

INCREASED HARVEST OF WARM WATER FISH
THROUGH SUPPLEMENTAL FEEDING

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PREFACE

The lack of an adequate harvest of fish from ponds and from large impoundments is one of the major problems in fishery management. Fishery biologists commonly agree that fish populations tend to become large and that individual kinds tend to become stunted due indirectly to an insufficient harvest. The present paper discusses experiments conducted to determine if fish could be aggregated in given areas by feeding and to determine if fish so aggregated could be more readily harvested.

The study herein described could not have been effected without the support of numerous cooperators. I wish to express my appreciation to all of them.

Special thanks are due my adviser, Professor W. H. Irwin, who proposed and directed the work as a graduate research problem and also assisted with some of the field work. I am also indebted to committee members Professors Roy W. Jones, Bryan P. Glass, Robert Totusek, Fred LeCrone and David S. Berkeley for their suggestions.

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INTRODUCTION

The data herein presented concern a study based on the hypothesis that fish in farm ponds could be caused to aggregate by distributing food in a given area and that the fish so aggregated could be more easily harvested. Food in dry, pellet form was distributed in seven ponds beginning on June 5, 1956 and ending November 13, 1956. Seines and wire traps were used to collect fish from areas where food was placed and from established check-areas. The resultant harvest of fish, with seines and with traps, showed that fish could be concentrated in an area where food was placed. It seems apparent that the increased harvest of warm-water fishes from impoundments would be beneficial.

Westerman (1949), Davis (1953), and Stroud and Seaman (1957) called attention to the fact that warm-water fish management has not received the attention nor has it attained the degree of improvement enjoyed by trout management. Yet, as pointed out by Westerman (1949), Meehan (1952), Salla (1952), Davis (1953), Carlander (1955), and others, more waters are available for warm-water fish, larger yields per unit area can be produced, and more people fish for warm-water fish than is true for trout.

It is apparent from observations made by Pryor (1941), Riggs and Sneed (1951), Swingle (1957), King (1957), and many others, that both large and small impoundments, now so commonplace in the plains states have a great potential for producing protein food in the form of fish.

Jenkins (1957) stated that unfertilized ponds in Oklahoma, less than 5 acres in size, support an average of 360 pounds of fish per acre per year and that the total poundage may vary from 150 to 670 pounds depending on the location of the pond and the conditions on the watershed. King (1955) suggested that an average of 200 pounds, or more, of game fish per acre is expected from the 500,000 acres of water (including lakes, ponds, and streams) now present in Oklahoma.

According to Thompson (1950) there were only 2 artificial lakes of more than 10 surface acres in existence in Oklahoma in the year 1900. Oklahoma now has at least 100,000 farm ponds with an additional 12,000 being constructed each year (Ward, Leonard, and Martin, 1954). Many of the ponds are not used for fish crops but could be so used if the fish could be adequately harvested. Aldrich (1947) said, "...there are thousands upon thousands of pounds of fish in Oklahoma waters unused and largely wasted because we are too specialized in our harvesting methods and tastes."

Considerable progress has been made toward understanding the difficulties involved in fisheries management. Fishery biologists including Bennett (1943), Swingle (1945), Irwin (1946, 1957), Thompson (1947), and Houser (1957) agreed that fish-populations tend to become large and individual kinds to become stunted or that an unfavorable balance between carnivorous and forage fish develops.

Irwin (1947) stated:

One of the most important practices in pond management is to make certain that the crop is harvested. This is good agricultural practice. Keep the numbers of the fish of all kinds balanced with their available food supply and they all grow well. Overplant any field and you harvest a poorer rather than a better crop.

The views expressed above by Irwin (1947) were supported by Swingle (1947), Eschmeyer (1951), Meehean (1952), Jenkins (1954), and Heard (1956).

Carlander (1952) and Maciolek (1954) stated that very few farm ponds are adequately harvested. In agreement with this statement, but with respect to large reservoirs, Thompson (1950) and Heard (1956) stated that the most important problem involved in reservoir management is the lack of an adequate harvest. They further stated, "We must harvest our fish crops if we are to preserve good fishing in our reservoirs."

As reported by Bennett (1943), Thompson (1947), Eschmeyer (1951), Carlander (1952), Moorman (1957) and Irwin (1957), it is evident in most instances that hook and line fishing does not sufficiently harvest a fish population from a pond or reservoir. Moorman (1957) discussed the harvest of fish by hook and line from 18 ponds in Iowa and pointed out that about 65 pounds of fish per acre per year were harvested from the 6 most heavily fished ponds and that the harvest from the other 12 ponds would not exceed 20 pounds per acre per year. However, a few exceptionally good harvests have been reported. Leonard (1950) reported that 326 pounds of bass, 149.5 pounds of bluegills, 186.75 pounds of crappie, 139.5 pounds of channel catfish, and 53 pounds of bullheads were harvested by hook and line from a four-acre pond near Stillwater during the period from April through November, 1949. Buck and Cross (1952) discussed a phenomenal harvest of crappie from a three-acre cove in Canton Reservoir. Within a period of 69 days extending from January 10, 1950 to March 25, 1950, hook and line fishermen harvested more than 426,000 legal-sized white crappie from the cove. The harvest amounted to 22 tons of fish per surface acre for the cove and was equivalent to a harvest of 27 pounds per surface acre for the entire reservoir. Krumholz (1952) said:

Ordinarily, at least half of the total weight of any fish-population can be harvested annually without having any detrimental effect on the ability of the population to maintain itself. In fact, the experimental evidence at hand indicates that such a harvest is highly desirable.

King (1955) stated:

Under most conditions Oklahoma's game fish species can be harvested up to about 70 percent and still have no worries about the populations maintaining themselves. In fact, they should be harvested to this amount to keep the population in a healthy catchable condition.

The foregoing observations indicate that under most circumstances, the success of hook and line fishing must be increased or harvest by some other means will be necessary to control fish populations in ponds and reservoirs.

Irwin (1957) said, "Fish concentrations lead to a greater harvest. Feeding the fish about fishing docks has some promise. ... Certainly the various means of fish concentrations should be studied."

Traps used in conjunction with baiting or feeding show some promise as a means of controlling populations (Byrd and Moss, 1955). Hubbs and Eschmeyer (1938) and an article in the Sport Fishing Institute Bulletin Number 35 (1954) have suggested that seining, when species are concentrated in certain areas, is beneficial by reducing populations of fish.

Feeding practices at trout hatcheries and farms have caused trout to congregate. Similar practices have been successful in limited experiments with other species (Brown, 1957). It seems probable that most species could be congregated in like manner.

Houser (personal communication) with a crew of fisheries men from the Oklahoma Department of Wildlife Conservation did some experimental feeding (baiting) in Fort Gibson Lake in 1957 and 1958. Cottonseed cake was broadcast by hand from a boat over selected areas, 150 to 200 feet square,

near the shoreline. Water depths were generally less than 12 feet in the areas used. During the initial stages of the investigation about 300 pounds of food were used in an area. In succeeding phases the amount of food was decreased to 50 pounds. Houser believed there was no apparent decrease in the number of fish caught when using the lesser amount of food. Samples of fish were taken with a nylon haul seine, 1,400 feet long and 15 feet deep. One half the seine was 1 inch mesh, the other half was 1½-inch mesh. Best results, during the summer months, were obtained when samples were made the day following the distribution of food. Best results were obtained in January and February when samples were made three days following food distribution. Houser's records showed that many more fish were caught in areas where food was placed than in check areas. He also felt that with this method there were possibilities for a more or less selective harvest of certain species of fish depending on the season of the year and the type of area used.

If fish can be aggregated in feeding areas in ponds and lakes, fishery workers and management agencies could have at their disposal techniques which might bring about a greater and more consistent harvest and a technique which would provide continuous fishing for the fisherman. Both would aid in controlling population sizes. The surplus fish harvested could be used to stock other waters if needed. The technique may well be more practical than complete eradication of fish by poisoning or by draining the impoundment.

PROCEDURES AND MATERIALS

Seven farm ponds were selected in May, 1956 for the purpose of studying the reactions of fish to supplemental feeding. The proximity of the ponds chosen permitted daily feedings and observations.

Areas used as feeding-sites in each pond were cleared of brush and other debris in order to facilitate seining and trapping operations. In addition, large quantities of aquatic vegetation were removed from the areas several times during the summer months.

Food was placed in a sampling area in each pond every day (a few Sundays excepted) during the period from June 5 to August 31, 1956. Food was distributed on alternate days beginning September 1 and continued in this manner to November 13 at which time all field work was suspended. Food was broadcast by hand from the bank at about the same hour each time a given pond was visited. Observations were made and notes were taken concerning feeding activity of fish, condition of the water, and condition of the weather on each visit to the ponds.

Seines (nets) and wire traps were used to collect fish in areas where food was placed (referred to as feeding-areas) and in other similar areas (called check-areas) where food was not placed. Fish that were collected were counted, identified, weighed, measured for total length and then were returned to the pond.

The following terms as used in the manuscript are defined.

1. Feeding-area, or feeding-site, is a sampling area where food was distributed.

2. Check-area is a sampling area where food was not distributed.
3. Clear water is water in which fish can be seen at a depth of 6 inches.
4. Turbid water is water in which fish cannot be seen except when they disturb the surface. Turbid water resulted from suspended soil particles or from algal blooms.
5. Intense activity. This term is used to denote first, that large numbers of fish (including small and/or large fish) created such a turmoil in the feeding-area that counting of their numbers was impossible, and second, that the activity began immediately after food was placed in a feeding-area and continued for the duration of the observation period.
6. Heavy activity. This term is used to indicate that fish 7 inches or more in length were observed at least 10 times during the observation period, or that groups (containing 10 or more small fish) were observed at least 6 times.
7. Moderate activity. This term is used to indicate that fish 7 inches or more in length were observed at least 5 but less than 10 times or that groups (containing 10 or more small fish) were observed from 2 to 5 times during the observation period.
8. Scattered activity. This term is used to denote that at least some activity occurred in the area but not enough to be placed in the other categories.

The activities of fish in feeding-areas, for purposes of clarity and simplicity, were recorded in fieldnotes under headings 5, 6, 7, and 8 listed above.

Pond Selection

The seven ponds, used in the study and numbered consecutively from 1 through 7, were selected from a large number of ponds examined in the vicinity of Stillwater. Ponds were chosen on the following bases:

1. size, about 1 surface acre or more,
2. suitability for sampling with seines and/or traps,
3. location, with respect to ease of access and to travel time required between ponds,
- and 4. cooperation of landowners.

Table I contains a list of the ponds, the owners, a legal description in reference to the Indian Meridian, maximum size in surface acres, and the condition of the water for each pond.

Areas for Sampling with Seines

Two areas to be sampled with seines were selected in Ponds 1, 2, 3, 5, 6, and 7. These areas, 25 feet wide and 25 feet long (625 square feet) and as similar as possible in all respects, were located on opposite sides of the pond or as far apart as feasible. The areas began at the feathered edge and extended to depths of 5 to 6 feet at points 25 feet from the shoreline. One area in Pond 1 was the dimensions given above, while the other was modified somewhat in size and shape because of stumps and deep water. No areas suitable for sampling with seines were found in Pond 4 because of the presence of large amounts of debris, a soft-mud bottom, and deep water.

The areas were measured and their corners marked with wooden stakes at the shoreline and with 1/2-inch pipes in the pond. The pipes were long enough to be driven into the bottom of the ponds and to extend 3 to 4 feet above the surface of the water. Extremely dry weather and the accompanying

TABLE I

A DESCRIPTION OF THE SEVEN FARM PONDS USED IN THE STUDY

Pond	Owner	Legal Description With Reference to the Indian Meridian	Maximum Size Surface Acres	Water Conditions
1	Chris G. White	SE1/4 SE1/4 S. 31, T. 20 N., R. 2 E.	1.04	clear
2	Chris G. White	SE1/4 NE1/4 S. 31, T. 20 N., R. 2 E.	1.50	clear-turbid
3	Chris G. White	NE1/4 NE1/4 S. 31, T. 20 N., R. 2 E.	3.30	turbid
4	Carl S. Andrews	NE1/4 SW1/4 S. 12, T. 19 N., R. 2 E.	2.10	turbid
5	W. E. Young	SW1/4 NW1/4 S. 18, T. 19 N., R. 3 E.	1.12	clear-turbid
6	E. B. Epperson	SE1/4 SW1/4 S. 18, T. 19 N., R. 3 E.	1.12	turbid
7	Stillwater Hatchery	SE1/4 SE1/4 S. 13, T. 19 N., R. 2 E.	2.53	clear-turbid

water loss necessitated moving the marker stakes in order to maintain sampling areas of their original size.

Food and Feeding Methods

The supplemental food used in all ponds during the course of the study was CO-OP 18-percent egg-mash in pellet form purchased from the Consumers Cooperative Association. Availability and moderate cost were factors which determined the choice of the food. The following is an analysis of the food as shown on the tag attached to each bag of food.

CO-OP

18 PERCENT EGG MASH

Guaranteed Analysis

Crude Protein, not less than	18.00 percent
Crude Fat, not less than	3.00 percent
Crude Fiber, not more than	7.50 percent
N.F.E., not less than	50.00 percent

FLEXIBLE FORMULA AND INGREDIENTS

Meat and Bone Meal	5.00 percent
Soybean Oil Meal	16.75 percent
Dehydrated Alfalfa Meal	10.00 percent
Wheat Bran and Wheat Gray Shorts	10.00 percent
Ground Corn and Grain Sorghum Chop	38.00 percent
Ground Oats	10.00 percent
*Poultry Mixing Balancer	2.50 percent
Ground Limestone	3.00 percent
Defluorinated Phosphate	1.00 percent
Salt	.50 percent
**CO-OP Mineral Concentrate	.25 percent
Feeding Cane Molasses	3.00 percent

*CO-OP Poultry Mixing Balancer contains Riboflavin, Calcium Pantothenate, Niacin, Choline Chloride, Vitamin B₁₂ Supplement, D-Activated Animal Sterol (Source of Vitamin D₃), D L Methionine, Antibiotic Feed Supplement, Fish Meal, Alfalfa Meal, Corn Distillers Solubles, Ground Corn, Grain Sorghum Chop, Dried Whole Whey, Cottonseed Meal, Dried Grain Fermentation Solubles, Vitamin A Feeding Oil, and Butylated Hydroxytoluene (Preservative).

**CO-OP Mineral Concentrate contains Manganese Sulphate, Ferrous Sulphate, Iron Oxide, Copper Sulphate, Cobalt Sulphate, Potassium Iodide, Zinc Sulphate, Sulphur, DiCalcium Phosphate.

