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Harvest of Wild and Stocked Fish From the Logan River Drainage

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HARVEST OF WILD AND STOCKED FISH FROM THE LOGAN RIVER DRAINAGE

by

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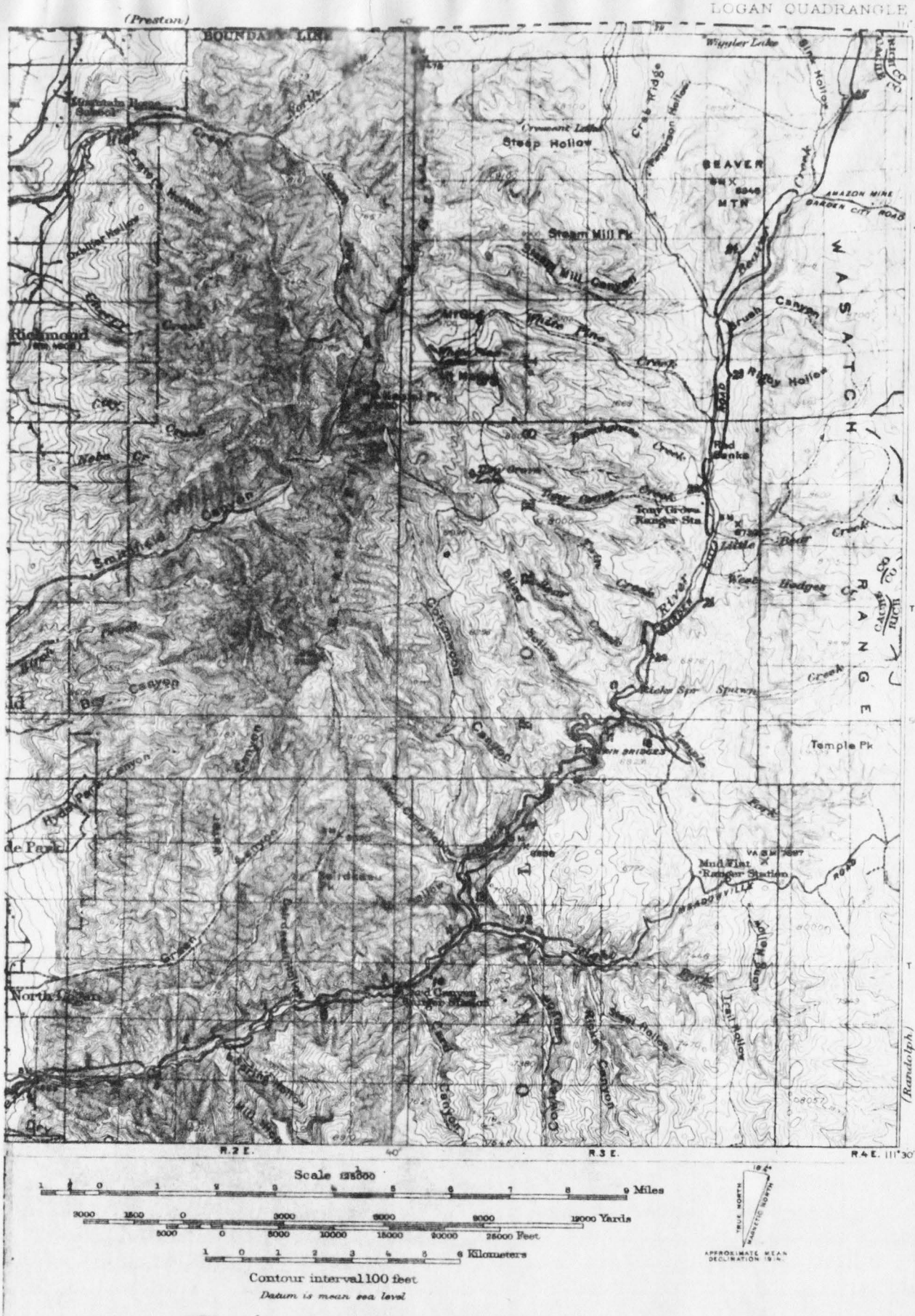

Frontspiece— The Logan River Study Area

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INTRODUCTION

Description of the Study Area

The Logan River heads in the southeastern corner of Franklin County, Idaho, and runs in a south and westerly direction. It enters the state of Utah through the northern boundary in the northeast corner of Cache County. The main stream is fed by two tributary streams which head in separate drainages a few miles apart. The Franklin Basin branch is the main contributing tributary while the Beaver Creek branch is nearly as large. The two tributaries join at a point about one mile south of Beaver Mountain which is six miles south of the Idaho state line. The stream then continues down Logan Canyon for some forty miles to the city of Logan. The headwaters enter Utah at an elevation of 8500 feet and drop about 4000 feet in the near 50-mile course to the state reservoir at the eastern city limits of Logan where the elevation is approximately 4500 feet. The gradient varies from approximately 35 feet per mile to 170 feet per mile on the main stream, while contributing tributaries reach a maximum gradient of 394 feet per mile in Spawn Creek. The extreme gradient for most of the stream and tributaries makes it mainly a white-water stream consisting mainly of riffles and swift channels with a minimum of pools. The average width of the river proper is approximately 38 feet with an average depth of 0.74 feet, which clearly shows the lack of pools, and is responsible for the very low average depth figure (Table 1).

The stream bottom is mostly boulders and rubble with occasional sand and gravel beds in the areas of lesser gradient or in areas sheltered against the main stream current. In many sections the stream runs through channels of solid bed rock with a few boulders strewn over the bottom. As a result of natural erosion, the impoundments are heavily silted in. The

city impoundment, because of its location, has probably suffered the most. Beaver dams in the upper reaches of the river are the only other places where silt in large quantities has settled.

The average velocity of the stream based on a yearly average is approximately 2.6 feet per second (Table 1). The greatest velocity is found in the Right Hand Fork tributary where it reaches 3.5 feet per second, and the lowest velocity is just below the city dam where it is 1.3 feet per second.

The Logan River drains an area of approximately 225 square miles of mountainous terrain composed chiefly of limestone and shale of the Paleozoic Age Brown (2) and Williams (39).

Beside the two main headwater tributaries, Right Hand Fork and Temple Fork are important both from the standpoint of water contributed and fishing furnished. These two tributaries add about twelve miles of fishable stream to the main river. Several other lesser side streams add little water to the stream and almost no fishing water. Some of the more important of these are White Pine Creek, Little Bear, and Spring Hollow.

The main stream of the Logan River is paralleled for about 25 miles by an asphalt all-weather highway which makes the stream readily accessible to anglers at any time. Four of the main tributaries are accessible by Forest Service roads. Although these roads are not generally passable when they are wet, they make it easy to reach the fishing areas back from the main stream when the weather is favorable. Approximately 20 miles of Forest Service roads are used extensively by anglers. It was estimated that these 40 to 45 miles of roads make approximately 70 miles of fishable stream in the study area which is all accessible. Even this is a rather false figure because the impoundments are measured the same as stream which does not give the proportional weight to these larger

Table 1. Arbitrary Divisions of the Logan River Drainage Employed in Collection of Creel Census and Car Count Data in 1949

Station Number	Major Division #	Description or Name	Miles from Dam Stations	Lgth. in mi. by road	Av. width in feet *	Av. depth in feet *	Av. velocity Ft./Sec. *	Gradient in feet/mi. *
2	1	First impoundment (state)	0	.5				
3		Power plant race into river to 2nd dam	.5	1.9	40.05	.73	3.11	35
4	1	Second impoundment	2.4	.4				
5	2	Second impoundment to third dam	2.8	1.3	26.00	.45	1.3	40
6	1	Third impoundment (city)	4.1	.8				
8	3	Malibu to Beirdneau Summer Home Area	5.4	1.0	48.30	.90	3.02	35
9	3	Beirdneau to Card R. S.	6.4	1.2	48.30	.90	3.02	35
10	3	Card R.S. to Preston valley picnic area	7.6	1.0	52.20	.79	2.08	55
11	3	Preston Valley Picnic area to Juniper Lodge Br.	8.6	1.0	52.20	.79	2.08	55
12	4	Right Hand Fork	9.6	1.85	10.70	.37	3.52	90
13	5	Juniper Lodge Br. to China Row	9.6	.8	41.90	.79	3.26	83
14	5	China Row to Jardine Juniper Trail foot	10.4	2.3	41.90	.79	3.26	83
15	5	Jardine Juniper Trail foot to Lower Dugway Bridge	12.7	1.4	41.90	.79	3.26	83
16	5	Lower Dugway Br. to upper Dugway Bridge	14.1	.8	41.90	.79	3.26	83
17	5	Upper Dugway Br. to Temple Fork road Br.	14.9	.7	41.90	.79	3.26	83
18	4	Temple Fork	15.6	2.6	14.00	.39	2.43	208
19	6	Temple Fork Road Br. to Ricks Spring Br.	15.6	.6	40.90	.65	2.98	100
20	6	Ricks Spring to Highway Cattle Guard	16.2	1.5	40.90	.65	2.98	100
21	6	Highway Cattle Guard to Tony Grove S.C. Br.	17.7	1.8	40.90	.65	2.98	100
22	6	Tony Grove S.C. Br. to Red Banks Br.	19.5	1.5	40.90	.65	2.98	100
23	6	Red Banks Br. to Franklin Basin Road Jct.	21.0	1.7	31.60	.66	2.33	80
24	7	Franklin Basin Road Jct. to Beaver Creek Road Jct.	22.7	3.6	9.20	.33	1.29	app. 200
25	7	Beaver Creed Road to Idaho Line	26.3 29.7	3.4	9.20	.33	1.29	app. 200
	8	Entire Stream or any Combination of Divisions						

*Brown (3)

≠For Analysis

water areas.

The Logan River, one of Utah's better trout streams, has carried more than its share of the increased fishing pressure of the past few years. Careful management of the drainage by the U. S. Forest Service has kept the Logan River free of serious water fluctuations and relatively unpolluted by silt and wastes. The only noticeable fluctuation in the stream is the annual runoff cycle which usually reaches its peak in May (Figure 1). This alone has contributed greatly to the ability of the river to withstand the increased fishing pressure which it has done quite well. The increase in fishing pressure can be better understood when it is learned that there has been a 500 per cent increase since 1920; and along with the increase in pressure came a relative decrease in the fishing waters for the state as a whole. If the Logan River is to continue to support the present army of anglers and retain a harvestable crop of fish for them, the management of the crop and the fishermen will have to be established on a sound basis.

Objectives of the Study

The chief purpose of this study is to contribute a share of knowledge to the sound management of, not only the Logan River, but to other similar bodies of water. Overlooking a single phase of management in such a delicate ecologically balanced area as this renders all other phases ineffective. However, there is much to be learned if the balance is to be maintained.

More people participate in fishing on the basis of total hours spent than any other single form of recreation. It appears that a large segment of the country's population depends on their favorite fishing hole for recreation and relaxation. To cope with this situation, State and Federal organizations are trying several methods to satisfy, at least

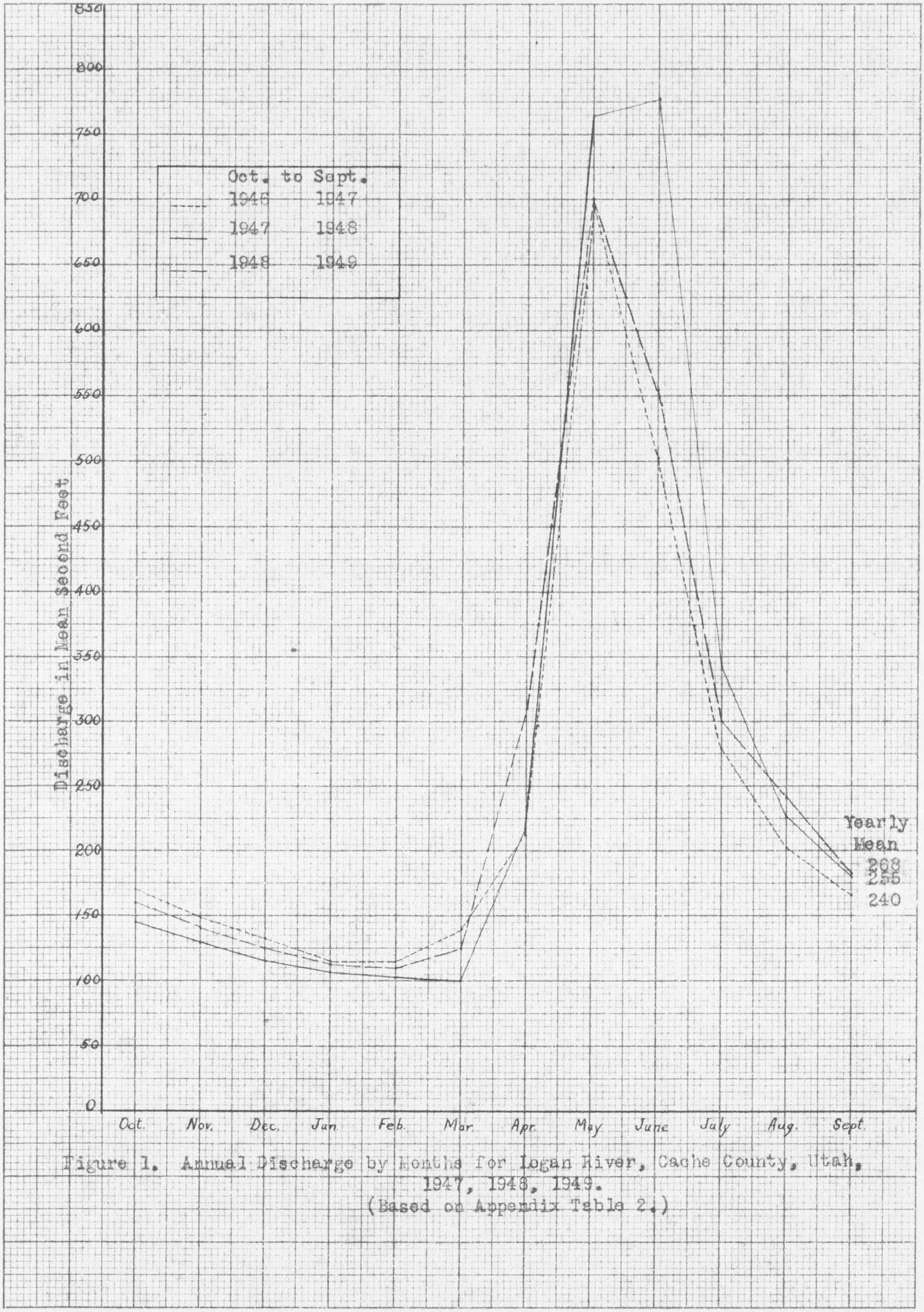


Figure 1. Annual Discharge by Months for Logan River, Cache County, Utah, 1947, 1948, 1949.
(Based on Appendix Table 2.)

partially, the wishes of millions of the country's anglers. The possibilities of habitat improvement are now gaining favor as a method of increasing the fish and game of the country. Until this method can be put into full use, the past practices of artificial propagation and planting of game and fish must continue. Any method that is employed to supply a few fish for all who angle is an expensive proposition; thus, it is to the advantage of those who have the task of supplying the crop for harvest to know all that is possible about that crop.

The second objective of this project is to learn whether or not the stocking program of the state is filling the order as the fishermen desire and how stocking should be handled to return the largest number of fish to the creel per dollar expended. What is the cost of the legal fish returned to the creels? The State Fish and Game Department will be interested in the results they are getting from the angler's dollar. The angler wants a certain amount of satisfaction for his dollar; that is, fish in his creel and a knowledge of how much his dollar contributes. The third interested party is the research men who want a practical, economical method of getting the answers desired by both conservation departments and anglers. A research phase in this problem is to find a satisfactory technique whereby the collection of data for such a study may be made practically and economically from the standpoint of both manpower and other costs.

Species of Fish Present

The Logan River study area contains six species of fish important to the management of the stream. The most sought after fish are four species of trout: the brown trout (Salmo trutta fario), rainbow (Salmo gairdneri irideus), cutthroat (Salmo clarkii), and brook trout (Salvelinus fontinalis). The fifth species, the Mountain Whitefish (Prosopium williamsoni) is of

considerable importance because of its competitive status with the more desirable trout. This fish abounds in the Logan River, especially in the impoundments and the deeper holes and channels of the stream. It is only rarely fished for, but it is occasionally taken by trout fishermen. The harvest certainly is not a decimating factor on the present population. The sixth species of fish, the bullhead or Belding's muddler (Cottus beldingii), is important as a source of food for the larger trout; however, it may be a food competitor of the trout. It is never taken by fishermen, but is occasionally used by anglers as bait for the very large trout. A seventh species, the smallfin redsided shiner (Richardsonius balteatus hydrophlox), found in a small section of one of the impoundments is of little or no known importance in the management of the river at present, but may prove so later. This assortment of species existing in the various types of water found along the length of the Logan River furnishes choice fishing to the many various types of anglers (Miller 18).

Scope of the Study

This project is divided into four separate and distinct phases which were necessary to arrive at the results. The development, operation, and presentation of findings are all the result of the first phase.

The initial step in any proposed project is to plan and map the procedure that is to be followed. Though not perfect, the results and methods used to obtain the results speak for the preparations that were made to carry out the study. The changes and improvements of procedure as the study progresses are also part of the first phase. That that phase of the project has not been neglected is indicated by improved methods, and new ones, described throughout this paper. The first phase actually defines the three phases that are to follow, and so it receives the greatest share of attention.

The second phase of the project is the marking and planting of the hatchery-reared fish which form the basis of the study. The second phase constitutes tagging or fin clipping all legal-sized fish that are planted in Logan River. This is an important step as it is one of the few instances wherein some control may be instated in the experiment.

The third phase is the car count, used mainly in determining the fishing pressure. This phase is of greatest interest to researchers and management as it offers the challenge of making a count of anglers and yet never actually seeing the angler. This situation presents itself on numerous streams and lakes where, if a satisfactory technique might be defined, a complete count of the angling pressure could be made.

The fourth phase in determining the harvest of wild and stocked fish from the Logan River, is the creel census. This is of value to a greater number of parties than is any other phase of the project. This phase is of interest, of course, to the angler whose creel is checked. He is interested in getting the fish in his creel; and if it remains empty, he wants to know why.. Phase four is of interest to the fishery management agencies who are operating the business, that is, to furnish fishing for those who want to fish. Lastly, this phase is of interest to the research agencies because it is needed to determine the harvest of wild and stocked fish from the Logan River.

REVIEW OF LITERATURE

Perhaps the most complex wildlife management problem today is the managing of streams and lakes to maintain fishing for the millions of anglers. Fish are probably the most difficult of wild animals to study. Their habitat is difficult to control because of its properties. Thus it appears that all problems pertaining to other forms of wildlife apply to fish with the addition of many others. With the great upsurge in numbers of anglers in the past ten years came the problem of supplying fish for them to catch. Many researchers have contributed their bit to aid in answering the problems.

Eschmeyer (8) has presented the objectives of fish management as "(1) to provide a maximum number of successful fishing trips without injury to future angling, and (2) to provide a fair distribution of the fish resources." He further presents the philosophy which he feels should be instilled into the fishing public if we are to successfully fulfill the objectives mentioned.

1. "Fishing should be regarded as a way to relax; it should no longer be directed toward getting meat for the table.

2. "Lakes and streams are really pastures. Fish are a crop. We must take the same rational viewpoint toward aquatic pastures that we take toward land pastures.

3. "The job of managing these publicly owned aquatic pastures, and of insuring continuous crops to their thousands of owners should be in the hands of experienced fishery managers. The job is a complicated one, involving an understanding of fish, fish habitat, and humans. These facts are quite well accepted as such among fishery workers and only now is the picture

being placed before the public with emphasis for acceptance. It must be that way, but the program should have been started long ago. Fishery investigators are now hard put to answer the flood of questions that need answering."

The problem is with the fish, so Bardach (1) suggested that we use the fish to supply the answer. This is well for the questions concerning only the fish, but there are other equally important questions concerning man and his influences on the fish. Greeley (13) declared that depletion by man is in a sense difficult; but when we consider the sum total of population pressures, man can upset badly the production of game fish. So it seems that the answers must come from a number of sources.

To recognize an individual fish, as such, is a most difficult task unless some identification can be attached to it. Some answers have been found to this problem as suggested by Rounsefell and Kask (26) and Shetter (28) whose procedure was followed to a certain degree in this study. The marking of planted fish has been done in many ways and for many reasons. Cobb (4) tagged fish for the purpose of determining their migrations and the results of the plants on the fishing success as it supplemented the wild stock. The success of planting various sized fish has been studied by marking the fish in question as Shetter (29) studied the return to the creel of planted fingerling trout. Shetter and Hazzard (30) studied the returns to the creel of marked legal-size fish planted in Michigan streams and lakes. Workers in West Virginia have discovered the percentage of returns of marked trout to the creel in a study just completed by Seaman and Stephens (27). The main interest seems to be the various ramifications of stocking fish, which is one of the main purposes of this study. Marking for identification may have important repercussions on the fish other than

those presently recognized. Markus (17) has studied the effects of tags on fresh water fishes while Shuck (32) showed the effects of jaw tagging on the condition of the trout. The removal of fins, their replacement, and the effects on the growth of trout so marked has received some attention from Wales (38) and Heacox (15). The growth and survival of spiny-rayed fish as affected by the removal of fins is a contribution of Ricker (25).

The dynamics of fish populations has been given considerable attention by both biologists and statisticians. Viosca (37) has labeled the statistics on the productivity of inland waters as the master key to better fish culture. This sutdy as well as many others have used Snedecor's (33) book on Statistical Methods as a guide to the study and analysis of fish populations. Ricker (24) devoted much thought and study in developing statistical methods applicable to fish populations. To give satisfactory interpretation to data collected and analyzed has been a problem among all experimenters. Mottley (19) has presented the statistical analysis of creel census data for fishery workers. De Lury (5) presented many suggestions and considerations that must be taken into account when estimating biological populations. Many studies of populations are confronted with distribution curves. In this study, as in others, the Poisson frequency distribution is met. From Ricker (23) and Garwood (11) the application and use of this tool of statistics in the analysis of fishery data are invaluable. Embody (7) presented a method of estimating the number of fish in a given section of stream; a statistic of interest to anglers, management agencies, and research workers.

Due to the habitat in which fish live, fishery workers have found it difficult to handle them without frequent injuries to the fish. Capturing,

transporting, marking, planting, taking spawn, and artificially propagating all require a certain amount of handling of the fish. Such handling necessitates a great amount of precaution and measures of care if the fish are to survive. Foster (10) and Gerking (12) have presented methods and materials for use as an aid in eliminating the injury to fish that must be handled. The techniques have paralleled the methods used on human beings, and the results have been equally as successful. The use of anesthetics on fish, though comparatively recent, has been a contribution of great value from the point of reduction of injuries to the fish and from the point of expediting and increasing the efficiency of handling the fish.

Since the planting of fish is one of the best answers to putting a few more fish in the creel at the present time, there is the question of when, where, and at what size to plant these fish. Surber (34) made an ecological study of the relations of the rainbow and the bottom fauna of one mile of stream, and Shetter and Leonard (31) made a similar study of the populations of fish in a limited section of a Michigan stream. Test streams were set up by Randle and Cramer (22), Needham and Rayner (20), and Needham, Moffett, and Slater (21) to study the best habitats of trout and the best season of the year in which to stock fish for the greatest economic returns. In Colorado Hess (16) reported the best returns from fish planted in April and May. It appears that stocking of legal-size fish just prior to and during the fishing season returns the greatest number to the creel. However, the most suitable species, and where to plant them has not been so generally established. Hazzard and Shetter (14) learned the difference in the success of planting rainbow and brook trout. If the trend is away from artificial propagation and stocking toward improvement of habitat, it is evident that more detailed ecological studies of fish

habitat are necessary; and this shall have to be worked out for each section of the country and for nearly every stream in the country. Likewise the requirements of each species of fish are different so what is optimum for one species may prove quite unsatisfactory for another. This will be met when the life histories of the various species have been compiled and understood from every biological angle.

