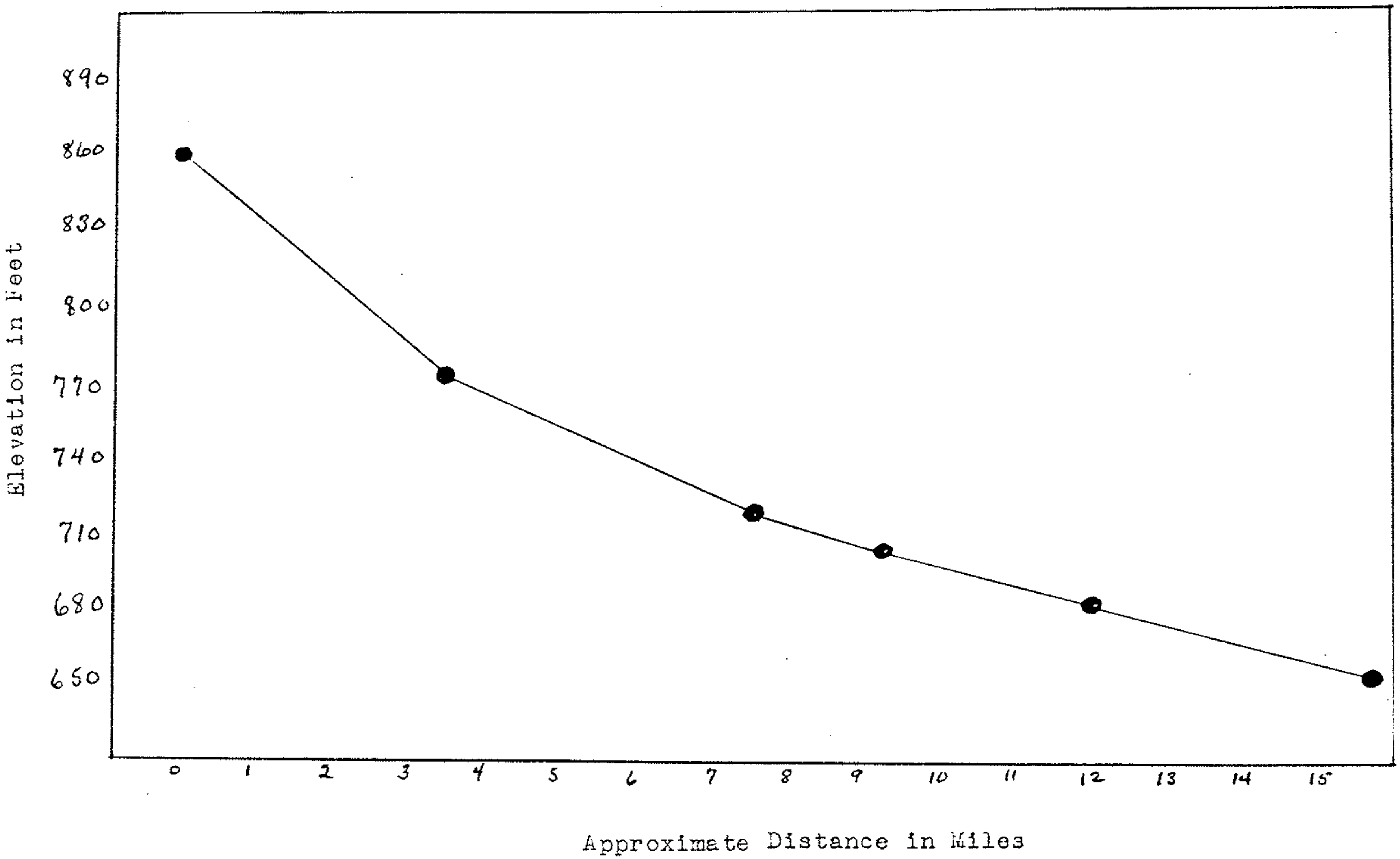
48
56
64
72
80
88
96
104
112
120
Approximate Distance in Miles

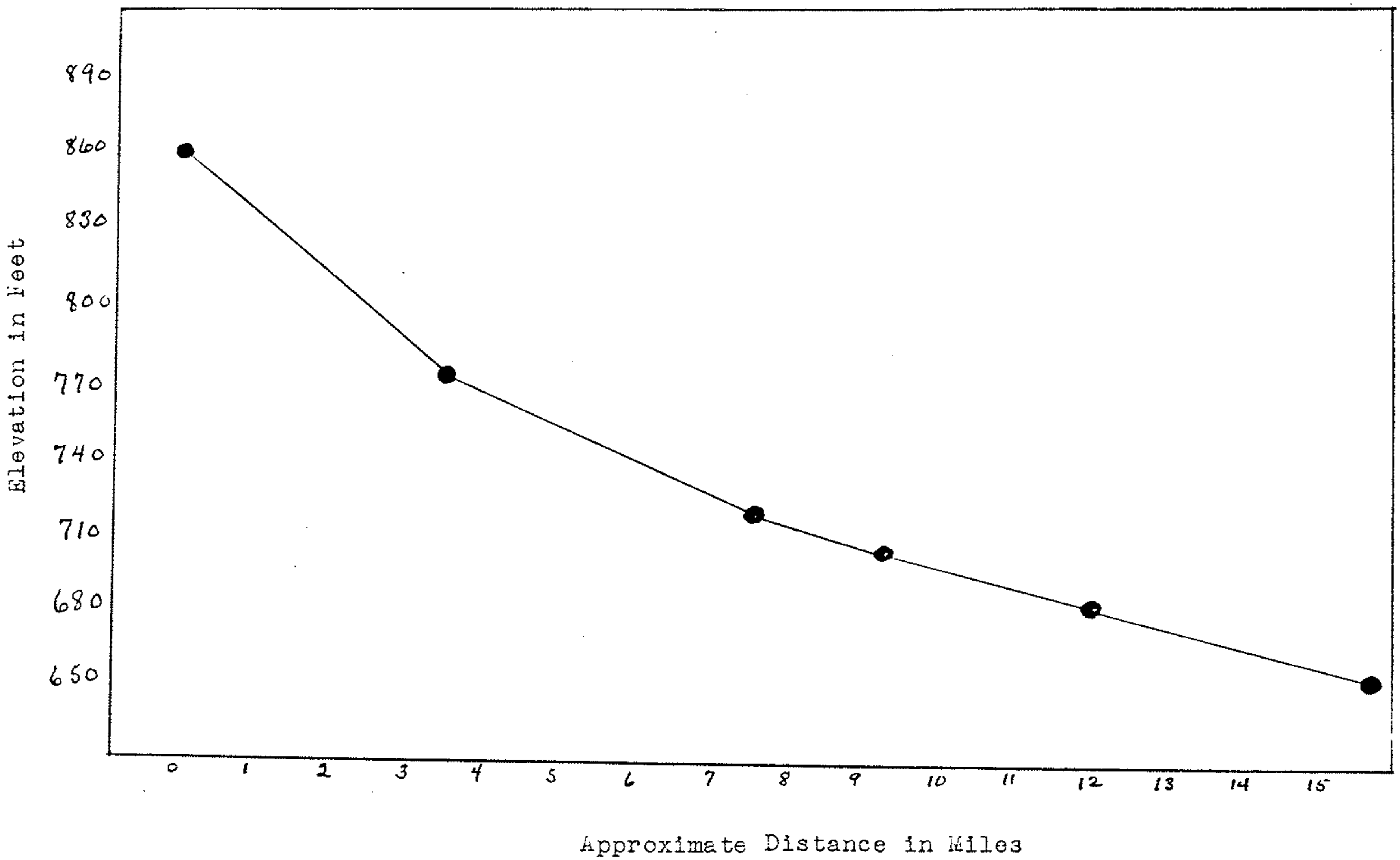
Profile of Johns Creek



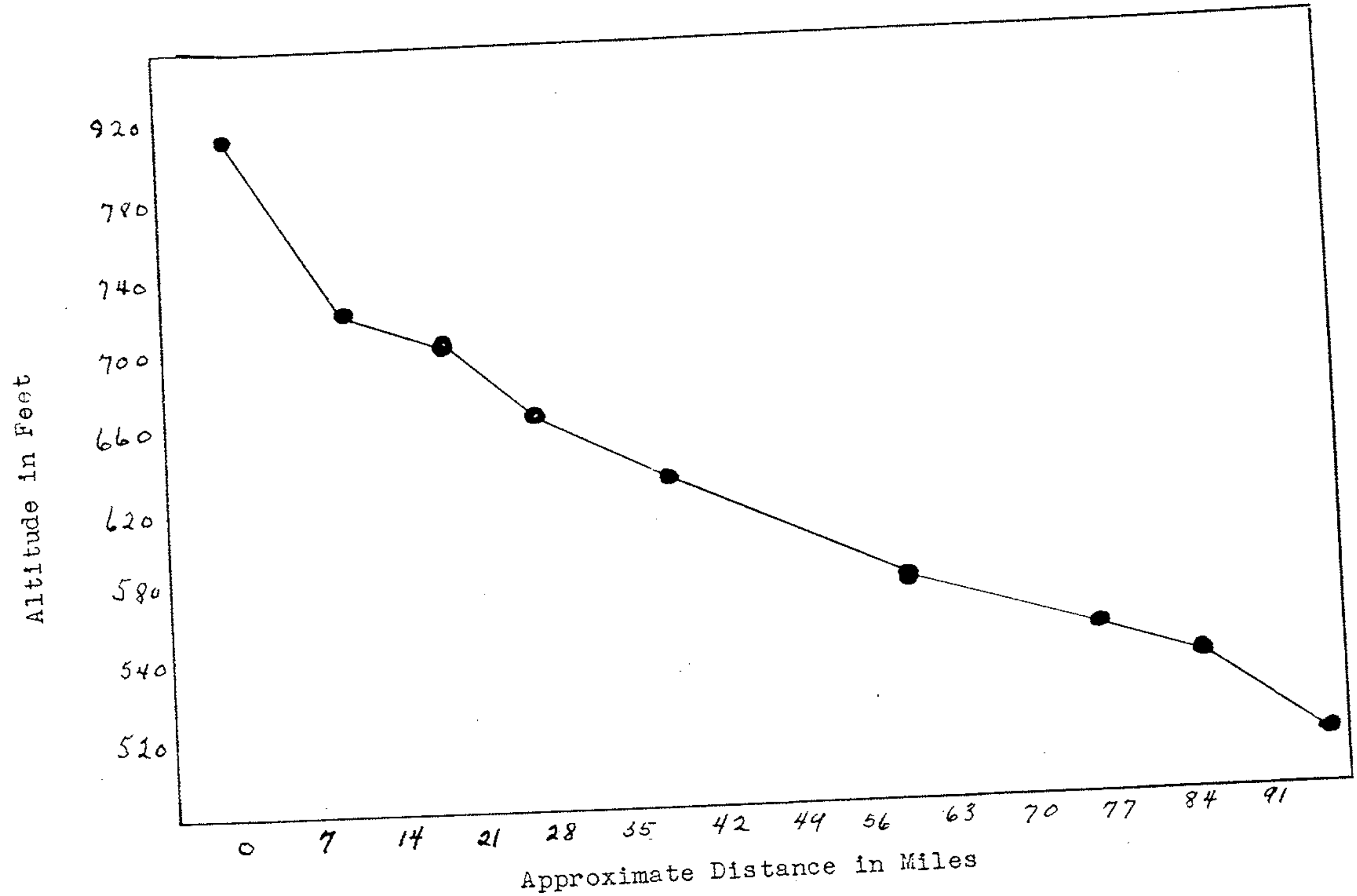
Profile of Russell Fork



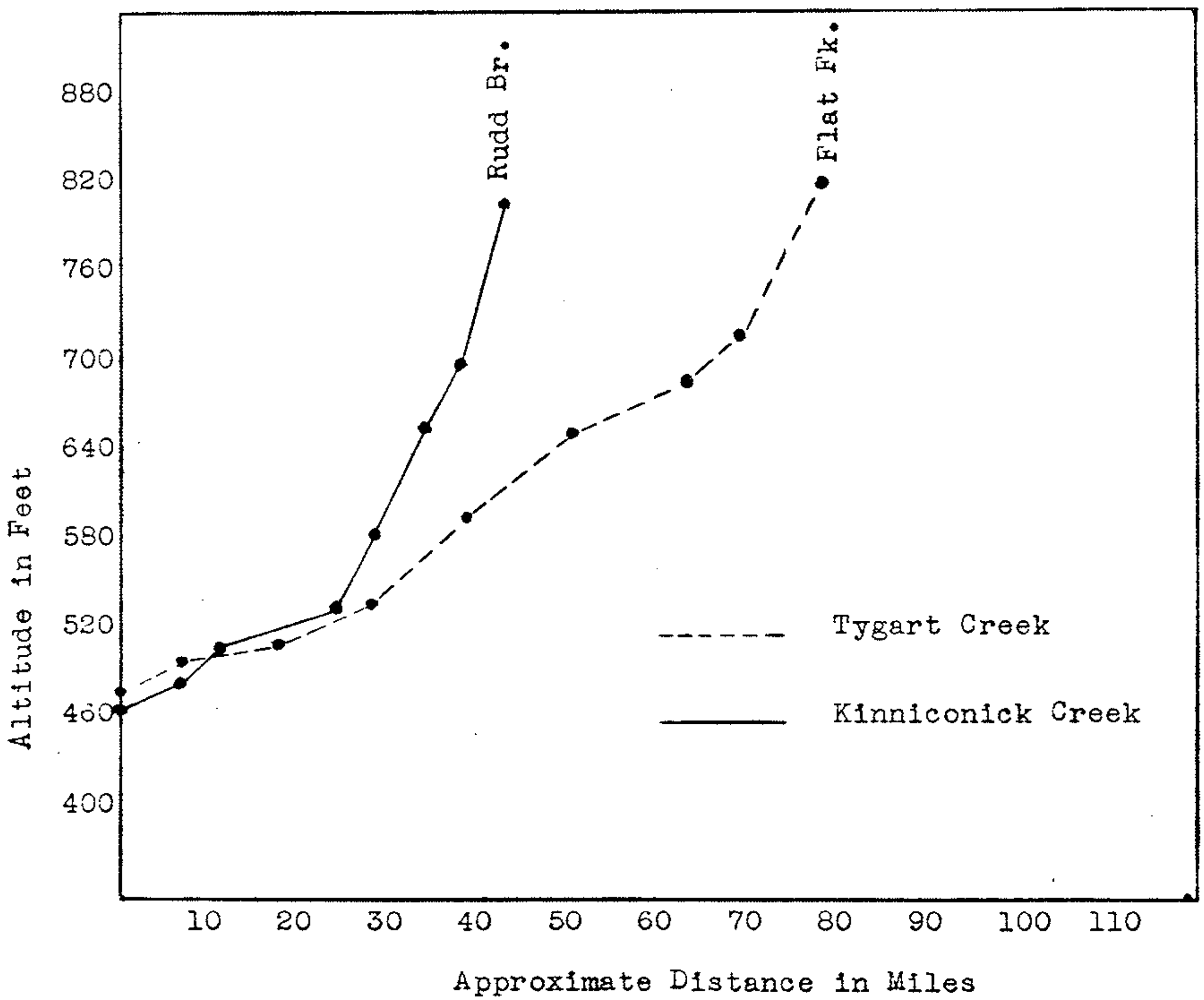
Profile of Russell Fork



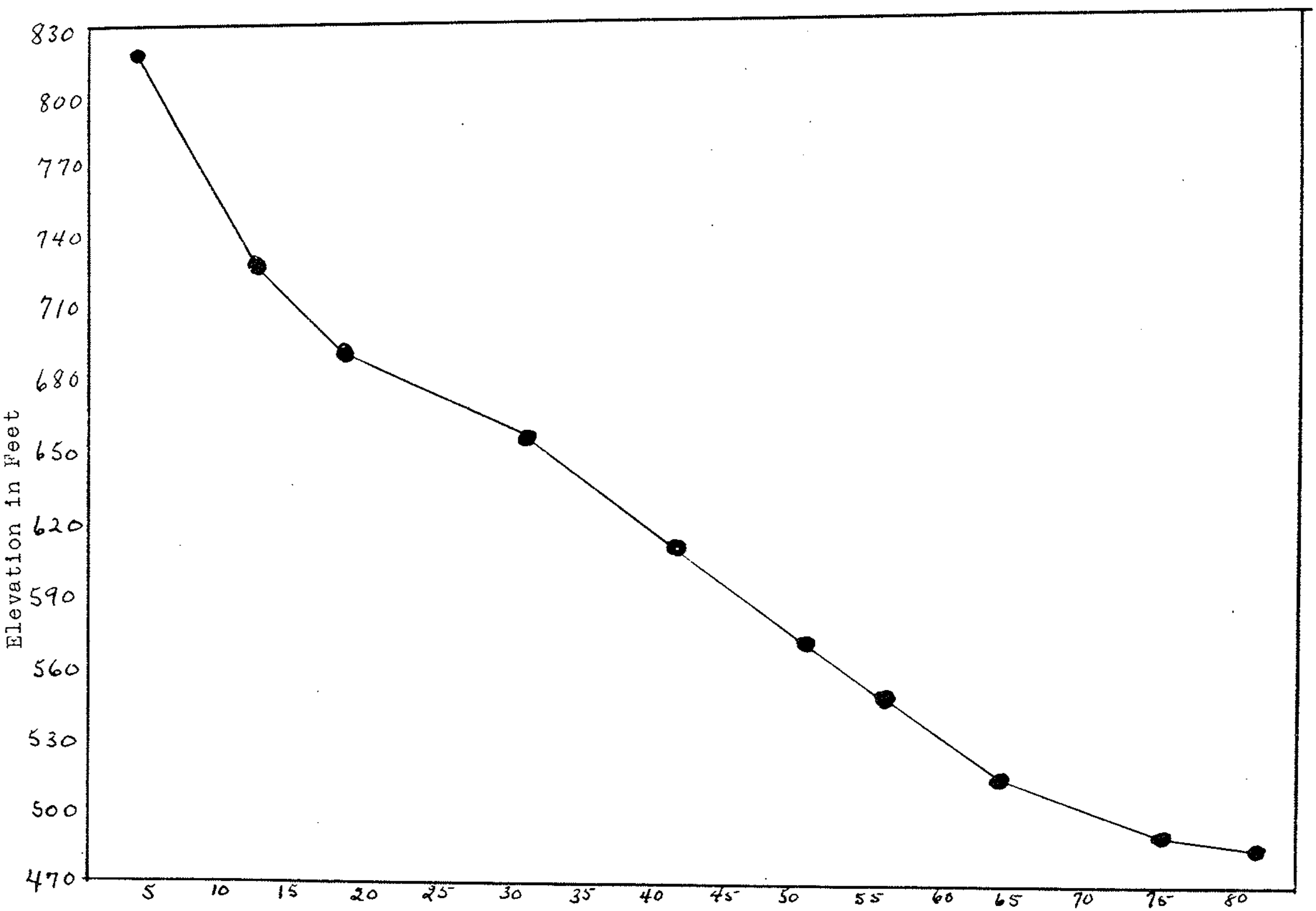
Profile of Tug Fork



A Comparative Study of Stream Profiles

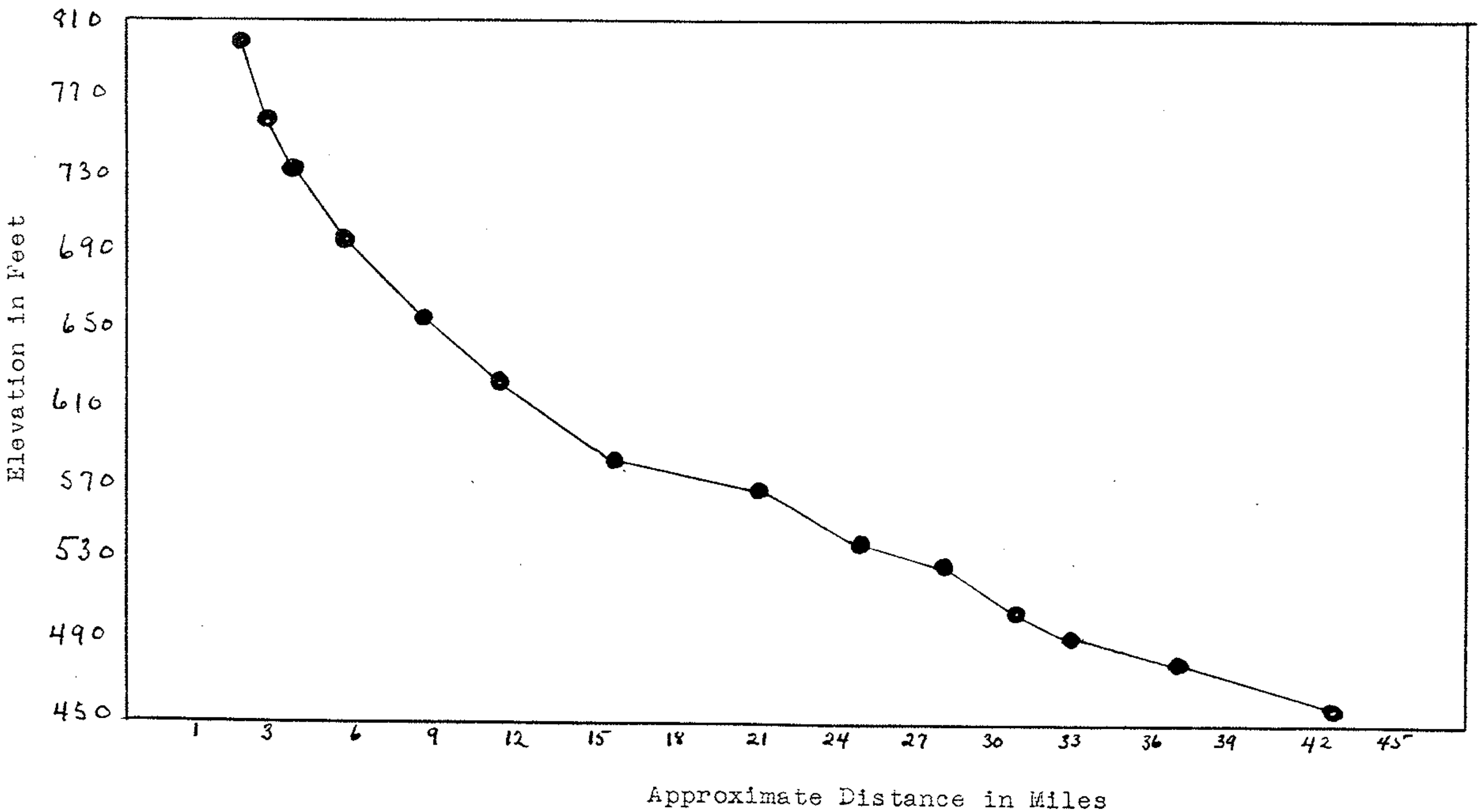


Profile of Tygart Creek



Appro: ate Distance in Miles

Profile of Kinniconick Creek



POLLUTION

Pollution

To many of our citizens the growing menace of polluted streams to the public health and the propagation of fish in our streams is scarcely realized. In many cases, it is only after large numbers of fish have been killed or severe epidemics have occurred that the public is aroused to action.