Ponds were visited daily during the period June 5 to August 31, 1956 and food was placed in one of the areas selected for sampling with seines. Approximately 3.5 pounds of pellets were scattered over each feeding-area. On September 1, 1956 the amount of food was increased to 5.0 pounds and the food was distributed only on alternate days throughout the remainder of the study.

One area in each pond, selected for sampling by seines, received food daily for a prescribed period of time. Periodically during the prescribed period, fishes were collected with seines and/or with traps from feeding-areas and from established check-areas. At the end of prescribed periods food was distributed in what had previously been the check-area; then the former feeding-area became a check-area and both areas were re-sampled.

Seines and Seining

Fish samples were taken with seines from the two selected areas in each pond at intervals of three to four weeks. Seines were usually set in the early morning hours, food thrown into the feeding-area one to two hours later, and the seines dropped about thirty minutes after feeding. The seines were then pulled into or near the shore where captured fish were collected.

Two seines, 75 feet long, 8 feet deep, and 3/4-inch square (1½-inch stretched) mesh, made of Number 9 Nyak thread, were used to obtain samples of fish from the areas described. Minnow seines, 75 feet long, 6 to 8 feet deep and of 1/4-inch mesh were also utilized to take samples in three ponds. Each seine was marked on the floatline and leadline with colored strings tied at intervals of 25 feet. The markers indicated the parts of the seine to be hung at the corners of the sampling area.

Pipes as illustrated in Figure 1 were rigged to hold and release seines. The pipes, 1/2-inch in diameter, were made in varied lengths for use in different depths of water. Some pipes were threaded which permitted extensions to desired lengths by the use of collars and added pipe. Pipes were driven into the bottoms of the ponds at intervals of 6 feet on three sides of the sampling areas (Fig. 2). The pipes were set in place a day or two before seined samples were taken.

Seines could usually be set around two areas in thirty minutes by two persons but when necessary one person could set the seines in sixty minutes. The sequence of steps generally followed in setting seines was as follows. (1) Seines were stretched along the shore in front of the area to be sampled. The parts of the seine bearing marker strings were placed adjacent to the wooden stakes denoting the limits of the area. (2) Each person went to a wooden stake and lifted both the floatline and the leadline. (3) Both persons waded from the shore to the corner pipes, pulling the seine. (4) One person draped the seine over a supporting arm (Fig. 1,d) on the corner pipe and held it firmly. (5) The other person then went to the center pipe, lifted the seine above the water, draped it on the supporting arm, repeated the operation at the second corner, and at all pipes between the corners. (6) Both persons, starting at the corners, worked toward shore draping the seine over arms on the pipes. (7) The seine was adjusted so that it did not touch the water and the ropes on the ends of the seine were tied to stakes on shore. (8) Cotton trip-ropes were tied to the pull rods (Fig. 1,c) on each pipe, tightened and tied by the second end to an anchor pipe located on shore midway between the boundary stakes. When the ropes were pulled, one after the other or

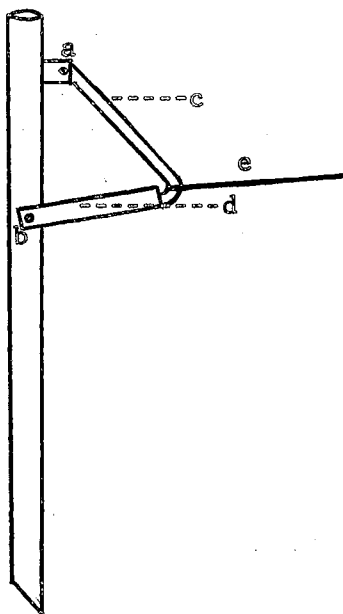


Figure 1. Sketch of a pipe rigged to hold and release seines.
 Legend. Points a and b are pivot points, e is a pull rope running to shore which pulls rod c, releasing the short pipe, d, on which the seine is draped and allows the seine to drop into the water.

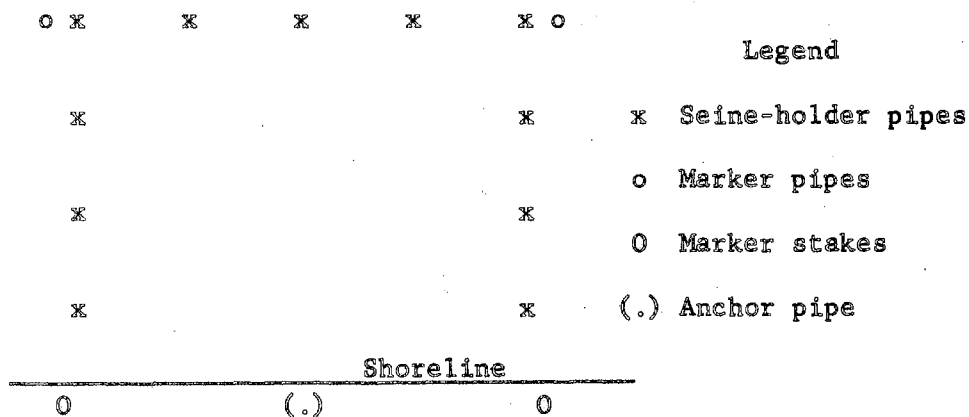


Figure 2. Sketch showing arrangement of pipes (rigged to hold and release seines) around a sampling area.

several at one time, the seine slid off the rods and into the water, thus forming a three-sided enclosure. Since the shoreline served as the fourth side of the enclosure, the ends of the seine could then be grasped and the entire seine pulled onto or near the shore where the entrapped fish were collected.

Traps and Trapping

Wire traps (Buck and Cross, 1951) with chicken wire netting of 1-inch mesh were used extensively in all ponds and were the only pieces of equipment used to obtain samples of fish in Pond 4. The traps had several advantages over seines. (1) Traps could be used in a greater variety of habitats than could seines. (2) They could be run and reset in a minimum of time, and by one man. (3) They could be left in the pond for several days without causing excessive damage to equipment or to fish. (4) They were durable, requiring only minor repairs to be kept in continuous operation. (5) Although bulky to transport, they could be moved from one pond to another and set in a minimum of time. (6) Most important, traps were effective in capturing fish in all ponds.

Periodically two or more traps were set in each pond to obtain samples of fish. Generally they were placed in the pond one or two days before checking began, and were set where water was not too deep for wading. This permitted the traps to be carried to and from the shore while setting and checking. Traps were generally set with one end facing toward the center of the pond. When only two traps were used, a trap was located at about the center of each area selected for sampling with seines. When more than two traps were used, the additional ones were set some distance from the feeding-areas in additional check-areas where water depths were comparable.

Traps were set in the same general area in each pond throughout the study, but were sometimes moved toward the center to compensate for the receding water level.

Weights and Measurements

All fish samples were analyzed as soon as they were removed from seines and traps. The usual field procedure was to carry traps to a convenient station on shore, remove the fish and place them in a container filled with water. Seines were pulled onto or near the shore where fish were removed by hand or with dipnets and placed in the containers. Each catch was sorted as to species and the following data recorded. The total lengths of the fish were measured to the nearest one-eighth inch. The total length used was that length from the most anterior point of the fish, mouth closed, to the most posterior tip, tail lobes compressed. Weights in pounds and hundredths of pounds were recorded for each fish. Departures from the described procedures were made in certain instances. Average lengths and/or weights were determined from a representative group selected from the catches consisting of small specimens.

When feeding was changed from one area to the alternate feeding-area, the actual numbers of fish caught in the new feeding-area and in the check-areas were recorded. No allowances were made, when tabulating data concerning fish caught, for the possible residual effects of food in the old area.

DATA AND OBSERVATIONS

Descriptions of the ponds studied, their watersheds, and uses are presented herein. In addition, feeding- and check-areas (including locations of traps) in each pond are described. Data concerning feeding, trapping, the numbers, kinds, and weights of fish captured both with traps and with seines are presented.

Pond 1

Pond 1 was formed in 1951 by the construction of an earthen dam across a comparatively deep ravine. Water was supplied by runoff from about 40 acres of prairie grassland and from a small spring located near the northwestern corner of the pond. Normally the grass on the watershed was not grazed but was cut for a hay crop. The soil of the watershed consisted of sandy loam over a red clay or claypan substrate. The water impounded cleared and at spillway level covered slightly more than one surface acre with water depths that reached 16 feet. The water level in the pond was approximately 2.5 feet below spillway level at the beginning of the study and dropped still more.

The pond was stocked with golden shiners in the summer of 1951 and with 125 largemouth bass fingerlings during the summer of 1952. The origin of the supply of green sunfish found in the pond was unknown. Fishing in the pond was limited to a few people and records of catches were not obtainable.

Food and feeding-areas. Food was first distributed in Pond 1 at 8:00 a.m. June 5, 1956. Approximately 3.5 pounds of pellets were scattered daily, through June 12, in the area indicated by X in Figure 3. This area was tentatively picked on June 5 as one of two feeding-areas in the pond. Later examination of the area, by wading and checking depths, revealed that water depths near the shore were too great and that aquatic vegetation was too dense for successful use of seines. After further examination of the pond during the afternoon of June 12, areas 1 and 4 (Fig. 3) were selected. The areas were used alternately as feeding-areas and as check-areas throughout the remainder of the study. Aquatic vegetation, rocks, and other debris which would hinder seining were removed by hand, with pitchforks, and by a chain dragged through the area.

Area 1, 25 feet wide by 25 feet long, was located where water depths ranged from less than an inch near the shore to 48 inches, 25 feet from the shore. The bottom soil was firm and sloped gradually toward the center of the pond. Considerable amounts of aquatic vegetation were removed from this area several times during the summer.

The size and shape of area 4 was modified because of stumps, the slope of the bottom, and deep water. This area, 16 feet wide by 39 feet long, was located where water depths ranged from about 1 inch near the shore to about 60 inches, 16 feet from the shore. The bottom soil was firm and sloped steeply toward the center of the pond. Lakeward, the water deepened rapidly, being 8 feet deep about 2 feet beyond the margin of the sample area.

Pond 1 was visited daily through August 31 and on each visit about 3.5 pounds of pellets were scattered in area 1 or in area 4. The amount

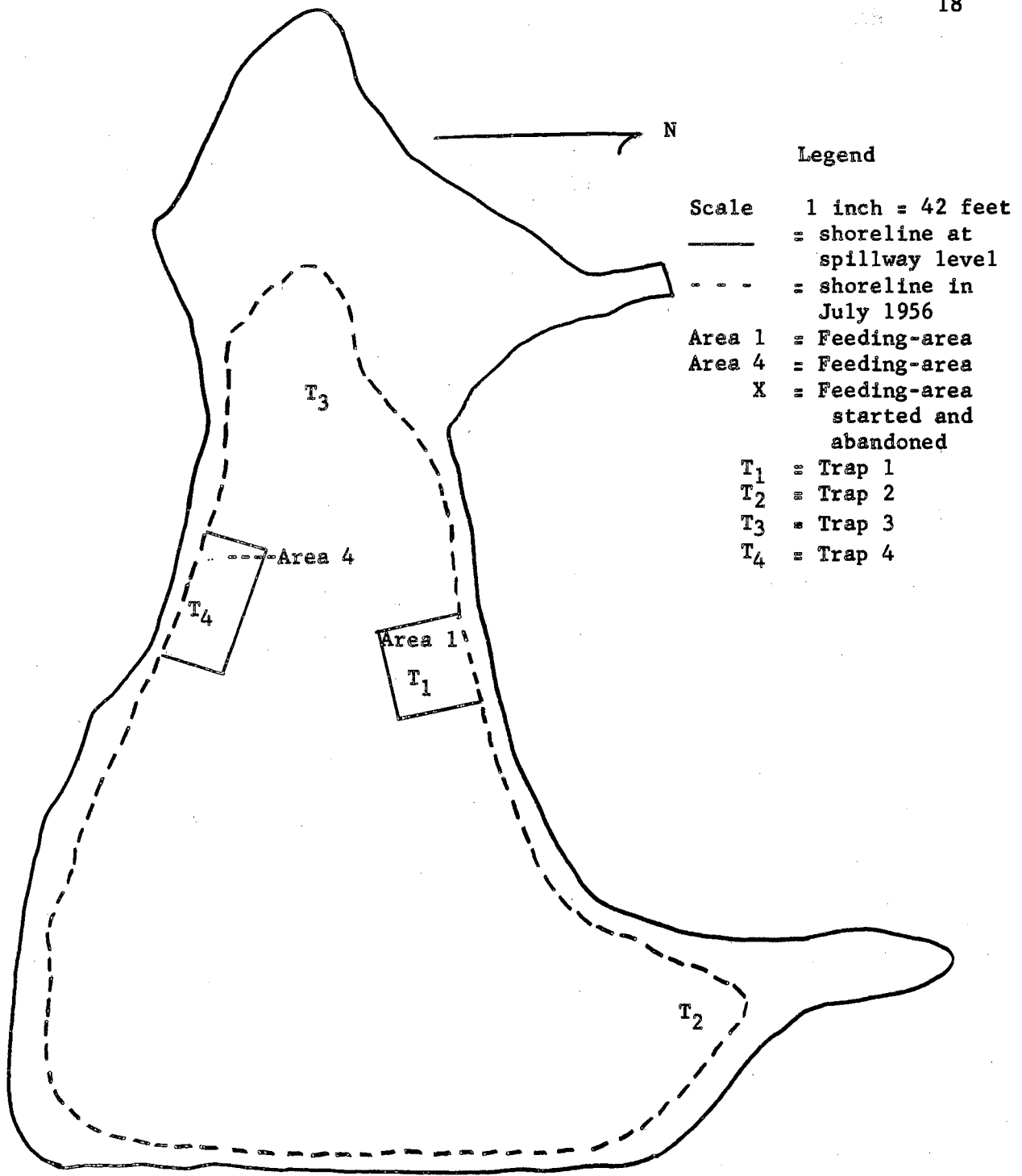


Figure 3. Locations of Feeding-areas and Traps in Pond 1

of food was increased to 5 pounds on September 1 and food was distributed on alternate days through November 13. All feeding in Pond 1 was done between the hours of 6:00 and 10:00 a.m. but more frequently between 7:30 and 8:00 a.m. Table II summarizes data concerning the feeding schedule followed in Pond 1.