The alterations of fish habitats by man must be studied to allow a change in species, numbers, harvest, and all other factors influencing the fish and influenced by the fish. T. V. A.'s Eschmeyer (9) presented the fisheries picture as the Tennessee Valley Authority affected it. A ten-year study of trout on a National Forest which revealed some of the effects of watershed alteration, was explained by Chamberlain and Huber (3). Edwards (6) revealed what he believes were the effects of nearly uncontrolled fishing on the Russian River in Alaska. Tarzwell and Miller (35) measured the fishing intensity on the lower T.V.A. reservoirs which certainly has changed with the impoundment of waters. The Missouri River Basin Studies are making and compiling extensive surveys and reports of the changes brought about by man's diverting, impounding, and otherwise changing the habitat of fishes on the Missouri River Drainage.

Some of the contributions of the above mentioned authors were utilized in this study. Some were used intact while others were revised to meet the situation confronting the execution of the study. Practically every problem is present on the Logan River. This makes it an ideal study stream. The river has a variety of fish, supports a heavy fishing pressure, is located in a forest that is being utilized, runs through a variety of aquatic environments, has three power and irrigation impoundments that have

altered its natural course, and it is stocked by artificially propagated fish. Of course, all of these factors cannot be considered in a single study; but all must be recognized if a single phase of management is to be successfully analyzed and understood.

MARKING AND STOCKING

Procedure

The number of stocked fish are the basis for the analysis of the creel census and total harvest each year. Identification of these fish from wild fish is not left to chance; but to insure accurate recognition, all hatchery-reared fish stocked in the Logan River were either tagged or fin clipped. This was the first phase of the field work for the 1949 study, as it also was in 1948. On June 4, 1949, a crew of five or six men began marking all of the fish to be planted in the river. This work was sporadic throughout the entire fishing season in order to replenish the supply when the previous plants were depleted by anglers. Based on the success of the 1948 tagging, the tags were again applied to the lower jaw of the fish. Several improvements in the tagging technique were instigated in 1949 as well as the use of a different type of tag.

The tags used for the 1949 marking were a small circular band-type of strap aluminum alloy, 3.75 mm. wide, and when closed around the lower jaw of the fish were seven to eight mm. in diameter (Figure 2b). The tag is applied with a special applicator made by altering a cheap pair of ordinary pliers. The pliers of the type used in this operation are of stamped sheet steel. The jaws of the pliers are about four mm. wide; and by simply drilling a hole through the jaws, half of the hole in each jaw, a very workable tool was made that fit the tag and securely fastened it around the fish's jaw (Figure 2a). By providing a slight offset in the jaws of the applicators, the ends of the tag were made to overlap slightly which made loss of the tags by the fish nearly impossible (Figure 3).

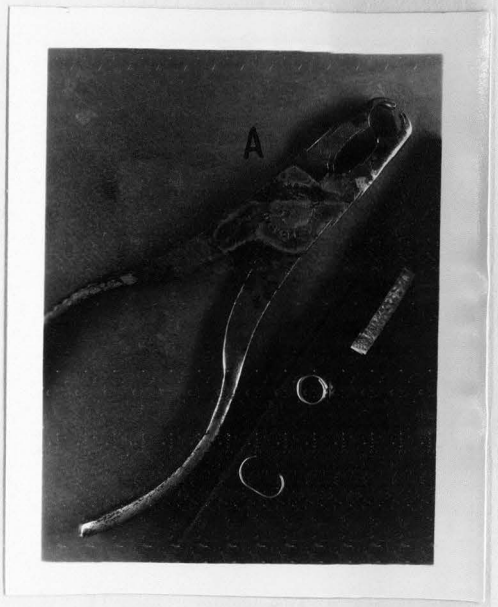


Figure 2.
a. Applicators for applying circular jaw tags.
b. Tag opened in preparation for application.
c. Tag as applied (Note overlap).
d. Flattened band.
(.6 actual size)

Figure 3.
Fish with tag applied around mandible.
(.6 actual size)

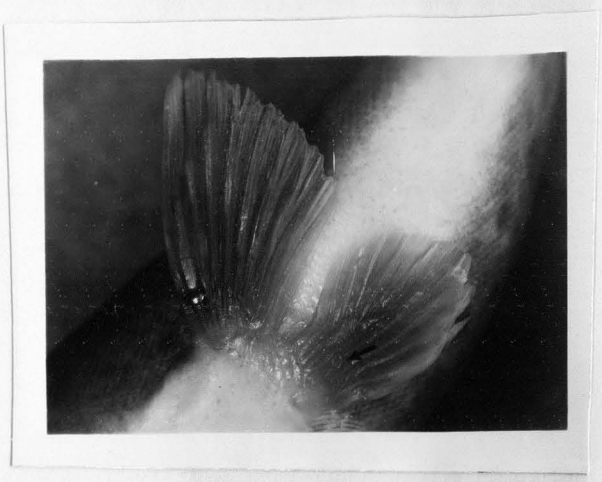


Figure 4.
Regenerated left pelvic fin, seven to nine months after clipping. (Note irregular margin and line of severance indicated by arrow).
(Actual size)

This type of tag attached correctly was quite satisfactory since it is very noticeable and requires no extra effort to locate it. It cannot be overlooked by the angler when he removes the hook from the fish's mouth. This must always be considered when no prizes other than the fish are received by the anglers for reporting the recovery of the tag. Returns on this type of tag were high; and as there were no prizes for the return of the tags, the success may be attributed to probably three main reasons. First, the project received considerable publicity on its inauguration in 1948 and reminders were again put out in 1949. Second, there are a certain number of sportsmen that are curious enough and interested in the project to expend some extra effort in seeing that the tags are turned in to the proper persons. And third, constant vigilance on the part of the project personnel increased the returns of the tags as it relieved the anglers of any effort required to report the tags.

The tagging procedure followed in 1949 was very similar to that used in 1948. Usually two crews of three men each worked simultaneously. One man on each crew did the tagging as the second man held the fish and measured it after it was tagged. The third man recorded the tag number and the length of the fish to the nearest quarter inch. The third man was also responsible for overseeing the anesthetizing of the fish which was one of the improvements in the tagging technique.

Anesthetizing added considerably to the efficiency of the tagging and clipping operation. The anesthetic used was ethyl carbamate (NH_2 CO OC_2 H_5) in crystalline form mixed with 5000 ppm. of water. Not only does anesthetizing the fish increase the efficiency of the operation, but it reduces the danger of injury to the fish. The anesthetic itself is

not dangerous to the fish. They are immersed in the solution for two or three minutes just before they are marked. Some fish were left in the solution for ten minutes to determine a maximum sub-lethal time of immersion, but all of the fish recovered with no bad effects. In the standard solution the longer the fish are left immersed, the longer is the time required for them to recover. The stronger the solution the longer is the time required for the fish to recover if left immersed for the same length of time. Continued use of the anesthetic reduces the strength as it is diluted each time a new net of fish is anesthetized. With a little experience in the use of the anesthetic, the proper length of time of immersion in the various strengths of the solution can be readily recognized, primarily by the activities of the immersed fish.

The actual process through which the fish are taken from the hatchery rearing ponds until they are planted in the river is a simple standardized method that was followed to conserve time and effort. Two or three men seined the fish from the rearing ponds and placed them in a wire mesh holding box which rested on the floor of the rearing pond. From this holding box the fish were removed by large dip nets and immersed in the anesthetic. When it was determined that the fish were anesthetized to the point where the taggers could handle them, the fish were removed from the anesthetic and given to the workers. After the fish were marked, measured, and the data recorded, they were then placed in a second wire mesh holding box also resting on the floor of the rearing pond. Here the fish were retained till seven or eight hundred were marked; then they were transferred to the tank-truck for transportation to the stream.

There are certain precautions that must be taken when marking fish, whether it is by tagging or fin clipping. Care must be taken when applying the jaw tags to avoid piercing the fish's tongue with the tag or pinching it between the jaws of the applicators. Also the tag should be so placed that it pierces the thin tissue just median to the anterior point of the mandible and not through the flesh at the base of the tongue or through the bone of the mandible. When clipping fins, proper instruments are important. Scissors with serrated edges work best on soft-rayed fins. The fin should be clipped at its attachment if regeneration is not desirable. For a study to cover several seasons, fins not clipped close and clean will be regenerated; and even though an experienced person may recognize the regenerated part, it is not easy. If complete removal of the fin is made, the wound will heal over smoothly with perhaps only a slight projection appearing under the scar. If incomplete removal is made, the fin will regenerate; and only careful scrutiny will reveal the line of severance, an irregularly shaped margin with distorted unparallel rays in the new organ. (Figure 4).

Using the above described marking procedure, two crews can easily tag and plant 2000 to 2500 fish per day. Fin clipping is a much faster and simpler procedure, and two crews can clip 6000 to 7000 fish in a day. The main factor influencing the efficiency of the marking operation is the temperature of the air and the water in which the men must work. While warmer temperatures are better for the men, it is harder on the fish.

Stocking: A total of 16,127 marked fish were planted in the Logan River during 1949. Twelve fish escaped into the stream without being marked. However, a load, estimated at 1000 unmarked fish, was planted into the

river by persons not informed of the project. This makes a total of 17,139 fish planted in the river during 1949 (Table 2).

Of the total marked fish planted, 10,784 were fin clipped and 5,343 were tagged. All marked fish were rainbows with the exception of 184 brown, five of which were tagged and 179 fin clipped. Thus, 5,338 rainbows were tagged, of which 402 also had the right pelvic fin removed to give a check on possible tag loss during the season. The 10,784 fin clipped fish had the left pelvic fin removed to distinguish from the 1948 fin clipped fish which had the adipose fin removed. All of the fish were planted prior to or during the regular trout fishing season of June 11 to October 3, inclusive, with the exception of 396 rainbow and five brown which were tagged and planted seventeen days after the close of the season. The postseason plant will be used in the 1950 study and will not contribute to the 1949 study. They will be used to contribute data to the determination of the survival and vulnerability to the angling of the next season.

In addition to the marked fish that were planted from the hatchery, 436 wild fish taken from the stream by means of the electrical shocker (Thoreson (36)) were also tagged and returned to the stream at the point of removal. These fish do not figure in the return of planted fish in the creels but were counted as wild fish. The purpose of the operation was to establish certain fish for an age and growth study that is being compiled at the present time. The records of these wild marked fish may later be used in a fish movement study.

Table 2. Trout Planted in the Logan River Study Area, Cache County, Utah, 1949.

Pre-season and in-season plants.		
Rainbow		
	Tagged Only	4,540
	Tagged and Clipped Right Pelvic	402
	Total Tagged	4,942
Rainbow		
	Clipped Left Pelvic	10,605
Brown		
	Clipped Left Pelvic	179
	Total Clipped	10,784
Rainbow		
	Fish Escaped Unmarked	12*
	Fish Planted Unmarked (Est.)	1,000*
Total Pre-season and in-season plant.		16,738
Postseason Plant		
Rainbow		
	Tagged Only 396	
Brown		
	Tagged Only 5	
		401**
TOTAL FISH PLANTED IN 1949		17,139

*Treated as Wild Fish in Creel) Not used in Harvest Calculations.
**Not Subject to 1949 Fishing)

RESULTS

Automobile Estimate

Procedure: Fishing pressure as used in this study is defined as the number of anglers pursuing the legal stock of fish available in the study area of the Logan River drainage. Since the number of anglers using the stream makes it impossible to contact each individual or even each party, the following method has been devised to make it practical for any agency desiring such information to secure it at a minimum expenditure of time and money. The procedure followed during the 1948 and 1949 seasons is not practical for any agency other than a research organization, because of the enormous sample taken. However, the statistical design did not permit a satisfactory check of the accuracy of the total fishing pressure. The large sample gives a certain increased measure of accuracy over a smaller sample. One of the objectives of this study is to devise a technique for determining the accuracy of the estimate of the number of fishermen, and to establish a minimum sample within the limits of predescribed accuracy.

The technique used for estimating the total number of fishermen in this study was essentially the same as that used in 1948 for the purpose of establishing the variable fishing pressure exerted throughout the day (Figure 5 Thoreson 36). The legal 16-hour fishing day was divided into four 4-hour periods. The number of periods, arbitrarily set at four was influenced by previous experience that the average fisherman day was approximately four hours. These daily divisions aid in taking and compiling the data. These periods are designated as follows, and as a matter of convenience:

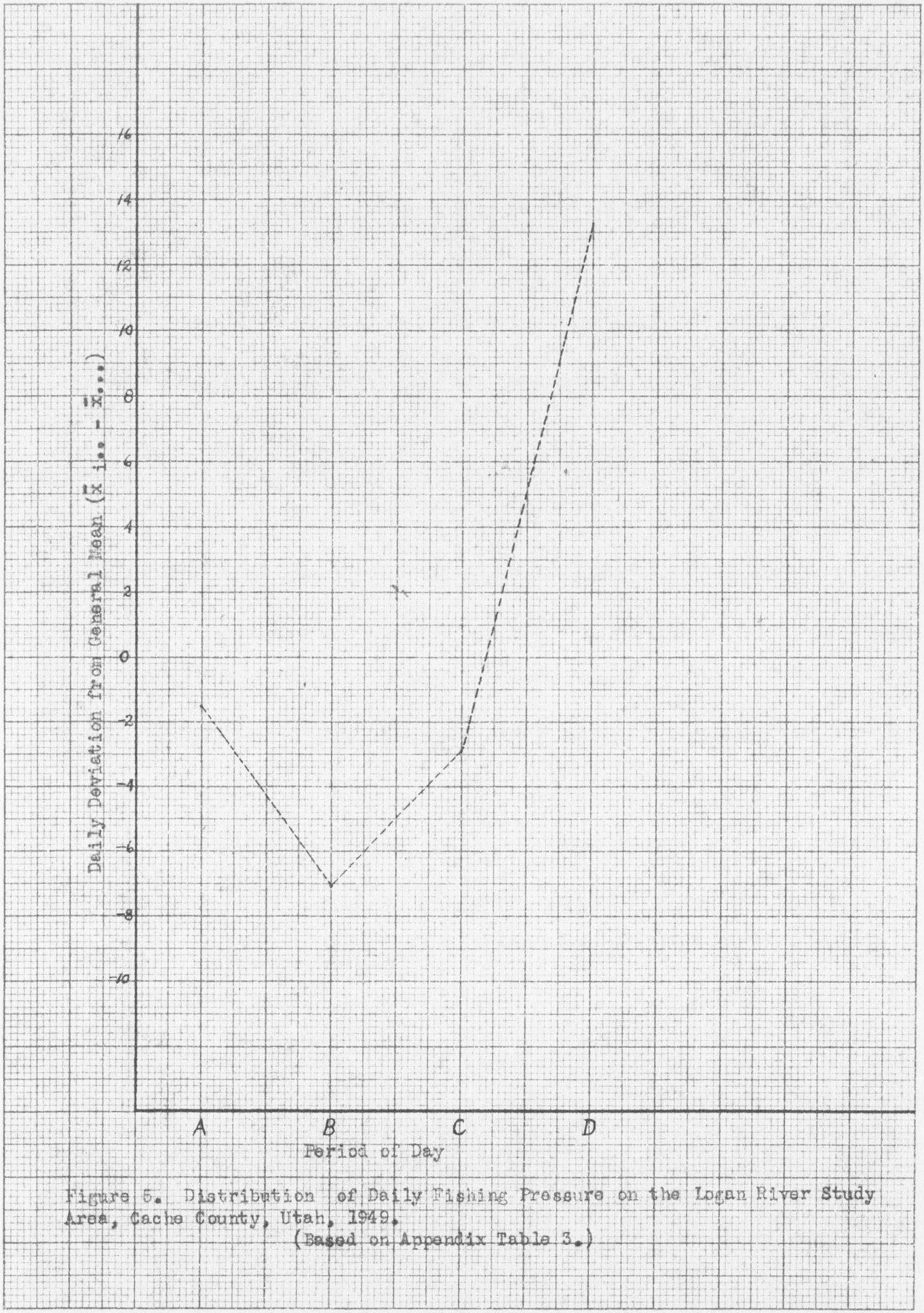


Figure 5. Distribution of Daily Fishing Pressure on the Logan River Study Area, Cache County, Utah, 1949.
(Based on Appendix Table 3.)

Period A	5 a.m. to 9 a.m.
Period B	9 a.m. to 1 p.m.
Period C	1 p.m. to 5 p.m.
Period D	5 p.m. to 9 p.m.

The second variable is an obvious one to even the most casual observer. The weekly variation in fishing pressure is influenced by the day of the week. Saturdays, Sundays, and holidays carry the greatest fishing pressure as the anglers tend to relax after their regular work week, during which they spend only a minimum amount of time fishing (Figure 6).

The third variable in fishing pressure is the seasonal trend. To aid in determining this trend the fishing season, June 11 to October 3, inclusive, was divided into ten two-week intervals, excluding opening day and the last three days of the season. Opening day is considered an interval because of the unusual fishing pressure, the success, and possibly other factors (Figure 7).

The fourth variable in the estimated total number of cars is the place fished. For the purpose of reference, the entire study area of the Logan River and its tributaries are divided into sections--twenty-five in all. As two of the sections were impractical to include in the study, only twenty-three were used. The sections were selected arbitrarily, using obvious landmarks as division points (Table 1). In 1948, this variable contributed to the square from which the sample was taken (Thoreson 36); but due to the number of sections which must be weighted according to their length, accessibility, etc., This method was not used in 1949, but was considered in its entirety. The sections varied in length from

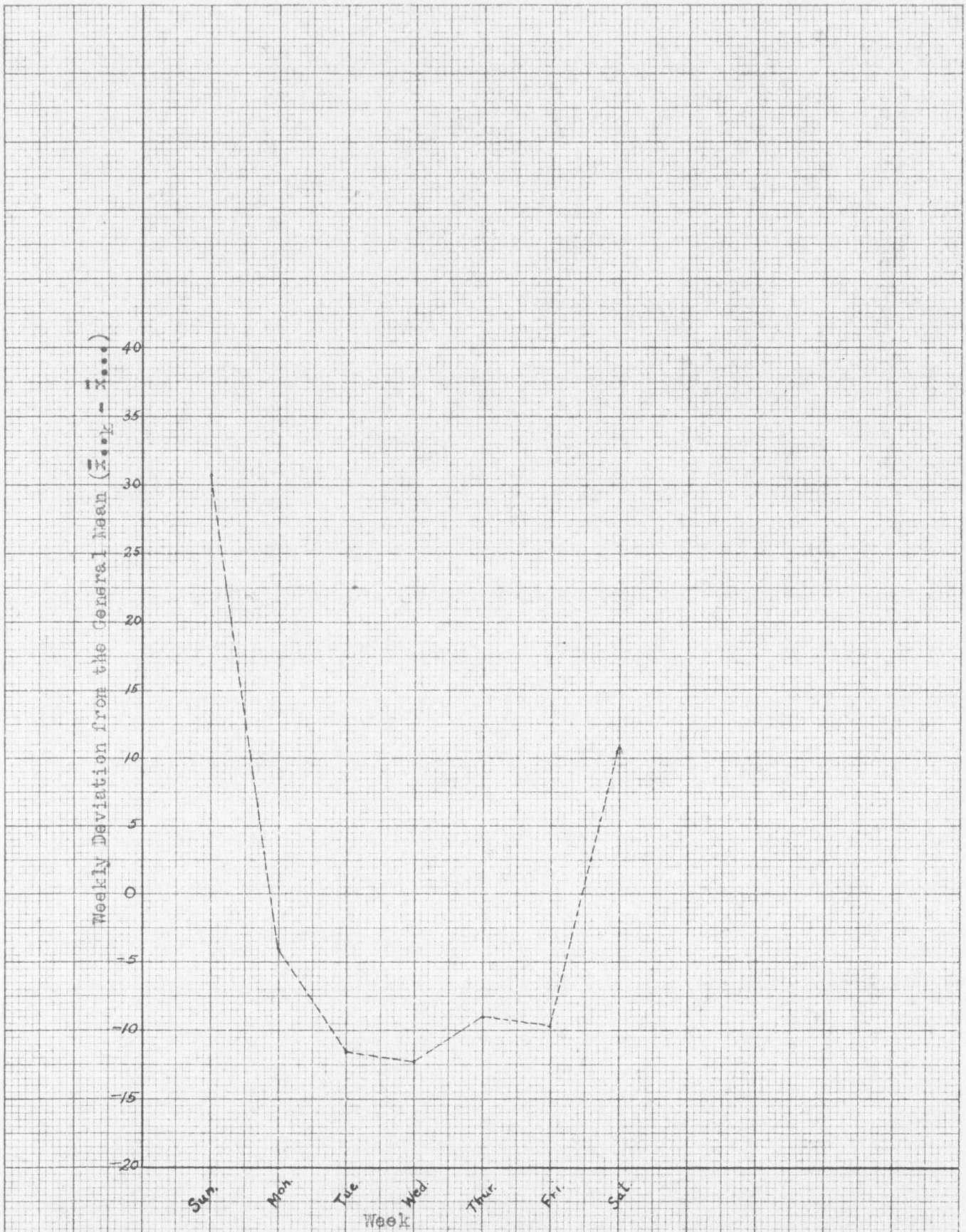


Figure 6. Distribution of Weekly Fishing Pressure on the Logan River Study Area, Cache County, Utah, 1949.
(Based on Appendix Table 3.)

0.4 miles to 3.6 miles. The length of car miles in the study area is about forty.

The impracticality of such a survey may better be understood when we calculate that the checks made for this study involved traveling approximately 10,000 miles and required about 500 man-hours excluding time spent on the creel census.

The number of anglers' cars along the river at any given time is dependent upon the first three variables just mentioned, that is, the period of the day, the day of the week, and the interval of the season. As it is nearly impossible and certainly impractical to count the cars along the river during each period of every day of the fishing season, the feasible method is to take a sample number of counts. A sample leaves a number of periods not represented with a car count, which omissions must be estimated to attain a total car count figure. By using the sample counts as a guide, it is possible to estimate the number of cars that would ordinarily be present on the stream at the particular time for which the estimate is made.

Assuming that the sample of the periods of the day is representative of all the periods, the sample of the seasonal intervals is representative of all the intervals, and the sample of the days of the week is representative of all the days during the season, one may then use the following procedure in estimating the number of cars along the river at any period.