About the middle of the nineteenth century the water carriage system of sewage-disposal was adopted with the idea in mind that a stream will "purify" itself. This system is still in use by all the towns found in the basins under discussion.

It is known by the best authorities that a given stream does not undergo a complete self-purification process but rather, partly a process of dilution. Thus, when several cities are located on the same stream, and all are using it as a means of sewage disposal, the process is no longer one of dilution but rather one of concentration. As it is with other organic matter, part of the sewage has a natural tendency to disappear. The carbon is converted into carbonic acid, the nitrogen into nitric acid, etc., with a residuum remaining. Not only are undesirable materials added to the water then, but oxygen is removed, removed in two ways. First, in the process of decomposition, oxygen is removed by the chemical reaction; and second, the escaping gases formed in the reaction catch and carry oxygen in their travel to the surface where it is lost.

Pikeville, Prestonsburg, towns located on Beaver Creek, Paintsville, and Louisa all turn their sewage into the river, as does Olive Hill on Tygart Creek. This sewage is a most complex mixture of excremental matters and other filth dissolved or suspended in the water.

Sewage containing living organisms, such as anaerobic bacteria, is transported down stream constantly to a distance depending upon the rate of flow. During the warmer months, when the stream flow is reduced, the organic debris from the towns mentioned above, and others on the watershed, accumulates below each point of entry at a distance depending upon the carrying capacity of the water. After a hard rain this accumulation is then washed down stream causing the dissolved oxygen content to be lowered, in some instances to a level, killing certain species of the

Catostomidae, and in some cases all other fishes as well, and destroying the nests of other species. It is now known that a single municipality may seriously affect fish life for a distance down stream as much as seventy-five miles.

Water tested from the river just above Prestonsburg contained 7.1 p.p.m. of dissolved oxygen and had a saturation of 78 pescent. Water taken from underneath the bridge on road 23 below Prestonsburg contained only 5.2 p.p.m. of oxygen and a saturation of 57 pe#cent. The temperature of the water as shown in the tables was 70° Fahrenheit. During mid-summer, when the temperature of the water is increased by 10 or 15 degrees, the dissolved oxygen present in the water is so lowered that fish are either driven down stream to a point where the oxygen level is high enough to meet their needs; or if they remain many die.

From Shelbiana on down the river to Louisa, more fish and spawn are destroyed annually by polluted waters than are taken illegally by the dynamiter, the seiner, and other unlawful meaas. This is true, too, for Tug Fork and even to a much greated extent than for Levisa Fork. On Paint Creek in Johnson County, the pipe lines carrying oil break occasionally, destroying all fish in the creek and for several miles in the river. Thus if a break occurs only onse in two or three years, and the writer was told that it occurs more often, fishing can never be improved in that region under such condition. Moreover, when the water does offer a fovorable environment, fishes migrate into the region only to be killed when the first break occurs. Thus the stock above and below the polluted area is depleted. In the lower section of Paint Creek a large amount of Paintsville sewage is emptied. A Sample of water taken from the mouth of this creek showed 2.1 parts per million of dissolved oxygen at a temperature of 56° Fahrenheit. It is into this same section of the creek that garages throw a large part of their used motor oil and people of the town discard trash. From here it is washed into the river.

In all of the largest towns on the Big Sandy, the writer has seen people carrying their garbage to "the bridge" where it is cast into the river, which seems to be regarded as the open sewer. In Pikeville, after observing such occurrences several times, the writer stood at the Williamson road bridge for an hour observing the amount of trash being empties into the river, First a load of paper boxes and paper arrived and was thrown in; second, a wheelbarrow load of tin cans; and third, two women carrying a tub of trash collected froma dooryard added their contribution to the river.

Located at Boldman on Levisa, on Middle Creek near Prestonsburg, ~~and~~ on Threemile Creek near Louisa, and on Right Beaver Creek Creek near Alphoretta are natural gas pump stations. At a number of times when the various streams were visited below each station, oil was found on the surface of the water. A few dead fish were found below the stations at Boldman and Alphoretta, and undoubtely some may be found below the other stations from time to time. Two stations are found on Tug Fork on the West Virginia side of the river. One is located at Kermit and the other just above Fort Gay. Only a trace of oil was found on the water below these last two stations. It was reported that many fish have died in Levisa around the mouth of Threemile Creek and that fish taken below all of the above stations taste of oil.

Also frpm the stations a steady flow of hot water is emptied into the stream. Water form the Boldman station has a lower temperature than any other. One half mile below the pump station near Alphoretta, the temperature of the water was 96° F.

At Pikeville the laundry turns its wastes directly into the river causing a further depletion of dissolved oxygen and the bottom of the stream to be covered with much lint.

Streams of this basin are also polluted by sawdust. Either it is dumped directly into the water, or placed so near the stream that rain leaches out harmful substances over the bank. Examples of these two conditions: a mill on Raccoon Creek near Zebulon disposes of its sawdust into the stream; another located on Elkhorn Creek, one-half mile above the Fish Ponds, piles its waste well back from the banks but on a slope, so that the harmful materials still reaches the stream. Unless this latter condition is corrected, the Fish Ponds themselves may suffer seriously from the pollution, since water is obtained from the creek to suppley the ponds.

Figure 5

Big Creek Near Suckey Br.

Showing sawdust placed on the stream's bank so that it may be carried away in times of high water.

As a whole, the streams in the antire drainage area suffer very little from this type of pollution as compared with other sources.

Due to the mining of ceal many fish have been killed in the various streams and in a few cases not even one species was tobe found. At the present time the United States Public Health Service is active in sealing abandoned mines and controlling the out-flow from active ones. There are about 130 railroad and wagon and truck mines in the Levisa region besides the more numerous private ones which a proprietor may operate for his own use. Although there is much coal mining done inthis fork of the Big Sandy, Levisa does not suffer the effectes of the pollution as does Tug Fork. As stated under the discussion of Tug Frok, the water in this stream remains black most of the time due to coal washing in West Virginia. Little is known about this type of pollution or its effectes on fish life. PLankton counts for the entire stream were very low indicating that food conditions are bad in this stream. Whether this is solely the result of the coal dust present in the water cannot yet be stated. However, it is known that the roily condition of the cuts off light from the plankton and thus limits its growth. This may or may not be the entire cause of the lack of plankton. This problem should be worked out as the washing of coal, causing coal dust in many of our streams, is undoubtedly destroying many fish and keeping others from developing,. This is not a problem that could be solved in a week or ten days but would require, most likely, an entire season or even longer.

On Steele Creek, a branch of Right Beaver, the Big Elkhorn Coal Company is allowing water from the mines to drain to the creek. Below the point of entrance of the mine water in Steele, and for two miles in Right Beaver below the mouth of Steele, no fish life was found on the day of the survey in 1937. In the summer of 1938 the mines began washing coal. This water, containing the suspemded coal dust, is allowed ro enter Steel Creek. The drainage from these mines gives Beaver Creek a black color for the rest of its length, and also casues the water in Levisa to have a considerably darker color as far below the mouth of Beaver as Prestonsburg. No dead fish were found at the time this condition was investigated by the writer nor was it reported that any died as result of this pollution. It is difficult to say, as stated above, just how detrimential this type of pollution is to fish life in Beaver. Many different harmful affects are to be expected. Just what concentration in the most harmful, and what affects the different amounts of coal dust has on fish life, can not be stated. It is certain that at least some fishes are able to tolerate this condition to an extent and at least for a limited time, since the creek chub was seen. But as to whether suspended coal dust interferes with spawning and to what extent, whether it affects certain families of fishes more than others, can not definitely be said here. It is known that coal dust affects respiration even causing asphyxiation at times.

On Middle Creek, water from an abandoned mine sends to total acidity present to 47 parts per million and on Tom's Creek, water from the North Eastern Coal Company caused a total acidity of 65 p.p.m. No fish were found in either creek below the point of entrance of the mine water.

Marrowbone Creek, on which are located several large mines, had a total acidity of 10 p.p.m. This percentage of acidity had no effect on Semotilus atromaculatus at least, because more were seen in this creek than any other of its size whith all of their Cyprinidae.

Kinniconick Creek receives very little pollution, as no town of any size is found in its basin. Tygart is polluted from the town of Olive Hill.

Location and Types of Pollution

Type of Pollution	Location	Water Polluted
Sewage	Elkhorn City	Russell Fork
Sawdust	Elkhorn Creek above Pikeville Fish Ponds.	Elkhorn Creek
Sawdust	Grapevine Cr., near mouth of.	Grapevine and Levisa Fork
Mine Water	Shelby Cr. near Penny Sta.	Shelby Cr.
Sewage	Pikeville	Levisa
Oil	Boldman	Levisa
Sewage	Prestonsburg	Levisa
Mine Water and Coal Dust	Steele Cr. of Rt.Beaver.	Beaver Cr.
Oil and Hot Water	Beaver Cr. near Alphoretta	Beaver
Sewage	Martin	Beaver
Oil,and Hot Water	Middle Cr., central section of.	Middle Cr.
Mine Water	Lower section of Middle Cr.	Middle Cr.
Sewage	Paintsville	Paint Cr. and Levisa
Oil	Any section of Paint Cr.(Caused by break in pipe line.)	Paint Cr. and Levisa
Mine Water	Muddy Br. , lower section	Muddy Br. at Thealka and Levisa
Mine water	Milo, Ky	Toms Creek

Location and Types of Pollution

Type of Pollution	Location	Water Polluted
Mine Water	Torchlight	Levisa
Oil	Threemile Cr.	Threemile and Levisa
Sewage	Louisa	Levisa and Big Sandy
Coal Dust	Tug River. From coal washing in West Virginia.	Tug Fork
Mine Water	Just above Sugarcamp Br.	Tug Fork
Mine Water	Tug Fk. near Coon Br.	Tug Fk.
Mine Water	Ky. side near Matewan, W. Va.	Tug River
Sewage	Williamson	Tug
Sewage	McVeigh, Pinson, and Stone.	Pond Creek
Mine Water	Shop Hollow	Pond Creek
Mine Water	Three mines in head of Turkey Cr.	Turkey Cr.
Mine Water	Borderland Br.	Borderland Br. and Tug
Mine Water	Chatin Br.	Big Creek
Sawdust	Near Suckey Br.	Big Cr.
Sawdust	Just below Dicks Fk.	Big Cr.
Sawdust	At mouth of Pigeonroost	Wolf Creek
Oil	Kermit, W.Va	Tug Fk.

Location and Types of Pollution

Type of Pollution	Location	Water Polluted
Mine Water	Ky Side at Kermit, W. Va.	Tug Fk.
Mine Water	Buch near Warfield	Buck Cr. and Tug Fk.
Sawdust	Setser Br.	Middle Fk. of Rockcastle
Mine Water	Upper Twin Br.	" " " "
Sawdust	Blacklog Fk	Coldwater " "
Sewage	Inez	Rockcastle
Sawdust	Rockcastle Cr. Near Preston Br.	"
Oil and Salt Water	Over the entire part of the main creek.	Blaine Creek
Oil and Salt Water	Twomile Cr.	" "
awdust.	Busseyville	" "
"	Rt. Fk. above Adams	" "
il	Refinery below Clifford	Tug Fork
il	" above Catlettsburg	Big Sandy
ine Water	Branck near Yatesville	Blaine Cr.
ine Water	Branch near Cadmus	Cat Creek
ime Water	Lawton	Soldier Fk. of Tygart Cr.
ewage	Olive Hill	Tygart Cr.

Location and Types of Pollution

Type of Polltion	Location	Water Polluted
Sewage and Oil	Perry Br.	Tygart Cr.
Sawdust	Above Blacklick Br.	Kinniconick
"	At Laurel Point	Laurel Creek
"	At Stagg Br.	Grassy Cr. of Laurel
"	Weed Br.	Grassy Cr.
"	Town Br. Lower Section	Kinniconick

Fishes of Big Sandy, Tygart, Kinniconick Creek and Their Tributaries

The Fishes

As a aprt of the Biological Survey program, fishes fromthe drainage areas covered were collected and s studied. All collections and identifications were made by the writer. Dr. Carl. L. Hubbs, University of Michigan, checked my work in some cases concerning closely related species.

Sô far very little is known about our fish life in Kentucky. In 1918 "The Fishes of Kentucky and Tennessee", by Barton Warren Evermann was issued by the Bureau of Fisheries. This paper is a summary of all work on fishes from Kentucky. From this paper we find that the first man to collect and study the fishes of Kentucky was Constantine Rafinesque who at the time - 1818 to 1825 - was professor of botany and natural history in Transylvania University.

David Starr Jordan, in the summer of 1876, began his collecting trips into Kentucky and surrounding states. In the summer of 1878 Jordan, Evermann, Brayton, and Charles Gilbert led a part of students on a walking trip through eastern Kentucky, during which the fishes of the region received much study. In May of 1883 Jordan, assisted by Joseph Swain, made collections from the streams of Whitley County. In 1889 Philip H. Kirsch collected fishes in the streams of Clinton County. In 1891 kirsch again collected from the southerntributaries of the Cumberland. In 1890 Albert Woolman examined several streams in the interest of the United States Fish Commission.

From 1898 until the present time, little ichthyological work if a faunistic character has been done in Kentucky. Dr. L. Y. Lancaster, Western State College, has made collections from the streams and caves around Bowling Green. Graduate students of the University of Kentucky have also made collections from creeks around or near Lexington.

My collections were all made by means of a minnow seine. A record was kept of the locality of collection as well as of the ecological data. In the present paper no lèngthy discussion is given for any one species nor is any key for identification given. It was thought best to withhold this material until more terrotiry has been studied and then publish all of it as the subject of a more or less complete report.

In the list of fishes given, only one common name for each species has been included,since it would be almost impossible to give all the names assigned to any one fish by the fisherman of Kentucky. Fishermen from different sections have many different names for the same fish and alist of all names would also be subject for the lengthier report. The one name given however is that most often used.

Family Lepisosteidae, The Gars

1. <u>Lepisosteus</u> <u>osseus</u> (Linnaeus): Long-nosed Gar

The garpike is a voracious, active, and well-protected fish which is the enemy of practically all other fishes in our waters. It eats very little but fishes, subtracting from the food supply of the more valuable species. The gar frequents quiet waters where they often lie motionless on the surface basking in the sun.

T his species spawns from the first of May to the middle of June among grass and weeds of shoal water.

Gars are of very little commercial value. A few skins are saved yearly for covering purses, etc. This fish is well distributed over the three watersheds.

Family Hiodontidae, The Mooneyes

2. <u>Amphiodon</u> <u>Alosoides</u> (Rafinesque): Northern Mooneye

This fish is rare in Kentucky but common northward. The one specimen obtained was taken from Blaine Creek at Fallsburg. This fish is said to be caught readily by minnow bait where they are present in a stream. It lives mostly on minnows, insects, and mollusks.

Family Dorosomidae Gizzard Shad

3. <u>Dorosoma</u> <u>cepedianum</u> (LeSueur): Hickory Shad

The greatest value of this species is that it furnishes an abundance of food for better fishes. This is an active fish, When surrounded by a seine, the writer has seen this species actually jump or dart out on the bank.

Taken in my collection from these watersheds only in Beaver Creek just above Martin.

Family Anguillidae, The True Eels

4. Anguilla rostrata (LeSueur): American Eel

The eel is among the most voracious of fishes, but are chiefly scavengers in their feeding habits. For many years the spawning habits of this fish remained a secret until it was discovered that all eels migrate to the sea near the West Indies to spawn. Only the young return to fresh water as the old members die.

The females are larger than the males, paler in color, and have smaller eyes and higher fins. Eels reach a length of 40 inches and a weight of 7 pounds. They are often taken on hook and line in all three watersheds.

Family Catostomidae, The Suckers, etc.

5. Ictiobus bubalus (Rafinesque) : Small Mouth Buffalo

This fish has a strong preference for flowing streams of deep water. About 75 percent of the food of this species is said to be animal, which consists mostly of mollusks, insects, and crustacea.

The buffalo reaches a weight of 40 pounds but is of little food value as the meat is filled with many fine bones. Specimen taken in Russell Fork at Elkhorn City.

6. Carpiodes difformis (Cope): River Carp

Common in the smaller rivers. This sucker is of small size and of little value as food. Taken by Woolman, 1892, near mouth of Big Sandy. Not in our collection.

7. Carpiodes velifer (Rafinesque): Quillback

This species ascends small streams in spring where they spawn. Not of this collection. Taken by Woolman, 1892, in Levisa near Pikeville, John and Raccoon Creeks near Zebulon.

8. Catostomus commersonnii commersonnii (Lacépède): Common white sucker

Our most common sucker with the one exception, Hypentelium Nigricans. It bites rather freely at small baited hooks. In April and May the fish spawns in riffle or swift-flowing water areas. Though bony this fish, which may reach a weight of 5 pounds, has a sweet and firm flesh and is readily eaten in many sections.

9. Hypentelium nigricans (LeSueur): Hog molly

One of the most common fishes over the entire three watersheds. This fish is seldom seen swimming about because for a large part of the time it rests motionless on the bottom half hidden in sand, among rocks, or under a leaf. When disturbed, it darts away for a short distance to settle to the bottom and to hide itself once more. So close does this fish nestle to the bottom and in stones that it is not easily seen even in shallow clear water because of its mottled coloration.

10. Moxostoma duquesnii duquesnii (LeSueur): Black Mullet

The status of this species and the next are indicated in Hubbs 1930 review of the suckers. My specimens were taken in Threemile Creek near Louisa and Levisa Fork near Pikeville.

11. Moxostoma erythrurum (Rafinesque): Golden Mullet

This species is fairly common over the watershed. It seems to avoid a muddy bottom and to show a preference for swift water. The golden mullet succumbs to impure conditions readily, sometimes perishing in vast numbers. It enters the smaller streams in April and May to spawn.

12. Moxostoma anisurum (Rafinesque): Silver Mullet

This species is not so common in the sections studied. It was taken only from Elkhorn Cr. of Russell Fk. Soon after the last ice, this fish runs upstream to spawn.

Family Cyprinidae, The Minnows

13. *Chrosomus erythrogaster* (Rafinesque): Red-bellied minnow

This is one of the most beautiful of all our fishes. Taken only once from Big Sandy watershed and that in Threemile Creek in Lawrence County; however, it is relatively abundant in the smaller branches of Tygart, and Kinniconick. It lives to a great degree on vegetable matter and hence serves as an excellent forage fish.

In breeding males the abdomen is a bright red and the fins are highly colored. However, specimens as brightly colored have been taken in October and November by the writer as any of those taken during the breeding season. This fish seems to prefer clear cool gravel bottom streams, but a few collections were made from bottoms of mud.

14. *Clinostomus vandoisulus* (Valenciennes): Rosy dace

The minnow was found to occur in much the same locality as *C. erythrogaster*.

15. *Semotilus atromaculatus atromaculatus* (Mitchill): Creek Chub

This fish which is the largest of our minnows, spawns on a bottom of coarse gravel where a nest is constructed of cleaned gravel made in a conspicuous ridge about 12 inches wide and from 1 to 15 feet long. The building of the nest and the guarding of the of the eggs is all done by the male, who drives away other fishes as they approach.

This species is abundant over the three watersheds where it is sought by fishermen for bait.

16. Rhinichthys atratulus obtusus (Agassiz) Southern Black-nosed dace.

This species is usually found near the headwater regions. It was more common in Tygart and Kinniconick than in the Big Sandy.

17. Hybognathus nuchalis (Agassiz); Smelt Minnow

Taken from the mouth of the Big Sandy by Gilbert and Henshall, 1888. Not of our collection.