TABLE II
FEEDING SCHEDULE FOR POND 1

Dates food was distributed		Feeding area used	Pounds of food used per feeding	
From	To			
June	5	June 13	X	3.5
June	14	June 19	1	3.5
June	20	July 9	4	3.5
July	10	August 7	1	3.5
August	8	August 31	4	3.5
*September	1	September 9	4	5.0
*September	10	October 16	1	5.0
*October	17	November 13	4	5.0

*Food distributed on alternate days only

Seines. Seines were used on three different occasions to obtain samples of fish from Pond 1. The areas were first sampled with 1/4-inch mesh minnow nets on July 27. The seines were set around areas 1 and 4 at 6:45 a.m., food was placed in area 1 at 8:45 a.m., and the seines were dropped at 9:15 a.m. A second sample was made with a 3/4-inch mesh seine on July 31. The seine was set around area 1 at 6:30 a.m., food was thrown into the area at 9:15 a.m., and the seine was dropped at 9:45 a.m. Only one green sunfish was captured in the seine. Data concerning this sample are not included in the results since only one area was sampled. A third sample was taken with 3/4-inch mesh seines on September 10. The seines

were set around areas 1 and 4 at 7:00 a.m., food was placed in area 4 at 9:00 a.m., and the seines were dropped at 9:30 a.m.

The dates on which samples were made, the feeding-area used, the kinds, the numbers and weights, and the ranges in lengths of the fish caught in feeding- and in check-areas are shown in Appendix A. Table III is a summary, compiled from data contained in Appendix A, showing numbers and weights and their corresponding percentages of fish caught with seines in feeding-areas and in check-areas in Pond 1.

Traps. Four wire traps were used in taking samples of fish from Pond 1. Samples were taken at periodic intervals during the months of July, August, October, and November. Traps were placed in the pond (in the general locations indicated in Figure 3) and periods of sampling began on July 23, on August 21, and on October 1. The traps were moved at times toward the center of the pond to compensate for changing water depths. They were visited, generally around 10:00 in the morning, on twenty-eight occasions during the periods described above.

The dates that the traps were visited, the feeding-areas, the kinds, numbers, and the total weights of the fish caught in the feeding- and in the check-areas are shown in Appendix B. A comparison of the numbers, weights, and ranges in lengths of the fish caught in the feeding- and in the check-areas is shown in Appendix C. Table IV is a summary, compiled from data contained in Appendix B, showing numbers and weights and their corresponding percentages of fish caught with traps in feeding-areas and in check-areas in Pond 1. Where two or more check-areas of equal size were used at the same time, the results were averaged.

Trap 1 was placed near the center of feeding-area 1. This area was

TABLE III

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES
OF FISH CAUGHT WITH SEINES FROM FEEDING-
AND FROM CHECK-AREAS IN POND 1

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	26	78.8	4.00	76.6
Check	7	21.2	1.22	23.4
TOTAL	33	100.0	5.22	100.0

TABLE IV

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES
OF FISH CAUGHT WITH TRAPS FROM FEEDING-
AND FROM CHECK-AREAS IN POND 1

Area	Total number	Percent of Total	Total weight in pounds	Percent of total
Feeding	300	71.4	79.39	70.8
Check	120	28.6	32.69	29.2
TOTAL	420	100.0	112.08	100.0

was cleared of vegetation and debris to facilitate seining and thus was barren of cover for fish. The trap was easily discernible from the shore on calm days when light conditions were suitable. The depths of water at the sites of trap 1 were 40 inches on July 23, 38 inches on August 17, and 54 inches on November 13.

Trap 2 was placed in a small cove near the northeastern corner of the pond. The trap was set in a small area relatively free of aquatic vegetation but surrounded on all sides by dense vegetation. It was placed with one end adjacent to a heavy stand of cattails. First impressions were that this particular area would be an ideal place for fish to loiter and trapping results indicated this to be true. Water depths in the area were 44 inches on July 23, 41 inches on August 17, and 48 inches on November 13.

Trap 3 was set near the western shoreline of the pond about 50 feet from trap 1. The trap was placed in an old erosion channel just off a ledge where aquatic vegetation was quite dense. Water depths in this area were 56 inches on July 23, 54 inches on August 17, and 42 inches on November 13.

Trap 4 was placed in feeding-area 4 approximately 60 feet across the pond from trap 1. The trap, set in an area free of vegetation, was placed with one end adjacent to the inner boundary of area 4. Here aquatic vegetation, stumps, and submerged trees provided suitable hiding places for fish. Water depths at the sites of trap 4 were 54 inches on July 23, 54 inches on August 17, and 48 inches on November 13.

Observations. Areas suitable for seining in Pond 1 were difficult to find and to maintain because of changing water levels and continued growth of aquatic plants. The water remained clear throughout the study and the

level dropped appreciably. Measurements of depth made on August 17 revealed that the water level was 19 inches below the level recorded on June 16. Flowering plants, consisting of Najas spp. and Potamogeton spp., and algae, primarily Chara spp., constituted a problem during June, July, and August and had to be removed from areas where samples were collected with seines.

Fieldnotes concerning the activities of fish in Pond 1 showed that fish were not seen as frequently in feeding-areas of this pond as in some other ponds used in the study. Fish were noticeably present in or around the feeding-areas on only 16 days during the 118 days that the pond was visited. The numbers of fish seen during any one observational period varied between 1 and 5 and consisted of bass or green sunfish (estimated at 6 to 10 inches in length). As is shown in Appendices A and B, largemouth bass and green sunfish were the predominant species captured both with traps and seines. The total catch of other species was represented by 1 bluegill, 1 golden shiner, 2 redear sunfish, and 1 hybrid sunfish.

Hook and line fishing in Pond 1 was tried and the results recorded on only three occasions. The first fishing was done just after 5:00 p.m. on June 26 by Mr. Claude Ward and the writer. Both persons used casting rods with small flatfish as lures and fished for 20 minutes. Mr. Ward caught 4 green sunfish and 3 largemouth bass from the feeding-area while the writer caught only 1 green sunfish from the alternate feeding-area. The other two trials with hook and line were conducted by the writer on June 27 and on October 15. Food was thrown into one feeding-area, fishing was tried for a 10-minute period in the area; then the alternate feeding-area was tested for a similar period of time. The results were as follows: 2 green sunfish and 1 largemouth bass were caught in the feeding-area on June 27 and

3 bass were caught in the feeding-area on October 15. No fish were caught either time in the alternate feeding-areas.

Data concerning trapping during October and November suggested that a greater catch per trap was made during this period than during the preceding months. However, this was not necessarily true since traps were visited only every 4 to 8 days as compared to daily visits during the preceding months.

Pond 2

Pond 2 was formed in 1952 by the construction of an earthen dam across a ravine. Water was supplied by runoff from approximately 55 acres of prairie grassland which was normally used as a pasture. The soil of the watershed consisted of sandy loam over a red clay or claypan substrate. The impounded water was turbid at the beginning of the study on June 5 and remained turbid until about August 1. At this time the water became quite clear and remained so, except for short periods of time following showers. At spillway level the water impounded covered about 1.5 surface acres with water depths that reached 17 feet. The water level in the pond was 3 feet below spillway level on June 5 and the level dropped still more.

The pond was stocked by Mr. Ford Mercer with approximately 250 golden shiners in the fall of 1952 and with 75 largemouth bass (about 6 inches long) in September, 1953. Additional shiners from a small pool located about one-fourth mile upstream undoubtedly entered Pond 2 during overflow periods. The black bullheads found in the pond were not listed in the records regarding the stocking of the pond. They probably came from an old pond located just across the fence which at high water levels became

a part of Pond 2. In 1956 water still remained in this old pond and contained hundreds of small catfish. Public fishing in Pond 2 was discouraged but some fishing did occur. No records of catches were obtainable.

Food and feeding-areas. Food was first distributed in Pond 2 at 8:20 a.m. June 5, 1956. Areas 1 and 2 (Fig. 4) were selected on June 11 and were used alternately as feeding- and as check-areas during the study. These areas were cleared of vegetation and other debris on June 11.

Area 1, 25 feet wide by 25 feet long, was located where water depths ranged from less than 1 inch near the shore to 58 inches, 25 feet from the shore. The bottom soil was firm and in some areas sandstone ledges made it quite difficult to drive the pipes used to hold seines. The bottom sloped gradually toward the center of the pond.

Area 2, the same size as area 1, was located nearer the dam on the same side of the pond where water depths were essentially the same as in area 1. Deep water and a fence on the opposite shore prohibited the use of seines on that side. The western boundary of area 2 was 95 feet from the eastern boundary of area 1. The bottom soil in area 2 was firm, but was covered with about 3 inches of fine silt which, when disturbed, caused the water to become quite turbid.

Pond 2 was visited daily beginning June 5 and ending August 31. About 3.5 pounds of pellets were scattered in area 1 or in area 2 on each visit. The amount of food was increased to 5 pounds on September 1 and food was distributed on alternate days through October 22. All feeding in Pond 2 was done between the hours of 6:15 and 10:15 a.m. but more frequently between 7:40 and 8:10 a.m. Table V summarizes data concerning the feeding schedule followed in Pond 2.

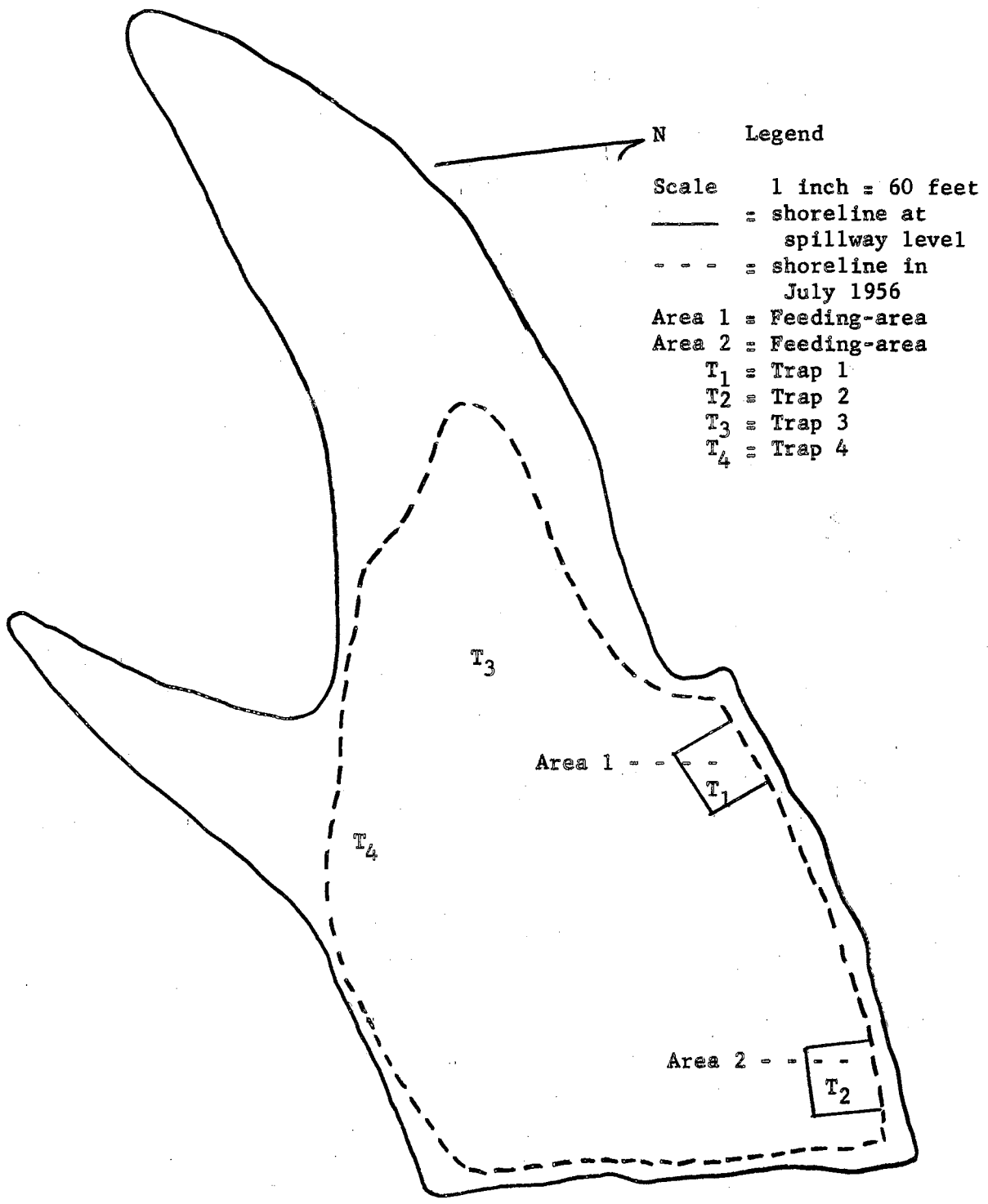


Figure 4. Locations of Feeding-areas and Traps in Pond 2

TABLE V
FEEDING SCHEDULE FOR POND 2

Dates food was distributed				Feeding area used	Pounds of food used per feeding
From		To			
June	5	July	3	1	3.5
July	4	July	22	2	3.5
July	23	August	31	1	3.5
*September	1	September	9	1	5.0
*September	11	October	1	2	5.0
*October	3	October	22	1	5.0

*Food distributed on alternate days only

Seines. Seines were used on five different occasions to obtain samples of fish from Pond 2. The areas were first sampled with 3/4-inch mesh seines on June 20. The seines were set around areas 1 and 2 at 6:00 a.m., food was placed in area 1 at 8:35 a.m., and the seines were dropped at 9:05 a.m.

A second similar sample was taken on July 13. Seines were set around both areas at 7:00 a.m., food was scattered in area 2 at 8:00 a.m., and the seines were dropped at 8:10 a.m. A strong wind made it difficult to keep the seines on the hangers. When the seines were dropped, one corner of the seine around area 1 caught on a pipe and had to be released. This necessitated wading the area to release the seine. The action may have disturbed any fish present. Hundreds of golden shiners were seen going through and over the seine as it was being pulled through the feeding-area toward the shore.

A third similar sample was taken on July 18. The seines were set around both areas at 8:00 a.m., food was placed in area 2 at 9:25 a.m., and the seines were dropped at 9:50 a.m. The water seemed to "erupt" as

hundreds of shiners leaped about as if other fish were chasing them. Again, in the feeding-area, hundreds of shiners were seen escaping through and over the net as it was pulled toward shore.