An estimate of the number of cars along the river at any given period is equal to the sum of the averages of the ith period of the day plus the jth interval of the season plus the kth day of the week minus twice the general mean. This may be represented symbolically by the following formula:

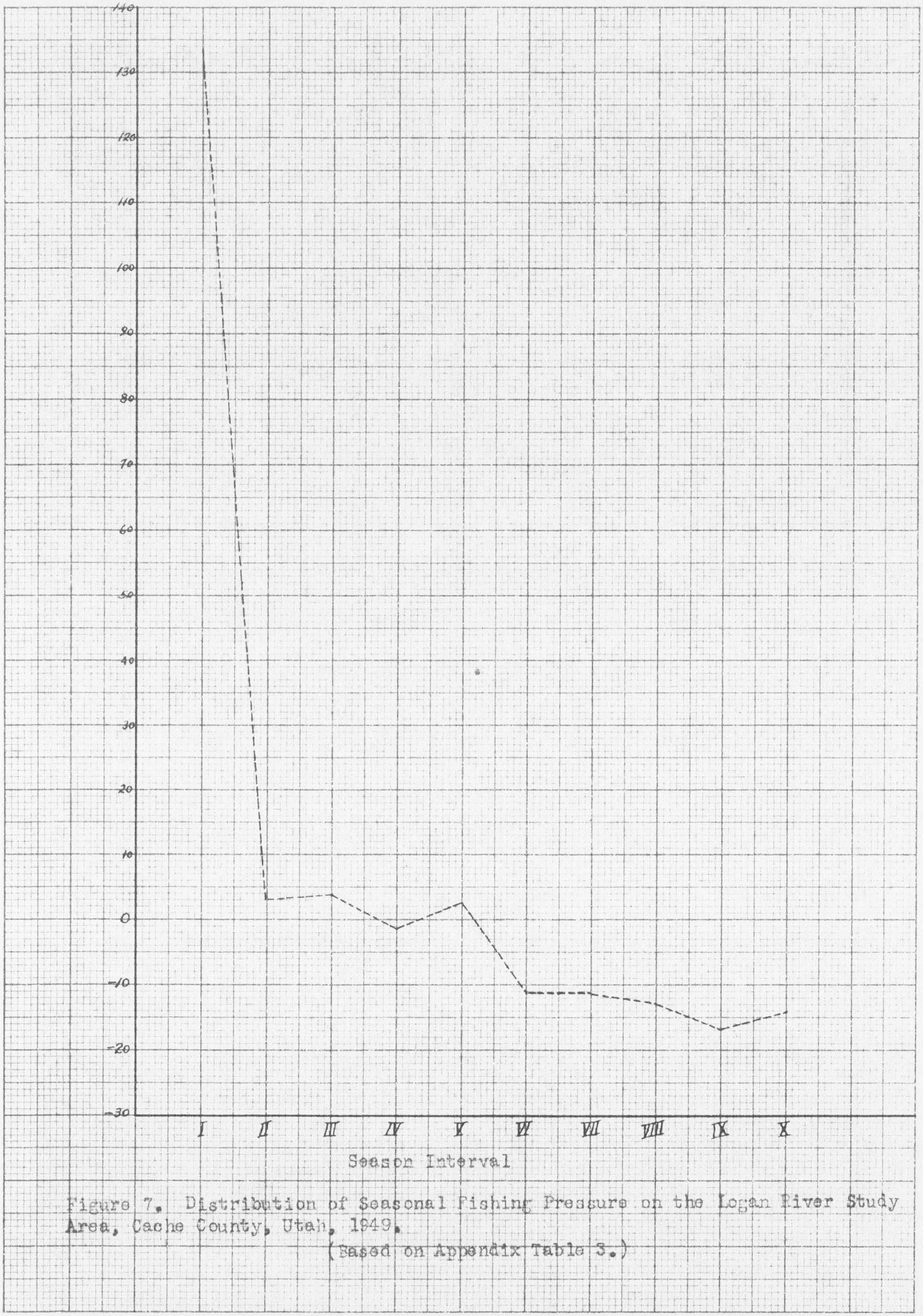


Figure 7. Distribution of Seasonal Fishing Pressure on the Logan River Study Area, Cache County, Utah, 1949.
(Based on Appendix Table 3.)

$$x_{ijk} = \bar{x}_{i..} + \bar{x}_{.j.} + \bar{x}_{..k} - 2\bar{x}_{...}$$

The general mean of the sample is represented by $\bar{x}_{...}$ and is the sum of the cars counted throughout the season divided by the number of checks made, or $\frac{S\ x_{ijk}}{n}$. The periods of the day from one to four are symbolized by the subscript '$_i$'. The subscript '$_j$' symbolizes the intervals of the season from one to ten. The days of the week from one to seven are represented by the subscript '$_k$'. The average for the ith period of the day, $\bar{x}_{i..}$, is the sum of the cars counted during the ith period throughout the season divided by the number of checks made during the ith period, or $\frac{S\ x_{ijk}}{n_i}$. Likewise, the average for the $_j$th season interval, $\bar{x}_{.j.}$, is the sum of the cars counted during the jth interval of the season divided by the number of checks made during the jth season interval, or $\frac{S\ x_{ijk}}{n_j}$. Finally the average for the $_k$th day of the week, $\bar{x}_{..k}$, is the sum of the cars counted during the $_k$th day throughout the season divided by the number of checks made on the $_k$th day, or $\frac{S\ x_{ijk}}{n_k}$.

For example, on the second Friday during the fourth seasonal interval, the second period was not checked. To get an estimate of the number of cars along the river during that period, x_{245}, the average for the 'b' period of the day, the second period in this case, is 22.19. The average for the 4th interval of the season, the fourth in this case, is 27.594. The average for the 5th day of the week, Friday being the fifth day in this case, is 19.484. The sum of the averages is 69.268 and twice the general mean (2 x 29.2) subtracted from the sum gives 10.868 cars or for this purpose, eleven cars are estimated for this particular period (Appendix Table 1).

This process repeated for each period of each day during the season when no car count was made gives a figure representing the number of cars

that would be expected if a count were made. The sample taken during the 1949 season was represented by 6,833 cars counted during 234 checks. As there was a possible total of 460 counts that might have been made, there were 226 checks missed. By the process just explained, a total of 4,458 were estimated to have been along the river during the 226 checks which were not made. Thus, in 50.87 per cent of the checks 60.52 per cent of the total estimated number of cars were counted. This difference is explained by the fact that a larger sample was taken during the first part of the fishing season when the greatest pressure is usually exerted (Figure 8 Appendix Table 1).

Figure 8. Cars, Counted and Estimated, by 1949 Season Intervals on the Logan River, Cache County, Utah, to determine Angler Pressure. (Anglers=Cars x 1.772)
(Based on Appendix Table 1.)

CREEL CENSUS

Procedure

The creel census has been used by nearly every fish management agency at one time or another. They have used the data for many purposes, some beneficial, others not. Contact with people harvesting the resource is undoubtedly the best and an accurate way to obtain data on what is happening to that resource. Therefore, the creel census will yield valuable information to management if the data are properly collected. The creel census can serve two big purposes:

1. It may be and should be used as a guide to management when drawing plans for the future.

2. It should be used to reveal the success or failure of the past plans and operations. The purpose of this study is to improve the techniques of obtaining a creel census, to increase the efficiency and accuracy of the analysis, and to secure a maximum amount of pertinent data for the angler, the management, and the research man.

It has been ascertained that there are certain incidental factors that account for the difference between a good and a bad creel census. The fishing public should know what is being done and should have the results periodically. This leads to better cooperation and more accurate reports from anglers. The data can only be as accurate as they are recorded; thus it has been to the advantage of the personnel to get the most accurate reports possible as they are responsible for analyzing it. A more comprehensive collection form was used to collect data in 1949 than in 1948 (Figure 9). Each item and sub-topic was given a code number for the purpose of making the data adaptable for analysis by the

Figure 9. Creel Census form used on the 1949 Logan River Study

CREEL CENSUS-LOGAN RIVER

Wildlife Department 1949 Utah State Agricultural College

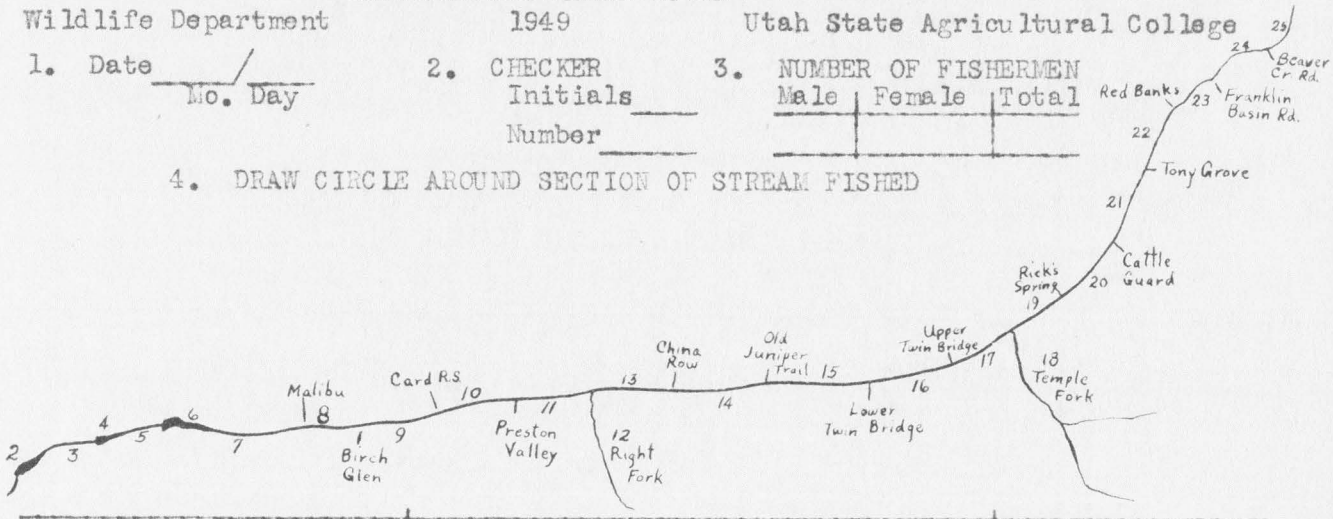
1. Date ___/___ Mo. Day

2. CHECKER Initials ___ Number ___

3. NUMBER OF FISHERMEN

Male	Female	Total

4. DRAW CIRCLE AROUND SECTION OF STREAM FISHED



5. KIND OF FISHING:
1. ___ Fly rod.
2. ___ Casting rod.
3. ___ Spinning rod.
Other ___ Specify

6. METHOD
1. ___ Trolling
2. ___ Casting
3. ___ Still Fishing

7. BAIT
Natural
Fresh
111 ___ Insect
112 ___ Worm
113 ___ Fish
___ Other ___ Specify
Preserved
121 ___ Insect
122 ___ Worm
123 ___ Fish
___ Other ___ Specify
Artificial
201 ___ Wet fly
202 ___ Dry fly
203 ___ Plug
204 ___ Spoon
205 ___ Spinner
20 ___ Other ___ Specify

8. FISHERMAN ADDRESS
10. ___ Cache
20. ___ Boxelder
__. ___ Other Utah county ___ Specify
__. State other than Utah ___ Specify

9. FISH CAUGHT - No. of

Species	Marked tag	Marked Clp	Not Marked	Total No.	Av. length inches
Hybrid					
Brook					
Rainbow					
Brown					
Native					
Whitefish					
Total					

10. AV. COST OF FISHING GEAR/F.
301 ___ $ 0.00 - $ 25.00
302 ___ 26.00 - 50.00
303 ___ 51.00 - 100.00
30- ___ 101.00 - over

11. DRAW LINE THROUGH HOURS AND QUARTER HOURS FISHED

A. M. P. M.
5 6 7 8 9 10 11 12 1 2 3 4 5 6 7 8 9

Do Not Mark Below This Line

1 2 4 8
6
3 12
15

No. of Qtr. hours fished ___.___ Ext'd qtr. hours ___.___ Period(s) ___

Stream Section fished

1 00	2 00	3 00	4 00	5 00	6 00	7 00	8 00	entire
02	01	07	12	13	19	24		stream
04	03	08	18	14	20	25		
06	05	09		15	21			
		10		16	22			
		11		17	23			

Fish per hour ___. Schedule No. ___

12.
___ Com. 1.
___ Inc. 2.

IBM punched card process*. There are twelve major items on the 1949 collection form each with one or more sub-topics. This narrows the main topic or item to a specific place, method, article, value, or time. Each item yields information in which one or more agencies are interested. All of this information is of little value to anyone unless a thorough and accurate method of analysis is adopted to handle this collection of individual reports. For this reason, the IBM process was used.

The IBM process involves transferring the data from the collection forms to special cards which are perforated according to the code assigned to the data on the collection forms. These cards are then put through a series of checks. The cards are then sorted and tabulated according to the way they are to be used in analyzing the data. By this process it is possible to accurately analyze the same amount of data in about five per cent of the time required by hand computations.

The storage of the information on the cards requires only ten per cent of the space required of the original collection forms, another valuable asset to research organizations. The cards may be used year after year as additional data are collected, and eventually a long-time study may be analyzed from the same data cards used in the series of short-term studies. Such advantages cannot be overlooked when the economics of such studies are of concern, primarily time and men.

The creel census was carried out in conjunction with the car counts, and through the use of road blockades. During the car counts, anglers were chosen purely by chance to be checked. No consideration was given as to the time of day, location on the stream, or weather. The same

* International Business Machine.

periods of time as used in the car count were recorded when taking the creel census, and the data were analyzed by these periods. The road blockades were held at the mouth of Logan Canyon. Police, game wardens, and personnel of this study all cooperated as law enforcement was combined with the collection of data to give a dual purpose to the blockades.

Analysis

Of the 928 anglers checked, 97.09 per cent were males. Of the total number of anglers checked, 656, or 70.7 per cent, had taken one or more fish. Ninety-seven and forty-one hundredths per cent of the successful anglers were males. The unsuccessful anglers amounted to 29.3 per cent of the total, 96.32 per cent of these were males.

To keep the explanation clear, a party or car is used synonomously in the following explanation. Each form was allowed to represent a fishing party. The average number of anglers per car is calculated from item 3. When the creels of the entire party were not checked, only those persons checked were recorded in the section set aside for item 3; but if there were others in the party, the total number of anglers was also recorded. This occurred only occasionally but was necessary to consider in order to determine the accuracy of the total number of anglers represented in the 600 parties checked. As there were 928 anglers checked in the 600 parties, it would give a false figure of 1.547 for average number per party.

The frequency distribution of the number of anglers per party was plotted and resembled a Poisson distribution. Then following the procedure presented in chapter 18 of Snedecor (33) the expected distribution was fitted and the Chi-square test applied. The test revealed Chi-square

to be 32.2 which is highly significant at three degrees of freedom. There was little difference between the expected and the actual distribution until the extreme upper end of the curve was reached. At this point it was noted that the sample had incorporated more parties with great numbers of anglers than would be expected in a Poisson distribution. This fact coupled with the very small expected values in this section of the curve changed Chi-square from 6.557 with two degrees of freedom to 32.2 with three degrees of freedom (Figure 10).

The mean number of anglers per party is the figure that is used from these data. The mean of the distribution was calculated as 1.772 which, in this case, is an underestimate of the variance as the result of the poor fit at the extremes of the distribution. Ordinarily, the variance is equal to the mean of a Poisson distribution. The standard deviation of the mean or standard error is 0.0543. Thus, the mean number of anglers per car will fall in the 95 per cent confidence interval of 1.5988 to 1.9444.

The mean number of anglers per car, 1.772, is multiplied by the estimated total number of cars. By this method, a total of 20,003 were estimated to have been on the study area of the Logan River during the 1949 season. However, this is based on an estimated four-hour day which did not actually exist; thus, a correction must be made to allow for the difference between the actual and the estimated fishing day.

The fishing day is calculated from the number of anglers, the time they fished, and whether or not they have finished fishing for the day. Of the total anglers checked, 367 had completed fishing a total of 1193 hours and 15 minutes. Thus each angler fished an average of 3.25 hours

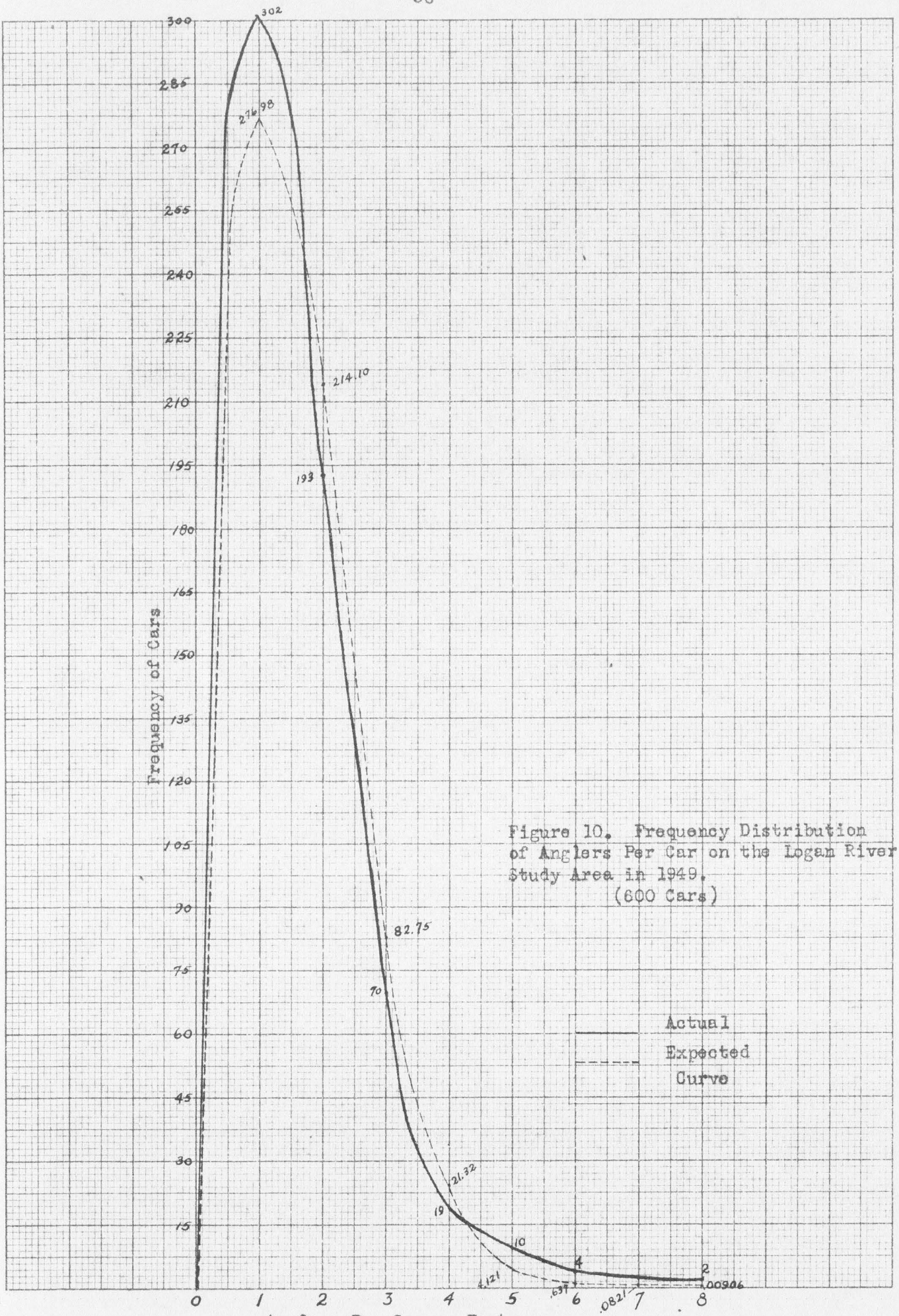


Figure 10. Frequency Distribution of Anglers Per Car on the Logan River Study Area in 1949. (600 Cars)

which is the fishing day for the 1949 season. To account for the difference of .75 hours between the estimated and the actual fishing day, a correction of 4,616 anglers must be added to the number calculated for the four-hour day. The corrected total number of anglers estimated to be present on the Logan River during the 1949 fishing season is 24,619. To better comprehend such a figure, it would mean approximately 215 anglers visited the river every day during the open season; and if evenly distributed along the fishable stream, there would be about three anglers along each mile of fishable water per day. Actually the distribution of anglers along the Logan River is anything but uniform.

On opening day, 1949, there were 1210 anglers along the stream, or 4.92 per cent of the total number for the season. This is one of the reasons for using the opening day of the season as a separate season interval. If weighted the same as any other day of the season, considerable bias would enter the analysis of the data. It is not only peculiar in the angler pressure but has a higher angler per car ratio, a lower rate of catch, a longer average angler day, and a different rate of return of marked fish to the creel. The same thing often happens in sampling holidays and weekends unless they are plentiful enough to be distributed evenly through the season.

The next figure, and perhaps the most important one to the angler and the managing agency, is the success in terms of the number of fish taken per hour. The total number of fishermen hours for the whole season was 24,619 anglers times 3. 25 hours, the average fishing day, or 80,012 hours. From the creel census sample, 928 anglers (item 3) spent 2,951 hours (item 11) catching 1,820 fish (item 9). One legal fish was taken every

1.621 hours or .6167 fish were taken every hour fished.

The total number of hours for the season divided by the average number of hours required to catch each fish (or multiplied by the number of fish caught each hour, 80,012 ÷ 1.621 or 80,012 x 0.6167,) gives a total of 49,343 fish taken during the 1949 season.

Of this total catch, 26.71 per cent were marked, or 13,180 marked fish were returned to the creels of anglers during the 1949 season. A total of 12,311 or 93.41 per cent were planted in 1949 and 869 or 6.59 per cent were planted in 1948. The 12,311 fish represent a return of 78.28 per cent of the total legal-size fish planted in the Logan River prior to, or during, the 1949 season. No sub-legal fish were planted. Wild fish, that is those not stocked, contributed 36,163 or 73.28 per cent of the creel. In the creel sample only .17 per cent of the anglers were checked with limit catches. Only 1.5 per cent of the anglers creeled twelve or more fish in a day. Contrary to beliefs, limit catches on the Logan River were very rare. A second method was used for the purpose of providing a check on the total fish harvest calculated by the first method. In the second method, the calculations were made for each of the ten intervals of the season as previously described. The estimated cars, as calculated for the first method (Appendix Table 1), for each interval were then multiplied by the anglers per car calculated for each interval, the product being the total number of anglers along the river for each interval.

The alternative used in determining the anglers per car for the second method was arrived at by using four typical stream sections as check areas. These check areas represented two impoundments and two

stream sections. As stream visibility was nearly 100 per cent from the road, it was possible not only to count every car on these sections but also to count every angler. From the two figures, cars and anglers, the average number of anglers per car was calculated. The figures used in this method are from the car count data, while the first method relies on creel census data for its basis.

From the creel census, the fisherman day was calculated for each of the season intervals just as the average fisherman day for the entire season was calculated in the first method. Then by correcting for the difference between the actual fishing day and the arbitrary four-hour day that was assumed and used for the collection of the data, the new corrected number of anglers was determined for each interval of the season. The corrected figures were then multiplied by the actual fishing day for each interval which resulted in the determination of the total fishing hours for each interval.

Again, the creel census provided data from which the average fishing success in fish per hour was determined for each of the ten season intervals. Each of these figures times the total fishing hours for the respective intervals gave the total fish taken for each interval. The percentage of marked fish in the creel for each interval was calculated from the creel census and taken times the total fish per interval which gave the return of marked fish for each season interval. There was a 2.41 per cent difference between the total numbers of fish taken for the season as calculated by the two methods. About a 5 per cent difference in the returns of marked fish resulted by the two methods of calculation. These figures give confidence to the techniques employed in this study (Appendix Table 5).

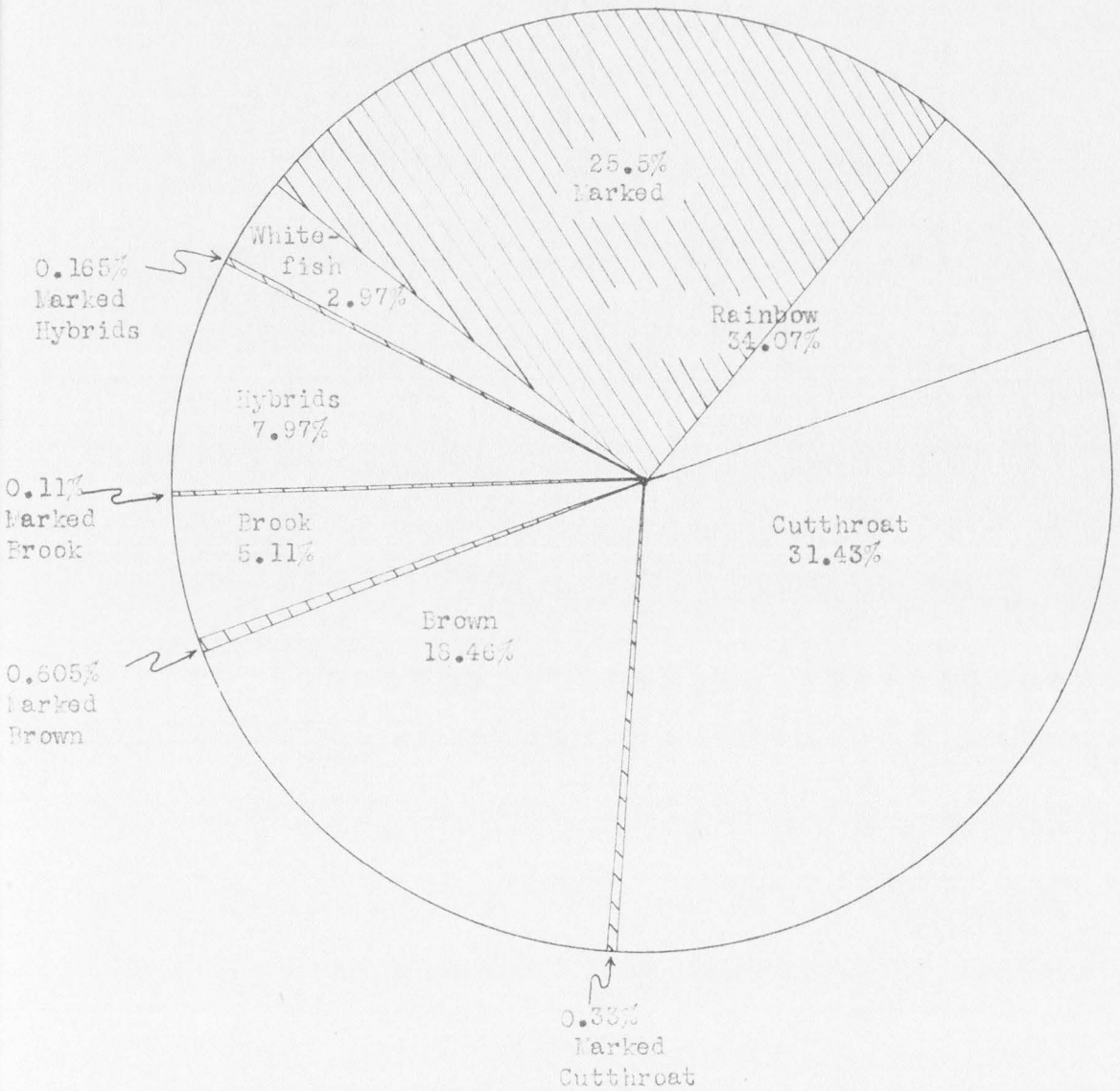


Figure 11. The Per Cent of Game Fish, Wild and Marked, in the Anglers' Creels sampled on the Logan River, Cache County, Utah, 1949.
(Based on Appendix Table 4.)