18. Extrarius aestivalis hyostomus (Gilbert): Ohio Speckled Chub

A comparatively rare fish which was taken only twice in Johns Creek, twice in Tygart, and once in Wolf Creek near Lovely. This fish from my five collections seems to prefer sandy bottoms near the mouth of good sized creeks.

19. Erimystax watauga (Jordan & Everman): Watauga Chub

A rare form taken only in Levisa Fork near the mouth of Big Creek.

20. Nocomis micropogon (Cope): River Chub

In my collections this is a swift water species preferring a hard bottom. It was collected in Paint Creek and Johns Creek of Levisa Fork; Laurel, Grassy, and main Kinniconick Creeks; Buffalo of Tygart and from Knox Creek of Tug Fork. It is one of the most active of its tribe and will bite at small hooks baited with white grub. This species makes an excellent bait for fishermen where it is found in abundance.

21. Notropis atherinoides delectus (Girard) Southern Emerald Shiner

Common is the clear waters of the three watersheds. This species seems to move and feed in large schools which can easily be observed, since they tend to stay near the surface in still water.

22. Notropis rubellus (Agassiz): Rosy-faced shiner

This species is very closely related to the above. It is not common in the Big Sandy or in Kinniconick and is absent from the collection of Tygart.

23. Notropis photogenis (Cope): Silver Shiner

Another minnow closely related to N. atherinoides and N. rubellus which are found under much the same conditions as these two, as shown by my data. While not common, it is found in all three of the water sheds.

24. Notropis cornutus chrysocephalus (rafinesque): Central Common Shiner

In the waters of this report this species was found to be present in practically every stream both large and small, constituting a bait and forage fish resource of considerable value. It is recommended by many fishermen as the best live bait for black bass though I would differ with these men on that subject.

This species begins spawning at the last of April and continues to the last of June. As it is apt to feed on most anything the shiner is often seen on the string of the young fishermen. It is of little importance as pan-fish however, since it does not exceed a length of 8 inches, usually much less.

25. Notropis spilopterus (Cope): Spot-finned shiner

According to a recent study by Dr. Hubbs, this and N. whipplii are to be regarded as distinct species. The two species were found together in my collections without intergradation.

26. Notropis whipplii (Girard): Steel-colored Shiner

This fish has a wide occurrence over the three drainage areas but it is not as abundant as N. cornutus. Specimens were collected more often in clear streams in the swift waters just below the riffle.

Small nuptial tubercles are present on breeding males. However, this character was observed on some of the males of this species as late as the middle of November. The spawning season is said to extend from the middle of May to the first part of July.

27. Notropis deliciosus stramineus (Cope): northern Sand Shiner

Common in most streams of the three watershed, being most abundant in branches of Tygart and Kinniconick.

28. Notropis volucellus volucellus (Cope): Mimic Shiner

Not at all common. Found in Georges Creek, 1 mile above the mouth; Levisa Fork near Pikeville; Kinniconick at Hamilton Br; Bear Cr., near mouth, Lawrence County and in Knox Cr. at Turkey Fk.

29. Notropis umbratilis umbratilis (Girard):

Rare, taken only once and that from Blaine Creek near Prosperity, Ky.

30. Notropis boops (Gilbert): Bull-eyed Minnow

Taken in Laurel Creek at Scotts Br. and in Briery Creek near mouth; tributaries of Kinniconick. Collected from clear cool water with a bottom of gravel.

31 Notropis ardens lythrurus (Jordon)

Distributed over the watershed of Tygart and Kinniconick Creeks

32. *Notropis coccogenis* (Cope)

A brilliant fish, resembling *Clinostomus*. Robinson Cr. near Robinson, Ky. Collected by Woolman, 1892. Not of this collection.

33. *Notropis ariommus* (Cope)

Levisa Fork near Pikeville, Woolman, 1892. Not of this collection.

34. *Notropis jejunus* (Forbes)

From the mouth of Big Sandy. Gilbert & Henshall, 1888; Woolman, 1892. Not of this collection.

35. *Ericymba buccata* (Cope): Silver-jawed Minnow

This fish is easily recognized by the peculiar tubular cavities in the bones of the side of the head and the lower jaw. It is one of the most abundant fishes of all three watersheds where it shows a preference for the smaller streams. In my collections the species was equally well distributed in streams with a mud bottom as in those of a sand or gravel. When the fish is present in a given stream, it usually is found in great numbers.

Females in near-spawning condition were taken by me from the middle of May up to the latter part of June.

36. *Hybopsis amblops amblops* (Rafinesque) Big-eyed Chub

A relatively common fish of the three watersheds.

37. Hybopsis storerianus (Kirtland)

Taken from near the mouth of Tygart Creek in two collections from a sand and mud bottom.

38. Ceratichthys vigilax taurocephalus (Hay) Fathead Minnow

Taken only from Tygart Creek, three miles above the mouth. Bottom was of mud.

39. Hyborhynchus notatus (Rafinesque): Blunt-nosed Minnow

A widely distributed minnow of the three watersheds though not abundant. It is well known to the fishermen, as this and the creek chub, Semotilus atromaculatus, are the most common minnows used for bass fishing. The minnow lives well on a hook.

It spawns from May to the middle of June, the eggs being placed on the flat lower surface of submerged objects near a bottom of sand and gravel.

40. Campostoma anomalum (Rafinesque) Stone Roller

This fish can easily be separated from all other Kentucky forms by the fact that the very long intestine is spirally wound around the air bladder. Fishermen often place this minnow in the sucker family because of its sucker-liker mouth. It lives near the bottom in the more shallow places where it picks up its food from the rocks of the stream. It is a desirable forage fish in that it offers little or no competition with the young of game fishes since its food consists mostly of microscopic plants.

This species is abundant in all streams of the three basins.

Family Ameiuridae, The Cat Fishes

41. Ameiurus natalis (LeSueur): Yellow cat

This species was taken only once, and that from Mudlick Creek of Levisa Fork just above the falls. The species is said to have a strong preference for a mud bottom of creeks. It is of small size never exceeding a weight of 2 pounds.

42. Ameiurus nebulosus (LeSueur): Common Bullhead

This species was taken only once, and that from Tygart Creek near Red Hot. It can live where a few others can survive, for when the dissolved oxygen content is past the point of supporting life in other fishes, it can come to the surface and renew the air in its swim bladder. The fish is able to live in dried out pools for some days by burying itself in the mud.

It reaches a length of 16 to 18 inches. Spawning occurs in the spring, the nest being found in shallow water with a sandy bottom.

43. *Ameiurus melas melas* (Rafinosque): Northern Blask Bullhead

This is the abundant catfish of the three watersheds. From my data the species seems to prefer the still and muddier parts of the larger creeks, but is often taken from the main stream. It is a small form rarely exceeding a length of 12 inches.

44. *Schilbeodes miurus* (Jordan): Brindled Madtom

Although said to prefer a swift current my three collections were from the more quiet part of the stream. It was taken in Paint Creek at the mouth of Jenny, Johnson County; Three Prong Fork near mouth at Kehoe, Ky.; near the mouth of Laurel Creek of Kinniconick. All were collected from a sand bottom.

The species has a poison gland beneath the epidermis surrounding base of the pectoral spine. With this spine a painful wound can be inflicted which may cause swelling and pain that will last for a day or so. Ths fish is of a small size, the largest specimen in my collection being only an inch and half long.

Family, Esocidae, The Pikes, etc.

45. *Esox vermiculatus* (LeSueur): Little Pickerel

This species was collected in the smaller tributaries of Kinniconick and Tygart Creek from quiet waters. It is of a small size, never exceeding a length of twelve inches nor weighing more than a pound. It feeds entirely on animals and is just as voracious as the muskallunge.

46. Esox masquinongy ohiensis (Kirtland): Muskallunge

A destrubtive fish which has been reported to reach a weight of 80 pounds and a length of 6 feet in other states. It is frequently caught in Kinniconick and is present in Tygart Creek. Thoreau said that the Pike is a "solemn, stately ruminant fish, lurkind under the shadow of a lily pad at noon, with still, circumspect, voracious eye, motionless as a jewel set in water, or moving slowly along to take up its position; darting from time to time at such unlucky fish or frog or insect as comes within its range and swallowing it at a gulp. Sometimes a striped snake, bound for greener meadows across the stream, ends its undulatory progress in the same receptacle".

Family Percopsidae, Trout-Perch

47. Percopsis omiscomaycus (Walbaum) Trout Perch

This species which was only taken from Upper White-Oak Creek of Tygart is characterized by the presence of the adipose fin of the salmon in connection with the mouth, scales, and fin-spines of a perch. It abounds in the Great Lakes, southern Canada, and is rarely taken as far south as Kentucky. Jordan has said that this fish would seem to find its place in Cretaceous rocks rather than in the waters of to-day.

Family Percidae, The Perches

48. Stizostedion vitreum (Mitchill): Jack Salmon

This is a piscivorous fish which inhabits clear swift water. It is a swift and vigorous swimmer, being able to overtake the bass. An enormous number of fish are required to feed this species, the hickory shad being about the only member able to meet the tremendous demands.

It reaches a length of three feet and a weight of twenty pounds or more. It spawns in early spring and before the young are 15 days old they begin to eat each other. This species should never be used for s tocking purposes unless a clear river can be found which contains an abundance of otherwise useless fish to serve as food.

The Jack Salmon was found in upper Levisa Fork and in Kinniconick Creek.

49. Cynoperca canadensis (Smith) Sand Pike

A smaller fish than the Jack Salmon which seldom exceeds a length of 12 inches. Its habits are similar to the above species. Not of our collection. Taken by Gilbert and Henshall, 1888; Woolman, 1892, from the Big Sandy River.

Family Etheostomidae, The Darters

51. _Percina caprodes caprodes_ (Rafinesque): Ohio Log-perch

A beautiful darter which occurs in my collection from the shallow water just above the riffle. While it was found in the streams of the Big Sandy it is not common as it is in Kinniconick or Tygart Creeks.

52. _Hadropterus maculatus_ (Girard): Black-sided Darter

Another beautiful darter which is well suited to the aquarium. It prefers clear water and a bottom of gravel. Moderately common in all clear streams of the three watersheds.

53. Hadropterus phoxcephalus (Nelson)

Not of our collection. Taken by Woolman, 1892, from Levisa Fork near Pikeville.

54. _Hadropterus macrocephalus_ (Cope): Big-headed Darter

This fish was taken only once and that from the mouth of Laurel Creek in Kinniconick. Length of specimen 4 inches.

55. Ethoostoma blenniodes newmanii: (Agassiz): Southern Green-sided datter.

A very pretty species inhabiting the swift waters of the smaller streams as shown by my data. It is generally distributed throughout the three watersheds.

56. Boleosoma nigrum nigrum (Rafinesque) Southern Johnny Darter

One may expect to find this species in any branch of the three watersheds which contains water. It was taken by me as often in still water as in swift and from mud bottoms as often as from sand or gravel.

57. Ammocrypta pellucida (Baird): Northern Sand Darter

This peculiar species lives for a large part of its time in the sand with only its eyes showing. While collecting in shallow clear water it was noted that the approaching seine did not disturb this species, and that often the fish would allow the seine to pass over it as it buried itself further in the sand.

58. Ammocrypta clara (Jordan & Meek):

According to Dr. Hubbs A. clara and A. pellucida have until now been regarded as eastern and western subspecies but my discovery of the two living together indicates that they are full species. My one specimen was taken from near the mouth of Wolf Creek in Martin County.

59. Poecilichthys variatus (Kirtland): Variegated Darter

This interesting fish which is rare in most areas was found to be abundant in the waters of Tygart Creek. By far the larger number of this species was taken from the riffle area and only once from still water. None were obtained from Kinniconick, but one specimen each from Tug Fork in the mouth of Knox Creek and Levisa Fork at Mouthcard, Ky.

60. Poecilichthys zonalis zonalis (Cope): Northern Banded Darter

This species was taken as often from the shallow pool areas as from the riffle. It shows a preference for the smaller clear streams and places abundant in algae or waterweed. It was taken once from Levisa Fork near Big Creek, once from John Creek near Johns Creek Bridge, and was found to be abundant in Kinniconick and Tygart Creeks.

61. Poecilichthys caeruleus caeruleus (Storer) Northern Rainbow Darter

This brilliant darter is the most abundant member of its family found in the three drainage areas. It was found equally as often in swift water as in the more quiet places but it showed a strong preference for gravel or gravel and sand bottoms. It occurred much more often in the smaller tributaries than it did in the larger streams. Males in breeding color have been taken as late as September.

62. *Poecilichthys spectabilis spectabilis* (Agassiz)

This species which closely resembles *P. caeruleus* may be separated from it by the brownish lengthwise lines. It also differs in many other characteristics, but this one is the most easily recognized. It is abundant in Kinniconick and Tygart Creeks, the same localities as the rainbow darter.

63. *Catonotus flabellaris flabellaris* (Rafinesque): Barred Fan-tailed Darter

This darter has about as wide a distribution as does the rainbow but it is far less abundant.

Family Centrarchidae, The Sunfishes and Bassess

64. *Huro salmoides* (Lacepede) Large-mouthed Black Bass

The species is widely distributed throughout all streams of the three watersheds being found more often in Levisa Fork above Pikeville, in John Creek, Knox Creek of Tug Fork, Kinniconick and Tygart Creeks.

The bass produces an enormous number of eggs. From records of the Fish Commission of 1892, it is interesting to note the following: 15 adult bass were placed in one rearing pond at Washington, 7 or 8 of which were females. These fishes spawned in June and at Thanksgiving. When the young were removed, there were taken out, by actual count, over 37,000 young, each 3 to 4 inches long, and 500 each weighing about one-half pound. The 500 larger ones had doubtless eaten many smaller ones of their kind.

Color is a poor characteristic often used in distinguishing between this bass, the Kentucky, and the small mouth. Cuvier and Valenciennes called it black and Rafinesque called it pale. Color is of little value in distinguishing between any of our fishes, since the color varies with the loaation. The writer has in his collection of small mouth bass a fish which according to color would be called a large mouth by those unfamiliar with the main characteristics. Scale counts, maxillary measurements, fin counts, and examination of the pyloric caeca often have to be made before the species can definitely be determined.

This fish is somewhat less active than the small mouth and it prefers lakes, bayous, and the more sluggish waters.

65. Micropterus punctulatus punctulatus (Rafinesque)
Kentucky Bass

The young of this species is slender and more pike-like than other basses but is fully as robust when full grown. The dorsal is more deeply emarginate than in the small mouth, but not so much so as the large mouth. Its soft dorsal never contains more than 12 rays nor does the fish have more than 66 scales along its lateral line.

This bass was taken more often in my collections of the watersheds than was the large mouth.

66. Micropterus dolomieu (Lacepede) Small-mouthed Bass

The small mouth is a better game fish by far than the large mouth. It is unyielding to the last and some even consider him pound for pound the gamest fish that swims. It is by preference a fish of the clear running streams and clearer, colder lakes. However, it has a habit of making itself at home wherever placed and because of this, it has been successfully planted in many parts of the country.

A discussion of the spawning habits of these basses is not given since this is a familiar subject to most fishermen.

The small mouth reaches a weight of 5 or 6 pounds.

67. Lepomis cyanellus (Rafinesque): Green Sunfish

This sunfish is widely distributed over the three watersheds but it is not as abundant as the long-eared sunfish. The green sunfish is more often found in creeks and the smaller streams than in rivers or lakes. It grows to a length of about 7 inches and reaches a weight of 7 ounces. It takes a hook readily, making a vicious fight for liberty. Although small in size it is a choice pan-fish.

68. Lepomis incisor (Cuvier & Valenciennes): Bluegill

Taken only once and that from Kinniconick near Hamilton Branch. The fish is said to prefer the larger streams which may account for the fact that it was so rare in my collection.

This is the largest of the sunfishes, reaching a weight of about one pound and a length of 12 to 15 inches. The bluegill is very variable, but is usually known by the black dorsal spot which it shares with the green suhfish.

The bluegill moves in schools and may be caught with any kind of bait. The flesh is firm and flaky and there is no better pan-fish. This fish is known as the gamest of all fishes of its size.

69. Lepomis macrochirus (Rafinesque)

This fish which was only taken once from Big Creek and once from Wolf Creek is closely related to the bluegill from which it differs in having no black spot on dorsal or anal fin.

70. Lepomis megalotis megalotis (Rafinesque): Central long-cared Sunfish

This is one of the most brilliant of all our fishes.

It is found in the larger streams as well as the smaller of all three watersheds and it is the most abundant member of its family. The fish reaches a length of 7 inches and does not differ essentially from any of the other sunfishes. It is extremely variable in color and form.

71 Amblopites rupestris (Rafinesque) : Goggle-eye

A common familiar pan-fish which is found in rivers, creeks, and smaller streams where the water is clear and cool. It prefers the quiet water of deep holes where there are large boulders among which some water-plants are growing. It reaches a length of 12 inches and a weight of 1 and ½ pounds. It spawns on a gravel bed where the water is moderately swift.

When first caught, the fish puts up a vigorous fight which it usually fails to keep up.

72. Pomoxis annularis (Rafinesque): White Crappie

This species which is taken from the Big Sandy River near Louisa is a fish to be found in ponds and sluggish streams. It reaches a length of 12 to 15 inches and, when found in clear cool water, is an excellent pan-fish. The crappie is often confused with the calico bass but the two are easily separated by the fact that the crappie has only 6 dorsal spines.

The species spawns from the middle of April to the last of May.

Family Atherinidae, The Silversides

73. Labidesthes sicculus sicculus (Cope): Northern Brook Silverside

This delicate little fish which is common in the waters of Levisa above Pikeville was taken at only one other place and that in Kinniconick near Hamilton Br.

The slender body of the silverside, with the bright lateral band, and the two dorsals are the characters which readily distinguish this species from all other of our Kentucky fishes.

Family Cottidae, The Sculpins

74. Cottus bairdii bairdii (Girard): Northern muddler

This particular species seems to be rare in Kentucky since C.b. carolinae is the characteristic form in the state. This species inhabits the clear rocky branches of all the three watersheds but it is not at all common. This species occurred most often in the branches of Kinniconick.

CHEMICAL ANALYSES OF THE STREAMS OF THE THREE WATERSHEDS

The Percent of Saturation of Dissolved Oxygen

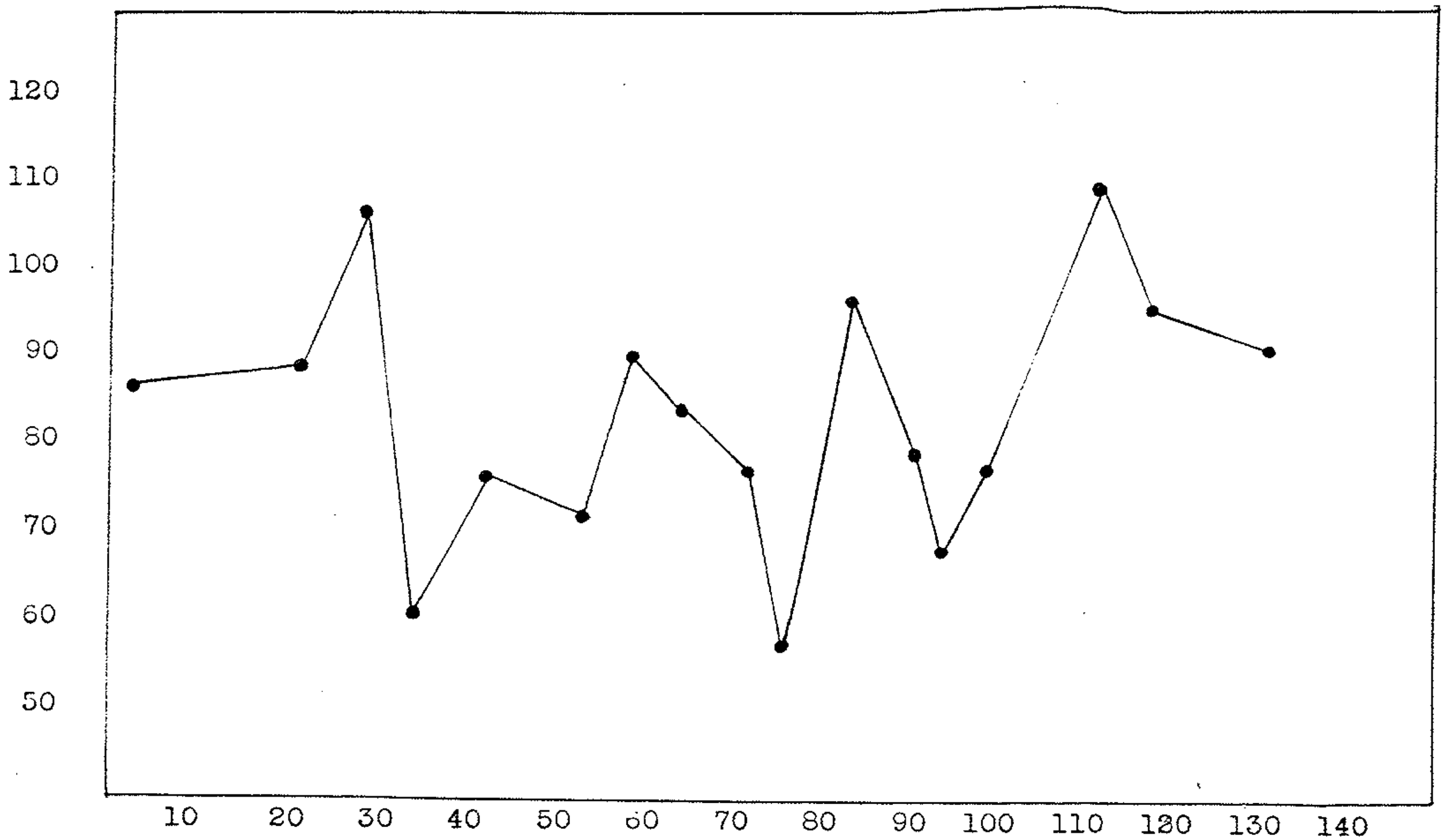
The amount of dissolved oxygen found in water is one of the controlling factors as to the species of fish that will be found in a given stream. Trout, small-mouthed bass, many of the darters, some of the minnows, such as Notropis whipplii, etc., prefer water that has a high oxygen content. As was stated earlier in this report, the dissolved oxygen content normally varies according to the following: (1) stream fall; (2) temperature; (3) oxygen produced by aquatic plants; (4) oxygen removed by aquatic plants and animals; and (5) the oxygen demand of organic detritus.