Minnow seines (1/4-inch mesh) were used on August 22 to take a fourth sample. The seines were set at 7:00 a.m., food was distributed in area 1 at 8:00 a.m., and the seines were dropped at 8:30 a.m. An estimated 7,200 golden shiners were captured in the feeding-area and 33 golden shiners were captured in the check-area. The estimate was based on counts made from a representative group that was weighed. The shiners in the group ranged from 1½ inches to 5 inches in length and there were at least 200 shiners per pound with a total catch of 36 pounds from the feeding-area.

A fifth sample, using 3/4-inch mesh seines, was taken on September 18. The seines were set around both areas at 6:30 a.m., food was distributed in area 2 at 8:00 a.m., and the seines were dropped at 8:30 a.m. A large number of shiners were seen going over and through the seine in area 2 as it was being pulled to shore.

The dates on which samples were made, the feeding-area used, the kinds, the numbers and weights, and the ranges in lengths of the fish caught in feeding- and in check-areas are shown in Appendix D. Table VI is a summary, compiled from data contained in Appendix D, showing numbers and weights and their corresponding percentages of fish caught with seines in feeding-areas and in check-areas in Pond 2.

Traps. Two to four wire traps were used in taking samples of fish from Pond 2. Samples were taken at periodic intervals during the months of June, July, and September. Traps were located in the pond in the general sites indicated in Figure 4. At times the traps were moved toward

the center of the pond to compensate for changes in water depth. Two traps were first set in the pond on June 27 and two more were set on July 6. The traps were visited, generally around 10:30 a.m., on fourteen different occasions during the period June 27 to July 13. Traps 1, 2, and 4, set on September 1, were visited on alternate days through September 21. The location for trap 3 became unsuitable for trapping because of shallow water and a dense growth of aquatic vegetation.

The dates that the traps were visited, the feeding-areas, the kinds, numbers, and the total weights of the fish caught in the feeding- and in the check-areas are shown in Appendix E. A comparison of the numbers, weights, and ranges in lengths of the fish caught in the feeding- and in the check-areas is shown in Appendix F. Table VII is a summary, compiled from data contained in Appendix E, showing numbers and weights and their corresponding percentages of fish caught with traps in feeding-areas and in check-areas in Pond 2. Where two or more check-areas of equal size were used at the same time, the results were averaged.

Trap 1 was placed near the center of feeding-area 1. This area was cleared of vegetation and debris to facilitate seining. The depths of water at the sites of trap 1 were 54 inches on June 29, 42 inches on August 17, and 38 inches on September 19.

Trap 2 was placed near the center of feeding-area 2. This area was also cleared of vegetation and debris. Water depths at the sites of trap 2 were 50 inches on June 29, 42 inches on August 17, and 39 inches on September 19.

Trap 3 was set near the western shoreline of the pond 75 feet from trap 1. Shallow water and dense vegetation prohibited use of this area

TABLE VI

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES
OF FISH CAUGHT WITH SEINES FROM FEEDING-
AND FROM CHECK-AREAS IN POND 2

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	7236	99.5	61.60	94.0
Check	40	0.5	3.90	6.0
TOTAL	7276	100.0	65.50	100.0

TABLE VII

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES
OF FISH CAUGHT WITH TRAPS FROM FEEDING-
AND FROM CHECK-AREAS IN POND 2

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	107	88.4	68.89	87.0
Check	14	11.6	10.32	13.0
TOTAL	121	100.0	79.21	100.0

for trapping after July 13. Water depths at the sites of trap 3 were 40 inches on June 29 and 24 inches on August 17.

Trap 4, placed in an old erosion channel just off a ledge, was located directly across the pond about 125 feet from trap 1. Areas nearby contained many limbs and stumps and had water depths that reached 7 feet. The depths of water at the sites of trap 4 were 48 inches on June 29, 36 inches on August 17, and 31 inches on September 19.

Observations. Changing water levels and growths of aquatic vegetation constituted problems in Pond 2 as they did in most of the ponds during the study. However, once the plants (mostly Chara spp. and Najas spp.) were removed from the feeding-areas they did not return in sufficient quantities to be a serious problem.

Fieldnotes concerning the activities of fish in feeding-areas showed that activity was first observed 7 days after feeding was begun and was apparent on 65 days during the 106-day period that the pond was visited. Intense activity was recorded for 20 days, heavy activity was recorded for 10 days, moderate activity was recorded for 13 days, and scattered activity was recorded for 22 days. On many occasions hundreds of golden shiners seemed to burst into activity immediately after food was added to a feeding-area. The fish rose to the surface and often into the air in a manner that reminded one of an eruption of a small geyser. Since they scattered in different directions in great haste, it seemed they must have been pursued by enemies. Larger fish, probably largemouth bass or black bullheads, often surfaced during these intense displays of activity which followed feeding. Records of fish caught in traps and seines (Appendices D and E) show that only largemouth bass, black bullheads, and golden

shiners were captured in this pond and were probably the species observed.

The heaviest activity of fish in feeding-areas occurred prior to August 1. By this time the water in the pond had cleared and remained so for the rest of the study period. Some fish were active in the areas after August 1, but they were not as numerous as in June and July.

Hook and line fishing was tried in Pond 2 on June 27 and on September 7. Food was thrown in and fishing was conducted for a 10-minute period in the feeding-area, then for a similar period in the check-area. The results were as follows: 3 bass (10 to 11 inches in length) were caught in the feeding-area on June 27 and 2 bass (11 inches in length) were caught in the feeding-area on September 7. No fish were caught in either test in the check-areas.

Pond 3

Pond 3 was formed in 1947 by the construction of an earthen dam across a comparatively deep ravine. Water was supplied by runoff from 48 acres of prairie grassland and from 6 acres of cultivated land. The soil of the watershed consisted of sandy loam over a red clay or claypan substrate. The impounded water was turbid and remained so throughout the study. The water at spillway level covered about 3.3 surface acres with water depths that reached 17 feet. The water level in the pond was approximately 3.5 feet below spillway level on June 5, 1956 and dropped still more. Forty to fifty head of cattle were pastured part time on the grassland for at least half of each year, and were permitted to drink at the pond.

The pond was stocked in the fall of 1948 with largemouth bass, green sunfish, black crappie, and bluegill. Public use of the pond for fishing

and swimming was permitted. Mr. White, the landowner, believed that other species of fish were released in the pond by fishermen. No records of catches were obtainable but general reports on fishing indicated an excellent catch of bass and crappie in 1955.

Food and feeding-areas. Food was first distributed in Pond 3 at 8:35 a.m. June 5, 1956. Areas 1 and 4 (Fig. 5) were selected on June 9 and used alternately as feeding- and as check-areas. These areas were cleared of vegetation and other debris on June 18.

Area 1, 25 feet wide by 25 feet long, was located where water depths ranged from less than 1 inch near the shore to 63 inches, 25 feet from the shore. The bottom soil was firm and sloped gradually toward the center of the pond.

Area 4, the same size as area 1, was located 130 feet across the pond from area 1. Water depths and conditions of the bottom soil were essentially the same as in area 1. A number of stumps and roots, located along the lakeward side of area 4, likely provided suitable hiding places for fish.

Pond 3 was visited daily beginning June 5 and ending August 31. About 3.5 pounds of food were distributed in area 1 or in area 4 on each visit. The amount of food was increased to 5 pounds on September 1 and food was distributed on alternate days through October 22. All feeding in Pond 3 was done between the hours of 6:20 and 10:30 a.m. but more frequently between 7:15 and 8:30 a.m. Table VIII summarizes data concerning the feeding schedule followed in Pond 3.

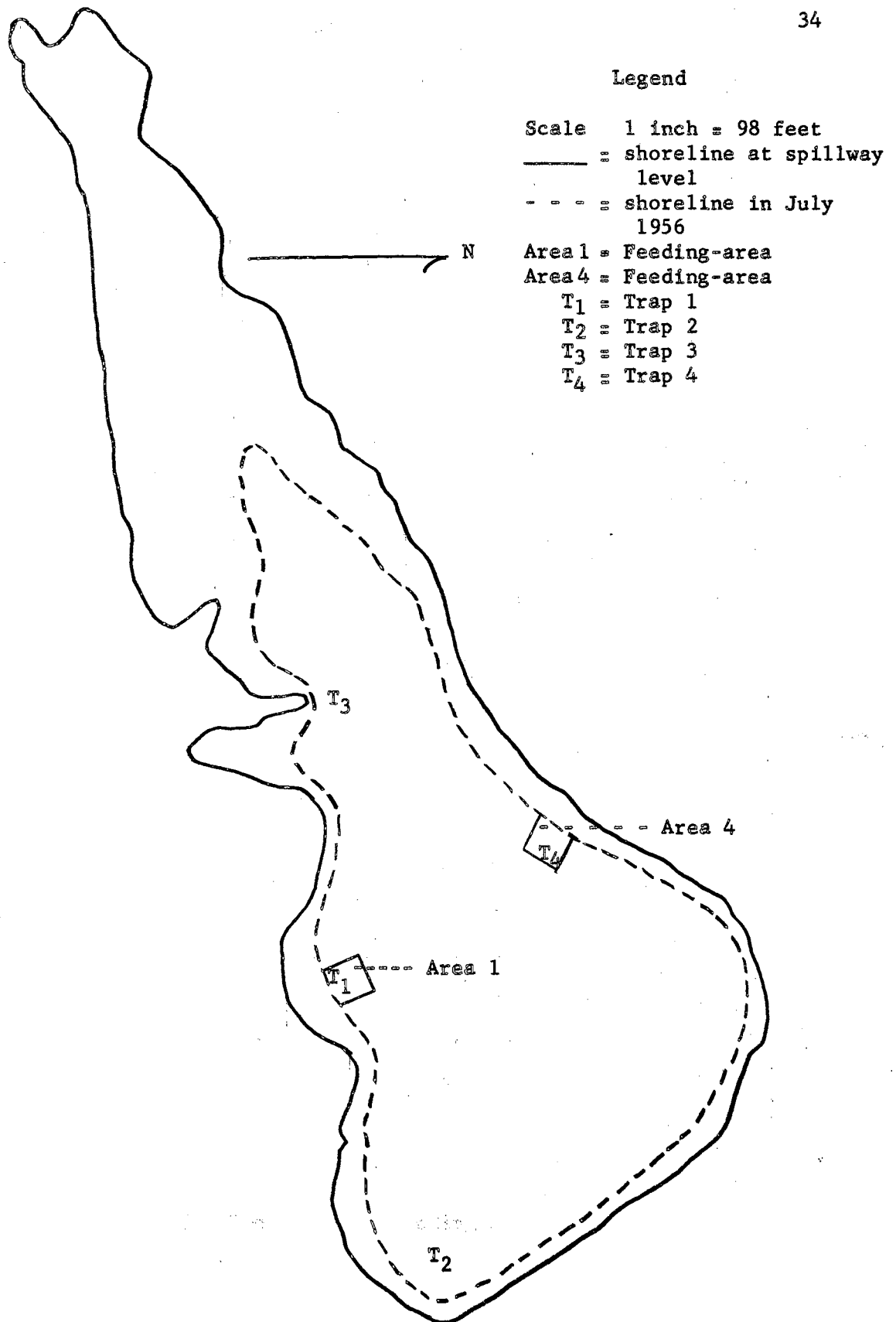


Figure 5. Locations of feeding-areas and traps in Pond 3

TABLE VIII
FEEDING SCHEDULE FOR POND 3

Dates food was distributed				Feeding area used	Pounds of food used per feeding
From		To			
June	5	June	12	1	3.5
June	13	July	4	4	3.5
July	5	July	21	1	3.5
July	22	August	31	4	3.5
*September	1	September	11	4	5.0
*September	12	October	22	1	5.0

*Food distributed on alternate days only

Seines. Seines (3/4-inch mesh) were used three times to obtain samples of fish from Pond 3. Feeding-areas were first sampled with seines on June 21. The seines were set around areas 1 and 4 at 6:30 a.m., food was placed in area 4 at 8:45 a.m., and the seines were dropped at 9:15 a.m. A few ripples on the surface of the water indicated that some fish were in area 4 when the seine was dropped. No activity was detected in area 1.

A second seined-sample was taken on July 19. Seines were set around both areas at 7:30 a.m., food was scattered in area 1 at 9:40 a.m., and the seines were dropped at 10:10 a.m. No visible sign of fish activity was detected in either area. Three largemouth bass, estimated length 10 to 12 inches, jumped over the net in area 1 as it was being pulled to shore.

A third sample was made on August 20. Seines were set around both areas at 6:30 a.m., food was distributed in area 4 at 7:55 a.m., and the seines were dropped at 8:25 a.m. There was no evidence of fish feeding in either area before the seines were dropped.

The dates on which samples were made, the feeding-area used, the kinds, the numbers and weights, and the ranges in lengths of the fish

caught in feeding- and check-areas are shown in Appendix G. Table IX is a summary, compiled from data contained in Appendix G, showing numbers and weights and their corresponding percentages of fish caught with seines in feeding-areas and in check-areas in Pond 3.

Traps. Four wire traps were used in taking samples of fish from Pond 3. Samples were collected at periodic intervals during the months of July, August, September, and October. The traps were set in the pond (in the general locations indicated in Figure 5) on the afternoons of July 17 and September 1. The traps were moved at times toward the center of the pond to compensate for changing water depths. They were visited on twenty-nine different occasions during the period described above, generally around 11:30 in the morning.

The dates that the traps were visited, the feeding-areas, the kinds, numbers and the total weights of the fish caught in the feeding- and in the check-areas are shown in Appendix H. A comparison of the numbers, weights, and ranges in lengths of the fish caught in the feeding- and in the check-areas is shown in Appendix I. Table X is a summary, compiled from data contained in Appendix H, showing numbers and weights and their corresponding percentages of fish caught with traps from feeding-areas and from check-areas in Pond 3. Where two or more check-areas of equal size were used at the same time, the results were averaged.

Trap 1 was placed near the center of feeding-area 1. This area was cleared of all vegetation and debris to facilitate seining. The depths of water at the sites of trap 1 were 52 inches on July 18, 46 inches on August 30, and 47 inches on October 22.

TABLE IX

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES
OF FISH CAUGHT WITH SEINES FROM FEEDING-
AND FROM CHECK-AREAS IN POND 3

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	103	82.4	17.68	86.1
Check	22	17.6	2.85	13.9
TOTAL	125	100.0	20.53	100.0

TABLE X

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES
OF FISH CAUGHT WITH TRAPS FROM FEEDING-
AND FROM CHECK-AREAS IN POND 3

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	280	84.6	47.97	84.2
Check	51	15.4	9.02	15.8
TOTAL	331	100.0	56.99	100.0

Trap 2 was placed near the dam and in the southeast corner of the pond. Sand had been placed over the bottom to provide a better area for swimmers. The trap was found several feet from its original site on several occasions. Evidently it had been moved by swimmers. Water depths at the sites of trap 2 were 51 inches on July 18, 48 inches on August 30, and on October 22.