The average angler's creel in 1949 was made up mainly of three species of fish: rainbow, 34 per cent; cutthroat or native, 31.5 per cent; and brown, 18.5 per cent. The remaining 16 per cent was made up of brook, 5 per cent; mountain whitefish, 3 per cent; and the rainbow and cutthroat hybrid, 8 per cent (Figure 11).

The 25.5 per cent of the rainbow which entered the creel as unmarked fish may represent some stocked fish that were planted unmarked. There were an estimated 1000 legals planted in 1948 and another 1000 planted in 1949, which through error were not marked; and consequently contributed to this portion of the creel. If these fish contributed at the same rate as the marked fish, then slightly more than 1.5 per cent of the unmarked rainbow may be from this source. The percentage of rainbow in the creel for 1949 compares closely with the 1948 creel when the rainbow made up 33 per cent of the total. However, in 1948, the hybrid was not recognized in the creel; and those fish making up this class were either recorded as rainbow or as cutthroat, whichever the checker chose to call them.

The 8 per cent contribution to the creel by those fish which were identified as hybrids, would not greatly influence the contribution of the two species with which they might be confused. Definite recognition of this cross is very difficult, which even the best taxonomist such as Miller will testify.[1] It appears that some good may come from such a cross, as Baker[2], through careful observations, has found little indi-

1. R. R. Miller, Personal Correspondence to W. F. Sigler dated March 27, 1949.
2. Harry W. Baker, Supt. Fed. Fish Hatchery, U. S. Fish and Wildlife Service, Ennis, Montana, made observations and notes personally confided.

cation of sterility among the hybrids, and the fertility of the spawn is believed to be nearly as high as that of pure strains of cutthroat or rainbow. Baker also suspects that hybrids may reach a greater average size than pure species. However, this could be only the vigor usually associated with the first or second generations of a cross.

The cutthroat made up 31.5 per cent of the creel sampled which was 7.5 per cent more than in 1948. This is partially explainable by the fact that the brown contributed 10.5 per cent less in 1949 than in 1948. Of considerable importance is the fact that due to construction work, the city impoundment behind the third dam was closed to fishing during the last half of the season. This area contributed heavily to the brown trout in the creels previous to that time. Its closure prevented any contribution during the last half of the season when, according to anglers, the brown trout fishing is the best. The increase in the percentage of cutthroat taken may be due to the increased pressure along the upper limits of the stream as a result of this impoundment being closed to angling. The number of anglers probably remained about the same but fished in different areas.

The mountain whitefish also dropped 25 per cent in the creels from the 1948 total. Since the city impoundment is one of the strongholds for this species, it seems evident that closing the area was responsible, at least to some degree, for the decreased appearance in the creels of the two species most prevalent in that section (Figure 12).

The 50 per cent decrease in the number of brook in the 1949 creels from that of 1948 may be partially explained by the sampling on opening day. Most of the brook were caught in a small area on opening day in 1948, and this area was sampled heavily by checking crews. It was

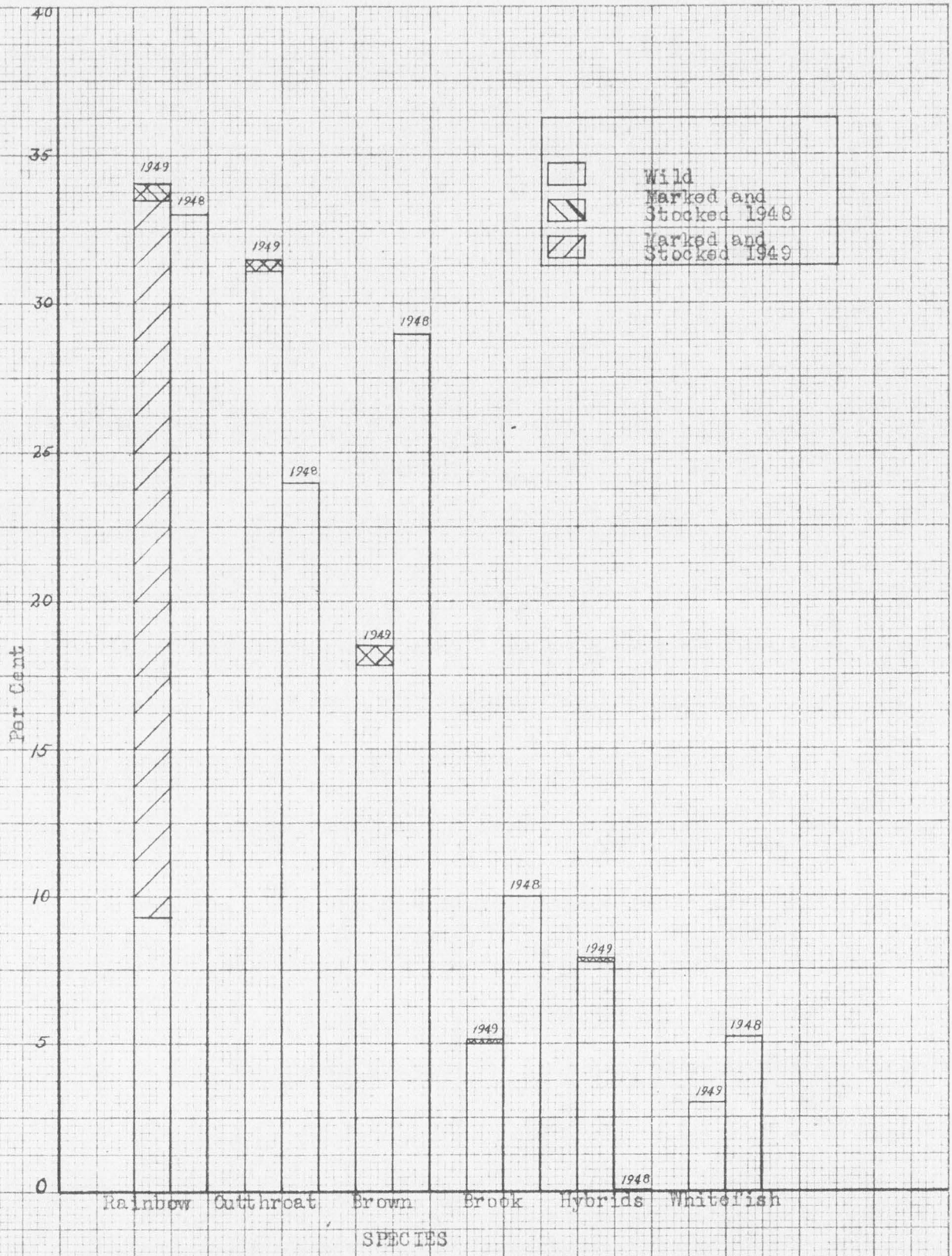


Figure 12. The Per Cent of Game Fish, Wild and Marked, in the Anglers' Creels Sampled on the Logan River, Cache County, Utah. 1948 - 1949

sampled much less on the 1949 opening. This is better understood when it is noted that 85 per cent of the brook checked in the creels were checked opening day in 1949 and an even higher percentage was checked in 1948 (Figure 15a).

Fishing Methods, Areas, and Time as Related to Species Taken

Success of Fishing Tackle (or Gear): Of special interest to the anglers and secondarily to the management agency, is the time and manner in which the various species of fish were taken. The information is extremely interesting and valuable (Appendix Table 4). The information does not predict what should be used, but it does tell the tackle most used, the method most employed, and the baits most used to capture the various species of fish on the Logan River in 1949.

Of all the fish taken, 85 per cent were taken on a fly rod with no other kind of tackle appearing to take more than 5 per cent of the fish. The brown is the only species taken less than 85 per cent of the time by the fly rod, and it was taken about 65 per cent of the time. The brook and brown were each taken with the casting rod nearly 10 per cent of the time, rainbow about 5 per cent; but the remaining three species seldom reached the creel of an angler with a casting rod. The spinning rod was most effective against the brown. They were taken with it about 14 per cent of the time.

The per cent each species represented in the catch by the fly rod was nearly identical with the per cent each species represented in the total catch. The correlation is surprisingly close with the greatest variation in the brown which might be expected as they are the most frequently taken by the casting rod (Appendix Table 4a).

Success of Methods Employed: The method of fishing employed in capturing the six species of game fish is limited mainly to casting either fly or bait. Again the brown is the least taken by any method of casting, followed by the whitefish and then the rainbow. These three species are taken in that order, and constitute most of the fish taken by still fishing, these being the only two practical methods employable since the use of boats was illegal on the impoundments and the stream (Appendix Table 4b).

Success by Baits Used: The baits used to lure the trout are varied but are not used in near equal proportions. Half of the fish harvested were taken on worms. The dry fly ranked a distant second as only one-eighth of the fish were taken on this lure. The cutthroat was taken 20 per cent of the time on dry flies, and represented nearly 55 per cent of the total fish taken on dry flies. Ten per cent of the fish were taken on wet flies; the brown were taken 14 per cent of the time by this method with the cutthroat next, 12 per cent of the time. The cutthroat represented nearly 40 per cent of the fish taken by this method, however. Rainbow were second to the cutthroat in that they represented 32 per cent of the fish taken on wet flies. Trichoptera larvae or rock-rollers, classified as natural fresh insects, lured 76 per cent of the whitefish. Rainbow and brown were taken in about equal numbers with the whitefish. They represented only about 7 and 12 per cent respectively of each of the species in the creel.

Preserved bait is only rarely used on the Logan River.

Next to the wet and dry flies among the artificial lures, the spoon type lures such as the "daredevil" ranked high. The rainbow was taken

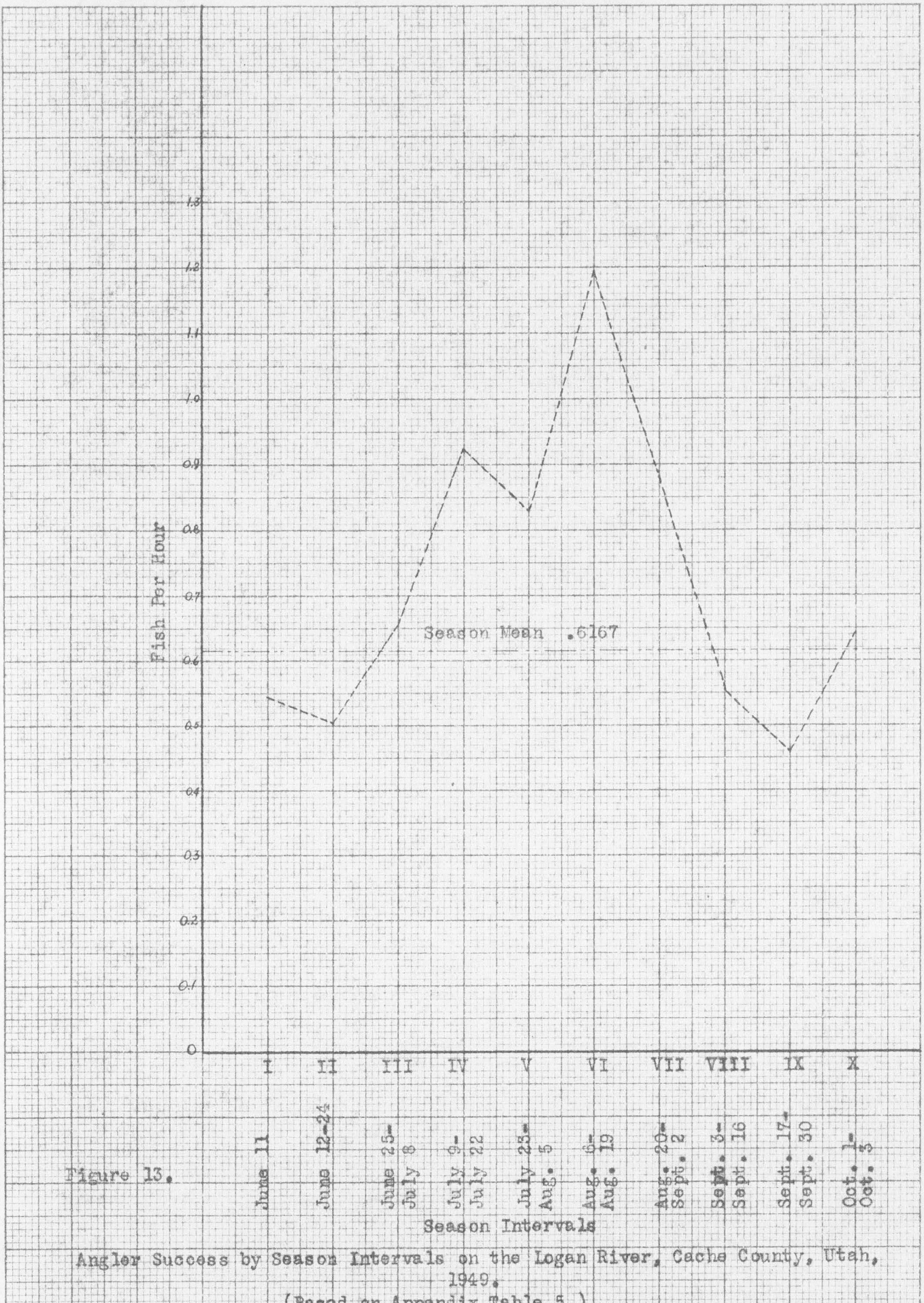


Figure 13. Angler Success by Season Intervals on the Logan River, Cache County, Utah, 1949.
(Based on Appendix Table 5.)

about 4 per cent of the time by this bait, and the brown took it about 7 per cent of the time. The two species represented 92 per cent of all the fish taken on this lure. Plugs were taken by a minor share of rainbow and brown which made up 89 per cent of all fish taken on plugs. Hybrids were taken on spinners about 2 per cent of the time and represented about 23 per cent of the fish taken by this lure. While the rainbow represented 46 per cent and cutthroat 31 per cent of the fish captured on spinners, they represented only a very small number of fish taken on this lure (Appendix Table 4c).

Success During the Day: The time of the day when each species of fish was taken in greatest numbers seemed to hold with the common belief. The morning hours showed a slight favor over the evening hours in number of fish taken; however, a difference of 10 per cent would be the maximum. Only two species of lesser importance to the creel, the hybrids and brook, showed a decided preponderance of numbers caught during the morning hours over the numbers caught in the evening. The other four species were nearly equal in numbers caught during the morning and evening (Appendix Table 4d).

Success by Kind of Water Fished: The stream sections of the river furnished about three-fourths of the hybrids, brook, rainbow, and cutthroat to the creels. The impoundments furnished approximately 60 per cent of the brown and 40 per cent of the whitefish to the creels with about 29 per cent of the brown coming from the stream sections and 26 per cent of the whitefish from the stream. One per cent or less of the hybrid and brook were taken from the impoundments. Eighteen per cent of the rainbow were taken from the impoundments, and 2 per cent of the cutthroat. The

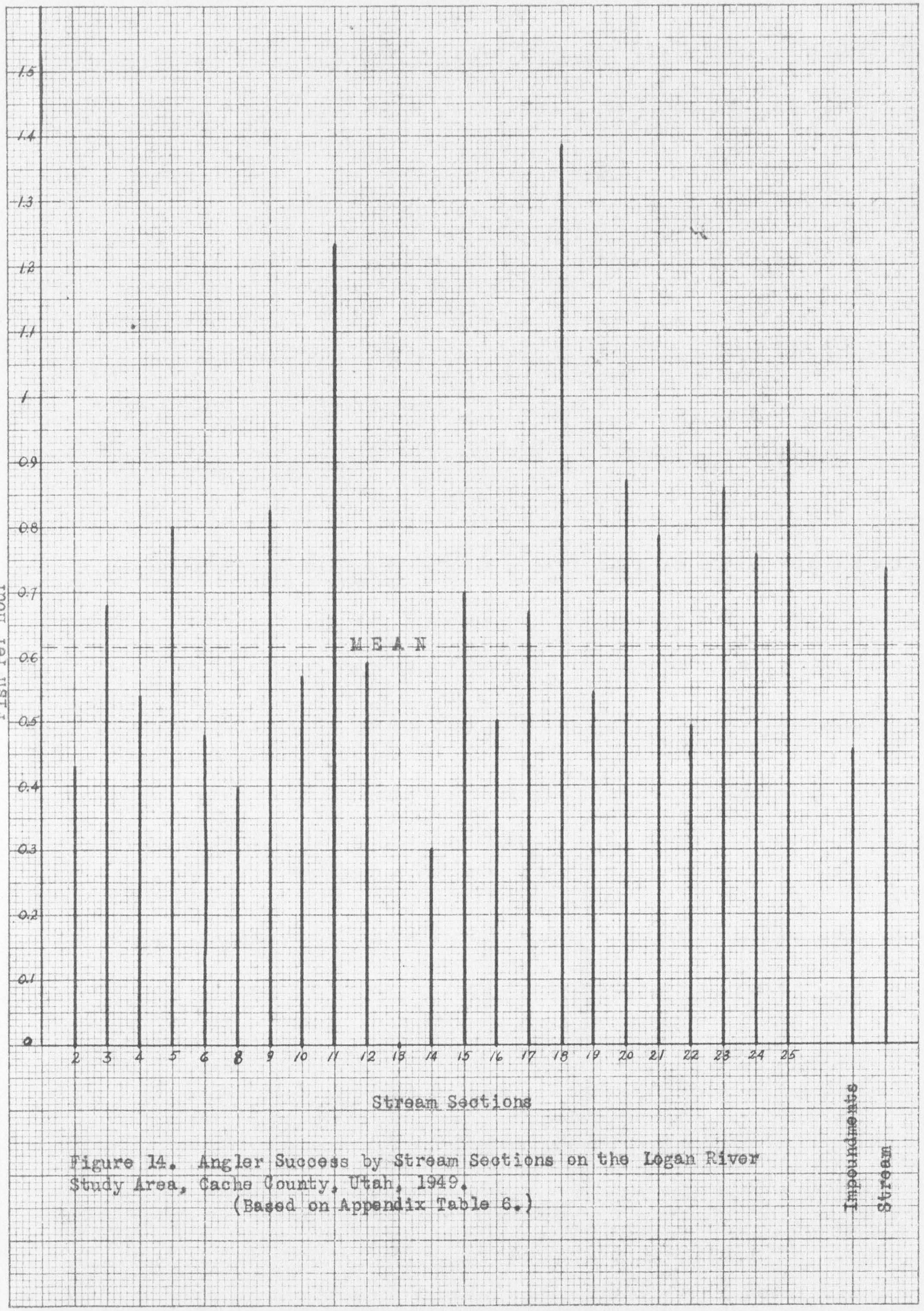


Figure 14. Angler Success by Stream Sections on the Logan River Study Area, Cache County, Utah, 1949.
(Based on Appendix Table 6.)

remaining percentages of each species taken was by anglers who had fished in both the impoundments and the stream and were unable to segregate the fish caught in the two sections of the river; thus they were recorded as taken in mixed types of fishing waters (Appendix Table 4e).

Success by Season Intervals: Contrary to the usual beliefs of the casual observers, the angler success for the opening day of the 1949 season was below the season average. The number of anglers was high, and the number of fish taken was large; but the fish taken per hour was 0.543 as compared to the season average of 0.6167. The second weekend the average angler success dropped still further to 0.504 fish per hour. After the second week, the success began to improve, and the fourth week was slightly above the season mean. Fishing continued to improve for two more weeks when it reached .925 fish per hour, then declined for the next two weeks to .831 fish per hour. The fifth two-week interval was marked by greatly improved fishing which rose to the season's high of 1.195 fish per hour. Following this peak the success then declined quite rapidly for the next four weeks to slightly below the season mean. The success leveled off during the next two weeks and then began to improve again during the final week of the season. The average success at the end of the season rested slightly above the season mean (Figure 13).

Success by Stream Section: The angler success on the various stream sections (Figure 14) showed great variation. There is a general trend of increased success in number of fish caught per hour as one progresses up the stream. It is explainable by the fact that the number of cut-throat taken per hour was slightly above that of the brown; however, the pounds of fish harvested in each case is inverse to the numbers taken in

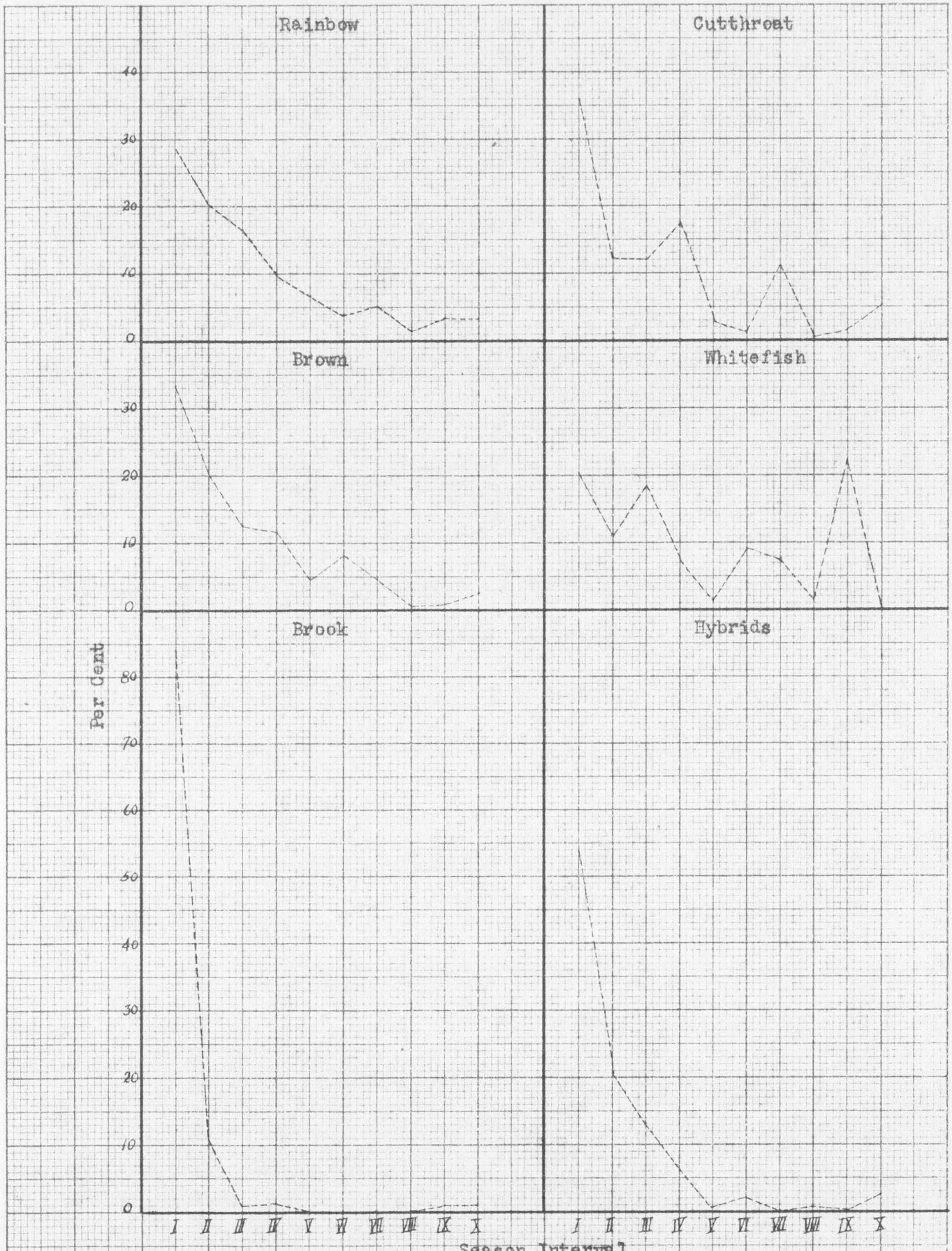


Figure 15a. Per Cent of Each Species of Fish Entering the Creel by Season Intervals, During 1949 on the Logan River Study Area, Cache County, Utah. (Based on Appendix Table 7.)