Long sluggish reaches of water contains less oxygen than the shorter pool, since water in passing over a riffle dissolves oxygen from the air. Any obstacle in a stream causes aeration of the water. Streams having a sharp descent have shorter pools and more riffles and a higher dissolved oxygen content. As water passes over riffles of rocks, gravel, sand, or any other obstacle that might be present, it is aerated. Futhermore, water wher-ever exposed to the air, is an absorber of oxygen up to a certain point depending on the temperature of the water. anyone who has heated water knows that as it becomes warmer, bubbles, dissolved oxygen, are given off and the hotter the water becomes the faster the bubbles rise to the surface. As the temperature increases in any body of water, oxygen is given off, thus lowering the amount of dissolved oxygen present. The colder the water remains, the more oxygen it is able to hold. Aquatic plants, such as algae, give off oxygen as a by-product as food is manufactured. At the same time, plants use oxygen in respiration, as do animals, and give off carbon dioxide. As all life in a body of water makes a demand on oxygen, the supply is continually being depleted. As a rule plants add much more oxygen to the water than they remove and it is only in rare instances of excessive growth that plants remove more oxygen than they supply. As organic detritus breaks down into more simple compounds, oxygen is taken from the water and used to form these compounds. At points below the entrance of sewers in streams, often the demand of the sewage on the oxygen of the water has been so great that the amount of dissolved oxygen left will not support fish life. Sewage under proper treatment will increase the plant life or the food of a given body of water and at the same time the harmful effects are decreased. The proper treatment of sewage contributes to the building up of fish life by the increase of food. All of the above have their effects on fish life be indirectly ot directly determining the species of fish which will thrive in any locality providing other conditions are favorable.

The following graphs show the percentage of saturations of dissolved oxygen present in the water at various stations on the day the tests were made. It is at once noted that a sharp increase or decrease of oxygen may occur in a short distance from any one point. It it were possible to make all of the tests from one stream on one day, when all conditions, such as temperature, level of the water, etc., were the practically the same, it is entirely possible tha t the sharp difference would not be observed in many instances. A series of tests made at the same station over a period of several days will show variation under about the same conditions. However, the amount of oxygen found will not drop from a fairly good standard to a low one unless some type of pollution is present.

Dissolved Oxygen-- Percent of Saturation

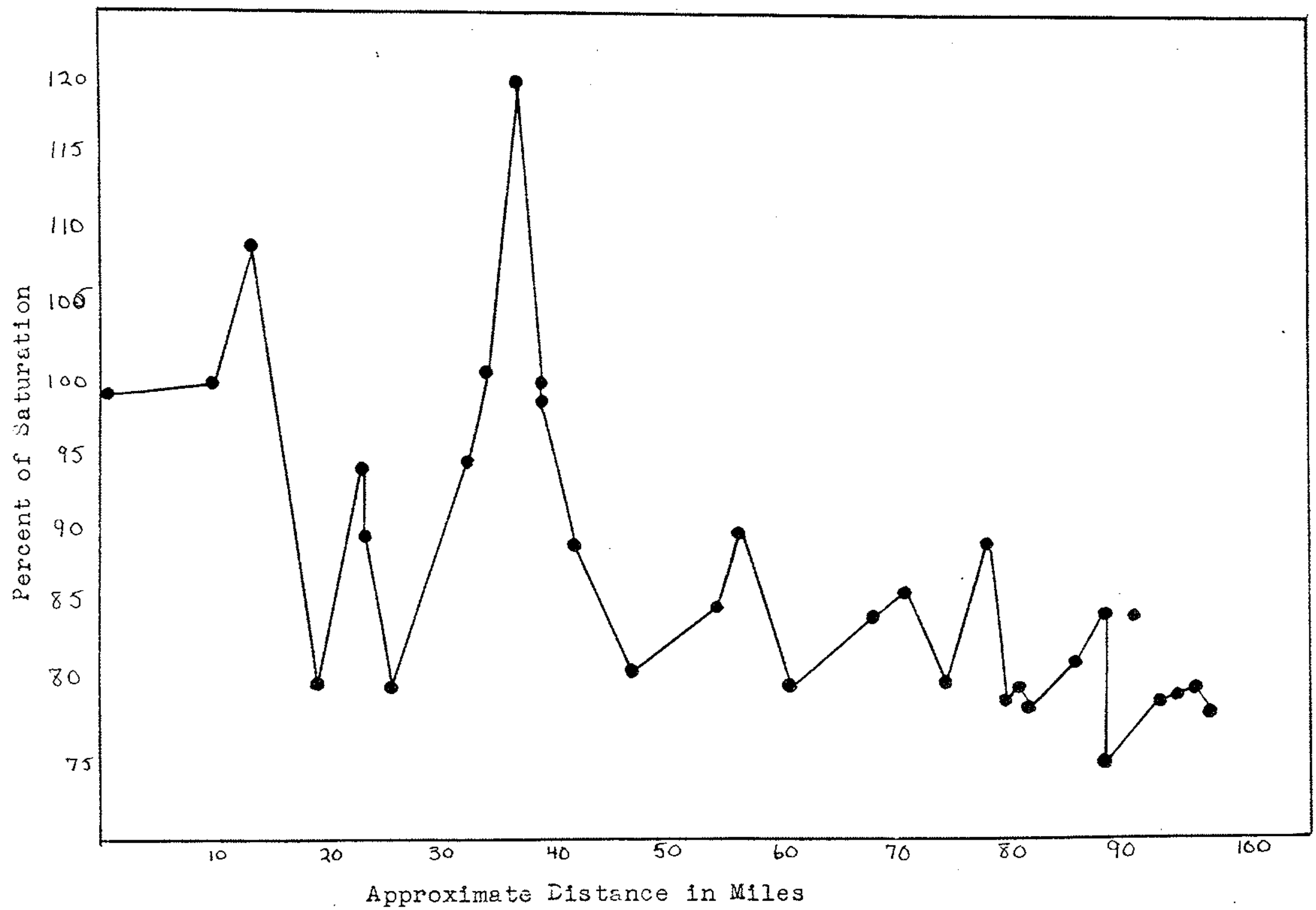
Levisa Fork



Distance in Miles

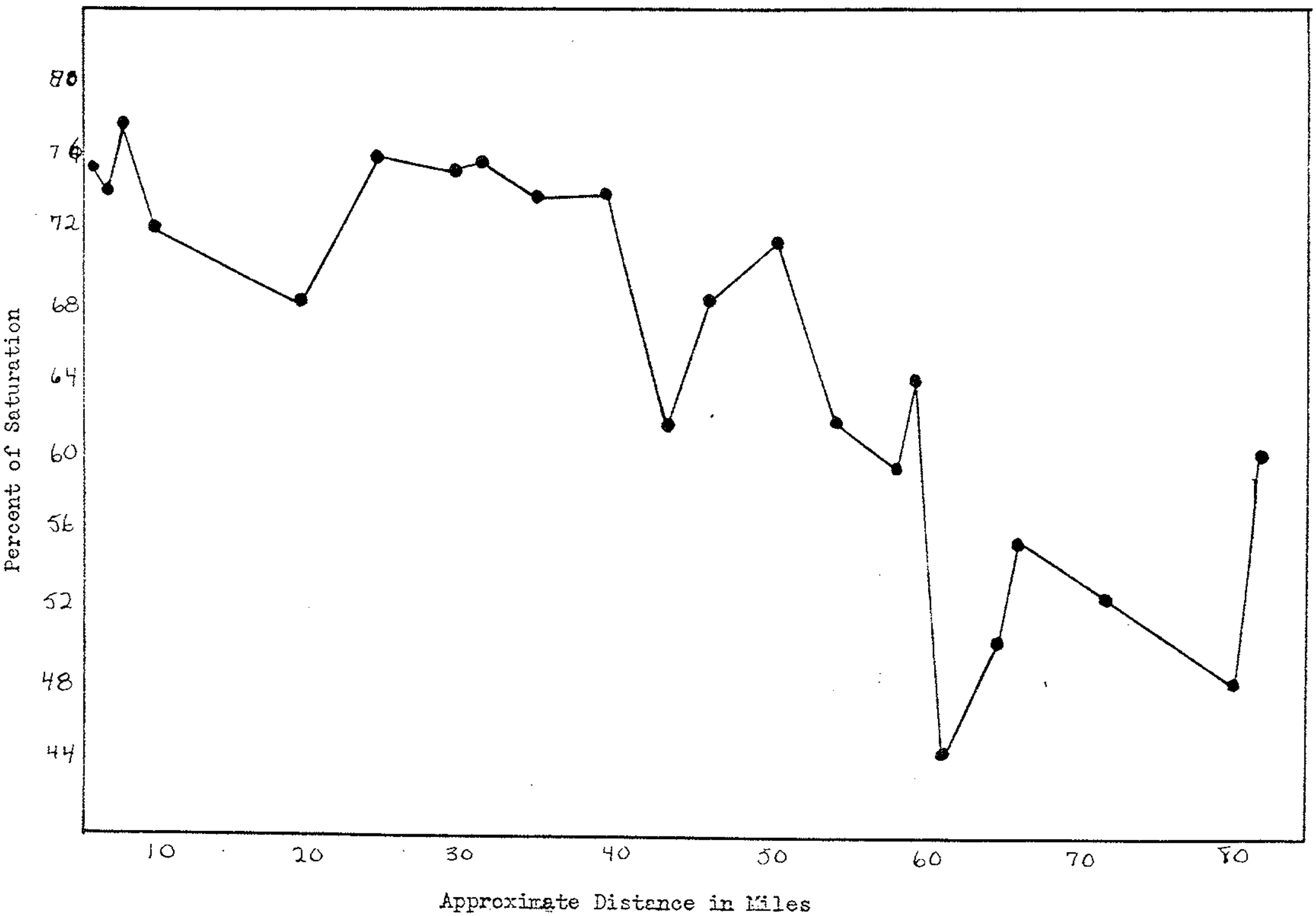
Dissolved Oxygen -- Percent of Saturation

Tug Fork



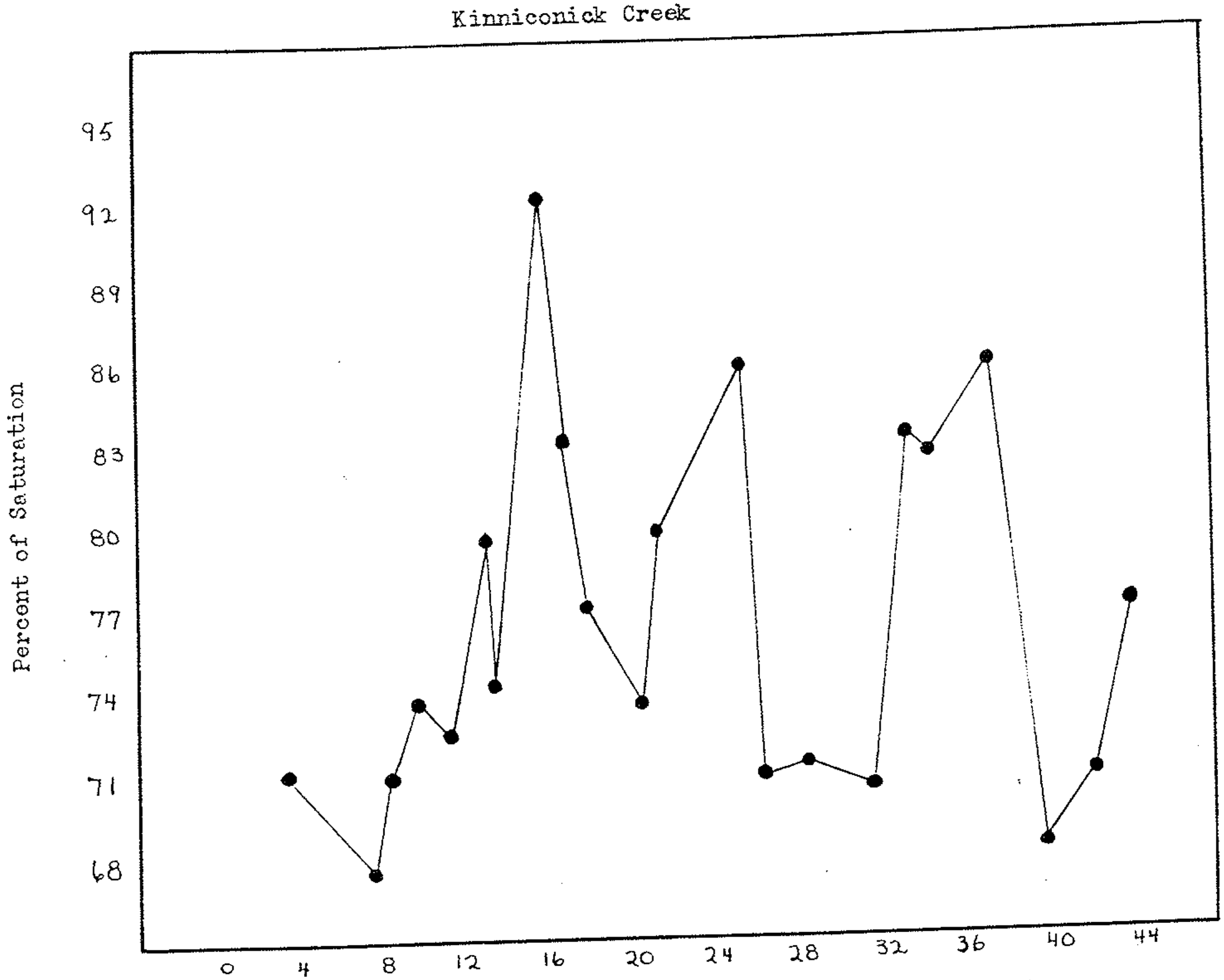
Dissolved Oxygen — Percent of Saturation

Tygart Creek



Dissolved Oxygen — Percent of Saturation

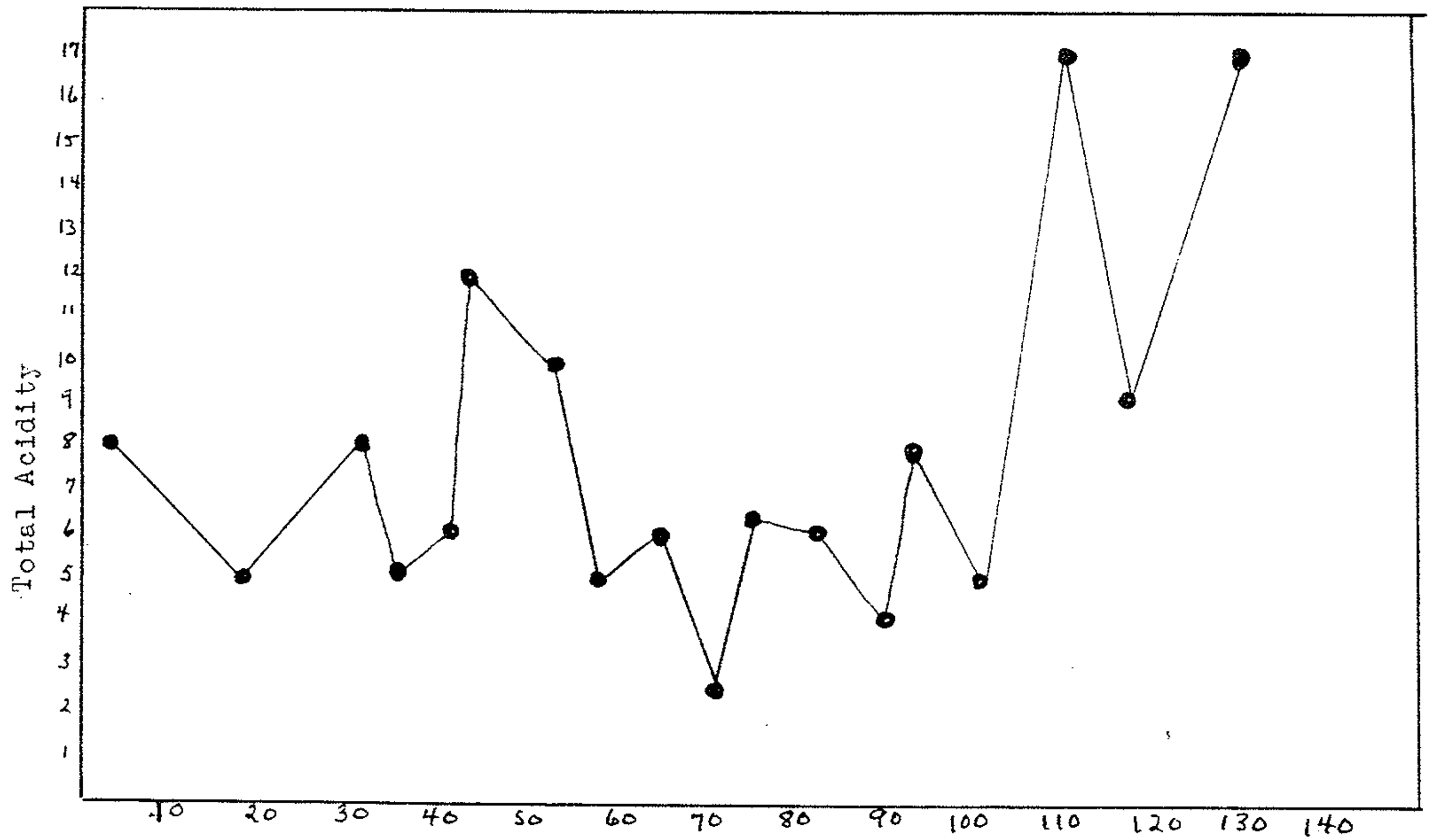
Kinniconick Creek



Approximate Distance in Miles

Total Acidity in p.p.m. of $CaCO_3$

Levisa Fork



Distance in miles

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Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. in p.p.m.	pH
	Tug River									
	Ky. - W.Va. Line	6/16	12:30	79	74	8.6	98.9	1	160	8.2
	At mouth of Knox Cr.	6/14	1:40	81	74	8.8	1 01	1	166	8.2
	Knox Cr. at mouth	6/14	1:30	81	74	8.6	98.9	2	69	7.2
	At Turkey Cr.	6/14	11:05	80	74	8.4	96.7	1.5	60	7.1
	At Camp Br.	6/14	11:15	80	74	9.4	108	2.5	63	7
	At popular Cr.	6/14	9:30	77	73	9.5	109	.5	170	8.2
	Popular Cr. At mouth.	6/14	9:45	78	72	8.1	91	2.5	123	7.8
	At Peter Cr.	6/15	10:00	79	74	7	80	0	150	8.2
	Peter at mouth	6/15	2:30	82	76	8.4	98	3	108	7.6
	At Point rock Br.	6/15	11:00	79	73	8.7	100	3	98	7.2
	At Fred Br.	6/15	11:10	79	73	9	103	.5	96	7.4
	At mouth of Rt. Fk.	6/15	11:20	79	73	8.8	101	.5	65	7.6
	)t Left Fork	6/15	11:22	79	73	8	92.1	6.0	85	7.8

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name Of Stream and Location of Sample	Date 1938	Time	Degrees F.		Dissolved Oxygen		CO_2 p.p.m.	Alkalinity Mo. in p.p.m.	pH
				Air	Sample	p.p.m.	% saturation			
	Tug River									
	At Sugarcamp Br. Ky. side.	6/15	9:45	76	74	7	80.1	5	156	7.8
	At Sugarcamp Br. W.Va. side.	6/15	9:50	76	74	8.2	94.1	2	150	7.8
	Blackberry Cr. Near mouth.	6/17	9:45	79	76	8.2	96.1	4	44	7.2
	At mouth of Peter Fk.	6/17	9:50	79	74	8.8	101	1	44	5.4
	At Hatfield Fk.	6/17	10:30	79	74	9	103	1	60	7.2
	At Dial Br.	6/17	10:45	79	73	9	103	1.5	68	7.2
	One mile below Coon Br.	6/17	9:15	79	74	6.9	79	21.0	80	6.6
	Above Longpole Br.	6/11	2:30	88	77	8	95	8	86	7
	At Maynard Br.	6/11	2:45	88	78	8.5	103	6	92	7.2
	One mile above Williamson	6/11	9:00	86	78	10	121	1.5	92	7.4
	At Williamson Toll Bridge. Ky. side	6/11	9:45	86	78	8.3	100.9	30.0	100	7.8
	At Williamson Toll Bridge. W.Va. side	6/11	9:50	86	78	8.1	98	28	100	7.8