Trap 3 was set in the western end of the pond in an old erosion channel just off a ledge. Water depths in this area were 49 inches on July 18, 39 inches on August 30, and 34 inches on October 22.

Trap 4 was placed near the center of feeding-area 4 where water depths were 53 inches on July 18, 48 inches on August 30, and 46 inches on October 22.

Observations. Changing water levels and growths of aquatic plants constituted some problems in Pond 3. Large amounts of aquatic vegetation (mostly Chara spp.) were removed from the feeding-areas on June 20 and the areas remained relatively clear of vegetation during the rest of the study. Trap-sites were not affected to any great extent by the lowering water-level since the traps could be moved to deeper water. Feeding-areas were more difficult to maintain because stumps, brush, and other debris had to be removed when it became necessary to extend the limits of the feeding-areas. Measurements of depth made on August 17 revealed that the water level was 17 inches below the level recorded on June 16.

Fieldnotes concerning the activities of fish in feeding-areas showed that activity was apparent on 32 days during the 106-day period that the pond was visited. Heavy activity was recorded for 7 days, moderate activity for 6 days, and scattered activity for 19 days. The kinds of fish involved in the activity were not identified.

Records showed that fish activity was first observed 10 days after feeding was begun. Further observations of activities were recorded daily during the month of June and through July 18. Scattered activity was observed on only seven visits after July 18.

When feeding was changed from one site to the alternate feeding-areas, records showed that no activities of fish were observed in the new feeding-area for a period of two to four days and that a similar period of time elapsed before a larger number of fish were caught in the trap located in the new feeding-area.

Pond 4

Pond 4 was formed in 1952 by the construction of an earthen dam across a ravine. Water was supplied from 25 acres of prairie grassland normally used as part of a pasture for 25 to 30 head of cattle. The soil of the watershed consisted of claypan prairie over a heavy clay subsoil. The impounded water was turbid and covered approximately 2.1 surface acres at spillway level with water depths that reached 17 feet. The water level in the pond was 3.5 feet below spillway level at the beginning of the study and dropped still more.

The pond was stocked with largemouth bass, green sunfish, redear sunfish, bluegill, and black crappie in the spring of 1953. Although black bullheads were caught in the traps during the study and catches of channel catfish were reported by fishermen, no data concerning stocking of the latter two species were recorded. The owner reported that 20 or 30 bass weighing 2.5 to 3.5 pounds were caught in 1955 but that only a few fish were caught during 1956.

Food, feeding-areas, and traps. Food was first distributed in Pond 4 at 9:15 a.m. June 5, 1956 and daily visits were made through June 16. The pond was not visited from June 17 to June 28, but daily visits were made again beginning June 29 and ending August 24. On August 24, the study of the pond was discontinued. About 5 pounds of food were scattered on the surface of the water in an area (about 6 feet by 15 feet) directly above trap 1 or trap 2 (Fig. 6) on each visit. The sites for trap 1 and trap 2 were selected and marked by stakes on July 1 and were used as alternate feeding-sites during the study. Trap 1 was set near the western shoreline of the pond where water depths were 44 inches on August 7 and 42 inches on August 17. Trap 2 was set about 400 feet across the pond from trap 1. Water depths at the sites of trap 2 were 46 inches on August 7 and 44 inches on August 17.

Food was distributed in the area above trap 1, June 5 through August 13, and in the area above trap 2 beginning August 14 and ending August 24. All feeding in Pond 4 was done between the hours of 10:45 and 11:45 a.m. The dates that the traps were visited, the feeding areas, the numbers, kinds and total weights of fish that were caught are shown in Appendix J. A comparison of the numbers, weights, and ranges in lengths of the fish caught in the feeding- and in the check-areas is shown in Appendix K. Table XI is a summary, compiled from data contained in Appendix J, showing numbers and weights and their corresponding percentages of fish caught with traps from feeding-areas and from check-areas in Pond 4.

Seines. The afternoon of June 13 was spent trying to find areas in Pond 4 suitable for seining. Deep water, a soft-mud bottom, a heavy growth of aquatic plants, parts of junked automobiles, wire, and other debris

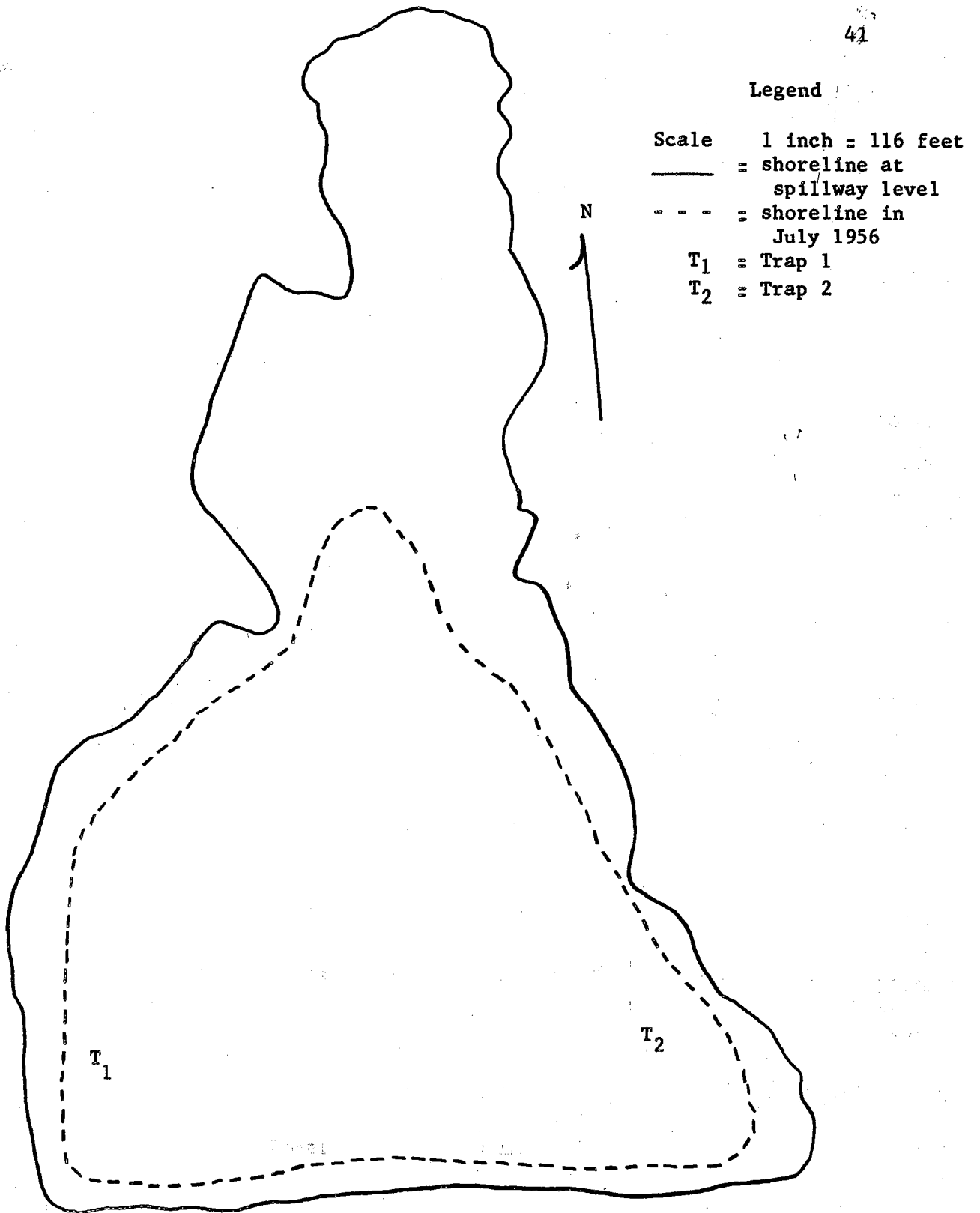


Figure 6. Locations of Traps in Pond 4

would have made seining practically impossible. Hence no seined samples were taken.

TABLE XI

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES OF FISH CAUGHT WITH TRAPS FROM FEEDING- AND FROM CHECK-AREAS IN POND 4

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	42	75.0	15.97	74.0
Check	14	25.0	5.61	26.0
TOTAL	56	100.0	21.56	100.0

Observations. The water in Pond 4 remained turbid throughout the study and measurements of depth, made on August 17, revealed that the water level was 20 inches below the level recorded on June 15. Aquatic plants created no real problem since seines were not used.

The pond was visited on 65 days during the months of June, July, and August. Fieldnotes concerning the activities of fish in feeding-areas showed that no activity was observed during the month of June. The first activity was observed on July 7, eight days after feeding was resumed on June 29. Fish activity in the feeding-area was observed on 25 days during the period from July 7 to August 24 with most of the activity occurring in July. Heavy activity was recorded for 9 days, moderate activity for 3 days, and scattered activity for 13 days. The fish did not often surface but on occasions churned the water into a froth. When changing from one feeding-area to another, there was a delay of about three days before the number of fish caught in the new feeding-area surpassed the number caught in the new check-area.

Pond 5

Pond 5, formed by the construction of an earthen dam across a ravine, was made deeper during the spring and summer of 1955. The low water level during 1955 permitted soil to be removed from the upper end of the pond. The soil removed was used to increase the height of the dam. Water was supplied by runoff from 5 acres of prairie grassland (a pasture) and from about 25 acres of cultivated soil. Water from the cultivated fields was diverted into the pond by the use of a series of terraces. The soil of the watershed consisted of prairie upland and silt-loam over a claypan substrate. The landowner stated that water in the pond ran over the spillway quite often during years in which rainfall was normal. The impounded water was intermittently clear and turbid during the study. At spillway level the water covered about 1.12 surface acres with water depths that reached 10 feet. The water level in the pond was approximately two feet below spillway level on June 5 and dropped still more.

The pond was stocked in 1955 with black crappie, channel catfish, and largemouth bass. Thirteen largemouth bass weighing 2.5 to 6.5 pounds were released in Pond 5 on June 8, 1956.

Food and feeding-areas. Food was first distributed in Pond 5 at 9:30 a.m. June 5, 1956. About 3.5 pounds of pellets were scattered daily through June 9 in an area indicated as area X in Figure 7. An examination of area X on June 9 revealed the water to be shallow and so choked with aquatic vegetation that seining was impossible. Areas 1 and 4 (Fig. 7) were then chosen and used alternately as feeding- and as check-areas throughout the remainder of the study. Vegetation and debris were removed from area 1 just before seines were used in July. Area 4 did not need to be cleared.

Area 1, 25 feet wide by 25 feet long, was located just off the dam where water depths ranged from about 6 inches near the shore to about 44 inches, 25 feet from the shore. The bottom soil had a firm layer on top but was spongy or "mucky" below, permitting a person to sink to the knees in mud when carrying a trap to or from the area.

Area 4, the same size as area 1, was located across the pond where water depths ranged from less than an inch near the shore to 49 inches, 25 feet from the shore. The bottom soil was firm and sloped gradually toward the center of the pond.

Pond 5 was visited daily through August 31 and on each visit 3.5 pounds of pellets were scattered in area 1 or in area 4. The amount of food was increased to 5 pounds on September 1 and food was distributed on alternate days through October 22. All feeding in Pond 5 was done between the hours of 8:00 a.m. and 11:45 a.m., but more frequently between 8:30 and 9:30 a.m. Table XII summarizes data concerning the feeding schedule followed in Pond 5. Food was placed in both feeding-areas 1 and 4 on August 15 and on September 26 in order to see how much time would elapse before the catch of fish in the new feeding-area would equal or surpass the catch in the new check-area.

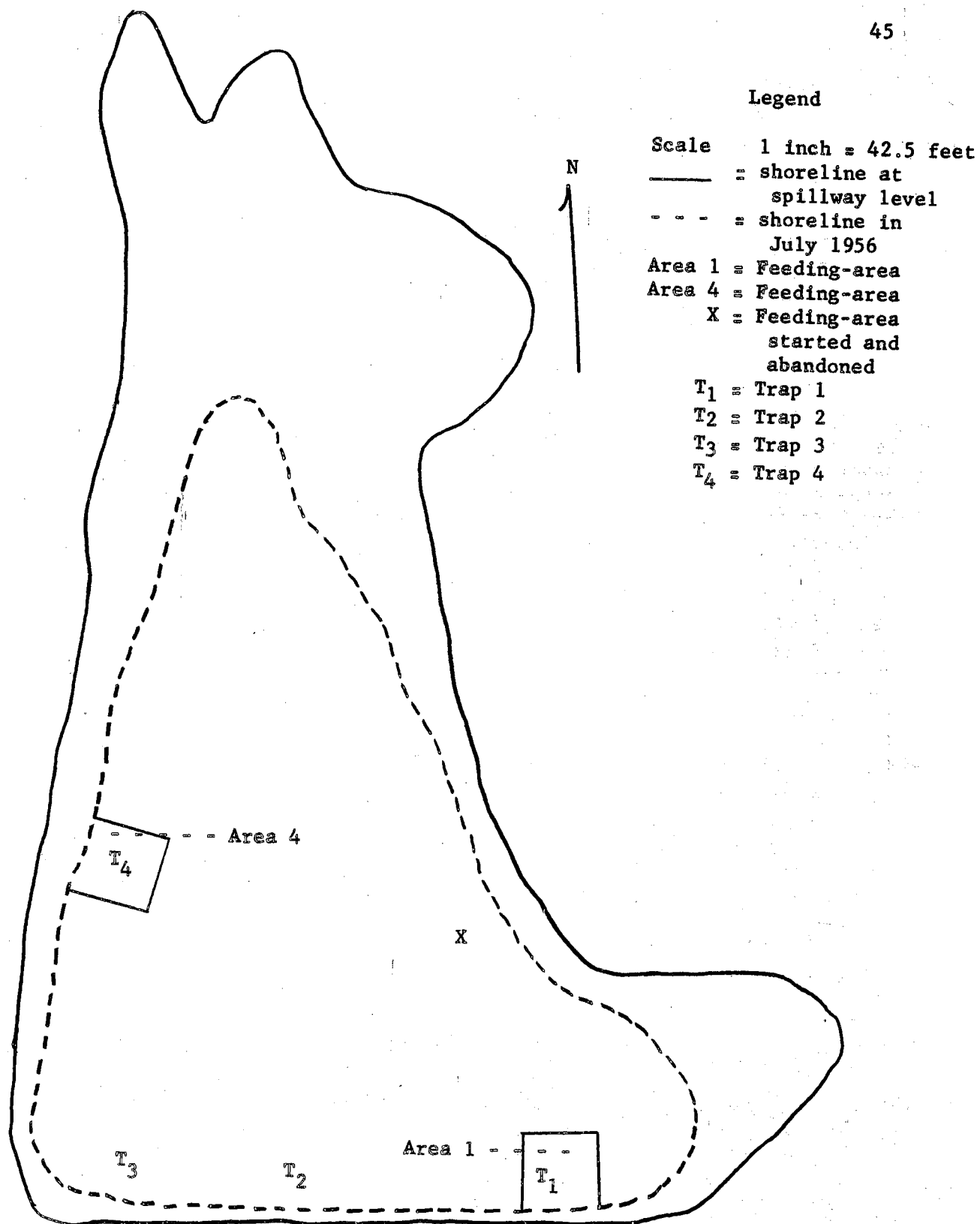


Figure 7. Locations of feeding-areas and traps in Pond 5

TABLE XII
FEEDING SCHEDULE FOR POND 5

Dates food was distributed				Feeding area used	Pounds of food used per feeding
From		To			
June	5	June	9	X	3.5
June	10	July	5	1	3.5
July	6	July	12	4	3.5
July	13	August	15	1	3.5
August	16	September	1	4	3.5
*September	3	September	26	1	5.0
*September	27	October	22	4	5.0

*Food distributed on alternate days only

Seines. Seines (3/4-inch mesh) were used on two occasions to obtain samples of fish from Pond 5. The first sample was taken on July 24. Seines were set around areas 1 and 4 at 6:30 a.m., food was distributed in area 1 at 8:45 a.m., and the seines were dropped at 9:20 a.m. A second sample was made on August 24. Seines were set around both areas at 7:00 a.m., food was scattered in area 4 at 8:40 a.m., and the nets were dropped at 9:15 a.m.