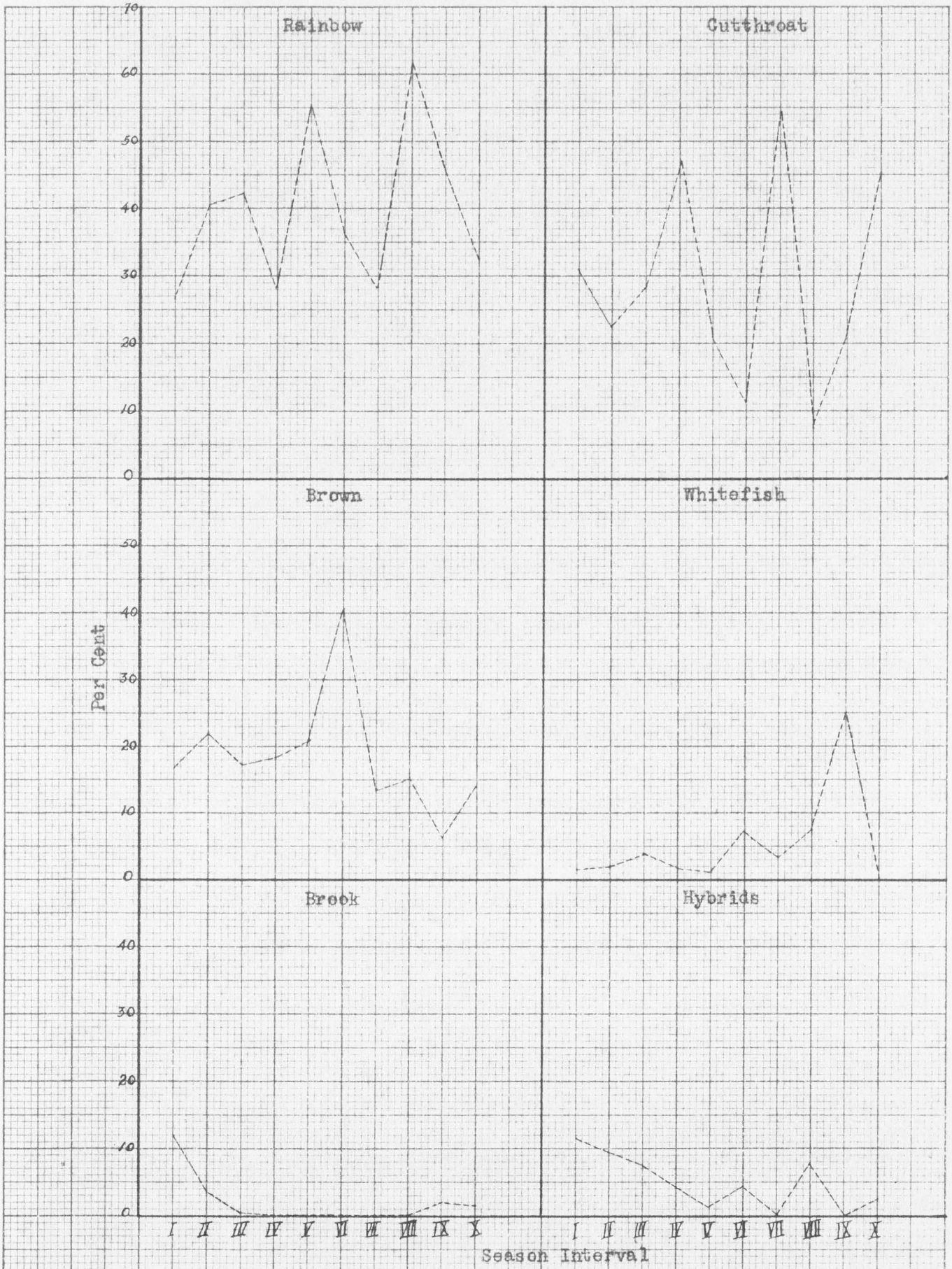


Figure 15b. Per Cent Contributed to the Creel by Each Species of Fish for Each Season Interval During 1949 on the Logan River Study Area, Cache County, Utah. (Based on Appendix Table 7.)

these two species. The brown averaged about ten inches in length while the cutthroat of the upper stream sections averaged about eight inches. The three areas from which the greatest numbers of brown were taken are the three impoundments, which lend themselves to more leisurely fishing and probably accounts for the decreased take in number of fish per hour. The three impoundments, all being located along the lower limits of the river, were in each case below the average in fish taken per hour. The cutthroat habitat does not allow easy angling. In most instances, the faster water, difficult terrain, and small pools must be worked actively if the fish are to be taken; and anglers are reluctant to spend much time per fish if the angling requires undue exertion. Temple Fork showed the highest angling success. This may be accredited to an easily accessible stream which is easily fished; and if fish were not taken in rapid succession, the impression was that the fish were lacking, thus the angler did not spend the time trying for the few stragglers that were left. This may be compared to Right Fork which is a very difficult stream to fish and thus was below the average fish taken per hour. It was fished by a few persistent anglers that spent considerable time taking fish.

Species Contributions to Creels by Season Intervals: Each species made its greatest contribution of numbers to the creels early in the season when the fishing pressure was the greatest and the interest still high. After about the eighth week the contribution of numbers of fish to the creels became more constant at a much lower level (Figure 15a). The relative importance of each species in the creel by season intervals may be seen in Figure 15b. The undulations in the rainbow contribution was

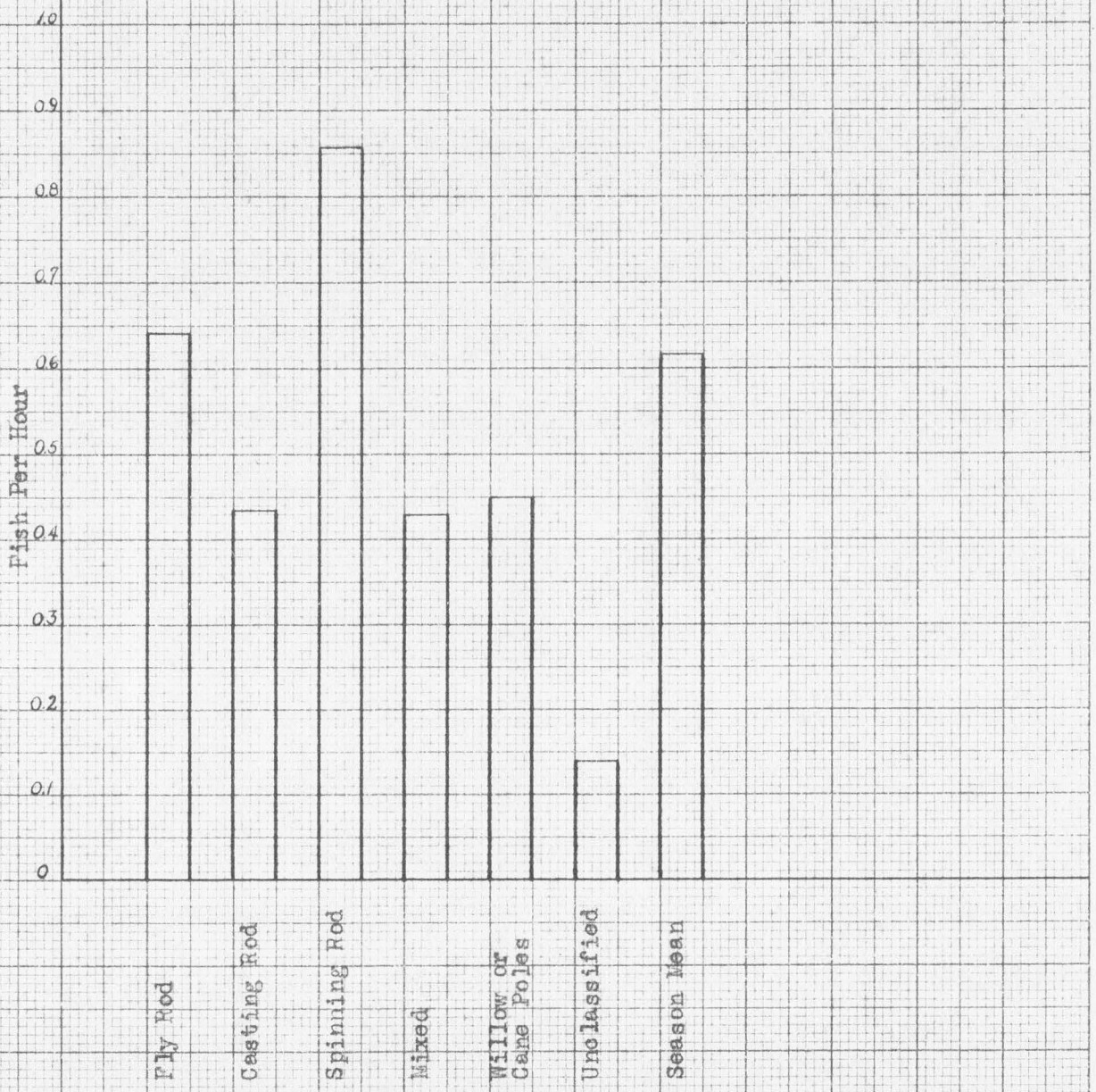


Figure 16. Angling Success by Kind of Tackle (Rod) During the 1949 Season on the Logan River Study Area, Cache County, Utah.
(Based on Appendix Table 8.)

nearly in exact opposition to that of the cutthroat. That is, the cutthroat contributed to the creel when the rainbow fell below normal; and, likewise, the rainbow contributed the heaviest when the cutthroat were being taken in smaller numbers. This was most important as these two species contributed about 65 per cent of the fish in the creel. The other important species was the brown which remained about constant throughout the season in its relative contribution, the exception being during the tenth to the twelfth weeks when the number nearly doubled. This peak occurred at the same time as the peak in fishing success. Since no other species were contributing exceptionally well to the creels during this period, it is obvious that this species was mainly responsible for the increased fishing success. It was just after this peak period of success and brown contribution to the creels that the city impoundment was closed to fishing. However, that cannot be determined but should be considered as an unnatural occurrence not to be encountered every year. Brook were of least importance in the creel. They made up 10 per cent of the creel early in the season, dropped to 4 per cent, and then disappeared entirely until near the end of the season.

Fishing Success by Rods Used

The spinning rod was the most successful among the rods used. By its use anglers took an average of .86 fish per hour throughout the season which was considerably above the seasonal mean of .6167 for all types of rods. It should not be looked on as a serious threat to the fishing as only a relatively few are being used at present, and their limitations are several. The greatest is the fact that on small brushy streams they are of little use. Their primary use is on areas where

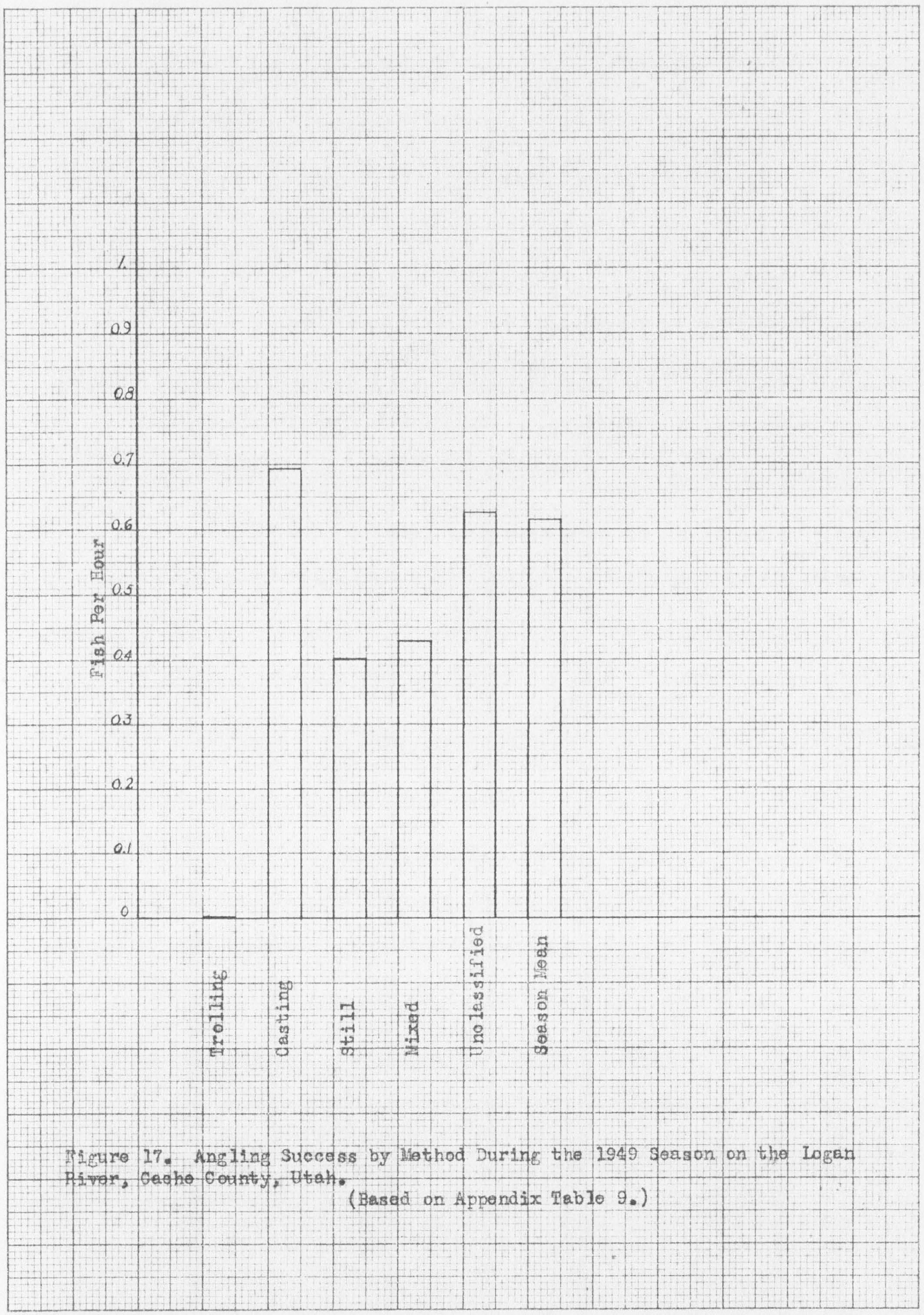


Figure 17. Angling Success by Method During the 1949 Season on the Logan River, Cache County, Utah.
(Based on Appendix Table 9.)

long casts with light lures are effective, such as on impoundments and larger streams. The fly rod was the most popular and held second in the class of rods, being slightly above the season mean for success. All other rods were far below the season mean, but the willow or cane poles were slightly more successful than the casting rods and the mixed rod category. Their use was very limited but effective in areas where usable (Figure 16).

Fishing Success by Method of Angling Employed

The manipulation of the rods and baits as affecting the angler success has two main methods to be considered. Casting both fly and bait was only slightly above the mean in success with .694 fish taken per hour. This method was employed in about 80 per cent of the angling, so should be expected to carry the most weight in determining the mean take in fish per hour. The second method employed in about 20 per cent of the angling was still fishing. This was limited to the impounded waters and was considerably below the mean with .404 fish taken per hour. This was expected since its use applied mostly in an area where leisurely fishing was enjoyed and the still fishing method lent itself to such angling (Figure 16). This method was the most effective for taking the few large trout that are taken nearly every year from the Logan River.

Fishing Success by Rod Used for Various Methods of Angling

Fishing with the spinning rod, either casting or still showed the greatest success. The success of still fishing with the spinning rod may be partially accredited to the fact that the bait may be cast far out into the water and is connected by nearly invisible nylon line without the use of leader or tippets. Casting with a fly rod was the third most

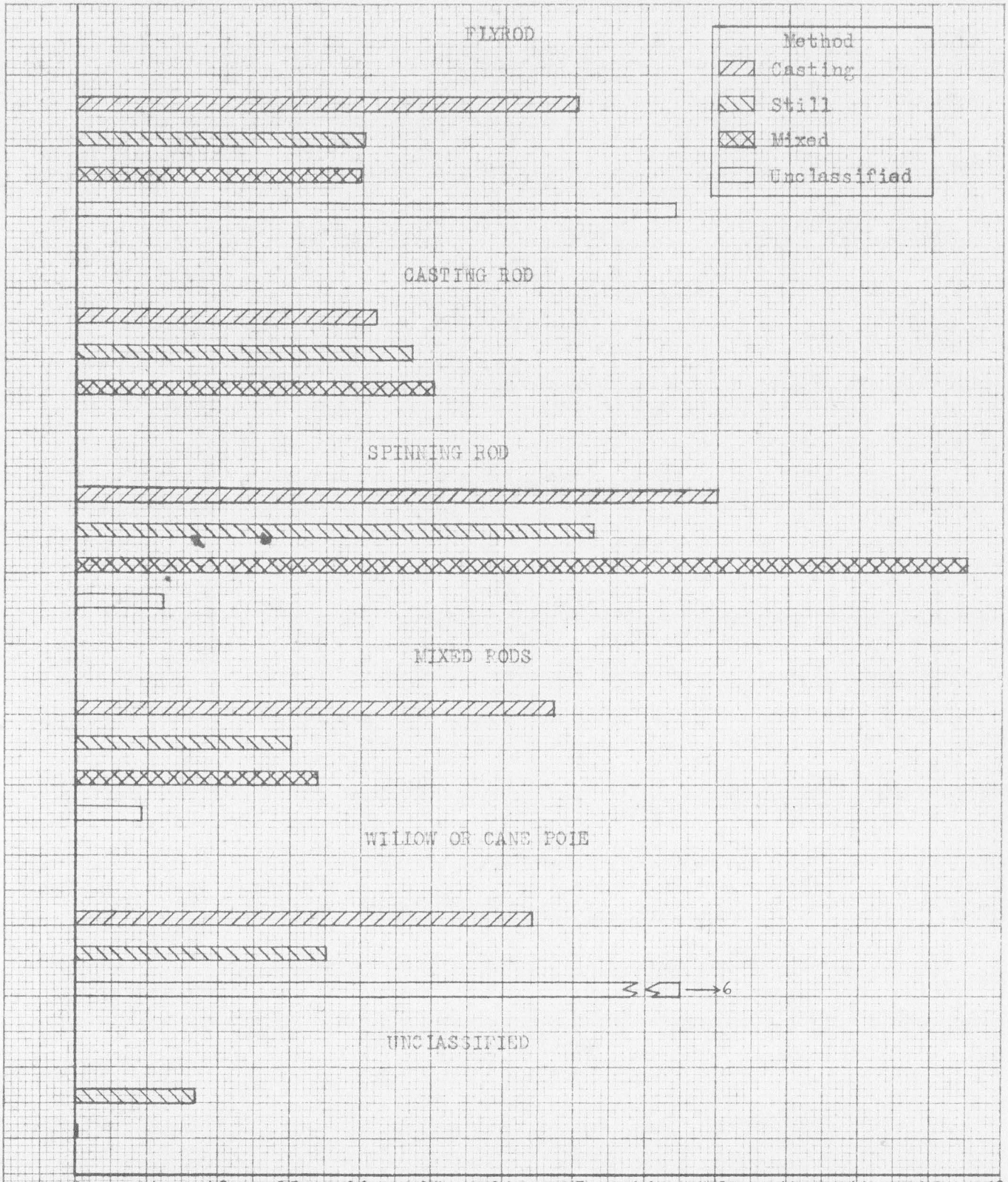


Figure 18. Angler Success by Kind of Tackle (Rods) and by Method of Angling During the 1949 Season on the Logan River, Cache County, Utah.
(Based on Appendix Table 10.)

successful method followed closely by casting with mixed rods and casting with a willow or cane pole. Casting as used in this study is meant to indicate that the bait or lure is kept in motion while in or on the water. Still fishing refers to allowing the bait or lure to lie motionless on the bottom. Still fishing with the casting rod was more successful than casting, but both were below the mean success (Figure 18).

Fishing Success by Baits

Baits played an important role in the success gained by the anglers; and although fresh earthworms or night-crawlers were used by 50 per cent of the anglers, the success on this bait was relatively low. This again may be from the fact that they were used considerably for still fishing which had a low success. Fresh dead fish and preserved insects showed a high success; the sample was so very small that it was not a true indication of the effectiveness of the baits. The use of dry flies gave the highest success of 1.150 fish per hour among the baits which were amply sampled. Plugs, though used only occasionally, showed the second highest success followed closely by wet flies. Fresh insects, of which the rock-roller or caddice fly larva was perhaps the most commonly used, showed slightly better than average success with .705 fish taken per hour. Fresh earthworms followed with slightly below average success at .570 fish per hour. The great number of anglers who used this bait accounted for the large number of fish taken (nearly 50 per cent of the harvest). The spoon and spinner were next in line of success; and as they were used only occasionally, they accounted for only scanty returns in the creel. Preserved baits were rarely used and accounted for only a trace in the creel (Figure 19).

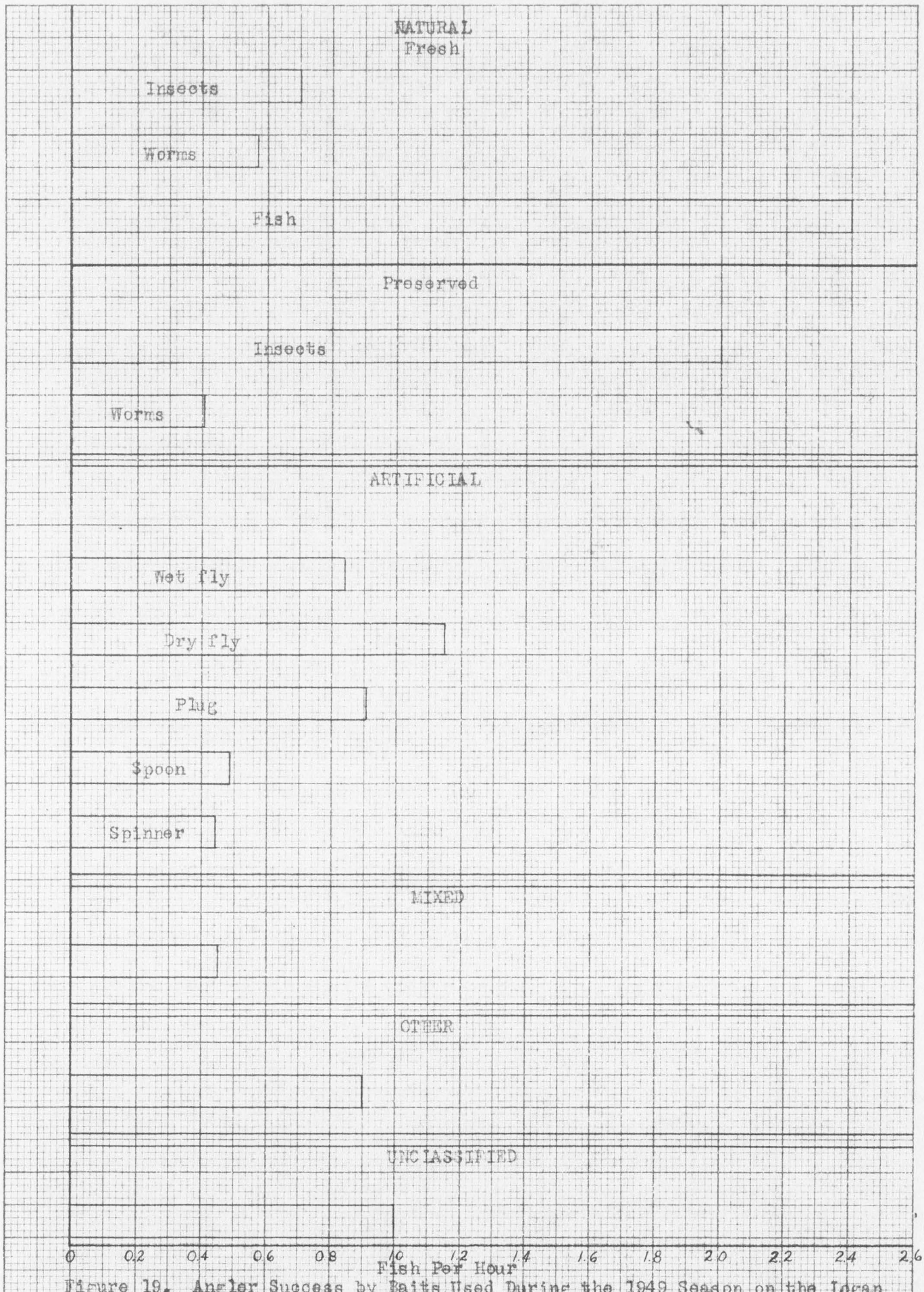


Figure 19. Angler Success by Baits Used During the 1949 Season on the Logan River Study Area, Cache County, Utah. (Based on Appendix Table 11.)