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F.		Dissolved Oxygen		CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
				Air	Sample	p.p.m.	% saturation			
	Tug River									
	Pond Cr. near mouth	6/11	1:00	88	81	8	99	4.	162	7.6
	Shop Hol. Br. near mouth	6/13	9:45	76	68	8.1	88	3.	142	8.
	Blackberry Fk. at mouth	6/13	10:00	76	70	8.8	97.8	1.	87	8.
	At Peg Br.	6/13	10:50	79	75	7.6	89	4.	128	7.6
	At Pinson Fk.	6/13	10:45	79	74	8.	92	3.	116	7.4
	Near Turkey Cr.	6/17	2:30	80	75	7.6	89	15.	98	7.6
	Turkey Cr. just above mouth	6/17	1:00	80	76	8.4	94	6.5	62	5.2
	Borderland Br. near mouth	6/22	1:30	88	77	3.3	39	5.		5.2
	One mile above mouth of Big Cr.	6/28	10:25	74	68	8.2	82	3.	40	6.8
	Big Creek - At mouth.	6/22	1:35	88	76	7.1	83 .2	4.	52	6.6
	Just above Chaffin Br.	6/22	2:30	89	77	8.3	99	1.5	40	6.8
	In Chaffin Br just above mouth	6/22	1:40	88	76	6.9	80.8			Acid

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date	Time	Degrees F.		Dissolved Oxygen		CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
				Air	Sample	p.p.m.	% saturation			
	Tug River									
	At Lowe Br. of Big Cr.	6/22	2:40	89	77	8.2	97	1.5	42	7
	At Long Br.	6/22	2;45	89	77	8.1	96	1	38	7
	Long Br. at mouth	6/22	2:45	89	76	8.2	96.1	1	36	6.8
	At Fraley Br.	6/12	3:25	80	78	7.6	92	5	40	6.8
	Rockhouse Fk. at mouth of.	6/12	3:15	80	78	8	97	2	56	7.2
	At Suckey Br.	6/13	12:10	79	78	8.6	104	2.5	60	7
	Road Fk. at mouth	6/13	12:00	79	78	8.1	98	1.5	64	7.4
	At mouth of Dick Cr.	6/13	11:45	79	76	8.4	94	1	76	7.2
	Stratton Fk. at mouth of.	6/12	2:00	80	78	8.4	102	0.5	78	7.2
	One-half mile below Steep Br.	6/28	10:15	73	68	7.9	86	4	46	7
	At Long Br.	6/28	9:20	72	68	8.3	90.4	2.5	50	7
	Long Br., at mouth of.	6/28	9:23	72	69	8.5	94	1	64	6.8

Chemical Analyses of Bgi Sandy River and Tributaries:

ap No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
	Tug River									
	At East Kermit School	6/28	9:10	72	68	8.7	94	2	46	7
	At Kermit Tobl Bridge	6/28	12:15	73	68	7.4	80.8	6	44	6.6
	Wolf Cr., at mouth ~~of.~~	6/23	2:00	82	70	8.1	90	2	38	6.8
	At Buck Cr.	6/23	9:45	77	68	7.9	86	2.5	34	6.8
	At Little Petercave.	6/23	9:50	77	68	8.1	88	1.5	42	7
	At Emily Cr.	6/23	8:15	75	68	8.3	90.4	3	44	6.8
	Emily Cr., at mouth ~~of.~~	6/23	8:18	75	67	8.4	89	2	46	7
	Emily at Whiteoak Br.	6/23	9:55	76	67	7.9	84	4	36	6.8
	At Pigeonroost.	6/23	8:30	75	68	7.9	86	4	36	6.8
	Pigeonroost, at mouth ~~of.~~	6/23	8:35	75	68	7	76	6	34	6.2
	At Meathouse Br.	6/23	11:00	80	69	8.3	92	1.5	36	7
	Meathouse Br. At mouth ~~of.~~	6/23	11:05	80	69	8.1	90	2	38	7.2

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
	Tug River									
	Collins Cr., near mouth ~~of.~~	6/30	9:05	78	70	7.5	83	8	36	6.6
	Buck Cr., near mouth ~~of.~~	6/30	12:25	80	70	5	55	--	--	Acid
	Just above Buck Cr.	6/28	12:20	73	68	7.4	80.8	5	44	6.8
	At Little Elk Cr.	6/28	12:30	73	68	7.9	86	3	42	7
	At Chaffin Br.	6/28	2:00	75	69	7.7	85	2.5	40	7.2
	At Elk Cr.	6/28	2:10	75	69	7.9	87	3	44	7
	Elk Cr., at mouth of.	6/28	2:15	75	71	7.9	89	2.5	40	7
	Just above Calf Cr.	6/30	2:15	81	72	7.2	81	2	40	7
	Lawrence Co. Line.	6/27	4:25	75	70	8.1	90	3	40	7.2
	Blankenship Br. near mouth.	7/12	1:05	84	82	6.6	83	2	52	7.2
	At Blankenship Br.	7/12	2:00	84	83	6.2	78	4	72	7.4
	At upper Tug School	7/12	1:00	84	83	6.4	80.7	3	74	7.4

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
	Tug River									
	At Baker Br.	7/12	2:10	84	83	6.1	77	4.5	74	7.4
	One-half mile below Rockcastle Cr.	7/12	10:45	82	82	6.6	83	3	76	7.4
	Rockcastle Cr. Above mouth.	7/11	8:30	85	78	5.9	71	3.5	46	7.2
	At Laurel Cr.	7/11	9:15	87	79	5.8	70	4	44	7
	At Buffalo Horn Cr.	7/11	10:35	91	83	5.5	69	3	44	7
	At Little Laurel Cr.	7/11	12:00	93	83	5.7	71	2	46	7
	At Grassy Br.	6/29	11:05	77	65	8.1	85.9	2.5	44	7
	Rockhouse at mouth	6/29	11:00	77	65	8	83	3	46	6.8
	At Spring Br.	6/29	9:05	75	64	8.2	85.9	2	46	6.8
	At Preston Br.	6/29	9:00	75	64	8	83	3	44	6.6
	Rockhouse at Williamson Br.	6/27	8:40	70	66	8.4	89	1	40	6.8
	[illegible]lliamson Br., at [illegible]outh.	6/27	[illegible]:45	70	68	8.1	88	2	38	6.6

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	ph
	Tug River									
	Rockcastle at Satfford Fk.	6/27	9:50	71	66	8	87.7	2.5	44	6.8
	At Milo.	6/27	1:00	78	68	7.8	85	3	42	7
	Middle Fk. near mouth	6/25	9:00	80	70	8.4	93	2	36	6.8
	At Crum School.	6/25	9:15	80	70	8.4	93	2.5	44	6.6
	At Venters Br.	6/25	9:20	80	71	7.7	85	3.5	48	7
	At Davella P.O.	6/25	10:00	82	71	8.6	97.4	1	48	6.8
	At Lower Twin Br.	6/25	10:10	82	70	9.1	101	0.5	46	6.8
	Cold water Fk. at Blacklog Br.	6/24	8:45	79	69	8	88	3.5	58	6.6
	At Carter Br.	6/24	8:50	79	66	8.1	86.6	3	44	6.8
	At Moore Br.	6/24	8:55	79	66	8	85.5	4	42	6.8
	At Cassady Br.	6/24	9:00	79	67	8.3	88.7	2	44	6.6
	At Mullet Br.	6/24	9:10	79	66	8.9	95.1	0.0	44	7

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
	Tug River									
	Maynard Br. (From Tug)	7/12	9:30	82	82	6.8	85.8	2.5	61	7.6
	At Maynard Br.	7/19	11:05	79	72	6.7	75	2	42	6.8
	At Donithon Br.	7/19	11:00	79	72	7.6	86	0.5	40	6.8
	At Powdermill Br.	7/19	9:50	78	72	6.9	78.1	2	70	7
	At Locks	7/19	9:05	77	72	7.	79.1	1.5	72	7
	At Copley, W. Va.	7/19	9:00	77	72	7	79.1	1	70	7
	At mouth	7/19	1:50	79	72	6.8	77	2	70	7
	Big Sandy River									
	Twomile Br. At State Rd. Bridge.	7/20	1:00	88	80	5.	61.9	4	36	7
	Just a bove locks at Louisa.	7/ 29	8:00	79	78	6.3	76	3	50	7.2
	At Twomile Br.	7/29	9:15	81	78	6.4	77	2	52	7.2
	Above mouth of Blaine cr.	7/29	10:30	82	78	6.3	76	3.5	48	7.2

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen %saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
	Big Sandy River									
	Blaine Cr., above mouth.	7/26	10:00	82	70	6.3	70	3	40	7
	At Hulette.	7/26	8:45	78	69	6.5	72	3	42	7
	At Long Br.	7/26	8:30	78	69	6.6	73	3	40	7
	Cat Cr. Near mouth	7/9	10:15	84	78	6.6	80	3	42	7
	Poorhouse Br.	7/9	8:40	81	76	6.9	80.8	--	--	Acid
	Jordan Fk. at mouth.	7/9	10:00	84	78	6.6	80	2	44	7
	Cooksey Fk. at mouth.	7/9	8:15	79	75	7.2	84	1.5	46	7
	At Fallsburg below falls of cr.	7/11	1:30	94	82	7.1	89.	0.5	40	7.2
	At Morgan Cr.	7/11	3:00	94	82	6.5	82	1	42	7.2
	At mouth ~~of~~ Little Blaine Cr.	7/6	8:00	74	67	7.4	79	2	40	7
	Little Blaine at Harriet Br.	7/6	8:50	78	68	7.2	78	3	36	6.[illegible]
	t. Fk. at Adams	7/6	9:00	78	68	7.3	99	3	46	6.[illegible]

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F.		Dissolved Oxygen		CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
				Air	Sample	p.p.m.	% saturation			
	Big Sandy River									
	Rt. Fk. At Mattie. (Blaine Cr.)	7/6	9:05	78	67	7.5	82	7.5	46	7
	At Irad.	7/25	1:00	88	73	6.3	72	3	42	7.2
	At mouth of Daniels	7/25	10:30	85	72	6.5	73	2	40	7.2
	At Rick Cr.	7/6	11:30	81	69	7	77	4	42	6.8
	Rich Cr., at mouth	7/6	11:05	81	68	7.5	81	2	44	7
	At Prosperity	7/25	8:45	80	70	6.8	75	1.5	42	7.2
	At Irish Cr.	7/6	11:15	81	70	6.8	75	5	40	7
	Irish Cr. at mouth	7/6	11:20	81	72	7.4	83	3	40	7
	At cherokee	7/5	2:00	83	72	6.5	73	5	44	6.8
	Cherokee at mouth	7/5	2:05	83	72	6.8	77	3.5	44	6.8
	At mouth of Cains Cr.	7/8	2:00	88	76	7	82	4	38	6.8
	H[illegible]ds Cr. near mouth	7/7	[illegible]00	83	71	7.8	[illegible]3	2.5	38	7

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F.		Dissolved Oxygen		CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
				Air	Sample	p.p.m.	% saturation			
	Big Sandy River									
	At Rockhouse Fk.	7/7	4:00	86	74	7.9	91	1	40	7.2
	Lower Laurel at mouth.	7/7	2:00	86	74	8	92	1	48	7
	At Franks Cr.	7/7	4:30	86	74	8.1	93	0.5	48	7.2
	Upper Laurel at mouth	7/8	9:15	84	72	7.7	87	1.5	44	7
	At Zelda Sta.	7/29	11:15	83	79	6.1	74	3	48	7.2
	At Buchanan	7/29	12:30	83	79	6.2	75	4	52	7
	At Buchanan	8/18	9:30	80	79	6.1	74	2	46	7
	At Kavanaugh	8/18	10:45	84	80	6	74	2.5	48	7
	At Durbin Cr.	8/18	1:00	89	80	5.9	73	3	48	7
	At Lockwood	8/18	2:15	89	80	5.7	51	3	50	7
	At White Cr.	8/22	9:00	79	79	5.7	69	3.5	50	7
	At Savage Br.	8/22	[illegible]:00	81	79	5.6	68	5	52	7

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F.		Dissolved Oxygen		CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
				Air	Sample	p.p.m.	% saturation			
	Big Sandy River									
	At Campbell Run	8/22	12:30	83	80	5.5	68.1	5	52	7
	At Chadwick	8/23	9:30	80	79	5.5	66.8	4.5	54	7
	At Peterman Cr.	8/23	10:45	82	80	5.4	65.7	6	54	7
	At Mouth	8/23	1:15	85	80	5.1	62.04	8	56	7
	Bear Cr. at Mouth	8/15	9:00	83	79	6.4	77.8	3	88	7.4
	At Left Fork	8/15	9.05	83	79	6.3	76.6	2	88	7.4
	At Brooks Cr.	8/15	11:45	89	80	6.2	75.4	2	86	7.4
	At Durbin Cr. at Mouth	8/16	1:00	88	82	6	76.	4	82	7
	At Left Fork	8/16	2:00	88	83	5.9	74.4	3	82	7.6
	At Cyrus Branch	8/16	2:45	88	83	5.6	70.7	3	84	7.4
	White Cr. at Mouth	8/16	8.30	79	75	6.5	76.2	1.5	76	7.4
	At Left Fork	8/16	8:40	80	75	6.6	77.3	1	76	7.4

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date	Time	Degrees F.		Dissolved Oxygen		CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
				Air	Sample	p.p.m.	% saturation			
	Big Sandy River									
	Whites Cr. At Rt. Fk.	8/16	10:15	82	78	63	76.6	2	72	7.4
	Savage Br., just above mouth [illegible]	8/17	1:15	87	80	5.3	66.8	3	44	7
	Chadwick Cr. in mouth [illegible]	8/17	8:30	81	75	6.5	76.2	1	50	7.2
	At Left Fk.	8/17	9:30	82	75	6.7	78.6	0.5	54	7.2
	Above mouth of Left Fk.	8/17	10:45	85	76	6.9	80.8	0.0	48	7.2
	Peterman Cr. near mouth	8/17	2:30	88	81	4.9	60.7	5	46	7.2

Chemical Analyses of Kinniconick Creek and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
	Kinniconick Creeek									
	At Peterville	9/6	11:15	90	75	6.2	72.6	2.5	22	6.2
	Above Blacklick Br.	9/6	11:25	90	74	5.8	66.8	3	24	6.4
	At Elklick	9/6	12:20	90	74	6.3	72.5	0.5	24	6.6
	At Cumstock Br.	9/6	1:30	91	75	6.3	73.8	3	26	6.2
	Indian Cr. in mouth of.	9/7	9:30	88	74	5.9	67.9	1.5	28	7.1
	At Wise Br.	9/7	10:20	88	73	7.1	82	1	30	7.2
	Briery Cr. at Straight Fk.	9/7	12:00	90	73	6.4	75	1.5	20	6.2
	At Jorden Fk.	9/7	2:00	91	75	6.5	76.2	2	22	6.2
	At Mutton Br.	9/8	9:30	75	70	7.2	80	2	26	6.2
	At Herrington Br.	9/8	10:10	75	70	6.9	76.7	1.5	26	6.5
	At Old House Br.	9/8	12:00	77	71	7	79.1	2	24	6.2
	[illegible] Board Br.	9/8	[illegible]:30	78	72	7	[illegible].1	1.5	26	6.2

Chemical Analyses of Kinniconick Creek and Tributaries

..p No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F.		Dissolved Oxygen		CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
				Air	Sample	p.p.m.	% saturation			
	Kinniconick Cr.									
	At mouth of Indian Cr.	9/15	8:30	69	71	7.4	82.3	3	28	6.6
	At Beaver Pond.	9/15	8:35	69	70	7.1	78.9	3.5	26	6.6
	At Holly Cr.	9/15	8:40	74	71	6.7	75.8	4	30	6.5
	At Grassy Cr.	9/15	10:50	78	72	8.2	92.8	3	26	6.5
	Grassy Cr. in mouth ~~of~~.	9/15	11:00	78	71	7.8	88.3	4.5	22	6.5
	At Leatherwood	9/15	3:00	76	70	7.5	83.4	2	26	6.6
	At Lietz Br.	9/15	4:00	76	70	7	77.7	3	28	6.8
	At Straight Fk.	9/15	1:30	76	71	6.5	73.6	1.5	28	6.8
	Straight Fk. in mouth ~~of~~.	9/16	1:20	80	71	6.6	74.7	2	28	6.6
	At Mosby Cr.	9/16	2:15	80	70	6.8	75.5	1	30	6.8
	At Bullick Br.	9/16	3:00	79	71	6.7	75.7	2	28	6.7
	[illegible] Varney Br.	9/16	3[illegible]0	79	70	6	6[illegible].7	3	26	6.6

Chemical Analyses of Kinniconick Creek and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH.
	Kinniconick Cr.									
	Straight Fk., at mouth	9/13	1:30	80	71	6.4	72.	3	28	6.6
	At mosby Cr.	9/13	2:30	80	71	6.9	78	1	30	6.8
	At Bullick Br.	9/13	3:15	79	70	6.8	75.5	1.5	28	6.7
	At Varney Br.	9/13	3:20	79	69	5.7	63	3	26	6.6
	At Blankenship Br.	9/16	9:00	76	69	7.2	80	2	3 2	6.8
	Laurel Cr. at mouth	9/14	11:00	78	70	6.9	76	.5	34	6.9
	At Scotts Br.	9/13	10:30	78	68	6.5	61	1	34	6.8
	At Clark's Br.	9/13	9:10	77	69	6.2	68	3	32	6.2
	At Laurel Point.	9/12	2:10	80	71	4.1	46	3	36	6.6
	At Sailor Br.	9/12	1:15	80	72	7.1	80	1	32	6.8
	At Nolam Br.	9/12	11:30	80	70	6.	67	3	32	6.4
	[illegible] Depot Br.	9/12	[illegible]:30	79	72	6.7	75	3	28	6.2

Chemical Analyses Of Kinniconick Creek and Tributaries

.p No.	Name of Stream and location of Sample	Date	Time	Degrees F.		Dissolved Oxygen		CO_2 p.p.m.	Alkalinity	pH
				Air	Sample	p.p.m.	% saturation			
	Kinniconick Creek.									
	At Tar Fk.	9/10	11:00	79	72	6.6	74	4	26	6.2
	At Bedford Fk.	9/10	10:15	78	72	6.6	74	3	28	6.2
	At Bee Br.	9/10	9:30	78	71	6.8	77	2	30	6.4
	Grassy Fk Of Laurel at mouth.	9/9	2:45	80	73	7	80	3.5	26	6.2
	At upper Twin Br.	9/9	1:30	80	73	6.7	77	3	24	6.2
	At Old Trace Fk.	9/9	11:35	78	72	6.9	78	2	24	6.4
	At Rayburn Br.	9/9	10:30	78	72	6.5	73	2.5	28	6.6
	At Emerson .	9/9	9:20	77	71	6.4	72	4	20	6.4
	At Pipelick Br.	9/16	10:05	78	70	7.8	86	1	30	6.8
	At Puncheoncamp Br.	9/19	1:00	68	67	6.7	71	3	26	6.6
	At Mckinney Br.	9.19	2:05	68	66	6.3	72	2	28	6.6
	Mills Br.	9/19	3:20	67	66	6.6	70	3.5	28	6.6

Chemical Analyses of Kinniconick Creek and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
	Kinniconick Creek									
	Rock Run, in mouth ~~of~~.	9/19	3:25	67	65	7.1	74	1	24	7
	Town Br. in mouth ~~of~~.	9/20	9:45	63	65	7.9	82	5	24	6.5
	At Trace Fk.	9/20	9:55	63	66	7.9	84	2	26	6.8
	Trace Fk. At Scott Br.	9/20	11:00	65	65	7.7	80.7	4	22	6.6
	At Rugless.	9/20	11:15	65	64	7.3	76	5	22	6.5
	At Englishman's Br.	9/20	1:00	66	65	7.9	82	.5	28	7.1
	At McDowell Cr.	9.20	2:30	65	66	8.1	86	1	30	7
	McDowell Cr in mouth ~~of~~.	9/20	3:15	65	65	8	83	1	26	7
	At Spy Run	9/21	3:55	64	65	6.6	69	1.5	28	7
	Spy Run, in mouth ~~of~~.	9/21	4:00	64	64	6.9	72	6	24	6.6
	AT Montgomery Cr.	9/21	2:10	65	65	6.8	71	1.5	30	7
	At mouth.	9/21	4:20	64	66	7.3	78	1	30	7.2

Chemical Analyses of Tyga rt Creek and Tributaries

ap No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
	Tygart Creek									
	At Flemming Fk.	11/11	10:10	59	48	8.8	75.9	1	42	6.8
	At Flat Fk.	11/11	10:00	59	47	8.7	73	2.5	40	6.6
	At Smith Run	11/11	10:25	63	50	8.8	77.5	1.5	44	6.8
	Soldier Fk. At mouth of Mocabee.	11/10	1:00	66	48	9.6	82	0	62	7.2
	At Lawton	11/10	2:25	66	49	9.7	83	.5	70	7.2
	At Lawton.	11/6	3:30	65	50	8.6	75.9	1	110	7.4
	At Enterprise	11/6	2:20	66	49	9.1	76	1	52	7
	At Hayward	11/6	2:15	66	49	9.5	81	.5	54	7
	At Garvien Br.	11/11	12:15	65	49	8.4	72	2	102	7.2
	At Griffty Br.	11/6	4:35	64	50	8.5	44.1	3	100	7.3
	At State Br.	11/13	2:00	68	50	6	52	6.5	110	7.2
	rry Br. at mouth of	11/11	[illegible]0	66	50	6.1	[illegible]	6	82	7