The dates on which samples were made, the feeding-area used, the kinds, the numbers and weights, and the ranges in lengths of the fish caught in feeding- and in check-areas are shown in Appendix L. Table XIII is a summary, compiled from data contained in Appendix L, showing numbers and weights and their corresponding percentages of fish caught with seines in feeding-areas and in check-areas in Pond 5.

Traps. Two to four wire traps were used in taking samples of fish from Pond 5. Samples were taken in August with four traps and in September with two traps. Traps were placed in the general locations indicated in Figure 7. At times the traps were moved toward the center of the pond

to compensate for changes in water depth. Four traps were set on August 7 at 1:00 p.m. The traps were visited daily from August 8 through August 20, generally around 10:45 a.m. Two traps were set, one in area 1 and one in area 4, on September 22 and were visited daily from September 24 through September 29, usually around 10:00 a.m. Trap-areas 2 and 3 were not used after September 22 because the traps were needed elsewhere.

The dates that the traps were visited, the feeding-areas, the kinds, numbers, and the total weights of the fish caught in the feeding- and in the check-areas are shown in Appendix M. A comparison of the numbers, weights, and ranges in lengths of the fish caught in the feeding- and in the check-areas is shown in Appendix N. Table XIV is a summary, compiled from data contained in Appendix M, showing numbers and weights and their corresponding percentages of fish caught with traps in feeding-areas and in check-areas in Pond 5. Where two or more check-areas of equal size were used at the same time, the results were averaged.

Trap 1 was placed near the center of feeding-area 1. This area was cleared of aquatic vegetation and debris to facilitate seining. The depths of water at the sites of trap 1 were 34 inches on August 8 and 28 inches on September 24.

Trap 2 was set outside the feeding-areas in water 37 inches deep and near a log surrounded by brush and aquatic vegetation.

Trap 3 was set outside the feeding-areas, in the southwest corner of the pond near a fallen tree. It was set in water 38 inches deep and was surrounded by brush and aquatic vegetation.

Trap 4 was placed near the center of feeding-area 4 across the pond from area 1. The depths of water at the sites of trap 4 were 42 inches on August 8 and 34 inches on September 24.

TABLE XIII

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES
OF FISH CAUGHT WITH SEINES FROM FEEDING-
AND FROM CHECK-AREAS IN POND 5

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	28	80.0	10.96	82.6
Check	7	20.0	2.31	17.4
TOTAL	35	100.0	13.27	100.0

TABLE XIV

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES
OF FISH CAUGHT WITH TRAPS FROM FEEDING-
AND FROM CHECK-AREAS IN POND 5

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	127	88.2	38.95	91.6
Check	17	11.8	3.58	8.4
TOTAL	144	100.0	42.53	100.0

Observations. The water in Pond 5 was turbid at the beginning of the study but began to clear about one week later. The water remained clear through August 15, became turbid and remained so for about 1 week, cleared for 5 days, became turbid for 1 week, cleared for 6 days, and then became turbid on September 11 and stayed turbid through October 22. Possible causes of these intermittently clear and turbid conditions follow. (1) The water level in the pond dropped considerably during the summer. Measurements of water depth made on August 14 revealed that the water level was 16 inches below the depth recorded on June 16. (2) When the water supply in other ponds on the farm was exhausted, the cattle (25 head of dairy cows) drank and waded in Pond 5, thereby stirring the silt on the bottom. (3) Organic matter carried from the barn and feedlot by runoff water was deposited in the pond. (4) Aquatic plants were quite numerous in the pond and may have helped in clearing the water.

Fieldnotes showed that Pond 5 was visited on 107 days and that activities of fish were observed on only 20 of these visits. All activities were recorded as scattered since only one to three fish were actually observed in the feeding-areas on any particular visit. Most of the activity observed occurred during the month of July. On several occasions live grasshoppers were thrown into the feeding-areas and they disappeared within seconds.

When feeding was changed from one site to the alternate feeding-area, records showed that two or three days elapsed before the number of fish caught in the trap located in the new feeding-area surpassed the number caught in the new check-area.

Turtles were often caught in the traps; and when food was thrown into an area, turtles came from all directions to the feeding-area.

Pond 6

Pond 6 was formed in 1936 by the construction of an earthen dam across a ravine. Water was supplied by runoff from about 20 acres of prairie grassland normally used as part of a pasture for three horses and three cows. Waste products from these animals and from a dog kennel (holding 20 to 40 dogs) washed into the pond and provided organic matter. In addition several pick-up loads of chicken litter were dumped into the pond in 1955. The impounded water was turbid from an algal bloom at the beginning of the study and became highly turbid before the pond was dropped from the study on September 3. An abundant supply of algae (mostly Microcystis spp. and Anabaena spp.) contributed to the apparent green color and the turbid nature of the water. At spillway level the water covered about 1.12 surface acres with water depths that reached 9.5 feet. A thick layer of silt deposited over the bottom soil of the pond decreased the depth of the pond and made wading in the pond difficult. The water level in the pond was 2.5 feet below spillway level at the beginning of the study and dropped still more.

The fish in the pond were poisoned with rotenone in the spring of 1954 and the pond was stocked in late summer with largemouth bass, black crappie, channel catfish, and bluegill. Some of the bass that were stocked weighed about two pounds. No records were available concerning the stocking of green sunfish in the pond. Fishing in the pond was not restricted but little fishing was done.

Food and feeding-areas. Food was first distributed in Pond 6 at 9:45 a.m., June 5, 1956. Areas 1 and 3 (Fig. 8) were selected on June 6 and were used alternately as feeding-areas and as check-areas during the

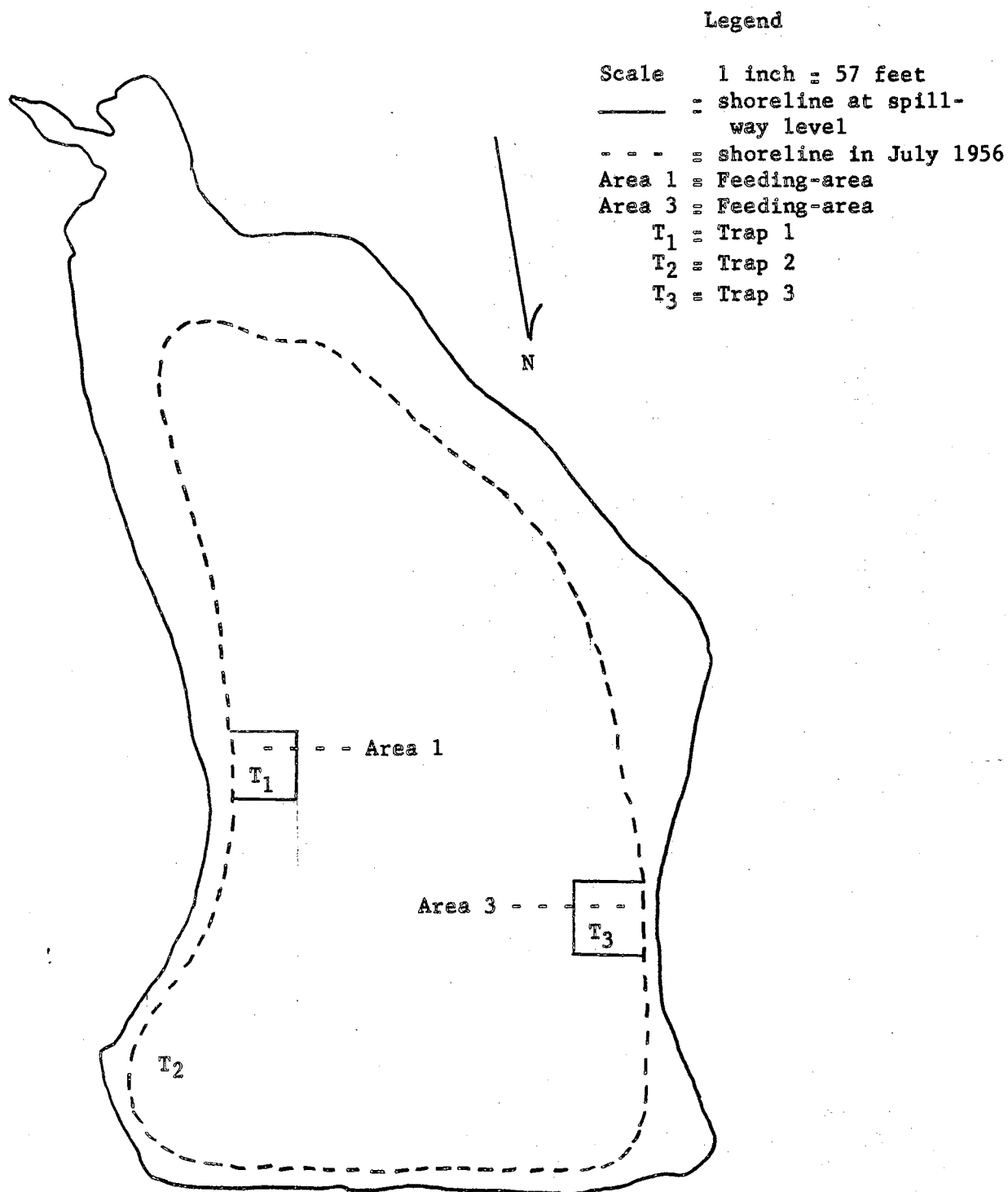


Figure 8. Locations of feeding-areas and traps in Pond 6

study. These areas were cleared of vegetation and other debris on June 22.

Area 1, 25 feet wide by 25 feet long, was located where water depths ranged from less than 1 inch near the shore to 42 inches, 25 feet from the shore. The bottom soil was firm but was covered with a layer of soft mud about 14 inches deep. The bottom sloped gradually toward the center of the pond.

Area 3, the same size as area 1, was located across the pond where water depths were essentially the same as in area 1. The bottom soil in area 3 was firm but was covered with a layer of soft mud 4 inches deep.

Pond 6 was visited daily beginning June 5 and ending September 3. About 3.5 pounds of pellets were scattered in area 1 or in area 3 on each visit. All feeding in Pond 6 was done between the hours of 8:30 and 11:00 a.m. but more frequently between 9:00 and 10:00 a.m. Table XV summarizes data concerning the feeding schedule followed in Pond 6.

TABLE XV
FEEDING SCHEDULE FOR POND 6

Dates food was distributed				Feeding area used	Pounds of food used per feeding
From	To				
June	5	June	20	1	3.5
June	21	July	21	3	3.5
July	23	August	8	1	3.5
August	9	September	3	3	3.5

Seines. Seines (3/4-inch mesh) were used twice to obtain samples of fish from Pond 6. The low water and the soft mud on the bottom made further seining impractical. The first sampling was done on July 9. Seines

were set around areas 1 and 3 at 6:30 a.m., food was placed in area 3 at 8:55 a.m., and the seines were dropped at 9:30. A second sample was made on August 7. Seines were set around both areas at 6:30 a.m., food was scattered in area 1 at 10:00 a.m., and the seines were dropped at 10:30 a.m.

The dates on which samples were made, the feeding-area used, the kinds, the numbers and weights, and the ranges in lengths of the fish caught in feeding- and in check-areas are shown in Appendix O. Table XVI is a summary, compiled from data contained in Appendix O, showing numbers and weights and their corresponding percentages of fish caught with seines from feeding-areas and from check-areas in Pond 6.

Traps. Three wire traps were used in taking samples of fish from Pond 6. The traps were placed in the pond in the locations indicated in Figure 8 on August 2. They were visited, generally around 10:45 a.m., on twelve occasions.

The dates that the traps were visited, the feeding-areas, the kinds, numbers, and the total weights of the fish caught in the feeding-area and in the check-areas are shown in Appendix P. A comparison of the numbers, weights, and ranges in lengths of the fish caught in the feeding- and in the check-areas is shown in Appendix Q. Table XVII is a summary, compiled from data contained in Appendix P, showing numbers and weights and their corresponding percentages of fish caught with traps from feeding-areas and from check-areas in Pond 6. Where two or more check-areas of equal size were used at the same time, the results were averaged.

Trap 1 was placed near the center of feeding-area 1. This area was cleaned of debris to facilitate seining. The depth of the water at the site of trap 1 was 34 inches on August 3.

Trap 2 was set in the northeast corner of the pond where the water was 34 inches deep and the mud 18 inches deep.

Trap 3 was set near the center of feeding-area 3 where the water was 36 inches deep and the mud 4 inches deep.