Throughout the season dry flies gave fair to good returns with the best success from them about the middle of the season. During the early season, plugs were the most effective with the spinner showing some good results. Wet flies gave fair results throughout the season, the best during the first half of the season. Worms yielded a low but very consistent return to the creel. The spoons made the best showing during the middle of the season, after the first three or four weeks and continuing for about six or seven weeks. The great variety of baits and lures made it difficult to single out any one bait or lure as most effective, as only one of a number of similar lures or baits may be the successful and thus influence the success of the entire category (Figure 20).

Dry flies were the most effective during the late morning and late evening hours. Those using wet flies had above-par results during the late morning and throughout the remainder of the fishing day. Plugs gave excellent results in the early morning and early afternoon; but again they were only used occasionally, and thus the take was small on this type of lure. The few fish taken on spoons were taken before noon as opposed to those taken on the spinner which was most effective in the evening. The use of worms again gave a rather constant return with no period of the day being an exceptionally good time (Figure 21).

It was quite difficult to analyze the stream section where the various baits were most effective. For the purpose of analysis, the twenty-three stream sections used in the collection of the data were lumped into major stream divisions of which there were seven with number eight being the entire river or any combination of major stream divisions not recorded elsewhere. The major divisions were grouped to include

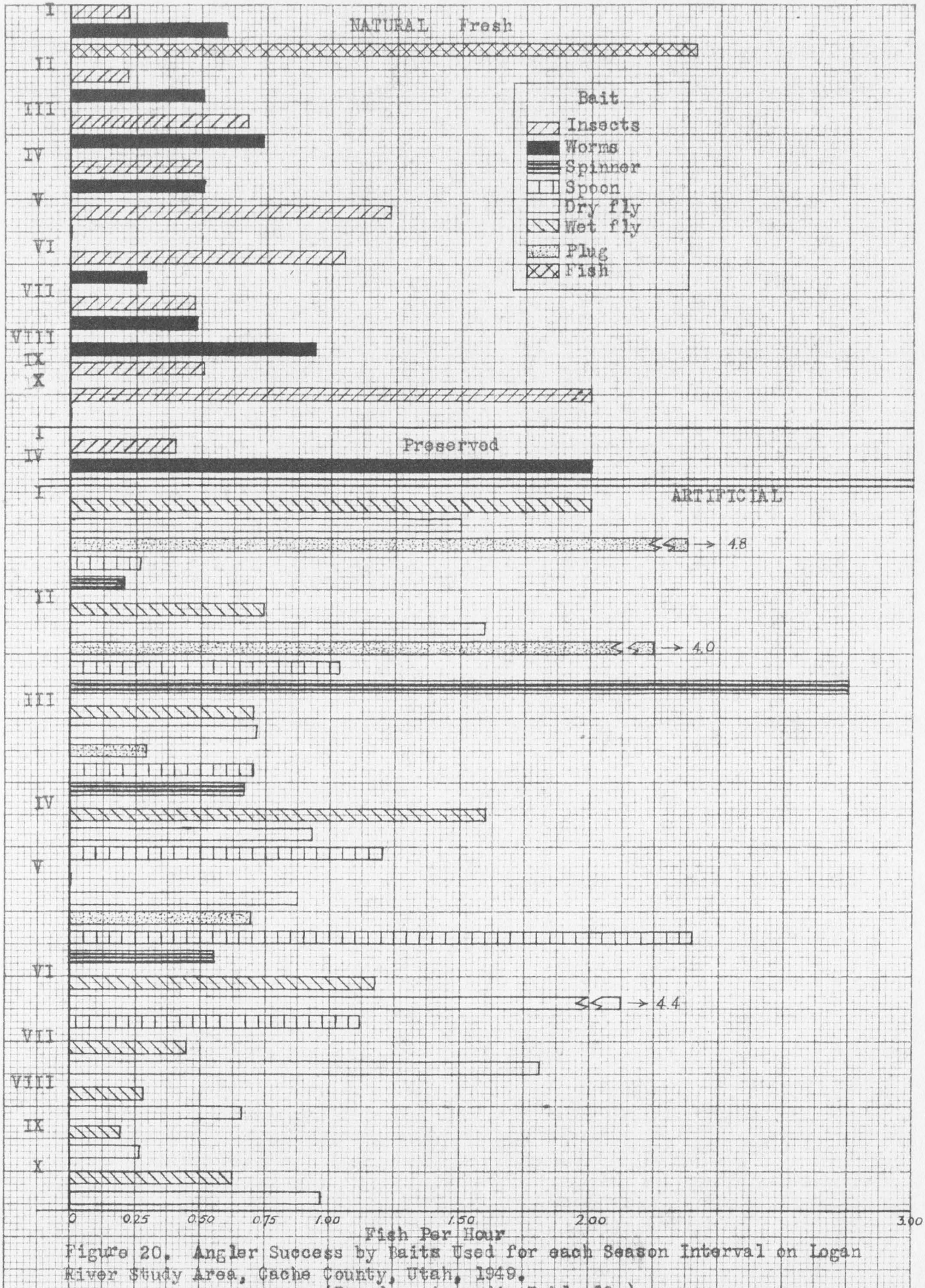


Figure 20. Angler Success by Baits Used for each Season Interval on Logan River Study Area, Cache County, Utah, 1949.
(Based on Appendix Table 12.)

similar types of waters under each division (Figure 5). In the impoundments, division number one, the wet fly was the most effective lure followed closely by the natural fresh insect baits. Dry flies and plugs were next in that order, on the impoundments.

In division number two, which included the stream areas between the impoundments, plugs, mainly flatfish, were by far the most successful followed by fresh insects which yielded far above the mean in fish per hour. This section of the stream should be mentioned as it was subject to drastic fluctuations as a result of the irrigation water and power plants drawing from the impoundments within the area. During the last half of the season, the stream was barely more than a trickle, but during this season of low water, the area was fished very little. Thus, the harvest from this area was mainly during the early part of the season (Appendix Table 15).

From the upper limits of the city reservoir to the mouth of Right Fork, the wet fly gave the best success with plugs above average. Earthworms gave average results on the third division of the stream.

Division number four included the two main tributaries of the Logan River, Temple Fork and Right Fork. Wet flies provided exceptional success on these areas. Fresh natural insects, such as small grasshoppers and rock-rollers gave very good results on the small branch streams. Dry flies were close to the insects in the fish taken per hour, being only alightly lower. Worms follow in order and yielded about 1.144 fish per hour of fishing.

The main stream included between the mouths of the two tributaries just mentioned was division number five and yielded best for dry flies.

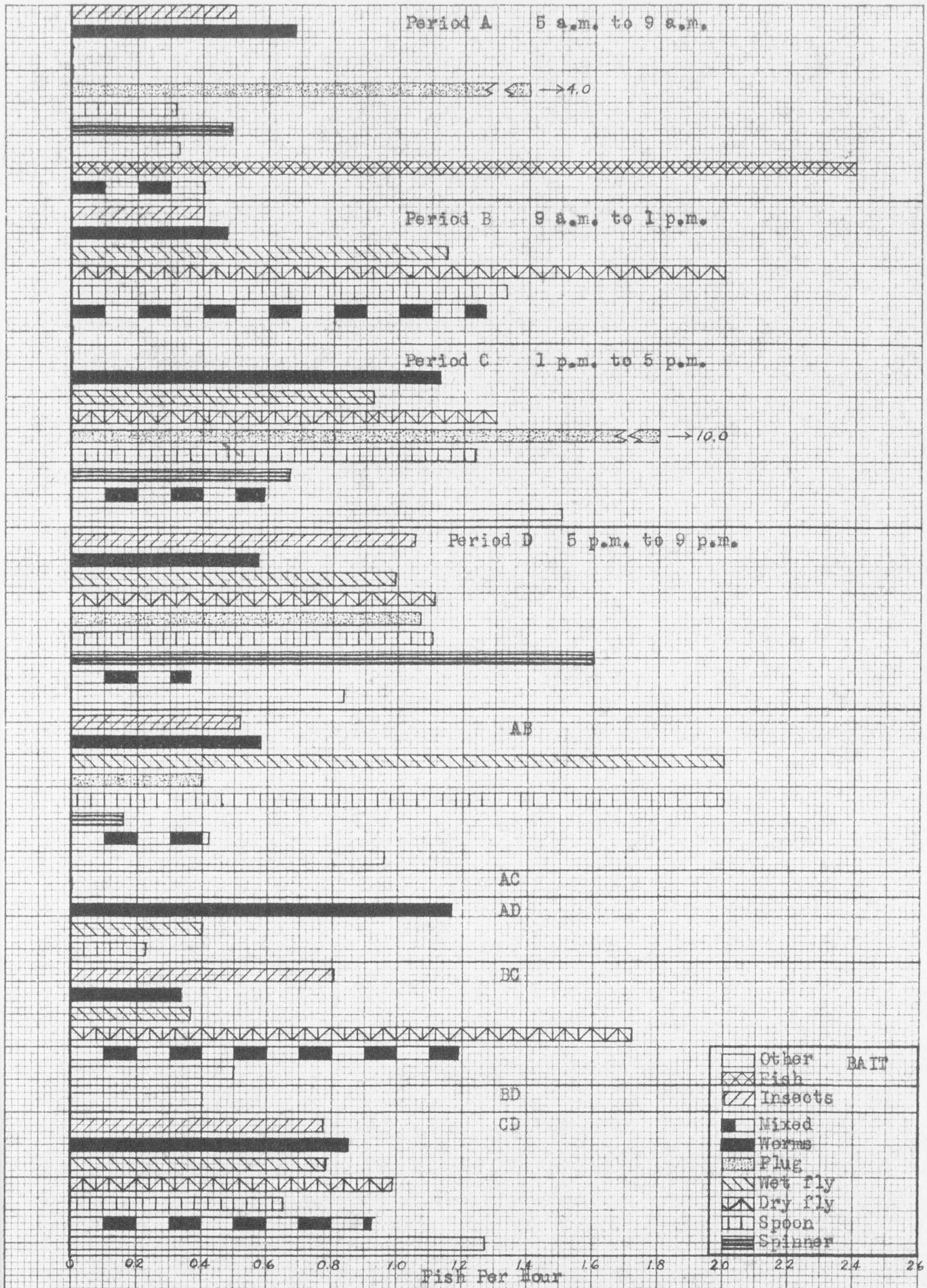


Figure 21. Angler Success by Baits Used During Periods of Day on the Logan River Study Area, Cache County, Utah, 1949. (Based on Appendix Table 13.)

The success here was nearly two fish per hour. Wet flies and worms were the only two other productive baits along this section of the stream. Fishing on this section of stream was hampered somewhat during the season by the construction work on the highway along the stream. Fishermen found it difficult to park their cars along the area while the work was in progress, and the banks of the stream were altered by bull-dozers removing vegetation and filling in with rocks. This work rendered the stream unfishable much of the time as it was made exceptionally roily and dirty for short periods of time. Thus data on this section of the stream were rather scanty.

The plugs and spoons were successful at the rate of three and two fish per hour respectively on division number six. This extended from the mouth of Temple Fork to the mouth of Beaver Creek and was, in addition to section seven, or Beaver Creek, predominantly the cutthroat waters. Fresh insects gave the next best success on division six, followed closely by two artificial baits, the wet and dry flies, that yielded on near equal terms. Worms gave better than average results on this section with all others falling below.

The spinner took an average of two fish per hour on Beaver Creek. Worms were next with slightly over one fish per hour and then wet flies with slightly under one fish per hour. Dry flies lured in above average success. The figure indicates the plug success was eight fish per hour, but this was a single sample of two anglers taking four fish in a half hour, and does not warrant a place among the larger samples (Figure 22).

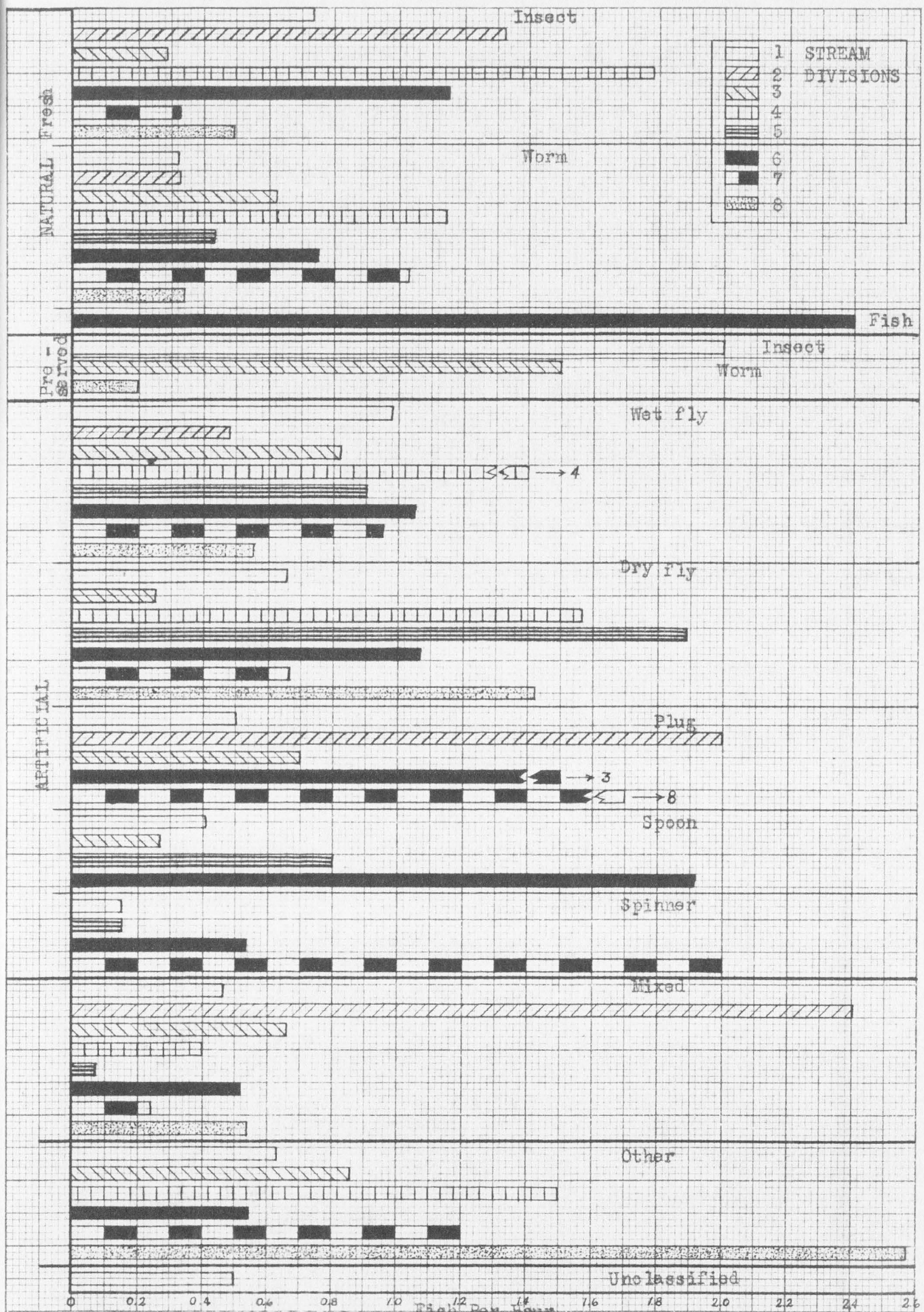


Figure 21. Angler Success by Baits Used on the Divisions of the Logan River Study Area, Cache County, Utah, 1949. (Based on Appendix Table 14.)

CONCLUSIONS AND RECOMMENDATIONS

1. There is a limited amount of competition between whitefish and trout. A study of the possible relationship should be made; and if measures of control are necessary and advisable, then they should be carried out on the less desirable whitefish.

2. A study of the hybrid cutthroat and rainbow in the Logan drainage should be made and definite recommendations toward the further development of the hybrids or their control should be made. The stocking program may be altered to cope with the situation.

3. Additional steps to supplement the present crop of fish other than by stocking should be investigated.

4. Stocked trout showed little tendency to move any distance from the point of stocking. The general movement was downstream for short distances, usually a half mile or less; but there are records of upstream movement of about the same distance.

5. The circular bands applied to the lower jaw of the fish appear to be a very satisfactory and permanent mark. No record of lost tags has been found.

6. Fin clipping is a temporary mark with the best results achieved by clipping the adipose. A clean clip close to the body showed the least signs of regeneration.

7. The use of an anesthetic on fish to be handled proved to be very satisfactory. The efficiency of the operation was greatly increased, the effect on the fish by the anesthetic was negligible, and the injuries to them as a result of handling was greatly reduced.

8. The car count and technique for estimating the total fishing pressure

was satisfactory, but the car count sample should be minimized to 10 per cent or less. The technique for estimating the total fishing pressure should be designed so that the accuracy of the estimate may be determined.

9. The creel census data and its analysis by IBM was a most satisfactory procedure. Only a few minor points on the creel census forms should be more defined for the purpose of accuracy and ease of analysis.

10. The stocking policy will have to be continued in its present form until more satisfactory stocking programs can be developed through research or until other methods of replenishment can be adequately substituted.

11. This study should be continued for a number of years to enable substantial conclusions to be drawn and various practices tried for approval or disapproval. The author hopes to make this contribution of some value.

12. Management will be able to satisfy a greater number of people if anglers will fish for the sport of fishing rather than for a fish on the table.

SUMMARY

On the Logan River study area during the 1949 trout fishing season, June 11 to October 3, inclusive, a total of 13,896 cars carried 24,619 anglers or an average 1.772 anglers per car. These anglers fished an average of 3.25 hours each for a total of 80,012 hours of fishing effort. For their efforts, the anglers caught an average of 0.6167 fish per hour or expanded 1.622 hours to catch each fish. A total of 49,343 fish were harvested from the study area.

Just prior to and during the season, 15,726 fish were marked by tagging or clipping and planted in the study area. The tags were circular bands on the lower jaw, and removal of the left pelvic fin was the clip used. Of the total number of fish harvested, 24.95 per cent were planted in 1949 and 1.76 per cent were planted in 1948, the remaining 73.29 per cent were wild fish supplemented possibly by a few unmarked hatchery-reared fish planted in error. Thus, 12,311 fish or 78.28 per cent of the total marked fish planted in 1949 were returned to anglers' creels. Eight hundred and sixty-nine fish caught in 1949 were planted and carried over from 1948.

About 375 to 390 anglers visited each mile of the Logan River during the 115-day season and took about 650 to 700 legal fish from each mile of stream. About 215 anglers visited the stream each day of the season. To distribute them along the stream would average three to four anglers along each mile. Each angler took slightly over two fish per day. These examples are based on the assumptions that there are 65 to 70 miles of fishable stream in the study area, and the impoundments are given the

same linear weight as the stream proper; also that the anglers distribute themselves evenly along the stream and leave and enter the study area randomly.

The success of the anglers was at its peak during the first two weeks of August. The anglers using the spinning rods were on the average more successful than those using any other kind of rod. Casting and keeping the bait in motion was more successful than still fishing. The running water furnished better fishing than the impoundments. The morning and evening hours were nearly equal in fishing success with the middle of the day the least productive. Worms were the most commonly used baits and were responsible for nearly 50 per cent of the fish in the creels. However, they were usually below average in the catch of fish per hour.

The fishing pressure was highest during the early part of the season and dropped off until the final week of the season when it rose again slightly. The pressure was highest in the morning and again in the evening. Wednesdays were the lowest days in fishing pressure during the week, with the weekends carrying the brunt of the week's fishing pressure.

The 1949 season cannot be termed typical as construction work interfered with the angling on the city reservoir which was closed to fishing during the last half of the season. Fishing on the stream between the mouth of Right Fork and the mouth of Temple Fork was poor as road construction interfered with anglers reaching the area, the stream bed was altered, and the water badly roiled on many occasions.

The brown trout and whitefish in the creel sample were reduced by the closing of the city reservoir during the last half of the 1949 season. These two species showed a 25 to 30 per cent decrease in the season's take

as compared to 1948. The rainbow and cutthroats appeared in about the same percentages as in 1948. The hybrids (rainbow x cutthroat) first recognized in 1949 as a separate category in the creel, furnished about eight per cent. Brook furnished about seven per cent of the 1949 creel, 85 per cent of them being taken on opening day of the season. The impoundments furnished most of the whitefish and brown. The cutthroat and hybrids were taken from the stream above section fourteen, to the upper end of the study area. The brook were taken mostly from section twenty-three, between Red Banks and the Franklin Basin-Beaver Creek junction. The rainbow were taken near the planting points.

		June 11	June 12 to June 24	June 25 to July 8	July 9 to July 22	July 23 to Aug. 5	Aug. 6 to Aug. 19	Aug. 20 to Sept. 2	Sept. 3 to Sept. 16	Sept. 17 to Sept. 30	Oct. 1 to Oct. 3	Total Counted	Total Count plus Estimate
Mon.	A		11	6 7	56 (22)	6 (26)	(26) (12)	(12) (12)	(12) 33	(11) (7)	(7) (9)	119	275
	B		(21)	8 7	42 (17)	(17) 48	(20) (7)	(7) 4	(7) 30	(5) (1)	(1) (4)	139	246
	C		20	18 7	40 12	26 50	21 11	17 15	3 (9)	(9) (5)	(5) 9	249	277
	D		43	40 29	42 43	39 (41)	38 27	33 (27)	22 (25)	(25) (21)	(21) 14	370	530
Tues.	A		17	7 11	(20) 11	(15) 8	19 5	(5) (5)	(5) (3)	(3) 1	(-1)	79	134
	B		6	10 11	(15) 10	(9) 9	13 5	15 (-1)	(-1) (-2)	4 5	(-6)	88	102
	C		25	20 24	11 (13)	15 (17)	(17) (4)	24 (3)	(3) (2)	8 (-2)	(-2)	127	182
	D		66	52 52	28 27	42 (33)	(33) (20)	(20) (19)	(19) (18)	(18) (14)	(14)	267	475
Wed.	A		11	8 9	14 9	11 15	(18) (4)	18 (4)	10 4	(2) (-2)	(-2)	109	133
	B		9	4 17	7 (8)	12 (12)	14 9	(-1) (-2)	3 (-3)	(-3) (-7)	(-7)	75	72
	C		19	12 13	(18) 19	(12) 23	(16) 13	14 (2)	(2) (1)	(1) (-3)	(-3)	113	159
	D		44	39 34	(34) 45	(28) (32)	51 (19)	(19) (19)	(19) 13	(17) (13)	(13)	226	439
Thurs.	A		22	6 12	(23) (17)	(17) 11	(21) (7)	9 (7)	(7) (6)	(6) (2)	(2)	60	175
	B		18	8 12	9 20	24 13	(16) (2)	(2) 15	(2) (0)	(0) (-4)	(-4)	119	133
	C		18	35 14	17 23	22 (20)	30 20	12 22	(6) (4)	12 20	(0)	245	275
	D		37	60 30	(37) (32)	(32) (36)	42 26	(22) (22)	(22) (20)	16 10	(17)	223	463
Fri.	A		6	12 13	(22) 13	(16) (20)	(20) (7)	(7) (6)	(6) (5)	(5) (1)	(1)	44	160
	B		11	13 10	17 10	(11*) (15)	17 7	5 (1)	(1) 6	(-1) (-4)	(-4)	96	115
	C		38	19 20	(20) (15)	20 22	25 18	(5) (5)	13 7	(4) (0)	9	191	240
	D		58	28 40	29 (31)	19 49	(35) (22)	26 (21)	24 (20)	(20) (16)	(16)	273	454
Sat.	A	301		42 32	21 27	(37) 16	(41) 23	(27) (27)	21 (25)	(25) (22)	(22) 6	489	715
	B	109		19 20	27 20	(31) 17	25 20	(22) 13	12 (20)	(20) 14	(16) 11	307	416
	C	112		29 34	47 (36)	26 (39)	43 (26)	7 12	(26) (24)	(24) (20)	22 (23)	332	550
	D	129		41 74	45 (52)	51 (56)	(56) (42)	22 (42)	(42) (40)	(40) 16	14 (39)	392	801
Sun.	A		112	60 68	84 (57)	52 (61)	49 (47)	(47) (47)	(47) 29	(45) (42)	(42) (44)	454	933
	B		98	61 63	83 49	42 (55)	75 51	(42) (42)	(42) 35	(40) (36)	(36) 17	574	867
	C		81	62 58	90 49	(56) 66	(60) 31	(46) 42	(46) (44)	22 (40)	(40) 32	533	865
	D		91	69 66	92 (72)	89 75	(76) (62)	(62) 52	(62) (60)	6 (56)	(56) (59)	540	1105
Total Counted		651	861	788	787	801	387	496	422	462	266	202	175	108	157	70	66	45	89	6833	
TOTAL		651	882	788	787	990	759	777	885	917	547	546	463	483	478	386	340	325	267		11291

* Cited by Example

() Estimates

Appendix Table 2 . Monthly Discharge for 1947, 1948, and 1949, of the Logan River at the mouth of Logan Canyon, Cache County, Utah, in second feet. *

	1947	1948	1949
October	170	145	160.6
November	149	128	142.0
December	132	115	125.17
January	115	106	113.95
February	115	102	108.4
March	138	97.7	124.44
April	215	226	312.53
May	692	763	697.2
June	503	776	556.6
July	280	342	298.4
August	203	227	211.4
September	164	182	182.0
Yearly Mean	240	268	252.7

* Furnished by D. R. Woodward, Assistant District Engineer, Water Resources Board, Geological Survey, U. S. Dept. Interior, Salt Lake City, Utah.