Chemical Analyses of Tygart Creek and Tributaries

ap No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F. Air	Degrees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
	Tygart Creek									
	At Dry Br.	11/72	9:30	59	47	8.5	71	1	136	7.6
	At Jones Br.	11/13	3:20	70	50	7.8	69	2	140	7.7
	At Cave Br.	11/12	11:00	62	48	8.9	76	.5	140	7.6
	At Adams Cr.	11/14	2:25	53	48	8.7	75	1	136	7.6
	At DeEvert.	11/14	3:40	52	48	8.8	75.9	0	130	7.5
	At Iron Hill Bridge	11/14	3:50	52	47	8.9	74	0	130	7.6
	At Ross Br.	11/15	9:15	45	46	8.8	74	1	126	7.6
	At Shores Br.	11/2	9:00	56	48	8.4	72	.5	120	7.4
	At Kehoe	11/2	10:15	57	48	7.3	62	1	112	7.3
	Buffalo Cr. at mouth of.	11/1	11:00	71	56	9.2	86	1	112	7.5
	At Zornes Br.	11/1	10:10	70	55	9.3	87	1	114	7.6
	( ) Carter City	11/1	(15	67	54	9.5	(7	1	114 ( )	7.6

Chemical Analyses of Tygart Creek and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F.		Dissolved Oxygen		CO_2 p.p.m.	Alaklinity MO. p.p.m.	pH
				Air	Sample	p.p.m.	% saturation			
	Tygart Creek									
	At Barn Hollow of Buffalo Cr.	11.14	11:00	52	48	8.8	75.9	1.5	132	7.6
	At Brushy Cr.	11/14	12:05	53	48	8	69	1	130	7.6
	At McGlone Fk.	11/14	12:10	53	49	8.2	70.7	1.5	136	7.6
	McGlone Fk. ~~In~~ mouth ~~of~~.	11/14	9:00	46	46	9.5	80.8	0	114	7.6
	Smith Cr. At Lick Br.	11/14	10:00	4 7	47	9.2	77	0	144	8
	Grassy at mouth	11/1	1:40	74	58	5.1	49	6	70	6.6
	At Kiser Br.	11/1	1:50	74	59	5.3	52	5	74	6.8
	Leatherwood Cr., at mouth ~~of~~.	11/5	2:00	73	54	6.5	60.9	5	28	6.6
	Three Prong Cr., at mouth ~~of~~.	11/5	2:10	73	53	6.6	61	4.5	30	6.7
	At Old She Br.	11/2	10:25	57	49	8.1	69	1	112	7.3
	At Red Hot	11.2	11:30	73	50	8.1	71.4	1	110	7.2
	Lost Cr.	11/2	[illegible]:50	76	51	6.9	[illegible]32	3	108	7.2

Chemical Analyses of Tygart Creek and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degreees F. Air	Degreees F. Sample	Dissolved Oxygen p.p.m.	Dissolved Oxygen % saturation	CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
	Tygart Creek									
	At Little White-Oak Cr.	11/2	1:10	76	52	6.6	59	4	98	7.2
	Little Whiteoak Cr at State Road.	11/2	1:05	76	54	9	82	1	42	7
	At Whiteoak Br.	11/2	1:20	76	52	7.3	65	1.5	110	7.2
	At Sugarcamp Br.	11/3	10:00	58	48	6.5	56	3	86	7.1
	At Brushy Br.	11/3	11:05	58	48	5.2	44.8	5	84	7
	At Beechy Br.	11/3	11:15	59	48	5.8	50.8	4	84	7
	At Plum Cr.	11/3	12:20	66	50	6.3	55.6	3.5	82	7
	At Warnock Hollow	11/3	1:30	70	50	6.2	54	3.5	84	7
	At Shultz Cr.	11/3	1:40	70	51	5.9	53.2	4	80	7
	At Rock Br.	11/3	1:50	71	51	5.4	48	5	76	7
	At Lower Whiteoak	11/3	3:00	72	52	6	54.1	2	80	7.1
	( ) Lick Br.	11/5	8:00	54	52	6.7	60.4	3	80	7.1

Chemical Analyses of Tygart Creek and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1938	Time	Degrees F.		Dissolved Oxygen		CO_2 p.p.m.	Alkalinity MO. p.p.m.	pH
				Air	Sample	p.p.m.	% saturation			
	Tygart Creek.									
	At Mouth	11/5	10:00	61	52	6.5	58	3.5	78	7
	Shultz Cr. at mouth of.	11/4	11:55	69	49	7.7	66	3	30	6.8
	At Petercave	11/4	10:45	67	50	9	79.4	3	26	6.6
	Beechy Br. At State Rd.	11/4	12:00	69	50	6.2	54.7	6	26	6.6

Chemical Analyses Of Big Sandy River and Tributaties

Map No.	Name of Stream and Location of Sample	Date 1937	Time	Degrees F. Air	Degrees F. Sample	Dissolved O_2 p.p.m.	Dissolved O_2 %saturation	CO_2 p.p.m.	Total Acidity p.p.m.	Hardness in p.p.m. $CaCO_3$	MO. Alkalinity p.p.m. $CaCO_3$
	Levisa Fork.										
	Russell Fk. Two miles above Elkhorn City	9/15	11:00					3	3		
	Elkhorn Cr., in mouth of.	10/30	9:00	54	48	11.2	96	2	7	40	66
	Below Elkhorn City in Russell Fk.	9/15	11:30					3.5	4		
	Below Elkhorn City (As above)	10/30	10:30	63	49	10.5	90	3	5	30	51
	At Marrowbone Cr.	10/30	1:00	67	49	11	94	2	7	40	52
	In mouth of Russell Fk.	11/16	12:30	48	46	12.6	106	0	10	48	50
	Marrowbone Cr. in mouth of	9/27	9:00	84	82			1	10		
	Marrowbone Cr. in mouth of.	10/28	11:45	68	52	9.7	87	6	7	60	40
	Levisa at Mouthcard, Ky.	9/27	1:00	85	82	7	87	3	8	38	50
	At mouth of Grapevine Cr.	9/29	9:00	82	81	7.3	90	8	5	35	54
	At Forks.	11/16	12:45	48	47	12.9	108	3	8	38	32
	Shel[illegible] Cr. in mou[illegible] of.	9/1	10:00	[illegible]	84	7.4	90	[illegible]	7.5	76	[illegible]2

Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1937	Time	Degrees F.		Dissolved O_2		CO_2 p.p.m.	Total Acidity p.p.m.	Hardness in p.p.m.	MO.Alkalinity p.p.m. $CaCO_3$
				Air	Sample	p.p.m.	%saturation				
	Levisa Fork										
	2½ miles above Pikeville.	9/1	2:00	94	86	5.9	77	5	6	48	50
	At bridge below Pikeville	11/16	1:00	47	47	9.	75	4	12	54	46
	Floyd-Pike Co. Line.	9/13	9:00	78	70	6.5	73	4	10	40	46
	At mouth of Bull Cr.	9/16	11:20	79	70	7.1	78	3	2.5	40	44
	At bridge below Prestonsburg.	9/16	9:05	78	70	5.2	57	4	6.5	44	50
	½ mile below Betsy Layne	9/18	2:20	68	54	9.9	92	3	5	40	48
	One mile below bridge to Allen	9/18	1:30	68	54	9	86	4	6	44	44
	Middle Cr. at mouth of.	9/16	10:15	78	71	4.3	47.8	35	45.0		
	At Prestonsburg bridge.	9/17	10:25	78	72	4.4	49.7	38	47.0		
	Below Ky-W.Va. Gas Sta.	9/17	2:35	75	71				6.5		
	Above Sta.	9/17	2:30	75	68	6.7	70	4	5.5	74	38
	M) Cr. in mouth of.	9/17	8:00	75	70	8.6	95	2	6	78	46

Chemical Anaiyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date 1937	Time	Degrees F. Air	Degrees F. Sample	Dissolved O_2 p.p.m.	Dissolved O_2 %saturation	CO2 p.p.m.	Total Acidity p.p.m.	Hardness in p.p.m.	MO. ALkalinity p.p.m. $CaCO_3$
	Levisa Fork										
	Beaver Cr. Below Martin, Ky.	9/22	9:45	69	61	4.9	49	11	10	76	48
	Left Beaver at Ostorn Br.	9/22	10:10	70	62	7.4	76	5.5	12	76	50
	Rt. Beaver 1 mile above Gas Sta.	9/20	3:25	79	64	6.9	72	6	12	70	46
	Rt. Beaver, just below Gas Sta.	9/22	1:00	77	96	3.1	?	4	7	80	44
	Abbott Cr. at mouth ~~of~~	11/11	8:15	52	48	10.3	88	7	14	54	68
	Johns Cr. at Bevins Br.	9/29	8.10	69	64	7.4	77	3	4	40	60
	Just below Meta, Ky.	10/5	10:30	82	68	7.2	78	7	8	34	58
	At John Cr. Bridge	10/12	8:30	78	58	10.2	98	3	6	52	56
	Raccoon Cr. at Zebulon, Ky	10/5	1:00	82	78	6.5	77	4	6	52	48
	Just below East Point	11/11	12:15	59	52	10.9	98	3	6	50	39
	One mile above Paintsville	10/21	9:30	63	54	8.4	79	4	4	48	60
	At T[illegible]alka	10/21	11:4[illegible]	65	56	7.3	68	5	8	46	66

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Chemical Analyses of Big Sandy River and Tributaries

Map No.	Name of Stream and Location of Sample	Date	Time	Degrees F. Air	Degrees F. Sample	Dissolved O_2 p.p.m.	Dissolved O_2 %saturation	CO_2 p.p.m.	Total Acidity p.p.m.	Hardness in p.p.m.	MO. Alkalinity p.p.m. $CaCO_3$
	Levisa Fork.										
	At River, Ky.	10/22	3:10	73	60	8	78	4	5	60	74
	Paint Cr. At Jenny Cr.	10/25	8:30	55	49	8.9	76	5	7	127	72
	Paint at mouth	10/21	11:30	65	56	2.1	18	19	21.5	110	108
	At Richardson	12/7	9:45	32	33	15.7	110	1.5	17	84	80
	At mouth of Shannon Br.	12/6	9:00	28	30	13.4	96	3	9	54	101
	Levisa at mouth	12/6	8:00	28	31	13	91	4	17	56	99
	Lick Cr. middle section.	12/6	11:15	29	34	20.5	150	0	13	71	110
	Nates Cr. at mouth	12/7	10:00	34	33	13.5	93	3	11	58	94
	Toms Cr. upper section	12/7	3:10	32	33	12.5	87	3	18	52	56
	Toms Cr. lower section	12/8	9:20	34	33	13.7	96	2	65		110

STOCKING POLICY FOR STREAMS OF THE WATERSHED

PREVIOUS STOCKING

STREAM STOCKED	SECTION OF STREAM	DATE	KIND	NUMBER	WHERE OBTAINED
Russell Fork	Near Elkhorn City	10/27/36	Lm.B	1,131	Pikeville Ponds
" "	Below Elkhorn City	10/27/36	Lm.B	1,034	" "
" "	At Elkhorn City	10/27/36	Lm.B	1,280	" "
Levisa Fork	Near mouth of Grape-vine	10/27/36	Lm.B	1,563	" "
Levisa Fk.	Near Fish Trap	10/27/36	Lm.B	1,350	" "
Levisa	At Millard	10/27/36	Sm.B	1,700	" "
Levisa	Shelby Junction	10/27/36	Sm.B	2,400	" "
Johns Cr.	Near Meta	10/27/36	Sm.B	1,444	" "
Russell Fk.	Elkhorn City to Va. line	1937	Lm.B;Sm.B	1,350	" "
" "	Elkhorn City to Belcher	1937	" "	2,500	" "
" " & Levisa	Belcher to Shelby	1937	" "	3,400	" "
Levisa	Forks to Mouthcard	1937	" "	4,600	" "
Shelby Cr.	Mouth to Virgie	1937	" "	2,000	" "

PREVIOUS STOCKING

STREAM STOCKED	SECTION OF STREAM	DATE	KIND	NUMBER	WHERE OBTAINED
ussell Fork	Entire	10/18/38	Lm.B	2,615	Pikeville Ponds
evisa Fork	Forks to Shelby	10/19/38	Lm.B	3,580	" "
" "	Shelby to Pikeville	10/20/38	Lm.B.	800	" "
" "	" "	10/20/38	Sm.B	863	" "
Russell Fk.	Lower section	10/28/38	Sm.B	7,850	" "
Shelby Cr.	Pike Co.	10/28/38	Sm.B	3,500	" "
Levisa Fk.	" "	10/28/38	Lm.B	6,374	" "
Knox Cr.	Pike Co.	10/21/38	Sm.B.	727	" "
" "	" "	"	Lm.B	328	" "
" "	" "	"	Sm.B	3,000	" "
Kinniconick Cr.	Central section	10/10/36	Lm.B.	1,020	Ashland Hatchery
" "	Lewis Co.	9/30/38	Lm.B	1,200	" "
Tygart Cr.	Red Hot	10/10/36	Lm.B.	239	" "

PREVIOUS STOCKING

Stream Stocked	Section of Stream	Date	Kind	Number	Where Obtained
Tygart Creek	Kehoe	10/11/36	Lm.B	2,250	Ashland Hatchery
" "	Antiock	10/11/36	Lm.B	1,200	" "
" "	Leatherwood	----	-----	2,350	----------------
" "	Olive Hill	10/11/36	Lm.B	720	Ashland Hatchery
" "	Carter Co.	10/29/37	Bass	470	" "
" "	" "	10/29/37	Bream	500	" "
" "	" "	10/29/37	Bass	450	" "
" "	" "	10/29/37	Bream	500	" "
" "	Olive Hill	10/29/37	Bass	2,200	" "
" "	Carter Co.	____	-----	------	" "
" "	Iron Hill	9/29/38	Lm.B	1,200	" "
" "	Antiock	9/29/38	Lm.B	1,080	" "

Guide to Tables Which Follow

LENGTH IN MILES refers to the entire length of a stream unless another division of the same stream is given, whereby, it refers to the distation in the entire section only.

AVERAGE WIDTH. This is the average for all stations and does not refer to any particular point.

AVERAGE DEPTH. Readings in the table are for the average of the entire stream or section of a stream. At a given station the average depth is secured at one-half of the distance between the one shore and the middle, at the middle, and at a point midway between the middle and the opposite side. The readings are added and divided by 1 more than the number of readings. This is to allow for 0 depth at each side.

BOTTOM. Abbreviations used

Ru. Rubble, a term applied to irregular stones ranging in size from an egg up to a boulder a foot in diameter.

Bo. Boulders

Gr. Gravel

Sa. Sand

POOL GRADE

S refers to size, T to type, and F to frequency of pools

Size

1. Pools with average width or length much greater than the width of the stream.

2. Pools having a length equal to the width of stream.

3. Pools shorter than the width of the stream.

Type

1. Deep exposed pools containing a great luxuriance of aquatic plants harboring a rich fauna; or deep pools with abundant shelter.

2. Pools intermediate in depth, shelter, and plant abundance.

3. Shallow exposed pools without shelter.

Frequency

1. More or less continuous pools -- about 75% to 25% relation of pools and riffle area.

2. 50 - 50 relationship between pools and rapids.

3. Pools infrequent with long stretches of shallow water.

By giving the entire combination of the above in the tables, it is believed that a better stream picture will be presented than had the combinations been reduced to A, B, and C grades.

Example, $S_1T_2F_3$.

S refers to the size of the pool and 1 to the grade which has been placed on the stream so far as the size is concerned. Thus S_1 meams that the pool has an average width or length much greater than the width of the stream.

Referring to the above example, T_2 meams that the pools are intermediate in depth, shelter, and plant abundance.

F_3 of the example means that pools are infrequent with long stretches of shallow water.

ABBREVIATIONS USED IN STOCKING LIST

Sm.B. Small-mouthed Bass

Lm.B. Large-mouthed Bass

R. B. Rock Bass or Goggle Eye

Co.B. Calico Bass

Bg.S. Bluegill Sunfish

Map No.	Name of Stream	Tributary To	Section Surveyed	Date 1937	Length in Miles	Average Width	Depth	Velocity	Vegetation	Bottom	Pool Grade
1	Elkhorn Cr.	Russell Fk	Entire	7/27	27	25'	10"	Rapid	Common	Ru. Bo. Gr. Sa.	$S_2T_2F_3$
1	Beaver Cr.	" "	"	7/28	5½	6'	6"	"	"	Ru. Gr.	$S_3T_3F_3$
1	Ferrell Cr.	" "	Mouth to Abner Fk.	7/28	4½	5'	2"	"	"	Gr. Sa.	$S_3T_3F_3$
1	Marrowbone Cr.	" "	Enitre	7/28	11½	10'	6"	Sluggish	Rare	Gr. Sa. Ru.	$S_3T_3F_3$
1	Russell Fk.	Levisa Fk.	Va. line to Elkhorn City	7/26	3½	70'	3'	Rapid	Common	Ru. Bo. Gr. Sa.	$S_1T_1F_1$
1	" "	" "	Elkhorn City to Marrowbone Cr.	7/29	8½	80	2½'	Moderate	Rare	Ru. Bo. Sa.	$S_1T_2F_2$
1	" "	" "	Marrowbone Cr. to mouth.	7/31	4	80	2'	"	"	Gr. Sa.	$S_1T_2F_2$
2	Feds Cr.	" "	Entire	8/5	7	4'	2"	Rapid	Common	Gr. Sa.	$S_3T_3F_3$
2	Big Cr.	" "	Entire	8/2	6	3'	3"	"	Rare	Gr. Ru. Sa.	$S_2T_2F_3$
2	Lick Cr.	" "	Mouth to Road Fk.	8/6	5¼	5'	4"	"	"	Gr. Ru.	$S_3T_3F_2$
2	GrapevineCr.	" "	Entire	8/2	6¼	4'	3"	"	"	Gr. Ru.	$S_3T_3F_3$
2	Levisa Fk	Big Sandy	Va. line to Forks.	8/12	30½	85'	2'.5	Moderate	Common	Gr. Sa. Ru.	$S_1T_1F_1$
3	Greasy Cr.	Levisa Fk.	Entire	8/27	6½	6'	6"	Sluggish	Rare	Gr. Ru. Sa.	$S_2T_3F_3$

Shade	Game Fish Present	Degree Fished	Fish Recommended	Section to be Stocked	Miles in Section	Remarks
Good	Sm. B. Lm. B.	Light	None			
"	Lm.B.	None	"			
"	None	"	"			
Fair	Lm.B	Light	"			
"	Lm.B. Sm.B Pp.	Medium	Sm.B.	Entire	$3\frac{1}{2}$	Annually
"	" "	Heavy	SM.B. Lm.B.	"	$8\frac{1}{2}$	"
Poor	Lm. B.	Medium	Lm. B.	"	4	Biennially
Good	None	None	None			
"	Lm. B.	"	"			
"	None	"	"			
Fair	"	"	"			
"	Sm. B. Lm. B. Pp.	Heavy	Sm.B.Lm. B.	Entire	$30\frac{1}{2}$	Biennially. Natural Spawning, good.
"	None	None	None			

Map No.	Name of Stream	Tributary To	Section Serveyed	Date	Length in Miles	Average Width	Depth	Velocity	Vegetation	Bot
3	Upper Chloe	Levisa Fk.	Mouth to Rt. Fk	8/16	4½	3'	4"	Rapid	Algae common	Gr.
3	Shelby Cr.	Levisa Fk.	Mouth to Robinson Cr.	8/19	8	20'	1.5'	Moderate	Common	"
3	" "	" "	Robinson Cr. to Virgie, Ky.	8/18	7¼	17'	6"	Moderate	Rare	" "
3	" "	" "	Virgie, Ky. to Source.	8/18	13	8'	4"	Rapid	Rare	Gr.
3	Long Fk.	Shelby Cr.	Entire	8/26	11½	9'	8"	Moderate	Common	Gr. Ru.
3	Indian Cr.	Long Fk.	"	8/26	6¼	4'	2"	"	"	Gr.
3	Robinson Cr.	Shelby Cr.	Mouth to Little Fk.	8/21	8½	3	4"	"	Algae	Bo.
3	Island Cr.	Levisa Fk	Mouth to Long Fk.	8/18	7½	3'	5"	Sluggish	Common	Sa.
3	Levisa Fk.	Big Sandy	Forks to Pikeville	8/31	12½	144'	3.2'	Moderate	Rare	Sa.
3	" "	" "	Pikeville to Floyd Co. line	9/2	11½	135'	1.6'	Sluggish	"	Sa.
4	Mud Cr.	Levisa Fk.	Entire	9/14	14	9'	8"	Moderate	Common	Gr.
4	Little Mud Cr.	Mud Cr.	Mouth to Wolfpen	9/14	9	7'	4"	Sluggish	"	"
4	Toler Cr.	Mud Cr.	Mouth to Left Fk.	9/14	7½	6'	4"	"	"	"