TABLE XVI

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES OF FISH CAUGHT WITH SEINES FROM FEEDING- AND FROM CHECK-AREAS IN POND 6

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	72	75.8	10.70	85.6
Check	23	24.2	1.79	14.4
TOTAL	95	100.0	12.49	100.0

TABLE XVII

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES OF FISH CAUGHT WITH TRAPS FROM FEEDING- AND FROM CHECK-AREAS IN POND 6

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	767	69.3	72.11	70.2
Check	339	30.7	30.58	29.8
TOTAL	1106	100.0	102.69	100.0

Observations. Areas suitable for seining or trapping in Pond 6 were difficult to maintain because of a decreasing water level and a soft-mud bottom. The water in the pond remained turbid throughout the study. Measurements of depth made on August 14 revealed that the water level was 20 inches below the level recorded on June 14.

A 3/4-inch mesh seine 150 feet long and 8 feet deep was pulled through Pond 6 on June 8. The seine was not long enough to cover the entire width of the pond near the dam, nor was it deep enough to reach the bottom at this point, but an attempt was made to seine as much of the pond as possible. Small fish were observed going over the seine both when progress was halted because of debris and while the seine was being pulled through the water. Mud and the large number of fish entangled in the seine made the landing operation difficult.

The total catch and the disposal of the fish caught in the seine follow. (1) An estimated 3,500 to 4,500 small fish (3.5 to 4.5 inches in length) consisting of bluegill and green sunfish were removed and piled on the shore. (2) About 100 bluegill and green sunfish (5 to 6 inches in length) were returned to the water. (3) Thirty golden shiners (3 to 7 inches in length) were returned to the water. (4) Ninety largemouth bass (8 to 12 inches in length) were returned to the water. (5) Thirteen largemouth bass (estimated weight, 2.5 to 6.5 pounds each) were transported to Pond 5 and released.

Most of the fish caught in the traps in Pond 6 (see Appendix O) on August 3, August 4, and August 6 were dead when the traps were examined. Hence the weights of these fish listed may be more than actual live-weights of the fish. More than 90 percent of the total number of fish caught with traps in Pond 6 were not returned to the water, but were left on the shore. The fish that were returned were largemouth bass, golden shiners and bluegill or green sunfish at least 6 inches in length.

Fieldnotes concerning the activities of fish in feeding-areas showed that activity was apparent on 31 days during the 83-day period that Pond 6

was visited. Heavy activity was recorded for 7 days, moderate activity was recorded for 9 days, and scattered activity was recorded for 15 days. Records showed that activities of fish in a feeding-area were first observed nine days after feeding was begun in the pond, and that most of the observations recorded thereafter occurred between June 13 and July 19. No activity was noted after July 31. Most of the activity that occurred in the feeding-areas was surface feeding of small fish and occasional splashes created by larger fish (probably largemouth bass).

When feeding was changed from one site to the alternate feeding-area, records showed that one to three days elapsed before the number of fish caught in the trap located in the new feeding-area surpassed the number caught in the new check-area.

Dead fish were found along the shoreline of Pond 6 on June 25 and 26, on July 18 and 19, and on August 1, 2, and 3. The largest kill was recorded on June 26 when 325 fish (consisting of 4 bass, 10 to 14 inches in length, and 321 small bluegills, golden shiners, and fathead minnows) were found near the perimeter of the pond. Kills recorded on other dates consisted of golden shiners and/or bluegill, five to fifteen in number.

Pond 7

Pond 7 was formed at least as early as 1938 by the construction of an earthen dam across a ravine. Water was supplied by runoff from about 35 acres of land. Water drained into the pond from 18 acres of prairie grassland, from cultivated fields, from residential lots and from city streets. The soil of the watershed was prairie upland over a claypan substrate. The impounded water was clear at the beginning of the study,

but became turbid (due primarily to the development of a heavy bloom of algae consisting of Microcystis spp., Chlorella spp., and Euglena spp.) by August 27 and remained so throughout the study. At spillway level the water impounded covered about 2.53 surface acres with water depths that reached 10 feet. The water level in the pond was 3 feet below spillway level on June 15 and dropped still more.

The water was drained from the pond and the pond made deeper in 1953. Later the pond refilled with water and was stocked with fish. An excess of chicken manure was dumped in the pond in the spring of 1954 which resulted in a fish-kill. The pond was restocked in the fall of 1954 with channel catfish, golden shiners, largemouth bass, and black crappie. Additional fish and other species were reported as being stocked by local fishermen.

Food and feeding-areas. Food was first distributed in Pond 7 at 10:30 a.m., June 15, 1956. Areas 1 and 2 (Fig. 9) were selected on June 16 and were used alternately as feeding- and as check-areas during the study.

Area 1, 25 feet wide by 25 feet long, was located where water depths ranged from less than 1 inch near the shore to 42 inches, 25 feet from the shore. The bottom soil was firm but was covered with a layer of silt about 3 inches deep. The bottom sloped gradually from the shore toward the center of the pond.

Area 2, the same size as area 1, was located on the same side of the pond where water depths and soil conditions were essentially the same as in area 1.

Pond 7 was visited daily beginning June 15 and ending August 31 and on each visit about 3.5 pounds of pellets were scattered in area 1 or 4.

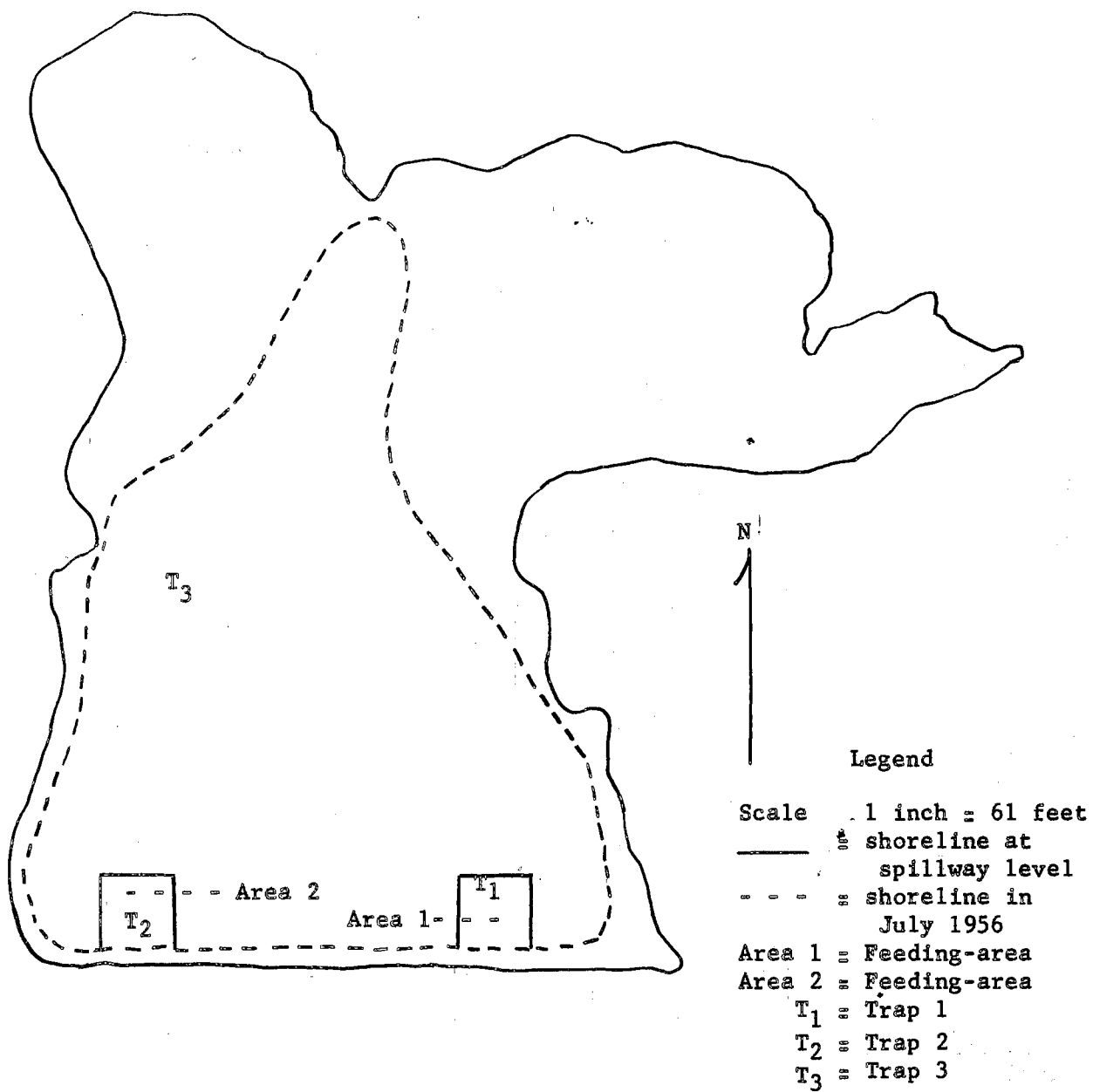


Figure 9. Locations of feeding-areas and traps in Pond 7

The amount of food was increased to around 5 pounds on September 1 and food was distributed on alternate days through October 22. All feeding in Pond 7 was done between the hours of 8:40 and 11:30 a.m. but more frequently around 9:30 a.m. Table XVIII summarizes data concerning the feeding schedule in Pond 7.

TABLE XVIII
FEEDING SCHEDULE FOR POND 7

Dates food was distributed				Feeding-area used	Pounds of food used per feeding
From		To			
June	15	July	4	1	3.5
July	5	July	29	2	3.5
July	30	August	17	1	3.5
August	18	August	24	2	3.5
August	25	August	31	1	3.5
*September	1	September	15	1	5.0
*September	17	September	26	2	5.0
*September	27	October	22	1	5.0

*Food was distributed on alternate days only

Seines. Seines were used on three different occasions to obtain samples of fish from Pond 7. The areas were first sampled with 3/4-inch mesh seines on June 25. The seines were set around areas 1 and 2 at 7:30 a.m., food was placed in area 1 at 10:15 a.m., and the seines were dropped at 10:45 a.m.

A second sample was made with 3/4-inch mesh seines on July 21. The seines were set around areas 1 and 2 at 6:30 a.m., food was scattered in area 2 at 9:45 a.m., and the seines were dropped at 10:25 a.m. Soon after food was thrown into area 2, the water seemed to "erupt" as hundreds of small fish (presumably golden shiners) leaped about as though they were

being chased by other fish. As the seines were being pulled to the shore, many small fish were noticed going through and over the net.

Minnow seines (1/4-inch mesh) were used on August 14 to take a third sample. The seines were set around areas 1 and 2 at 6:30 a.m., food was scattered in area 1 at 9:30 a.m., and the seines were dropped at 10:00 a.m. An estimated 9,600 golden shiners were caught in the feeding-area and 20 golden shiners were caught in the check-area. The estimate was based on counts made of a representative group of shiners that was weighed. The shiners in the group ranged from 1.5 inches to 6 inches in length and there were at least 200 shiners per pound with a total catch of 48 pounds from the feeding-area.

The dates on which samples were made, the feeding-area used, the kinds, the numbers and weights, and the ranges in lengths of the fish caught in feeding- and in check-areas are shown in Appendix R. Table XIX is a summary, compiled from data contained in Appendix R, showing numbers and weights and their corresponding percentages of fish caught with seines in feeding-areas and in check-areas in Pond 7.

Traps. Three wire traps were used in taking samples of fish from Pond 7. The traps were placed in the pond (in the general locations indicated in Figure 9) on August 16 and on September 22. At times the traps were moved toward the center of the pond to compensate for changes in water depth. They were visited between the hours of 9:30 and 11:30 a.m. on 18 different occasions during the months of August and September.

The dates that the traps were visited, the feeding-areas, the kinds, numbers, and the total weights of the fish caught in the feeding- and in the check-area are shown in Appendix S. A comparison of the numbers,

TABLE XIX

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES
OF FISH CAUGHT WITH SEINES FROM FEEDING-
AND FROM CHECK-AREAS IN POND 7

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	9645	99.7	61.00	97.6
Check	25	0.3	1.50	2.4
TOTAL	9670	100.0	62.50	100.0

TABLE XX

NUMBERS AND WEIGHTS AND THEIR CORRESPONDING PERCENTAGES
OF FISH CAUGHT WITH TRAPS FROM FEEDING-
AND FROM CHECK-AREAS IN POND 7

Area	Total number	Percent of total	Total weight in pounds	Percent of total
Feeding	84	76.4	47.42	78.9
Check	26	23.6	12.70	21.1
TOTAL	110	100.0	60.12	100.0

weights, and ranges in lengths of the fish caught in the feeding- and in the check-areas is shown in Appendix T. Table XX is a summary, compiled from data contained in Appendix S, showing numbers and weights and their corresponding percentages of fish caught with traps in feeding-areas and in check-areas in Pond 7. Where two or more check-areas of equal size were used at the same time, the results were averaged.

Trap 1 was placed near the center of feeding-area 1 where water depths were 30 inches on August 17 and 24 inches on September 24.

Trap 2 was placed near the center of feeding-area 2 where water depths were 33 inches on August 17 and 26 inches on September 24.

Trap 3 was placed near the northwestern corner of the pond where water depths were greater than the depths in the feeding-areas. However, rocks and concrete on the bottom prohibited the use of this area as a feeding-area because pipes, rigged to hold seines, could not be driven into the bottom. The depth of the water at the site of trap 3 was 47 inches on August 17. No trap was used in this location during September.

Observations. Water from Pond 7 was used in cooling processes in the Stillwater Hatchery and as stock-water for several horses. A decreasing water level with the accompanying loss in surface area and an abundant growth of algal forms created some problems in Pond 7 but did not seem to affect the activities of fish in the feeding-areas to any great extent.

Fieldnotes concerning the activities of fish in feeding-areas showed that activity was apparent on 72 days during the 100-day period that the pond was visited. Intense activity was recorded for 22 days, heavy activity was recorded for 20 days, moderate activity was recorded for 10 days, and scattered activity was recorded for 20 days.

Activity of fish in a feeding-area was first observed on June 29, 14 days after feeding was begun in the pond. The activity was scattered but gradually increased in intensity during the month of July. A great many small fish and a few large ones were observed in the feeding-areas during the period from July 7 to July 28. The greatest activity of fish in feeding-areas occurred during the period from July 29 through August 16. During the latter period, hundreds of golden shiners seemed to "erupt" from the area and to scatter in all directions as though they were being chased. These "eruptions" often occurred within minutes after food was placed in an area and continued for the entire observation period. Observation periods varied from five to thirty minutes in this pond. Larger fish often surfaced during the intensive displays of activity which followed feeding. Fish were observed in the feeding-area nearly every day throughout the remainder of the study but their activity was not as great as that occurring through August 16.