Appendix Table 3 . Calculations for Determination of Daily, Weekly, and Seasonal Variations for Estimation of Cars Along the Logan River Study Area, for 1949.

		Total Cars x	No. of Checks n	Mean $\bar{x}_{i\cdot\cdot}$	Deviations from Mean $\bar{x}_{i\cdot\cdot} - \bar{x}_{\cdot\cdot\cdot}$
Periods of Day	a	1354	49	27.633	- 1.567
	b	1398	63	22.190	- 7.010
	c	1790	68	26.324	- 2.876
	d	2291	54	42.426	+ 13.226
				$\bar{x}_{\cdot j\cdot}$	$\bar{x}_{\cdot j\cdot} - \bar{x}_{\cdot\cdot\cdot}$
Seasonal Intervals	1	651	4	162.750	+ 133.550
	2	1649	51	32.333	+ 3.133
	3	1588	48	33.083	+ 3.883
	4	883	32	27.594	- 1.606
	5	884	28	31.571	+ 2.371
	6	468	26	18.000	- 11.200
	7	283	16	17.688	- 11.512
	8	227	14	16.214	- 12.986
	9	111	0.9	12.333	- 16.867
	10	89	6	14.833	- 14.367
				$\bar{x}_{\cdot\cdot k}$	$\bar{x}_{\cdot\cdot k} - \bar{x}_{\cdot\cdot\cdot}$
Days of Week	Sun. 1	2101	35	60.029	+ 30.829
	M. 2	854	34	25.118	- 4.082
	T. 3	584	33	17.697	- 11.503
	W. 4	523	31	16.871	- 12.329
	Th. 5	647	32	20.219	- 8.981
	F. 6	604	31	19.484	- 9.716
	S. 7	1520	38	40.000	+ 10.800

$\bar{x}_{\cdot\cdot\cdot} = 29.200$

Appendix Table 4a . Percentage of Species of Game Fish As Taken From the Logan River Study Area, Cache County, Utah, During 1949.

KIND OF FISHING (RODS)	SPECIES													
	Hybrids		Brook		Rainbow		Brown		Cutthroat		Whitefish		Total	
	% of Hyb.	% of allsp.	% of Brk.	% of allsp.	% of Rb.	% of all sp.	% of Brn.	% of allsp.	% of Cutt.	% of allsp.	% of Wh.	% of allsp.	% of Sp.	% of Kind
Fly Rod	90.34	8.50	90.32	5.45	85.48	34.37	64.88	14.14	93.18	34.57	85.19	2.98	84.73	100
Spinning Casting Rod	.69	1.39	9.68	12.50	4.35	37.50	9.23	43.06	.70	5.56			3.96	100
Rod					4.68	33.33	13.99	54.02	1.57	10.34	3.70	2.30	4.78	100
Fixed	6.21	12.00			3.39	28.00	6.55	29.33	3.50	26.67	5.56	4.00	4.12	100
Willow or Cane Pole	2.76	9.52			1.94	28.57	5.36	42.86	1.05	14.29	3.70	4.76	2.31	100
Unclass.					.16	50.00					1.85	50.00	.11	100

Appendix Table 4b Continued.

METOD OF ANGLING

	SPECIES													
	Hybrid		Brook		Rainbow		Brown		Cutthroat		Whitefish		Total	
Unclass. Fixed Casting	% of Hyb.	% of allsp.	% of Brk.	% of allsp.	% of Rb.	% of allsp.	% of Brn.	% of allsp.	% of Utt.	% of allsp.	% of Wh.	% of all sp.	% of Sp.	% of thd.
	93.10	9.30	98.92	6.34	76.29	32.58	52.08	12.05	94.76	37.33	64.81	2.41	79.78	100
Still	2.76	1.91			13.71	40.67	28.27	45.45	2.45	6.70	20.37	5.26	11.48	100
Mixed	2.07	2.50	1.08	.83	8.39	43.33	13.10	36.67	2.62	12.50	9.26	4.17	6.59	100
	2.07	7.69			1.61	25.64	6.55	56.41	.17	2.56	5.56	7.69	2.14	100

Appendix Table 4c Continued.

SPECIES

BAIT	Hybrids		Brook		Rainbow		Brown		Cutthroat		Whitefish		Total	
	% of Hyb.	% of all sp.	% of Brk.	% of all sp.	% of Rb.	% of all sp.	% of Brn.	% of all sp.	% of Cutt.	% of allsp.	% of Wh.	% of all sp.	% of Sp.	% of Bait
NATURAL Preserved Fresh Worm Insect					7.10	36.97	12.5	35.29	1.22	5.88	75.93	34.45	6.54	100
NATURAL Worm	77.24	12.57	78.49	8.19	46.94	32.66	41.07	15.49	45.80	29.41			48.96	100
NATURAL Insect					.97	100.00							.33	100
NATURAL Fish					.48	60.00	.60	40.00					.27	100
ARTIFICIAL Wet fly					.48	60.00	.30	20.00			1.85	20.00	.27	
ARTIFICIAL Dry fly	1.38	1.14			9.03	32.00	13.69	26.29	11.89	38.86	7.41	2.29	9.62	100
ARTIFICIAL Spoon Plug	10.34	6.32	7.53	3.18	8.23	23.18	6.04	12.27	20.80	54.09			12.09	100
ARTIFICIAL Spinner					1.13	38.89	2.68	50.00	.35	11.11			.99	100
ARTIFICIAL Mixed					4.03	48.08	6.85	44.23	.70	7.69			2.86	100
ARTIFICIAL Other	2.07	23.08			.97	46.15			.70	30.77			.71	100
Unclass.	6.21	3.26	11.83	3.99	19.35	43.48	11.31	13.77	15.91	32.97	12.96	2.54	15.16	100
	2.76	10.26	2.15	5.13	1.29	20.51	2.68	23.08	2.62	38.46	1.85	2.56	2.14	100
							.30	100.00					.05	

Appendix Table 4d Continued.

PERIOD(S) OF DAY	SPECIES	Hybrids		Brook		Rainbow		Brown		Cutthroat		Whitefish		Total	
		% of Hyb.	% of all sp.	% of Brk.	% of all sp.	% of Rb.	% of all sp.	% of Brn.	% of all sp.	% of Cutt.	% of all sp.	% of Wh.	% of all sp.	% of Sp.	% of Pds.
A		82.41	13.43	46.24	12.29	15.97	28.29	17.56	16.86	17.15	28.00	7.41	1.14	1823	100
B		3.45	10.87	1.08	2.17	3.23	43.48	1.79	13.04	2.1	26.09	3.70	4.35	2.53	100
C		12.41	17.14			7.10	41.90	2.68	8.57	5.48	32.38			5.77	100
D		2.76	1.76	7.53	3.08	12.74	34.80	30.95	45.51	3.85	9.69	20.37	4.85	12.47	100
AB		25.52	8.98	37.63	8.50	18.87	28.40	25.60	20.87	22.55	31.31	14.81	1.94	22.64	100
AC															
AD						1.13	77.78	.60	22.22					.49	100
BC		4.83	7.45			4.03	26.60	4.76	17.02	6.29	38.30	18.52	10.64	5.16	100
BD						.16	50.00	.30	50.00					.11	100
CD		8.97	3.66	2.15	.56	19.68	34.37	9.52	9.01	31.82	51.27	7.40	1.13	19.51	100
ABC				1.08	3.23	3.23	64.52	2.38	25.81	.35	6.45			1.70	100
BCD		6.21	10.71	2.15	2.38	2.58	19.05			7.87	53.57	22.22	14.29	4.62	100
ACD						.32	13.33	2.38	53.33	.35	13.33	5.56	20.00	.82	100
ABD						.32	66.67	.30	33.33					.16	100
ABCD		3.45	5.75	2.15	2.30	10.65	75.86	1.19	4.60	1.75	11.49			4. 78	100

Appendix Table 4e Continued.

TYPES OF WATER		SPECIES													
		Hybrids		Brook		Rainbow		Brown		Cutthroat		Whitefish		Total	
		% of Hyb.	% of all sp.	% of Brk.	% of all sp.	% of Rb.	% of all sp.	% of Brn.	% of all sp.	% of Cutt.	% of all sp.	% of Wh.	% of all sp.	% of Sp.	% of Types
Stream	No.			77.42	5.96	71.61	30.85	29.17	8.13	80.94	38.42	20.93	1.16	66.21	100
	Per Cent	78.62	9.46												
Impoundments	No.			1.08	.29	17.74	31.98	59.23	57.85	2.10	3.49	38.89	6.10	18.90	100
	Per Cent	.69	.29												
Mixed	No.			21.51	7.38	10.65	24.35	11.61	14.39	16.96	35.79	35.19	7.01	14.89	100
	Per Cent	20.69	11.07												
TOTALS		145		93		620		336		572		54		1820	
Per cent of Total Creel		7.97		5.11		34.07		18.46		31.43		2.97			

Appendix Table 5. Total Harvest of Wild and Stocked Fish From the Logan River Study Area for 1949, Calculated by Season Intervals.

	Estimated Car Count	Anglers/Car From Check Stations 2, 6, 21, & 25	Anglers	Fisherman Day	Hours	Angler Success Fish/ Hour	Total Fish	Per Cent Marked	No. Marked
I	651	1.859	1210	3.302	4840	.543	2628	16.43	432
II	1670	1.5914	2658	2.893	10632	.512	5444	31.85	1734
III	1777	1.5376	2732	2.452	10928	.642	7016	25.82	1812
IV	1536	1.434	2203	3.198	8812	.925	8151	14.53	1184
V	1802	1.368	2465	2.614	9860	.831	8194	38.17	3128
VI	1093	1.456	1591	2.403	6364	1.195	7605	21.24	1615
VII	966	1.383	1336	3.023	5344	. 892	4767	16.08	767
VIII	864	1.086	938	2.136	3752	.553	2075	27.35	568
IX	665	1.333	887	4.533	3548	.460	1632	22.97	375
X	267	1.250	334	3.125	1044	.640	668	19.81	132
TOTALS			16354		65124		48180		11747

Appendix Table 6 . Angler Success by Stream Sections of the Logan River Study Area, Cache County, Utah, During 1949.

Stream Section	No. of Anglers	No. of Fish	Hours Fished	Average Fish per Hour
2	121	123	286	.430
3	8	8	11.75	.681
4	12	12	22.25	.539
5	4	6	7.5	.800
6	137	184	386.5	.476
8	16	15	37.75	.397
9	6	13	15.75	.825
10	18	20	35.25	.567
11	15	33	26.75	1.234
12	21	23	38.75	.593
13	0	0	0	0
14	16	20	66.5	.301
15	26	54	77.5	.696
16	9	21	42.	.500
17	3	4	6.	.667
18	43	152	109.75	1.358
19	8	11	20.25	.543
20	34	88	101.0	.871
21	76	226	283.75	.786
22	17	22	44.5	.494
23	50	132	153.75	.858
24	19	39	51.5	.757
25	51	139	149.25	.931
Stream	534	1205	1637.25	.736
Impoundments	286	344	777.75	.456
TOTAL*	928	1820	2951.	.6167 Mean.

* Not Sum of above figures as some anglers fish several areas, thus were not adaptable for this summary.

Appendix Table 7 . Number and Percentage of Creel Composition by Season Intervals for 1949 on the Logan River Study Area, Cache County, Utah.

INTERVALS	SPECIES						
	Hybrids	Brooks	Rainbow	Brown	Cutthroat	Whitefish	Total
I. June 11							
Marked	1	2	109	9	4	0	125
Not Marked	77	77	69	103	201	11	538
Total	78	79	178	112	205	11	663
Per cent by Period	53.79	84.04	28.71	33.33	35.84	20.37	36.41
Per cent Composition	11.76	11.92	26.85	16.89	30.92	1.66	100.0
II. June 12-June 24							
Marked	0	0	100	0	0	0	100
Not Marked	30	11	27	69	71	6	214
Total	30	11	127	69	71	6	314
Per cent by Period	20.69	11.70	20.48	20.54	12.41	11.11	17.24
Per cent Composition	9.55	3.50	40.45	21.97	22.61	1.91	100.0
III. June 25-July 8							
Marked	0	0	63	0	0	0	63
Not Marked	19	1	40	42	69	10	181
Total	19	1	103	42	69	10	244
Per cent by Period	13.10	1.06	16.61	12.50	12.06	18.52	13.40
Per cent Composition	7.79	.41	42.21	17.21	28.28	4.10	100.0
IV. July 9-July 22							
Marked	0	0	52	1	0	0	53
Not Marked	9	0	9	38	100	4	161
Total	9	0	61	39	100	4	214
Per cent by Period	6.21	1.06	9.84	11.61	17.48	7.41	11.75
Per cent Composition	4.21	.47	28.50	18.22	46.73	1.87	100.0
V. July 23-Aug. 5							
Marked	0	0	41	1	0	0	42
Not Marked	1	0	1	15	16	1	34
Total	1	0	42	16	16	1	76
Per cent by Period	.69	0	6.77	4.76	2.80	1.85	4.17
Per cent Composition	1.32	0	55.26	21.05	21.05	1.32	100.0

Appendix Table 7 Continued.

INTERVALS	SPECIES						
	Hybrids	Brooks	Rainbow	Brown	Cutthroat	Whitefish	Total
VI. Aug. 6-Aug. 19							
Marked	0	0	24	0	0	0	24
Not Marked	3	0	1	28	8	5	45
Total	3	0	25	28	8	5	69
Per cent by Period	2.07	0	4.03	8.33	1.40	9.26	3.79
Per cent Composition	4.35	0	36.23	40.58	11.59	7.25	100.0
VII. Aug. 20-Sept. 2							
Marked	0	0	31	0	1	0	32
Not Marked	0	0	2	16	62	4	84
Total	0	0	33	16	63	4	116
Per cent by Period	0	0	5.32	4.76	11.01	7.41	6.37
Per cent Composition	0	0	28.45	13.79	54.31	3.45	100.0
VIII. Sept. 3-Sept. 16							
Marked	0	0	5	0	0	0	5
Not Marked	1	0	3	2	1	1	8
Total	1	0	8	2	1	1	13
Per cent by Period	.69	0	1.29	.60	.17	1.85	.71
Per cent Composition	7.69	0	61.54	15.38	7.69	7.69	100.0
IX. Sept. 17-Sept. 30							
Marked	0	0	17	0	0	0	17
Not Marked	0	1	5	3	10	12	31
Total	0	1	22	3	10	12	48
Per cent by Period	0	1.06	3.55	.89	1.75	22.22	2.64
Per cent Composition	0	2.08	45.83	6.25	20.83	25.00	100.0
X. Oct. 1-Oct. 3							
Marked	0	0	20	0	1	0	21
Not Marked	4	1	1	9	28	0	43
Total	4	1	21	9	29	0	64
Per cent by Period	2.76	1.06	3.39	2.68	5.07	0	3.51
Per cent Composition	6.25	1.56	32.81	14.06	45.31	0	100.0
Marked	1	2	462	11	6	0	482
Not Marked	144	91	158	325	566	54	1339
Total	145	93	620	336	572	54	1821
Per cent by Period	100.0	100.0	100.0	100.0	100.0	100.0	100.0
Per cent Composition	7.96	5.16	34.05	18.45	31.41	2.97	100.0

Appendix Table 8 . Angling Success by Kind of Fishing (Rods) Used on the Logan River Study Area, Cache County, Utah, During 1949.

	Fly Rod	Casting Rod	Spinning Rod	Mixed Outfits	Willow Pole, Cane Pole, Etc.	Unclassified	Total
Number of Anglers	735	59	40	54	36	4	928
Number of Fish	1542	72	87	75	42	2	1820
Number of Hours Fished	2402.25	165.5	101.5	173.75	94.75	14.25	2951
Fish per Hour	.642	.435	.857	.432	.448	.140	.6167

Appendix Table 9 . Angling Success by Method of Fishing Employed on the Logan River Study Area, Cache County, Utah, During 1949.

	0 Unclassified	1 Trolling	2 Casting	3 Still	4 Mixed	Total
Number of Anglers	25	0	645	178	80	928
Number of Fish	39	0	1452	209	120	1820
Number of Hours Fished	62.25	0	2092.5	516.75	279.5	2951
Fish per Hour	.627	0	.694	.404	.429	.6167

Appendix Table 10 . Average Angler Success by Kind of Tackle (Rods) and by Method of Angling on the Logan River Study Area, Cache County, Utah, During 1949.

Kind of Tackle (Rods)		METHOD			
		Casting	Still	Mixed	Unclassified
Fly Rod	Anglers	555	111	51	18
	Fish	1298	137	73	34
	Hours	1838.25	339.25	184.25	40.5
	Fish/Hour	.706	.404	.396	.840
Casting Rod	Anglers	36	21	2	
	Fish	49	22	1	
	Hours	116.75	46.75	2	
	Fish/Hour	.420	.471	.500	
Spinning Rod	Anglers	26	8	4	2
	Fish	52	14	20	1
	Hours	57.75	19.25	16	8.5
	Fish/Hour	.900	.727	1.250	.118
Mixed Rods	Anglers	18	10	23	3
	Fish	40	8	26	1
	Hours	59.5	26.5	77.25	10.5
	Fish/Hour	.672	.302	.337	.095
Cane or Willow Poles	Anglers	10	25		1
	Fish	13	26		3
	Hours	20.25	73		.5
	Fish/Hour	.642	.356		6.000
Unclassified	Anglers		3		1
	Fish		2		0
	Hours		12		2.25
	Fish/Hour		.167		.000

Appendix Table 11. Angler Success by Baits Used During the 1949 Season on the Logan River Study Area, Cache County, Utah.

			Anglers	Fish	Hours Fished	Fish/Hour
Natural						
	Fresh					
		Insect	53	119	168.75	.705
		Worm	469	891	1563.5	.570
		Fish	1	6	2.5	2.400
	Preserved					
		Insect	1	5	2.5	2.000
		Worm	4	5	12.25	.406
Artificial						
		Wet fly	77	175	208.5	.839
		Dry fly	74	220	191.25	1.150
		Plugs	8	13	14.25	.912
		Spoons	38	52	105.5	.493
		Spinners	13	13	28.75	.452
Mixed			169	276	604.5	.457
Other			18	39	42.75	.912
Unclassified			3	6	6	1.000

Appendix Table 12. Angler Success by Baits Used by 1949 Season Intervals on the Logan River Study Area, Cache County, Utah.

BAIT		SEASONAL INTERVAL									
NATURAL											
Fresh		1	2	3	4	5	6	7	8	9	10
Insect	Anglers	4	5	9	2	10	7	11		4	1
	Fish	2	4	14	2	40	27	12		16	2
	Hours	10.5	17.75	21	4	32.75	25.5	25.25		31	1
	Fish/Hr.	.190	.225	.667	.500	1.221	1.059	.475		.516	2.000
Worms	Anglers	245	137	54	16	2	5	4	5		1
	Fish	551	206	77	32	0	3	15	7		0
	Hours	928.5	408.5	104.75	62.75	4	10.5	31	7.5		6
	Fish/Hr.	.593	.504	.735	.510	0.000	.286	.484	.933		0.000
Fish	Anglers	1									
	Fish	6									
	Hours	2.5									
	Fish/Hr.	2.400									
Preserved											
Insect	Anglers				1						
	Fish				5						
	Hours				2.5						
	Fish/Hr.				2.000						
Worms	Anglers	4									
	Fish	5									
	Hours	12.25									
	Fish/Hr.	.408									
ARTIFICIAL											
Wet fly	Anglers	1	8	31	16	3	3	3	3	2	7
	Fish	11	11	62	56	0	10	3	3	1	18
	Hours	5.5	14.75	87.75	34.75	6	8.5	6.5	10.5	5.25	29
	Fish/Hr.	2.000	.746	.707	1.612	0.000	1.176	.462	.286	.190	.621
Dry fly	Anglers	2	12	10	12	6	3	12	1	7	9
	Fish	3	35	17	30	12	11	78	1	6	27
	Hours	2	22	23.75	32.25	13.75	2.5	43	1.5	22.5	28
	Fish/Hr.	1.500	1.590	.716	.930	.873	4.400	1.814	.667	.267	.964
Plug	Anglers	3	1	2		2					
	Fish	6	1	2		4					
	Hours	1.25	.25	7		5.75					
	Fish/Hr.	4.800	4.000	.286		.696					
Spoon	Anglers	20	9	4	1	1	3				
	Fish	20	15	4	3	3	7				
	Hours	75.25	14.5	5.75	2.5	1.25	6.25				
	Fish/Hr.	.266	1.034	.696	1.200	2.400	1.120				
Spinner	Anglers	6	2	2		3					
	Fish	3	3	2		5					
	Hours	15.75	1	3		9					
	Fish/Hr.	.190	3.000	.667		.556					
MIXED	Anglers	35	38	41	19	5	2	9		8	12
	Fish	56	39	61	73	11	9	2		14	11
	Hours	167	134.5	123	77.25	14	3.5	16.25		38	31
	Fish/Hr.	.339	.290	.496	.945	.786	2.571	.123		.368	.355

Appendix Table 12 Continued.

BAIT		SEASONAL INTERVAL									
		1	2	3	4	5	6	7	8	9	10
OTHER	Anglers				5	2	1	4	2	2	2
	Fish				12	0	2	6	2	11	6
	Hours				14.25	3	1	8	4	7.5	5
	Fish/Hr.				.842	0.000	2.000	.750	.500	1.467	1.200
UNCLAS-SIFIED	Anglers			2		1					
	Fish			5		1					
	Hours			4		2					
	Fish/Hr.			1.250		.500					

Appendix Table 13. Angler Success by Baits Used During the Periods of the Day on the Logan River Study Area, Cache County, Utah.