…om	Pool Grade	Shade	Game Fish Present	Degree Fished	Fish Recommended	Section to be Stocked	Miles in Section	Remarks
…u.	$S_2T_2F_2$	Fair	None	None	None			
	$S_1T_2F_2$	Good	Sm.B. Lm.B.	Medium	Sm.B.	Mouth of Robinson Cr. to mouth	6½	Biennially
	$S_2T_3F_3$	Fair	Lm.B	Light	Stocking not recommended at this time			
Ru.	S_3T_3~~F_3~~	Good	Lm.B	Light	None			
Sa.	$S_2T_2F_2$	Good	None	None	None			
Ru.	$S_3T_3F_3$	Fair	None	None	None			
Gr.	$S_3T_2F_3$	Good	Lm. B.	None	None			
Gr.	$S_2T_2F_3$	"	None	"	"			
Gr.	$S_1T_1F_1$	Fair	Lm. B.	Medium	Sm.B.	Fks. to upper Chloe& Ford Br. Island Cr.	7	
Gr.	$S_1T_3F_2$	Poor	Sm.B. Lm.B.	Light	None.	Stocking Not recommended at this time		
Sa.	$S_2T_2F_2$	Fair	Sm.B. Lm.B.	Light	None	Serves as an excellent nursey stream. Natural spawning adequate.		
"	$S_3T_3F_3$	Good	None	None	None			
"	S_3~~T_3~~F_3	"	"	"	"			

Map No.	Name of Stream	Tributary To	Section Serveyed	Date 1937	Length in Miles	Average Width	Average Depth	Velocity	Vegetation	Bottom
4	Prater Cr.	Levisa Fk.	Mouth to Johnson Fk.	9/13	7	3'	2"	Rapid	Algae	Gr. Sa.
"	Beaver Cr.	Levisa Fk.	Mouth to Fks.	9/20	7	10'	10"	Sluggish	Common	Gr. Sa.
"	Rt. Beaver Cr.	BeaverCr.	Entire	9/21	37½	10'	8"	Moderate	Rare	Sa. Gr.
"	Caney Fork	Rt. Beaver	Mouth to Lick Br.	9/23	12	6'	6"	Rapid	Algae, Sa.	Gr. Ru. Sa.
"	Left Beaver	Beaver Cr.	Entire	9/20	30½	8'	8"	Moderate	Common	Gr. Ru.
"	Bull Cr.	Levisa Fk.	Mouth to Rt. Fk.	9/15	7	Dry				
"	Cow Cr.	Levisa Fk.	Entire	9/10	5	4'	2"	Moderate	Common	Gr. Ru.
"	Middle Cr.	Levisa Fk.	Mouth to Colie, Ky.	9/15	14	10'	8"	Sluggish	Common	Sa. Gr.
"	Left Fk. of Middle Cr.	Middle Cr.	Mouth to Caney Cr.	9/7	11	8'	6"	"	"	" "
"	Spurlock Cr.	Middle Cr.	Mouth to Conley Br.	9/7	7	6'	4"	"	"	" "
"	Levisa Fk.	Big Sandy	Pike-Floyd Co. Line to mouth of Beaver Cr.	9/9	13	134	2.5'	Moderate	Rare	Sa. Gr.
"	" "	" "	From Beaver to Abbott Cr.	9/16	12	147	2.3	"	"	" "
5	Johns Cr.	Levisa	Bevins Br. to Source.	9/24	18	12	8"	Moderate	Abundant	Ru. Bo. Gr. Sa.

3 3

Pool Grade	Shade	Game Fish Present	Degree Fished	Fish Recommended	Section to be Stocked	Miles in Section	Remarks
$S_3T_3F_3$	Good	None	None	None			Mostly Dry
$S_1T_2F_2$	Fair	"	Light	"	Stocking not recommended at this time.		
$S_1T_2F_3$	"	Lm.B.	"	"	" "	" "	" "
S_2T_3~~F_3~~	Good	None	None	None			
$S_2T_2F_3$	Fair	Lm.B.	"	"	Stocking not recommended at this time		
	Good	None	None	None			Dry
$S_3T_2F_3$	Fair	Lm. B.	"	"			
$S_2T_3F_2$	Good	Lm.B.	Light	None	Stocking not recommended at this time		
$S_2T_2F_2$	Good	none	none	"			
$S_2T_3F_3$	"	"	"	"			
$S_1T_3F_1$	Poor	Lm. B.	Medium	None	Not at this time.		
~~$S_1T_3F_1$~~	Poor	Lm. B.	"	LM.B.	From Cow Cr, to Prestonsburg.	7	Annually
$S_1T_2F_3$	Good	Lm. B. Sm. B.	Light	None	Natural spawning adequate.		

Map No.	Name of Stream	Tributary To	Section Serveyed	Date 1937	Length in Miles	Average		Velocity	Vegetation	Bottom
						Width	Depth			
5	Johns Cr.	Levisa Fk.	Bevins Br. to Sycamore Cr.	9/25	19	15'	10"	Moderate	Abundant	Gr. Ru. Sa.
"	Johns Cr.	" "	Sycamore Cr. to Dicks Cr.	10/6	17	21'	1.5'	"	Common	Gr. Ru. Sa.
"	Johns Cr.	" "	Dicks Cr. to Mouth	10/11	15	24'	1.5'	Sluggish	"	Sa. Gr.
"	Raccoon Cr.	Johns Cr.	Entire	10/1	11	8'	6"	Moderate	"	Sa. Gr.
"	Brushy Cr.	" "	Mouth to Forks.	10/5	11	3'	1"	"	"	Gr. Sa.
"	Brushy Fk	Brushy Cr.	Mouth to Little Br.	10/5	8	Dry				
"	Buffalo Cr.	Johns Cr.	Entire	10/7	11	Mostly Dry				
6	Abbott Cr.	Levisa	"	9/10	7	4'	3"	Rapid	Common	Ru. Gr. Sa.
"	Little Paint Cr.	Levisa Fk.	Mouth to Rt. Fk.	10/12	4	Mostly Dry.				
"	Paint Cr.	" "	Mouth to Fks.	10/22	20½	15	10"	Moderate	Common	Gr. Sa.
"	Little Paint Cr.	Paint Cr.	Entire	10/14	15	8'	5"	Rapid	Rare	Gr. Ru. Sa.
"	Open Fk	" "	"	10/13	14	5'	8"	"	"	Ru. Gr.
"	Mudlick Cr.	" "	Joes Cr. to Mouth	10/13	10	3'	3"	Moderate	Algae	Sa. Gr. Md.

4

Pool Grade	Shade	Game Fish Present	Degree Fished	Fish Recommended	Section to be Stocked	Miles in Section	Remarks
$S_1T_2F_2$	Good	Lm. B. Sm. B.	Medium	Sm.B. Lm.B	At Bent Br. &from Macks Br. to ~~Sycamore Cr.~~	9	Biennially
$S_1T_2F_2$	Good	Lm. B.	Medium	R.B. Lm.B., SM. B.	Entire	17	"
$S_1T_2F_2$	Good	" "	Light	Lm.B.	"	15	
$S_2T_3F_3$	Fair	Lm.B.	None	None			
$S_3T_3F_3$	Good	None	None	None			
	"	"	"	"			
	Fair	"	"	"			
$S_2T_2F_3$	Good	"	"	"			
	"	"	"	"			
$S_2T_2F_3$	Good	Lm. B.	Light	None	Stocking not recommended at this time		
$S_2T_2F_3$	"	None	None	"			
$S_2T_2F_3$	"	"	"	"			
$S_1T_2F_3$	"	Lm.B.	Light	"			

Map No.	Name of Stream	Tributary To	Section Serveyed	Date	Length in Miles	Average Width	Average Depth	Velocity	Vegetation	Bottom
6	Jenny Cr.	Paint Cr.	Mouth to Mill Cr.	10/15	15	6'	3"	Moderate	Common	Sa. Gr.
6	Toms Cr.	Levisa Fk.	Entire	10/19	13	6'	3"	"	" (Upper part)	Gr. Sa.
6	Greasy Cr.	" "	Mouth to Lick Br.	10/20	8	4'	3"	Rapid	Common	Gr. Sa. Ru.
6	Levisa Fk.	Big Sandy	From Abbott Cr to BuffaloCr.	10/18	18	189'	4.3'	Moderate	Rare	Sa. Gr.
6	" "	" "	Buffalo Cr. to Lawrence Co. Line.	10/25	12	182'	2'	Moderate	Common	Ru. Gr. Sa. Bo.
7	Nates Cr.	Levisa Fk	Mouth to Evans Fk.	12/1	7½	3	2"	Rapid	Algae	Gr. Sa.
7	Georges Cr.	" "	Entire	11/30	11¼	7'	6"	"	"	Gr. Sa
7	Griffith Cr.	" "	"	11/24	8	7'	6"	"	Rare	Gr. Ru.
7	Lick Cr.	" "	"	LL/27	10	10'	11"	"	Algae	Ru. Gr. Bo. Sa.
7	Levisa Fk	Big Sandy	Johnson Co. Line to Griffith Cr.	11/25	16½	202'	2.5	Moderate	Rare	Sa. Gr.
7	" "	" "	Griffith Cr. to mouth of Levisa.	11/26	9	253	8.7'	Sluggish	Rare	Sa. Gr. Ru.

Pool Grade	Shade	Game Fish Present	Degree Fished	Fish Recommended	Section to be Stocked	Miles in Section	Remarks
$_2T_2F_3$	Good	None	None	None			
$_2T_3F_3$	"	"	"	"			
$_3T_3F_3$	Fair	"	"	"			
$_1T_1F_1$	Poor	Lm. B.	Light	Lm. B.,B.C.	East Point to J.Brown Br.	5¼	Biennially
$_1T_2F_2$	Fair	Sm. B. Lm. B.	Medium	Sm.B., Lm. B.	mouth of Buffalo to Toms Cr.	5¼	Annually
$S\ T_3F_3$	Good	None	None	None			
$S_2T_2F_3$	Fair	None	None	None			
$S_2T_2F_3$	Fair	Lm.B.	"	"			
$S_1T_2F_3$	Good	Lm.B.	Medium	Lm.B. B.C.	Mouth up3/4 mile	3/4	Annually
$S_1T_2F_3$	Poor	----	Light	None			
Back-water from dam.	Poor	Lm. B.	Medium	Lm.B. Co.B	From Gallup, Ky to mouth of 3 Mile Br.	9	Biennially

Map No.	Name of Stream	Tributary To	Section Serveyed	Date	Length in Miles	Average Width Feet	Depth	Velocity	Vegetation	Bottom
8	Tug Fork	Big Sandy	Ky.-Va.Line to Blackberry Cr.	6/16	24	125	3.37'3	Moderate	Rare	Gr. Ru. Sa.
8	Tug Fork	" "	Blackberry Cr. to Williamson,W.Va	6/8	15½	125	1.25'	Moderate	Rare	Gr, Sa.
8	Tug Fork	" "	Williamson to Steep Br.	6/4	16½	135	1.5'	Moderate	Rare	Mostly sand
8	Knox Cr.	Tug Fork	Entire section in Ky.	6/1	8½	50	1'-10"	Moderate	Common	Ru. Gr. Bo. Sa.
8	Peter Cr.	Tug Fork	Mouth to Doty Br.	5/31	8½	38	10"	Moderate	Rare	Gr. Ru. Sa.
8	Right Fork of Peter Cr.	Peter Cr.	From main cr. to Ashlick Fk.	6/2	5½	11	4"	Rapid	Rare	Ru. Gr.
8	Blackberry Cr.	Tug Fork	Mouth to left Fk	5/27	7	10	3"	Moderate	Rare	Gr. Bo. Ru.
8	Pond Cr.	Tug Fork	Mouth to Mullen Fk.	5/23	9	20	8"	Moderate	Rare	Ru. Gr.
8	Blackberry Fk.	Pond Cr.	Entire	5/24	5½	9	4"	Rapid	Rare	Gr. Bo. Ru.
8	Big Cr.	Tug Fk.	Mouth to Long Fk.	5/26	7½	35	1'-2"	Moderate	Rare	Sa. Gr.
8	Big Cr.	" "	Long Fk to Road Fk.	5/25	8	18	6"	"	"	Sa. Gr. Ru.
8	Rockhouse Fk.	Big Cr.	Mouth to Middle Fk.	5/24	2	Dry				Gr. Sa.
9	Wolf Cr.	Tug Fk.	Mouth to Pigeon-roost Fk.	5/6	7	24	9"	Moderate	Rare	Gr. Sa.

Pool Grade	Shade	Game Fish Present	Degree Fished	Fish Recommended	Section to be Stocked	Miles in Section	Remarks
$S_1T_2F_1$	Fair	Sm.B., Lm. B.	Light	None.			See discussion of Tug Fork.
$S_1T_2F_2$	Poor	" "	Medium	"			
$S_1T_2F_3$	Poor	" "	Light	"			
$S_1T_1F_2$	Good	Sm.B. Lm.B.	Medium	Sm.B.	Entire region if this stream is opened to fishing.		
$S_2T_2F_3$	Poor	Sm.B.	Light	None.			
$S_1T_2F_3$	Good.	None.	None.	None.			
$S_3T_3F_3$	Poor.	Lm.B.	None.	None.			Not enough water to stock.
$S_2T_3F_3$	Poor.	"	"	"			" " " "
$S_3T_3F_3$	Fair.	"	"	"			
$S_2T_2F_3$	Good	Lm.B. Sm.B.	Light	None	Natural spawning adequate.		
$S_2T_2F_3$	Fair.	" "	"	"	" "	"	
	Good.	None	None	None			
$S_2T_3F_3$	Fair	Lm.B.	"	"	Not enough pool area for stocking purposes		

Map No.	Name of Stream	Tributary To	Section Serveyed	Date	Length in Miles	Average Width	Depth	Velocity	Vegetation	Bottom
9	Wolf Cr.	Tug Fk.	Pigeonroost Fk. to Meathouge Fk.	5/6	7	15	6"	Rapid	Rare	Gr. Sa.
9	Pigeonroost Fk.	Wolf Cr.	mouth to Hobbs Fk.	5/9	7	11	3"	Moderate	Common	Gr. Ru.
9	Emily Cr.	Wolf Cr.	Mouth to Roost Br.	5/9	2¼	12	4"	"	Rare	Gr. Sa.
9	Elk Cr.	Tug Fk	Entire	5/19	5	10	5"	Rapid	Common	Gr. Ru.
9	Rockcastle Cr.	" "	Mouth to Little Laurel Cr.	7/13	7½	32	8"	Moderate	Common	Sa. Gr.
9	"	" "	Little Laurel Cr. to Middle Fk.	6/20	10	36	7"	"	"	Gr. Sa.
9	Rockhouse Fk.	Rockcastle Cr.	Enitre	6/26	17½	15	4"	"	Rare	SA. Gr/
9	Mid dle Fk.	Rockcastle Cr.	Entire.	5/10	15	17	5"	"	"	Sa. Gr.
9	Coldwater Fk.	Rockcastle Cr.	"	5/20	14½	12	6"	"	"	" "
9	Tug Fk.	Big Sandy	Steep Br. to Buck Cr.	5/19	7½	130	1.7'	"	Rare	Sa. Some Gr.
9	Tug Fk.	" "	Buck Cr. to Calf Cr.	5/17	13	137	2.17'	"	"	Sa. Gr Bo.
9	Tug Fk.	" "	Calf Cr. to Rockcastle Cr.	4/26	12	155	2.91'	"	"	Sa. Some Gr., Bo.

Pool Grade	Shade	Game Fish Present	Degree Fished	Fish Recommended	Section to be Stocked	Miles in Section	Remarks
$S_3T_3F_3$	Fair	None	None	None			
$S_3T_3F_3$	Fair	Lm.B.	None	None			
$S_3T_3F_3$	Poor	Lm.B.	None	None			
$S_2T_3F_3$	Poor	None	None	None			
$S_2T_2F_3$	Fair	Lm.B. Sm. B.	Light	None			
$S_2T_2F_3$	Fair	Lm.B. Sm. B.	Medium	Sm. B. R. B.	From Albpha Br. to Petercave Br.	5	
$S_3T_3F_3$	Fair	Lm.B Sm.B.	None	None			
$S_1T_2F_3$	Fair	" "	"	"			
$S_2T_3F_3$	Good	" "	"	"			
$S_1T_2F_3$	Poor	Sm.B. Lm.B Sunfishes	Li_ht	None	See discussion of +ug Fork		
$S_1T_2F_2$	Fair	" "	"	"			
$S_1T F$	Fair	" "	"	"			

Map No.	Name of Stream	Tributary To	Section Serveyed	Date	Length in Miles	Average Width	Depth	Velocity	Vegetation	Bottom
19	Tug Fork	Big Sandy	Clifford to Locks	4/28	5¼	200	2.2'	Sluggish	Rare	Mostly Sa.
19	" "	" "	Locks to mouth	4/29	5¼	210	5.6'	"	"	Sa.
19	Big Sandy	Ohio	Forks to mouth of Blaine	4/20	7¼	225	6.9'	"	"	Sa.
19	Blaine Cr.	Big Sandy	Mouth to Fallsburg.	4/25	7½	50'	2'	Moderate	Rare	Sa. Sc. Gr. Ec
19	Blaine Cr.	Big Sandy	Fallsburg to Christmas	4/21	9	52	1.8'	"	Common	Sa. Gr Ru.
19	Blaine Cr.	Big Sandy	Christmas to Prosperity	4/30	12	45	1.4''	"	"	Sa. Gr
19	Blaine Cr.	Big Sandy	Prosperity to Martha	4/26	12	24	10''	"	Rare	Sa/ Gr
19	Upper Laurel Cr.	Blaine Cr.	The lower 3 miles	5/4	9	14	6"	"	Common	Gr. Sa Bo.
19	Lower Laurel	Blaine Cr.	The lower 4 miles	5/2	9	18	7"	"	"	Rm. Gr Sa.
19	Hood Cr.	Blaine Cr.	Lower 2½ miles	5/1	11½	15	6"	"	"	Gr. S
19	Bushy Cr.	Blaine Cr.	Mouth to Bear Br.	4/26	10	9	3"	"	"	Gr. S
19	Little Blaine Cr.	Blaine Cr.	Central Section	4/24	12	9	4"	"	Rare	Sa. G
19	Cat Creek	Blaine Cr.	Mouth to central section of both Fks.	7/9	9	14	5"	"	"	Sa. G.