Period of Day	NATURAL		ARTIFICIAL					MIXED	OTHER	MISC.	
	Fresh Insect	Worms	Wet Fly	Dry Fly	Plug	Spoon	Spinner			Fish Fresh	Pres. Worm
A	2	191	2	1	1	14	4	23		1	4
5 a.m.-9 a.m.	1	304	0	0	1	9	5	19		6	5
	2	447.5	1.5	1.25	.25	20.5	10.25	58.5		2.5	12.25
	.500	.379	0.000	0.000	4.000	.316	.488	.325		2.400	.408
B	4	33	5	1		4		9	2		
9 a.m.-1 p.m.	3	23	6	2		6		6	0		
	7.5	48.75	5.25	1		4.5		4.75	3		
	.400	.172	1.143	2.00		1.333		1.263	0.000		
C	1	21	6	15	2	2	2	12	2		
1 p.m.-5 p.m.	0	36	8	41	5	4	2	6	3		
	2.5	33.75	8.5	31.5	.5	3.25	3	10.25	2	?	Pres. Insect
	0.000	1.120	.923	1.302	10.000	1.231	.667	.585	1.500		
D	15	51	31	34	4	7	3	42	4	1	1
5 p.m.-9 p.m.	24	36	54	30	9	13	4	25	5	1	5
	22.75	81	54.25	45	7.5	11.75	2.5	69	6	2	2.5
	1.055	.469	.995	1.111	1.067	1.106	1.600	.362	.833	.500	2.000
AB	6	106	1		3	1	4	32	1		
	12	303	11		4	3	2	71	6		
	23.25	522.75	5.5		10	1.5	13	107.75	6.25		
	.516	.580	2.000		.400	2.000	.154	.423	.960		
AC		1									
		0									
		3.25									
		0.000									
AD		1	1			1					
		7	1			1					
		6	2.5			4.5					
		1.167	.400			.222					
BC	5	11	1	5				6	1		
	20	15	1	34				22	2		
	24.75	44.75	2.75	19.75				18.5	4		
	.808	.335	.364	1.722				1.189	.500		

Appendix Table 15. Continued.

Period of Day	NATURAL		ARTIFICIAL					MIXED	OTHER	MISC.
	Insect	Fresh Worms	Wet Fly	Dry Fly	Plug	Spoon	Spinner			
BD									1 2 .5 .400	
CD	16 42 54.5 .771	20 63 73.75 .854	21 94 121.25 .775	15 67 70.25 .954		4 7 10.75 .651		24 61 66.5 .917	7 21 16.5 1.273	
ABC		9 18 74 .243				3 6 26.25 .229		7 7 56.75 .123		
BCD	4 17 31.5 .540	7 33 51.5 .641	1 2 9 .222	3 26 22.5 1.156		1 0 8.75 0.000		4 6 24 .250		
ACD		6 15 52.75 .284								
ABD		1 0 4.5 0.000				1 3 5.75 .522				
ABCD		11 34 119.25 .285						10 53 128.5 .412		

Appendix Table 14. Angler Success by Baits Used on the Stream Divisions of the Logan River Study Area, Cache County, Utah, 1949.

BAIT		STREAM DIVISIONS							
NATURAL		1	2	3	4	5	6	7	8
Fresh Insect	Anglers	24	2	10	1		8	1	7
	Fish	46	2	9	12		30	1	19
	Hours	62.25	1.5	31	6.75		26	3	38.25
	Fish/Hr.	.739	1.333	.290	1.778		1.154	.333	.497
Worms	Anglers	151	1	28	37	43	120	48	41
	Fish	143	1	44	109	79	302	133	80
	Hours	441	3	71	95.25	183.5	403.75	129.75	236.25
	Fish/Hr.	.324	.333	.620	1.144	.431	.748	1.025	.339
Fish	Anglers						1		
	Fish						6		
	Hours						2.5		
	Fish/Hr.						2.400		
Preserved Insect	Anglers	1							
	Fish	5							
	Hours	2.5							
	Fish/Hr.	2.000							
Worms	Anglers			1					3
	Fish			3					2
	Hours			2					10.25
	Fish/Hr.			1.500					.195
ARTIFICIAL									
Wet fly	Anglers	14	7	12	1	9	16	7	11
	Fish	33	6	26	1	25	41	16	27
	Hours	33.5	12.5	31.5	.25	27.75	39	16.75	47.25
	Fish/Hr.	.985	.480	.825	4.000	.901	1.051	.955	.571
Dry fly	Anglers	21		5	11	6	21	1	9
	Fish	24		2	44	27	79	1	43
	Hours	36.5		8	28	14.25	73.75	1.5	30.25
	Fish/Hr.	.658		.250	1.571	1.895	1.071	.667	1.421
Plug	Anglers	3	1	2			2	2	
	Fish	5	2	4			3	4	
	Hours	10	1	5.75			1	.5	
	Fish/Hr.	.500	2.000	.696			3.000	8.000	
Spoon	Anglers	31		1		1	5		
	Fish	38		1		2	11		
	Hours	93.5		3.75		2.5	5.75		
	Fish/Hr.	.406		.267		.800	1.913		
Spinner	Anglers	2				4	6	1	
	Fish	3				3	7	1	
	Hours	2				13	13.25	.5	
	Fish/Hr.	1.50				.154	.528	2.000	
MIXED	Anglers	35	1	16	12	13	40	16	36
	Fish	37	3	23	6	3	94	19	91
	Hours	80.25	1.25	34.75	16.25	40.5	180.5	80.75	170.25
	Fish/Hr.	.461	2.400	.662	.369	.074	.521	.235	.535

Appendix Table 14 Continued.

BAIT		STREAM DIVISIONS							
		1	2	3	4	5	6	7	8
OTHER	Anglers	3		4	2		6	2	1
	Fish	9		6	3		6	6	9
	Hours	14.25		7	2		11	5	3.5
	Fish/Hr.	.632		.857	1.500		.545	1.200	2.571
UNCLAS-SIFIED	Anglers	1							
	Fish	1							
	Hours	2							
	Fish/Hr.	.500							

Appendix Table 15. Average Fisherman Success by Season Intervals by Stream Divisions on the Logan River Study Area, Cache County, Utah, 1949.

Seasonal Interval		MAJOR STREAM SECTIONS								
		1	2	3	4	5	6	7	8	Total
1	Anglers	115	1	25	22	24	70	28	36	321
	Fish	104	1	49	93	39	177	118	82	663
	Hours	367	3	78.5	80.25	99.75	255.25	114.75	222	1220.5
	Fish/Hr.	.283	.333	.624	1.159	.391	.693	1.028	.369	.543
2	Anglers	73	1	17	15	10	49	19	28	212
	Fish	95	0	14	8	20	106	29	42	309
	Hours	198.25	.5	34.75	18.5	46.25	151	48.5	115.5	612.75
	Fish/Hr.	.479	0.000	.403	.432	.432	.702	.598	.364	.504
3	Anglers	56	5	7	10	8	37	19	13	155
	Fish	53	7	16	21	8	99	14	26	244
	Hours	112.25	7	21	16	25.75	100.25	46	51.75	380
	Fish/Hr.	.472	1.000	.762	1.312	.311	.988	.304	.502	.642
4	Anglers	16	4	3	4	13	24	1	7	72
	Fish	40	4	1	5	35	80	2	46	213
	Hours	39.25	7.35	2	4	52.5	103.25	1.5	20	230.25
	Fish/Hr.	1.019	.516	.500	1.222	.667	.775	1.333	2.300	.925
5	Anglers	9	0	4	3	0	16	3	0	35
	Fish	17	0	4	8	0	46	1	0	76
	Hours	17.75	0	9.75	9.75	0	47.25	7	0	91.50
	Fish/Hr.	.958	0	.410	.821	0	.974	.143	0	.831
6	Anglers	9	0	1	4	6	3	0	1	24
	Fish	25	0	1	16	15	11	0	1	69
	Hours	23.75	0	3.75	8.75	15.5	3	0	3	57.75
	Fish/Hr.	1.052	0	.266	1.829	.968	3.667	0	.333	1.195
7	Anglers	4	0	15	0	6	12	0	6	43
	Fish	6	0	24	0	18	35	0	33	116
	Hours	9.25	0	31	0	21.75	28.75	0	39.25	130
	Fish/Hr.	.648	0	.774	0	.828	1.217	0	.841	.892
8	Anglers	2	0	1	2	3	0	3	0	11
	Fish	3	0	2	4	3	0	1	0	13
	Hours	4.25	0	.5	2.25	11	0	5.5	0	23.5
	Fish/Hr.	.706	0	4.000	1.777	.273	0	.182	0	.553
9	Anglers	1	0	3	0	4	8	0	7	23
	Fish	1	0	4	0	0	18	0	25	48
	Hours	5	0	8.5	0	5.5	42.75	0	42.5	104.25
	Fish/Hr.	.200	0	.470	0	0.000	.421	0	.588	.460
10	Anglers	1	1	3	4	2	6	5	10	32
	Fish	0	2	3	20	0	7	16	16	64
	Hours	1	1	5	9	3.5	24	14.5	42	100
	Fish/Hr.	0.000	2.000	.600	2.222	0.000	.292	1.103	.381	.640

LITERATURE CITED

1. Bardach, J. E.
1949 Lake Mendota Perch teach school. Wisconsin Conservation Bulletin 14 (7): 11 - 12.

2. Brown C. J. D.
1935 A survey of the water of the Cache National Forest, Utah. Report to Bureau of Fisheries, Department of Commerce, Mimeo. 32 page.

3. Chamberlain, T. K. and W. W. Huber
1947 Ten years of trout stream management on the Pisgah. Progressive Fish-Culturist, 9 (4) 185 - 191.

4. Cobb, Eben W.
1933 Results of trout tagging to determine migrations and results from plants made. American Fisheries Society Transactions, 63: 308 - 318.

5. De Lury, D. B.
1947 On the estimation of biological populations. Biometrics, 3 (4): 145 - 167.

6. Edwards, Oliver T.
1940 Measurement of fish catch in the Russian River, Alaska. Fifth N. A. Wildlife Conference Transactions, 1940: 264 - 267.

7. Embody, D. R.
1940 A method of estimating the number of fish in a given section of a stream. American Fisheries Society Transactions, 69: 231 - 236.

8. Eschmeyer, R. W.
1949 Recent advances in fresh water fishery management. Fourteenth N. A. Wildlife Conference Transactions, 1949: 207 - 224.

9. _____, _. _.
1949 The fisheries picture with special reference to the T. V. A. impoundments. Wildlife in North Carolina, 13 (2): 16 - 18.

10. Foster, Richard F.
1941 Marking trout under anesthesia. Progressive Fish-Culturist, Memo. I - 131, No. 54: 30 - 31.

11. Garwood, F.
1936 Fiducial Limits for the poisson distribution. Biometrics, 28: 437 - 442.

12. Gerking, Shelby D.
1949 Urethane (Ethyl carbamate) in some fishery procedures. Progressive Fish-Culturist 11 (1): 73 - 74.

13. Greeley, John R.
1948 Fish populations necessary for successful angling. Thirteenth N. A. Wildlife Conference Transactions, 1948: 555 - 562.

14. Hazzard, Albert S. and David S. Shetter
1938 Results from experimental plantings of legal-sized brook trout (Salvelinus fontinalis) and rainbow trout (Salmo irideus). American Fisheries Society Transactions, 68: 196 - 208.

15. Heacox, C.
1942 Fin regeneration in brown trout. American Fisheries Society Transactions, 72: 231 - 232.

16. Hess, R. H.
1948 North Fork of South Platte. Multiple Purpose Project. Fish Management Division, The Colorado Game and Fish Department.

17. Harkus, Henry C.
1938 The effects of tags upon fresh water fishes. American Fisheries Society Transactions, 63: 319 - 325.

18. Miller, R. R.
1949 A list of the fishes of Utah with keys to identification. Mimeo. by Wildlife Department, Utah State Ag. College, Jan. 1950, 13 pp.

19. Mottley, C. McC.
1940 The statistical analysis of creel census data. American Fisheries Society Transactions, 76: 290 - 300.

20. Needham, P. R. and H. John Rayner
1939 The experimental stream, a method for study of trout planting problems. Copeia, 1939, No. 1: 31 - 38.

21. Needham, P. R., J. W. Moffett, and D. W. Slater
1945 Fluctuations in wild brown trout populations in Convict Creek, California. Journal of Wildlife Management, 9 (1): 9 - 25.

22. Randle, Allen C. and Frederick K. Cramer
1941 The Squaw Creek test stream. California Fish and Game, 27 (3): 172 - 184.

23. Ricker, W. E.
1937 The concept of confidence or fiducial limits applied to the poisson frequency distribution. Journal of the American Statistical Association, 32: 349 - 356.

24. _____, _____.
1948 Methods of estimating vital statistics of fish populations. Indiana University Publications, Science Series, No. 15: 101 pp.

25. _____, _____.
1949 Effects of removal of fins upon the growth and survival of spiny-rayed fishes. Journal of Wildlife Management, 13 (1): 29 - 40.

26. Rounsefell, George A. and John Lawrence Kask
1943 How to mark fish. American Fisheries Society Transactions, 73: 320 - 363.

27. Seaman, E. A. and R. F. Stephens
1950 Percentage returns of marked trout in two West Virginia streams. Progressive Fish-Culturist, 12 (1): 29 - 31.

28. Shetter, David S.
1936 The jaw-tag method of marking fish. Papers of the Michigan Academy of Science, Arts, and Letters, 21: 651 - 653.

29. _____, _____.
1939 Success of planting of fingerling trout in Michigan waters as demonstrated by marking experiments and creel census. Fourth N. A. Wildlife Conference Transactions, 1939: 318 - 325.

30. Shetter, David S. and A. S. Hazzard
1941 Results from plantings of marked trout of legal size in streams and lakes of Michigan. American Fisheries Society Transactions, 70: 446 - 456.

31. Shetter, David S. and Justin W. Leonard
1942 A population study of a limited area in a Michigan trout stream. American Fisheries Society Transactions, 72: 35 - 51.

32. Shuck, Howard A.
1942 The effect of jaw tagging upon the condition of the trout. Copeia, 1942 No. 1: 33 - 39.

33. Snedecor, George W.
1948 Statistical Methods. Fourth Edition. Iowa State College Press, Ames, Iowa. 476 pp.

34. Surber, E. W.
1937 Rainbow trout and bottom fauna in one mile of stream. American Fisheries Society Transactions, 66: 193 - 202.

35. Tarzwell, Clarence M. and Lawrence F. Miller
1942 The measurement of fishing intensity on the lower T. V. A. reservoirs. American Fisheries Society Transactions, 72: 246 - 256.

36. Thoreson, Nels A.
1949 An evaluation of trout stocking in the Logan River Drainage. Thesis (MS) U. S. A. C.

37. Viosca, Percy, Jr.
1935 Statistics on the productivity of inland waters. The master key to better fish culture. American Fisheries Society Transactions, 65: 350 - 358.

38. Wales, J. H.
1947 Growth rate and fin regeneration in trout. Progressive Fish Culturist, 9 (2): 86 - 89.

39. Williams, J. Stewart
1948 Geology of the Paleozoic Rocks, Logan Quadrangle, Utah. Geological Society of America, 42 pp. 2 maps.

GENERAL BIBLIOGRAPHY

Baugham, R. V. and Neville L. Bennington
1938 Movement of fish instreams. American Fisherois Society Transactions, 68: 265 - 262.

Carbine, W. F. and V. C. Applegate
1946 Recaptures of tagged walleyes, (Stizostedion v. vitreum) (Mitchill), in Houghton Lake and the Muskegon River, Roscommon County, Michigan. Copeia, 1946 (2): 97 - 100.

Carlander, Kenneth D. and William M. Lewis
1948 Some precautions in estimating fish populations. Progressive Fish-Culturist, 10 (3): 135 - 137.

Clark, Frances N. and John F. Janssen Jr.
1945 Movements and abundance of the sardine as measured by tag returns. Fishery Bulletin No. 16: 7 - 42.

Clark, G. H.
1934 The need of a measure of the angler catch. American Fisheries Society Transactions, 64: 49 - 53.

Costley, Richard J.
1941 A preliminary study of the productiveness of the Logan River. Procedures of the 21st Annual Conference of the Western Association of State Game and Fish Commissioners. (Original report to U. S. Forest Service Intermountain Region, May 16, 1940. Typed 4 pages.

Croker, Richard S.
1936 How California is measuring the angler's catch. American Fisheries Society Transactions, 66: 301 - 305.

Curtis, Brian
1939 Anglers' catch records in California. American Fisheries Society Transactions, 69: 125 - 131.

———, ———
1941 Creel counts in California. California Fish and Game 27 (3): 185 - 189.

Davis, H. S.
1938 Instructions for conducting stream and lake surveys. U. S. Bureau of Fisheries Circ. 26: 55 pp.

———, ———
1938 Objectives in trout stream amangement. American Fisheries Society Transactions, 68: 76 - 81.

Elkins, Winston A.
1936 A fish yield study for certain lakes in the Chequamegon National Forest. American Fisheries Society Transactions, 66: 306 - 312.

Eschmeyer, R. W.
1935 Analysis of the game-fish catch in a Michigan Lake. American Fisheries Society Transactions, 65: 207 - 223.

———, ———.
1939 Summary of a four year creel census on Fife Lake, Michigan. American Fisheries Society Transactions, 68: 354 - 358.

———, ———.
1936 The Michigan Creel Census as an aid to the hatchery man. Progressive Fish-Culturist, No. 19: 11 - 14.

———, ———. and O. H. Clark
1939 Analysis of the population of fish in the water of the Mason Game Farm, Mason, Michigan. Ecology, 20 (2): 272 - 286.

———, ———. and C. M. Tarzwell
1941 An analysis of fishing in the T. V. A. impoundments during 1939. Journal of Wildlife Management, 5 (1): 15 - 41.

Fry, Donald H., Jr. and Phil M. Roedel
1939 Progress report on tagged Pacific macherkel. California Fish and Game, 25 (1): 2 - 17.

Gee, Merle A.
1941 Report on the upper Pecos River creel census, Santa Fe National Forest. Fifth N. A. Wildlife Conference Transaction, 1940: 207 - 217.

——, ———.
1942 Success of planting legal-sized trout in the Southwest. Seventh N. A. Wildlife Conference Trans., 1942: 238 - 244.

Gerking, Shelby
1949 Characteristics of stream fish populations. Investigations of Indiana Lakes and Streams, 3 (7): 283 - 309.

Hanson, Harry A.
1938 A creel census as an aid to a better fish stocking program. Progressive Fish-Culturist, Memo. 1 - 131, No. 37: 17 - 19.

Harkness, W. J. K.
1941 Catches of speckles trout from the plantings of hatchery-raised fish in private waters of Ontario. American Fisheries Society Transaction, 70: 410 - 413.

Hazzard, Albert S.
1936 A preliminary study of an exceptionally productive trout water, Fish Lake, Utah. American Fisheries Society Transactions, 65: 122 - 128.

Hoover, Earl E.
1938 Fish populations of primitive brook trout streams of northern New Hampshire. Third N. A. Wildlife Conference Transactions, 1938: 486 - 496.

Johnson, Raymond E.
1949 The problems of "good" fishing. Wisconsin Conservation Bulletin 14 (7): 16 - 18.

Keil, William M., Thomas K. Chamberlain, and Reuben O. Knuth
1939 Report on Pisgah fish Management. Progressive Fish-Culturist, Memo. I - 131, No. 44: 1 - 10.

Iagler, Karl F. and Mary Jane Iagler
1942 A summer creel census for Foots Pond, Indiana. Investigations of Indiana Lakes and Streams 2: 111 - 115.

McCutchin, T.
1949 Stricter trout fishing regulations--Why? Wisconsin Conservation Bulletin 14 (4): 10 - 12.

Mottley, C. McC.
1942 Experimental Designs for Developing and Testing a Stocking Policy. Seventh N. A. Wildlife Conference Transactions, 1942: 224- 232.

———, ———.
1942 Modern methods of studying fish populations. Seventh N. A. Wildlife Conference Transactions, 1942: 356 - 360.

Moore, Emmeline, J. R. Greeley, C. W. Greene, H. M. Faigenbaum, F. R. Nevin, and H. K. Townes
1935 A problem in trout stream management. American Fisheries Society Transactions, 64: 68 - 80.

Moore, Emmeline, and Staff Members
1937 A creel census at Chautauqua Lake, New York, American Fisheries Society Transactions, 67: 130 - 138.

Needham, P. R.
1937 Methods of measuring anglers' catches in inland waters. Copeia, 1937: (1) 41 - 48.

———, ———.
1947 Survival of trout in streams. American Fisheries Society Transactions, 77: 26 - 31.

Needham, P. R. and P. H. Sumner
1941 Problems of high western lakes with returns from marked trout plant in Upper Angora Lake, California. Progressive Fish-Culturist, Memo I - 181, No. 55: 41 - 42.

Needham, P. R. and J. W. Slater
1944 Survival of hatchery reared brown and rainbow trout as affected by wild trout populations. Journal of Wildlife Management, 8 (1): 22 - 36.

Nesbit, R. A. and J. A. Kitson
1937 Some results of trout tagging in Massachusetts. Copeia, 1937 (3): 168 - 172.

Pogue, Ralph
1949 Stocking fish--Does it pay? News for Immediate release, State of Missouri Conservation Commission. Jefferson City, Missouri.

Ricker, W. E.
1942 Creel census, population estimates and rate of exploitation of game fish in Shoe Lake, Indiana. Investigations of Indiana Lakes and Streams, 2: 215 - 255.

———, ———.
1948 Fish populations of two artificial lakes, Investigations of Indiana lakes and Streams, 2: 255 - 265.

———, ———.
1945 Fish Catches in three Indiana lakes. Investigations of Indiana Lakes and Streams, 2 (16): 325 - 344.

Ricker, W. E., Harrell E. Hosbaugh, and Maurice Lung.
1949 Utilization and survival of trout in Indiana. Investigations of Indiana Lakes and Streams, 3 (6): 271 - 281.

Rose, E. T.
1947 The population of yellow pikeperch (Stizostedion v. vitreum) in Spirit Lake, Iowa. American Fisheries Society Transactions, 77: 32 - 41.

Schneberger, Edward S.
1943 Wisconsin's trout program. Wisconsin Conservation Bulletin, 14 (7): 13 - 15.

Seaman, E. A.
1948 Channel catfish tagging in West Virginia. Progressive Fish-Culturist, 10 (3): 150 - 152.

Shoemaker, Hurst H.
1935 Testing Raunkiaer's law of frequency against distribution of fishes in the streams of Wayne County, Indiana. Ecology, 16: 568 - 572.

Shuck, Howard A.
1943 The effect of population density of legal-sized trout upon the yield per standard fishing effort in a controlled section of stream. American Fisheries Society Transactions, 71: 236 - 248.

_____, _____ and _____.
1945 Survival, population density, growth and movement of the wild brown trout in Crystal Creek. American Fisheries Society Transactions, 73: 209 - 230.

Smith, L. L.
1941 The results of planting brook trout of legal length in the Salmon Trout River, northern Michigan. American Fisheries Society Transactions, 70: 249 - 258.

Smith, Oliver H. and John Van Oosten
1939 Tagging experiments with lake trout, whitefish, and other species of fish from Lake Michigan. American Fisheries Society Transactions, 69: 65 - 84.

Smith, Osgood R.
1938 A creel census from Dry river, New Hampshire. American Fisheries Society Transactions, 68: 313 - 315.

Surber, E. W.
1949 A trout survey. Maryland Conservationist 26 (2): 18 - 21.

_____, _____ and _____.
1949 Results of Planting Conditioned and Pond Trout of legal size in North and Big Spring Creeks, Virginia. Virginia Wildlife 8 (4): 14 - 17 April; 8 (5): 6 - 8 May; 8 (6): 14 - 15 June, 1949.

Swift, Ernest F.
1949 The economic basis of conservation trends. Wisconsin Conservation Bulletin, 14 (4): 7 - 9.

Trembley, Gordon L.
1943 Results from plantings of tagged trout in Spring Creek, Pennsylvania. American Fisheries Society Transactions, 73: 163 - 172.

Trippensee, R. E.
1937 Fish population studies on some New Hampshire trout streams. New Hampshire Fish and Game Commission, Concord, New Hampshire. 119 - 124.

Vestal, Eldon H.
1943 Creel returns from hatchery trout in June Lake, California. California Fish and Game, 29 (2): 51 - 63.

Wickliff, E. L.
1933 Returns from fish tagged in Ohio. American Fisheries Society Transactions, 63: 326 - 331.

Williamson, Lyman O. and Edward Schneberger
1942 The results of planting legal-sized trout in the Deerskin River, Vilas County, Wisconsin. American Fisheries Society Transactions, 72: 92 - 96.

Wright, Stilman
1943 Some unregarded factors in creel census studies. Eighth N. A. Wildlife Conference Transactions, 1943: 387 - 392.