Pool Grade	Shade	Game Fish Present	Degree Fished	Fish Recommended	Section to be Stocked	Miles in Section	Remarks
·1 T_2F_2	Poor	Lm. B. Sm. B.	Light	None	See discussion of Tug Fork		
ack water	Poor	" "	"	"			
"	Poor	" "	Medium	Lm. B.	At, and above mouth of Blaine 1 mile	1	
T_2F_3	Poor.	" "	"	None	This creek should not be stocked until it is cleared of its pollution. (Oil and brine water)		
T_2F_3	Good.	" "	Light	"	" " "	" " "	" " " "
T_2F_3	Good	" "	Light	"			
T_2F_3	Good	" "	Very light	"	Section heavily polluted		
T_2F_3	Good	" "	None	"	Not enough pools		
T_1F_3	Good	" "	Light	"	Natural spawning adequate		
T_2F_3	Good	" "	"	"	" "	"	
T_2F_3	Fair.	None	None	None			
T_3F_3	Fair	None	None	None			
T_3F_3	Fair	LM. B.	None	None			

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Pool Grade	Shade	Game Fish Present	Degree Fished	Fish Recommended	Section to be Stocked	Miles in Section	Remarks
	Poor	LM B. Sm. B.	Light	Lm.B.; B.C	Entire	$8\frac{1}{2}$	
$S_2T_2F_3$	Poor	Lm.B.	Light	None.			
$S_1T_1F_2$	Fair	LM.B. SM.B Pike	Medium	Lm.B Bh.C	Entire	16	
$S_1T_1F_2$	Fair	" "	"	"	"	10	
$S_1T_1F_2$	Good	" "	"	Sm.B. R.B.	"	12	
$S_1T_2F_3$	Poor	Lm. B. Pickerel	Light	None	Natural spawning adequate		
$S_2T_3F_3$	Fair	None	None	None			
$S_3T_3F_3$	Good	None	None	None			
$S_3T_3F_3$	Fair	None	None	None			
$S_1T_1F_1$	Good	Lm. B. Sm. B. Pike	Medium	Sm. B.	Enitre	10	
$S_1T_1F_2$	Good	" "	Light	" " Bg.S.;R.B	Entire	$4\frac{1}{4}$	
$S_1T_1F_3$	Good	" "	Medium	" "	"		
$S_2T_2F_3$	Good	" "	Light	None			

Map No.	Name of Stream	Tributary To	Section Serveyed	Date	Length in Miles	Average Width	Depth	Velocity	Vegetation	Bottom
10	Big Sandy	Ohio	From Blaine Cr. to Lett W. Va.	4/15	8½	240	6.8'	Sluggish	very rare	Sa.
11	Bear Creek	Big Sandy	Enitre	4/14	6	10	7"	Moderate	Common	Sa. Gr.
12	Tygart Cr.	Ohio	Mouth to Plum Cr.	10/21	16	40	1.5'	Sluggish	Common	Sa. Mud Gr.
"	Tygart Cr.	Ohio	Plum Cr. to mouth of Cub Run	10/18	10	44	2.2'	Moderate	Common	Sa. Gr. Mud. Ru.
"	Tygart Cr.	Ohio	Cub Run to Leatherwood Creek	10/17	12	38	2.5'	"	"	Gr. Ru. Sa.
"	Schultz Cr.	Tygart Cr.	Mouth to Bry Fk.	10/12	8½	8	6"	"	"	Gr. Sa. Ru.
"	Whiteoak Cr.	" "	Mouth to Stockum Br.	10/14	6½	8	3"	"	"	Sa. Gr.
"	Leatherwood Cr.	" "	Mouth to Smith Br.	10/19	3	6	3"	"	Abundant	Sa. Gr.
"	Three Prong Fk.	" "	Entire	10/19	7½	9	2"	"	"	Gr. Sa.
"	Tygart Cr.	Ohio	Leatherwood Cr. to Iron Hill Bridge.	10/11	10	40	2.5'	"	"	Gr. Sa.
13	Tygart Cr.	"	Iron Hill to Elk Cr.	11/9	4¼	30	1.8'	"	"	Gr. Ru. Sa.
"	Tygart Cr.	"	Elk Cr. to Jones Br.	11/10	9	32	1.5	"	Rare	Ru. Gr Sa.
"	Tygart Cr.	"	Jones Br. to Ollive Hill	11/12	6½	35	10"	"	"	Gr. Sa

Map No.	Name of Stream	Tributary To	Section Surveyed	Date	Length in Miles	Average Width	Depth	Velocity	Vegetation	Bottom
13	Tygart Cr.	Ohio	Ollive Hill to Flat Fk.	11/13	7½	20	8"	Moderate	Rare	Sa. Gr.
"	Soldier Fk.	Tygart	Entire	11/10	8	8	4"	"	"	Gr. Sa. Ru.
"	Smoky Valley Cr.	Tygart	Lower	11/16	9	10	4"	"	"	Gr. Ru
"	Buffalo Cr.	"	Mouth to Carter City	11/1	7	22	8"	"	"	Sa. Gr Ru.
"	" "	"	Carter City to Jordan Fk.	11/1	4½	14	5"	"	"	Gr. Sa
"	Grassy Cr.	Buffalo	Mouth to Nigger Hollow	10/30	5	6	2"	"	Algae	Gr. Sa
14	Kinniconick Cr.	Ohio	Mouth to McDowell Cr. Bridge.	10/5	6¼	78	1.5'	"	Common	Gr. Ru. Sa.
"	Kinniconick Cr.	"	McDowell Cr. to Pipe Lick Br.	10/6	12	63	1.9'	"	"	Ru. Gr. Bo. Sa.
"	Kinniconick Cr.	"	Pipe Lick Br. to Hamilton Br.	10/7	9½	51	2.3'	"	"	Gr. Ru. Bo. Sa.
"	Kinniconick Cr.	"	Hamilton Br. to Long Br.	9/23	9	48	2'	"	"	Ru. Gr Sa. Bo
"	Indian Cr.	Kinniconick	Mouth to Cooper Fk.	9/8	9	8	8"	"	"	Gr. Ru Sa.
"	Briery Cr.	"	Mouth to Straight Br.	9/7	6½	4	2"	Rapid	Algae	Ru. Gr Bo.
"	Straight Fr.	"	Mouth to Old House Br.	9/13	8¼	6	3"	Moderate	"	Ru. Bo

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Pool Grade	Shade	Game Fish Present	Degree Fished	Fish Recommended	Section to be Stocked	Miles in Section	Remarks
$S_2T_2F_3$	Good	Lm. B. Sm. B. Pike	Light	None.	The water that could be stocked is polluted.		
$S_3T_3F_3$	Fair	Lm. B.	None	None			
$S_2T_3F_3$	Fair.	None	None	None			
$S_1T_2F_3$	Good	Lm. B.B$Sm.	Light.	None.	Natural spawning adequate		
$S_3T_3F_3$	Fair	"	None	None			
$S_3T_3F_3$	Good	"	"	"			
$S_1T_1F_2$	Good	Lm.B.;Sm.B Pike	Medium	Lm. B. Bg.S	Entire	6¼	
$S_1T_1F_1$	Good	" "	Medium	Lm.B. Bg.S	"	12	
$S_1T_1F_1$	Good	" "	Heavy	Sm.B.; R.B.	"	9½	
$S_1T_1F_1$	Good	" "	Very Heavy	Sm.B.;Lm.B. R.B.	"	9	Stock annually
$S_2T_1F_3$	Good	Lm.B. Pickerel	None	None			
$S_3T_3F_3$	Good.	None	None	None			
$S_3T_3F_3$	Fair	Pickerel	"	"			

Map No.	Name of Stream	Tributary To	Section Serveyed	Date	Length in Miles	Average Width	Depth	Velocity	Vegetation	Bottom
14	Laurel Cr.	Kinniccnick	Mouth to Grassy Cr.	9/22	5½	40	10"	Moderate	Common	Gr. Sa.
"	Laurel Cr.	"	Grassy to Hamilon Br.	9/10	10	26	8"	"	"	Gr. Ru. Bo.
"	Grassy Cr.	Laurel Cr.	Mouth to Old Trace Fk.	9/9	9	16	5"	"	Rare	Gr. Ru.
"	Trace Fk.	Kinniccnick	Mouth to Rugless	9/20	7	7	3"	"	Algae	Gr. Sa.
"	McDowell Cr.	Kniinconick	Mouth to central section	9/20	6½	6	2"	"	"	Gr. Sa.
	Montgomery Cr.	"	Mouth to Rexton	9/21	6½	8	3"	"	Algae	Gr. Sa. Bo.

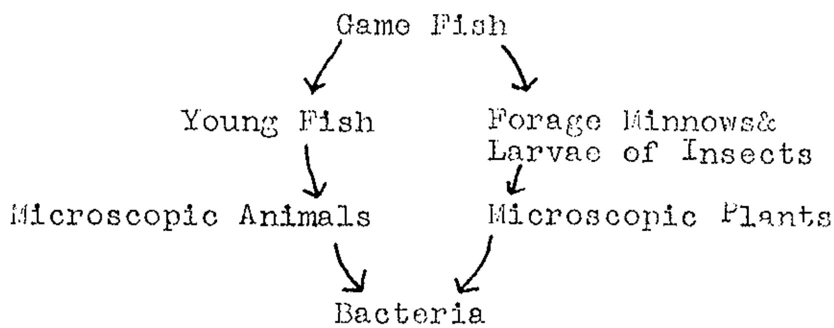
Pool Grade	Shade	Game Fish Present	Degree Fished	Fish Recommended	Section to be Stocked	Miles in Section	Remarks
S T F	Good	Lm. B. Pickerel	Light	None	Natural spawning adequate for		the present
S T. F	Good	" " Sm. B.	"	"			
S T F	Fair.	" "	None	None			
S T F	"	" "	"	"			
S T F	"	None	None	None			
S T F	"	"	"	"			

The Plankton

The Plankton

The occurrence of plankton in water has a definite and direct bearing upon the occurrence of fish life. By the term plankton is meant all the floating plants and animals in a given body of water which are microscopic. In fact the organisms are often so small that only one cubic centimeter of water may contain amny thousands. The microscopic plants are called phytoplankton while the microscopic animals are called zooplankton.

Few of our game fishes feed directly on phytoplankton, but the ones that do serve as excellent forage fishes. The zooplankton forms a major article of diet of young bass, bream, and crappie. The young bass feeds on zooplankton until it grows larger and changes its diet to insects and the like. These insect larvae eat microscopic plants, or animals forms which have eaten the plants. Many animals and plants are decomposed by bacteria, and the bacteria in turn are eaten by the microscopic animals which furnish food for the young fishes. Thus complete cycles are set up between adult fish and these microscopic organisms. Futhermore, the number of fish which a stream will support is directly related to the amount of plankton found in that body of water.



The organism which is pointed to by an arrow is eaten by the organism from which the arrow leads. Some micro-plants do not however feed on bacteria but use inorganic substances found in the water.

A study of the plankton samples taken from Tug Fork reveals that this stream contains little plankton, as compared with that of the other streams studied. In making recommendations for the stocking of any stream, the amount of food material present played an important a part in deciding whether the water should be stocked as did any other factor. The results of the counts made at each station on all streams is on file at the office of Division of Game and Fish

A list of the Plankton Found

MYXOPHYCEAE

Oscillatoria
Phormidium

BACILLARIEAE

Navicula
N. radisa
N.oblonga
Fragalaria
Tabellaria
Gyrosigma
Melosira
Amphora
Amphipleura
Stauroneis
Synedra
Pinnularia
Gomphonema
Frustulia
Cymbella
Meridion
Surirella
Stephanodiscus

CHLOROPHYCEAE

Pachycladon
Closteriopsis
Cosmarium
Closterium
Sphaeroples annulina
Gonatozygon
Mougeotia
Chaetophora
Spirogyra
Hyalotheca
Ankistrodesmus
Netrium
Sphaerella
Pleurotaenium
Sphaerocystis
Dictyosphaerium
Penium
Spondylomorum
Eudorina
Chlorococcum
Pandorina
Rhoicosphenia
Planktosphaeria
Gonium
Selenastrum
Ulothrix
Chlorella
Coelastrum
Oedogonium
Rhizoclonium
Oocystis

PROTOZOA

Vorticella
Paramecium
Urosoma
Euglena
E. siproya
E. viridis
Stylonichia
Leucophys
Eutreptia viridis
Trachelomonas
Chlamydomonas
Pleuromonas
Ramosonema
Actinophrys
Lepocinclis
Cyathomonas

NEMATODA

Chromadora
Trilobus

ROTATORIA

Proales
Synchaeta
Furicurlia
Anuraea
Trosphaera

Crustacea

Daphnia
Cyclops

General Recommendations

Fish management is now a live and growing field and for this reason the best practices now current in most progressive circles are bound to become obsolete as time passes. Fish constitute an importtant element in the aquatic resources of any state for many reasons. Some of the more important are that fish provide a large source of food, recreation, education, and research. Thus there is ever a growing demand from the people that every possible means be used in keeping our streams and lakes supplied with fishes.

Due to the removal of sand and gravel for the improvement of the roads over the drainage areas, many streams have been stripped of all their pools. Streams that at one time were known to contain many fish, now not only have had their fish driven out but during the summer months no water is to be found where once were good pools sections. Too because of the deforestation followed many times by destructive fires which have denuded the mountain sides of their forest growth, the water now rushes off the bare slopes causing a short but destructive flood. These floods scour the stream beds destroying shelter and food. As the present program of reforestation advances in the areas, the streams will improve somewhat.

Farmers living along streams should be induced to leave at least a 50 foot strip next to the stream in which no living tree or shrub would be cut.

Game wardons if furnished with thermometers and form sheets so that they might record temperatures of a stream from June to September could provide a large amount of valuable information as to our best streams, so far as the temperature factor is concerned.

Rather than release the entire number of fish alloted per mile at one station, it is believed better to divide the allotment into small groups so as to distribute them over the entire section.

It is fubther recommended that a questionnaire be prepared to accompany each lot of fish sent out for stocking purposes. From these forms complete information will be on hand about all fish released. The form sheets should have spaces for filling in the name of the stream, the exact place where released, number and kind released, date, approximate width and depth of the stream, type of bottom, etc. This should be signed by the game warden of the region and one or two other persons present when the fish are released.

KEY TO MAPS

.P NO.	WATERSHED	MAIN TRIBUTARIES OF WATERSHED AND SECTION OF RIVER
1.	Russell Fork	Shelby Cr. & Marrowbone Cr. From state line to forks.
2.	Levisa Fork	State line to forks of river.
3.	Levisa Fork	Shelby Cr. From Forks to Floyd Co. line.
4.	Levisa Fork	Mud Cr., Beaver Cr., and Middle Cr. From Pike Co line to Prestonsburg.
5.	Johns Creek	All of watershed except the lower four miles.
6.	Levisa Fork	Abbott Cr., Paint Cr., and Toms Cr. From Prestonsburg to Lawrence Co. line
7.	Levisa Fork	From Johnson Co. line to Louisa.
8.	Tug Fork	Knox Cr., Peter Cr., Blackberry Cr., Pond Cr., and Big Cr. From Virginia state line to Naugatuck, W. Va.
9.	Tug Fork	Wolf Cr. and Rockcastle Cr. From Naugatuck to Clifford.
10.	Big Sandy	Blaine Cr. Tug Fork from Clifford and Big Sandy to mouth of Blaine Cr.
11.	Big Sandy	From mouth of Blaine Creek to mouth of river.
12.	Tygart Creek	Lower section -- From mouth to Kehoe, Ky.
13.	Tygart Creek	Upper section -- From Kehoe to head of creek.
14.	Kinniconick Creek	Entire Creek.

EQUIPEMENT AND METHODS

Equipment and Methods

A. Equipment

Since the survey has been a one-man enterprise, it was considered desirable to use a trailer as a traveling laboratory. In this, all equipment necessary for field work could be carried and at the same time furnish living quarters.

The trailer idea proved to be a most excellent one, especially as to the ease with which one camp site could be changed for another. The equipment for use on any one day can readily be put in place and everything made ready to move in less than ten minutes. In many cases then, it is possible to pull out to the stream's bank, finish work in that locality, move and be ready for work the following morning in the new site. Thus, time is saved in not having to drive back to a more permanent location; furthermore, all equipment is on hand at a given station. This is especially desirable in water analysis.

The principal equipment for the survey was as follows: compass, anaeroid barometer, geological survey maps, thermometers, seines of various sizes, form sheets for recording data, hip boots and waders, rubber collapsible boat, and the various materials needed in making the chemical and other tests.

B. Methods

1. Dissolved Oxygen

The reason for testing for dissolved oxygen in a given stream is to ascertain whether it contains enough free oxygen to support fish life. A suitable environment is the very essence of existance for any organism, whether it be man or fish, since life depends on a proper exchange of essential substances between the organism and its surroundings. Several factors may influence the amount of oxygen present. Such factors are the decomposition of organic matter, the temperature, the amount of agitation which the water receives, etc.

The procedure used in collecting and testing the water is as follows: first, the temperature of the air and the water, the hour of collection, and the condition of the sky is recorded. For accurate work attention must be given to the barometric pressure, the normal pressure in the region being preferable to the specific pressure at the time of sampling.

The sample is collected in a 250 cubic centimeter glass-stoppered bottle. In order to avoid contaminating this water with air bubbles, the bottle is filled by pouring from a dipper through a funnel, to the bottom of which a rubber tube is attached, reaching the bottom of the bottle. At no time after pouring begins is the funnel allowed to empty itself because of the possibility of working bubbles through the sample. At least 500 cubic centimeters of water is poured through the funnel. This excessive amount washes out any air which the bottle may have contained. The tube is then withdrawn carefully so as to leave the bottle full of water; the stopper is inserted with care that no air bubles are caught beneath.

Having thus collected the sample, the stopper is removed, and by means of a pipette 1 ml. of manganous sulfate solution followed by 1 ml. of alkaline-iodide solution is added well below the surface of the liquid so as to avoid loss of precipitate on replacing the stopper. Replace the stopper immediately and shake the bottle well by inverting it several times so as to distribute the precipitate uniformly throughout the bottle. Unless a clear supernatant is obtained after a few minutes of rest, the dissolved oxygen in the upper part of the bottle has not been absorbed and the shaking should be repeated.

Allow the bottle to stand until the brownish precipitate has settled to the bottom. This usually requires from five to ten minutes. One ml. of concentrated sulfuric acid is then added and the bottle shaken.

From the time the manganous sulfate is added to the sample until the precipitate is dissolved by the acid, every precaution must be taken to avoid exposing the water to the air. Unless ferric salts or certain forms of organic matter are present, it is possible to delay the titration for many hours without interfering with the accuracy of the determination.

At this point it is possible to form some idea of the amount of oxygen present by noticing the various shades of brown color. This color is due to the iodine set free in the reaction which takes place with the dissolved oxygen. If a very dark color is obtained, a large amount of oxygen is present; while on the other hand, no color at all is noticed when all oxygen is absent from the sample.

Of the above solution, 200 ml. is transferred from the bottle to the flask and N/40 sodium thiosulfate is added from a burette until a color corresponding to a pale straw is produced.

Add 1 or 2 ml. of freshly prepared starch solution. The iodine present combines with the starch, producing a dark color. Titrate rapidly until the first disaapearance of the blue color.

If the volume of water titrated is equal to 200 ml. after acidification, the dissolved oxygen content in parts per million is equal to the number of milliliters of N/40 thiossulfate used, or

$$\text{p.p.m. of } O_2 = \frac{200 \times \text{ml. of N/40 thiosulfate}}{\text{ml. of sample titrated}}$$

For the percentage of saturation of dissolved oxygen, note in the table, page 153 of "Standard Methods" the oxygen in parts per million for the temperature of the water where the sample was taken. The number of ml. of thiosulfate used is then divided by the number obtained from the table.

$$\text{\% Saturation} = \frac{\text{ml. of N/40 thiosulfate used}}{\text{p. p. m. of } O_2 \text{ obtained from the table}}$$

2. Carbon Dioxide.

The same procedure is used in collecting the sample as in the case of oxygen. Because of the ease with which free carbon dioxide escapes from the water, the analysis should be made as soon after collection as possible.

A. Of the sample, 100 ml is placed in a tall narrow vessel, such as a 100 ml. Nessler tube. Add 10 drops of phenolphthalein indicator and titrate rapidly with

N/44 sodium hydroxide until a faint pink color is produced. The tube may be agitated from time to time distributing the color throughout.

The free carbon dioxide in parts per million is equal to ten times the number of ml. of N/44 sodium hydroxide used. The faint pink color produced should persist for at least three minutes.

p.p.m. of CO_2 = ml. of N/44 NaOH used x 10

B. Total Acidity

Pour 50 ml. of the sample into an Erlenmeyer flask and add 10 drops of phenolphthalein indicator. Place the flask over a white surface and add N/50 sodium hydroxide until the solution turns pink. The total acidity in parts per million of calcium carbonate is equal to 20 times the number of ml. of N/50 sodium hydroxide used.

In the examination of water coming from mines, the volume taken should first be diluted with recently boiled distilled water.

C. Hydrogen Ion Concentration

The hydrogen ion concentration is an expression of the intensity factors of acid or alkaline properties.

For our work in 1938 a S. D. C. Colorimeter was purchased to be used in determining the pH value of our streams. The colorimetric method depends on the use of indicators whose colors in solution are characteristic of the hydrogen ion concentration of the solution.

D. Methyl Orange Alkalinity

Place 50 ml. of the sample in an Erlenmeyer flask and add 2 drops of methyl orange indicator. Add N/50 sulfuric acid until a faint pink coloration appears. The methyl orange alkalinity in parts per million of ml. of N/50 sulfuric acid used multiplied by 20.

3. Total Hardness by Soap Method

The determination of hardness by this method roughly approximates the amount of calcium and magnesium in water.

The "Total Hardness Method", is used in selecting streams or portions of streams where the larger and more desirable forms of crustacean fish food are likely to be found, or may be cultivated. Crustaceans form a considerable part of the food of many fishes. In the hard waters, the crustaceans are larger and ofteh times more numerous than those found in the soft waters.

Of the water to be examined, 50 ml. is measured out into an 8-ounce glass-stoppered bottle. Add the standard soap solution from a burette in small portions. After severaldrops have been added, shake the sample violently for a time and note whether a lather forms. In the course of procedure any false end-point obtained may be assumed to be the dividing line between the calcium and the magnesium salts. The final end-point obtained is a lather which is permanent for a period of 5 minutes. To get the total hardness in parts per million of calcium carbonate, deduct the latter factor from the final burette reading and multiply the remainder by 20.

4. Microscopical Examination of Water

To collect the sample, a one liter bottle is thrust down about one foot beneath the surface of the water, mouth downward, with tthe stopper removed. The bottle is inverted and allowed to fill.

For concentrating the sample, the Sedwick-Rafter filter funnel is used. This is prepared by inserting the glass U-tube in the end of the rubber stopper, covering the wetted small end with a disk of bolting cloth, and placing the whole in the lower end of the funnel. Sand, such as white Berkshire, is poured into the funnel to form a layer one-half inch deep on top of the disk. Add 5 ml. of distilled water to wash down all the sand and to drive out the air.

From 250 to 1000 ml. of the sample is measured into a graduate to according to the density of microscopic organisms present and poured slowly into the funnel.

The water is allowed to filter into the sand and the sides are washed down with distilled water. As soon as all the water has passed through the sand, the funnel is transferred to a horizontal position and the stopper removed. Then the funnel is raised to a vertical position allowing the plug of sand to drop into a small beaker. The sides of the funnel are washed down with 5 or 10 ml. of distilled water which is collected in the beaker.

The sample is thoroughly mixed by a rotary motion, and by means of a pipette, 1 ml. is transferred to a call 20 x 50 x 1 mm. and cover glass applied.

Using a microscope containing a micrometer and a 16 mm. objective, the total count is made by enumerating all the organisms found in ten fields. If desired, the volume of the organisms is estimated at once in volumetric standard units and at the same time an estimate of amorphous matter may be made.

For the total number of organisms in one ml. -

n = the number of squares counted

t = the total number of organisms found in all of the squares counted.

v = the number of cubic centimeters of the sample filtered.

c = the number of cubic centimeters of water used in washing the sample.

The number of organisms per c.c. by this formula is

$$N = \frac{t}{n} \times \frac{1000 \quad c}{v}$$

The above procedure is used to indicate pollution by sewrage or industrial wastes, the progress of the self-purification of streams, the study of the food of fish, and to identify the sources of water that is mixing with another.