When feeding was changed from one site to the alternate feeding-area, records showed that no activity was observed in the new feeding-area for three to five days and that activity was still observed in the old feeding-area during this time.

DISCUSSION

Although ponds used in the study were carefully selected, Pond 4 and Pond 6 became unsuitable in late summer and were eliminated from further study because of low water levels and/or growths of aquatic plants. Drouth conditions and high rates of evaporation during the summer of 1956 decreased water levels in all the ponds studied. In addition, pond waters were used extensively by livestock, thereby decreasing water levels still further.

Seines and Traps

In all ponds studied, data concerning the numbers of fish caught in feeding- and in check-areas, with seines and with traps, showed that in all cases more fish were caught in feeding-areas than in check-areas. On an average, at least three times as many fish were caught in feeding-areas as were caught in corresponding check-areas. Where two or more check-areas of equal size were used at the same time in trapping, the results were averaged. The numbers of fish caught in all ponds, both with seines and with traps in the feeding- and check-areas, and their corresponding percentages are summarized in Table XXI.

The total number of fish which were caught with seines from all ponds was 17,234. Disregarding the numbers of golden shiners, the numbers of other fish caught in the feeding-areas represented 81.4 percent of the total number caught with seines from all ponds.

TABLE XXI

THE NUMBERS OF FISH CAUGHT WITH TRAPS AND WITH SEINES IN FEEDING-
AND IN CHECK-AREAS AND THEIR PERCENTAGES¹

Pond	Traps				Seines			
	Feeding-Area		Check-Area		Feeding-Area		Check-Area	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	300	71.4	120	28.6	26	78.8	7	21.2
2	107	88.4	14	11.6	7,236 ²	99.5	40	00.5
3	280	84.6	51	15.4	103	82.4	22	17.6
4	42	75.0	14	25.0	no seined samples were taken			
5	127	88.2	17	11.8	28	80.0	7	20.0
6	767	69.3	339	30.7	72	75.8	23	24.2
7	84	76.4	26	23.6	9,645 ²	99.7	25	00.3
TOTAL	1,707	74.6	581	25.4	17,110	99.3	124	00.7

¹Percentages were computed by dividing the total numbers caught in a pond into the number caught in each area.

²Includes golden shiners taken in 1/4-inch mesh seines.

The total number of fish which were caught with traps from all ponds was 3,037. This total represents the number of fish taken from feeding-areas and from the check-areas in all ponds. On a per area basis, the numbers of fish caught in the feeding-areas represented 74.6 percent of the total number caught with traps.

Species of Fish and their Relative Abundance

The following outline reviews in order of decreasing abundance the species of fish which were caught with seines and with traps in all ponds. The numbers of each species caught with seines and with traps, the percentages of the total catches, and the ponds from which the fish were caught are included.

Large numbers of golden shiners were captured when minnow seines (1/4-inch mesh) were used in Ponds 2 and 7. The number of shiners accounted for approximately 98.0 percent of the total catch with seines. Since all other seined-samples were made with seines of 3/4-inch mesh, percentages for the other species caught can be better expressed by omitting the numbers of golden shiners from the total. Also the golden shiner is the only fish included which is not considered a sport-fish and probably should be omitted for practical purposes. The percentages shown for the fish caught with seines in items 2 through 9 are therefore based upon the total catch of all species, exclusive of golden shiners.

1. Golden shiner, Notemigonus crysoleucas (Mitchill)

Seines. Total number, 16,858; percentage of total 98.0

From Ponds 2, 6, and 7

Traps. Total number, 40; percentage of total, 1.3

From Ponds 1, 2, 3, 6, and 7

2. Bluegill, Lepomis macrochirus Rafinesque
Seines. Total number, 163; percentage, 43.4
From Ponds 3 and 6
Traps. Total number, 1,420; percentage of total, 46.8
From Ponds 1, 3, 4, and 6
3. Green sunfish, Lepomis cyanellus Rafinesque
Seines. Total number, 76; percentage, 20.2
From Ponds 1, 3, 5, 6, and 7
Traps. Total number, 694; percentage of total, 22.9
From Ponds 1, 3, 4, 5, 6, and 7
4. Largemouth bass, Micropterus salmoides (Lacépède)
Seines. Total number, 53; percentage, 14.1
From Ponds 1, 2, 3, 5, 6, and 7
Traps. Total number, 394; percentage of total, 13.0
From Ponds 1, 2, 3, 5, 6, and 7
5. Black crappie, Pomoxis nigromaculatus LeSueur
Seines. Total number, 49; percentage, 13.0
From Ponds 3, 5, and 7
Traps. Total number, 348; percentage of total, 11.5
From Ponds 3, 4, 5, and 7
6. Black bullhead, Ictalurus melas (Rafinesque)
Seines. Total number, 31; percentage, 8.2
From Ponds 2, 5, and 7
Traps. Total number, 106; percentage of total, 3.5
From Ponds 2, 4, 5, and 7
7. Redear sunfish, Lepomis microlophus (Günther)

Seines. Total number, 4; percentage, 1.1

From Pond 3

Traps. Total number, 32; percentage of total, 1.1

From Ponds 1, 3, 4, and 7

8. Channel catfish, Ictalurus punctatus (Rafinesque)

Seines. Total number, 0.

Traps. Total number, 2; percentage of total, insignificant

From Pond 7

9. Hybrid sunfish, Lepomis spp.

Seines. Total number, 0

Traps. Total number, 1; percentage of total, insignificant

From Pond 1

For all species listed, except channel catfish and hybrid sunfish, considerably higher percentages in both numbers and weights of fish were caught in feeding-areas than in check-areas. Channel catfish and hybrid sunfish were not caught in sufficient numbers to warrant conclusions.

Golden shiners were readily attracted to feeding-areas but were not collected in large numbers when seines with 3/4-inch mesh or traps covered with 1-inch mesh chicken wire were used. On many occasions shiners were seen in feeding-areas in Ponds 2, 6, and 7. Larger fish, either bass, bluegill, bullheads, crappie, or green sunfish, were seen in the areas at the same time. Whether the larger fish were attracted by the concentration of shiners, by the food, or by a combination of the two is not known. At times activities of fish were quite vigorous in feeding-areas as shiners scattered in all directions when disturbed or pursued by the larger fish.

Bluegill, green sunfish, largemouth bass, black crappie, black bullheads, and redear sunfish were also attracted to feeding-areas. The numbers of fish for each of these species constituted about the same proportionate part of the total catch with seines (excluding golden shiners from the catch) as with traps. In clear ponds, bass and green sunfish were often observed snatching pellets of food before the pellets could sink to the bottom. Some of the fish captured from feeding-areas with seines were dissected in order to see what they had been eating. Pellets of food were found at one time or another in the digestive tracts of all species listed.

Activity of Fish

Fieldnotes concerning the observation periods showed that visible activities of fish were more pronounced in ponds with turbid water than in ponds with clear water. An absence of visible activity did not signify that fish were not utilizing the area since comparable numbers of fish were caught, both with seines and with traps, in ponds with clear water and ponds with turbid water.

In ponds where activities of fish were observed, records showed that the fish were first noticeable seven to fifteen days after feeding was begun. When feeding was changed to the alternate feeding-area, one to three days elapsed before the catch in the new feeding-area exceeded the catch of the new check-area.

Alternate Feeding

There were no significant differences between feeding 3.5 pounds of food daily or feeding 5.0 pounds of food on alternate days, neither with

respect to the amount of visible activities nor with respect to the number of fish caught.

Possible Values of Supplemental Feeding Programs

Information gained from the study indicates that a supplemental feeding program would be valuable in the following respects.

1. Fish could be concentrated in the desired locations in ponds or in larger impoundments.

The results of seining and trapping during the study showed that the common species of fish found in farm ponds tended to congregate where food was placed. It seems probable that these species and perhaps other species found in larger impoundments would react to feeding in a similar manner. Some feeding experiments were conducted in one of the large reservoirs in Oklahoma by Mr. Al Houser. The results of his investigations (personal communication with Mr. Houser) indicated that many of the species of fish found in reservoirs were also attracted to feeding-areas. Some of Houser's experiments were conducted during the summer months of 1957 and January and February, 1958. During the summer months, catches of 3,800 pounds of fish (including game and non-game species) were taken in a single seine haul. Houser reported that total catches averaged somewhat larger during the months of January and February and that fewer game species, including bass, crappie, and channel catfish were taken during this period.

2. Concentrations of fish should lead to greater harvests.

The tremendous harvest of white crappie by hook and line

fishermen from Canton Reservoir were the results of large concentrations of fish in a small area (Buck and Cross, 1952).

Concentrations were not caused by feeding in this case. Feeding or baiting techniques are employed around fishing docks in order to concentrate fish for the angler. Though hook and line fishing was not tested sufficiently to draw definite conclusions about catches from feeding-areas, the fact that fish did concentrate should give fishermen a better chance to harvest them. A greater harvest of fish from areas of concentration would certainly be possible if seines, traps, or chemicals were used.

3. Concentrations of fish in desired locations in ponds or in larger impoundments should be of value in population studies.

Studies of fish populations with respect to numbers, kinds, and growth rates could possibly be made from fish obtained by seining or trapping in selected areas where they were concentrated by feeding. Likewise, seining or trapping in selected areas could be used to control populations by thinning undesirable numbers or species.

SUMMARY

1. Experiments were conducted in farm ponds from June 5 through November 13, 1956 to determine if feeding would concentrate fish, thereby allowing them to be more easily harvested. The results are presented.
2. The food used in the study was CO-OP 18-percent Lay-Mash in pellet form.
3. A method was devised for suspending a seine above the water and for dropping it, when desired, in such a manner that warning to the fish was minimal.
4. In order of their abundance the following species were concentrated and captured with seines and/or with traps: golden shiners, bluegill, green sunfish, largemouth bass, black crappie, black bullhead, redear sunfish, channel catfish, and a hybrid sunfish.
5. Greater numbers of the fish harvested were found in feeding-areas than in check-areas.
6. Data concerning fish caught with seines (including golden shiners) show that 99.3 percent of the total catch came from feeding-areas. Excluding golden shiners from the catch with seines, 81.4 percent of the remaining species were caught in feeding-areas. Data concerning fish taken with traps reveal that 74.6 percent of the total catch was from the feeding-areas.
7. Fish were first observed to congregate in feeding-areas as early as 7 days in some ponds and as late as 15 days in other ponds after feeding

was begun. After fish became accustomed to eating in an area and the feeding was changed to an alternate area, fish were observed to congregate in the new area after 1 day in some ponds and after 3 days in other ponds.

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A P P E N D I X

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07

APPENDIX A

FISH CAUGHT WITH SEINES IN POND 1

Date	Feeding Area	Species of Fish ¹	Total Numbers From Areas		Total Pounds From Areas		Length Range in Inches From Areas	
			Feeding	Check	Feeding	Check	Feeding	Check
July 27 ²	1	1. bass	2	1	0.11	0.18	5.3-5.5	6.8
		g. sunfish	11	2	0.70	0.20	1.3-3.5	4.3-5.3
Sept. 10	4	1. bass	6	1	1.55	0.32	7.0-8.1	8.1
		g. sunfish	7	3	1.64	0.52	5.6-7.8	5.1-6.5
TOTAL			26	7	4.00	1.22		

¹1. bass = largemouth bass; g. sunfish = green sunfish.

²1/4-inch mesh seines used.

APPENDIX B

FISH CAUGHT WITH TRAPS IN POND 1

Date	Species of Fish ¹	Feeding-Area		Check-Areas					
		Number	Pounds Total Weight	Number	Pounds Total Weight	Number	Pounds Total Weight	Number	Pounds Total Weight
		Area 1		Area 2		Area 3		Area 4	
July 24	l. bass	10	2.03	5	0.88	3	0.58	2	1.03
	g. sunfish	13	4.04	0		5	1.19	5	1.13
	g. shiner	0		0		0		1	0.20
	h. sunfish	1	0.42	0		0		0	
July 25	l. bass	7	1.30	1	0.22	1	0.19	1	0.13
	g. sunfish	8	2.11	4	0.81	3	0.72	8	1.68
July 26	l. bass	6	1.41	4	1.90	2	0.29	0	
	g. sunfish	3	0.68	3	0.64	3	0.35	0	
July 27	l. bass	3	0.79	0		0		2	0.24
	g. sunfish	5	0.91	2	0.43	1	0.12	1	0.05
July 28	l. bass	0		1	0.18	0		1	0.16
	g. sunfish	2	0.39	2	0.20	2	0.71	2	0.57
July 30	l. bass	4	1.21	1	0.68	4	1.23	0	
	g. sunfish	8	1.89	5	1.44	2	0.53	6	1.77
July 31	l. bass	1	0.17	0		0		1	0.13

APPENDIX B (Continued)

		Area 1		Area 2		Area 3		Area 4	
July 31	g. sunfish	9	1.73	0		4	1.03	2	0.31
	r. sunfish	0		0		0		1	0.44
Aug. 1	l. bass	0		0		1	0.18	1	0.19
	g. sunfish	6	1.48	0		2	0.60	1	0.24
	r. sunfish	0		0		0		1	0.42
Aug. 2	l. bass	1	0.24	0		1	0.13	0	
	g. sunfish	4	1.06	1	0.15	2	0.52	0	
Aug. 3	l. bass	3	1.21	0		0		0	
	g. sunfish	6	1.14	0		3	0.83	2	0.66
Aug. 4	l. bass	1	0.20	1	0.15	4	0.73	0	
	g. sunfish	0		3	1.21	0		3	0.90
Aug. 6	l. bass	1	0.27	1	0.24	1	0.70	4	0.64
	g. sunfish	10	2.04	3	0.81	0		3	0.73
Aug. 7	l. bass	3	1.12	1	0.79	2	0.80	0	
	g. sunfish	4	0.98	0		0		4	0.64
		Area 4		Area 2		Area 3		Area 1	
Aug. 23 ²	l. bass	4	1.04	2	0.70	0		0	
	g. sunfish	4	1.09	0		0		2	0.48

APPENDIX B (Continued)

		Area 4		Area 2		Area 3		Area 1	
Aug. 24	l. bass	3	1.12	0		0		0	
	g. sunfish	2	0.44	1	0.19	1	0.15	1	0.21
Aug. 25	l. bass	4	1.36	3	1.65	0		1	0.34
	g. sunfish	3	0.61	0		0		2	0.46
Aug. 26	l. bass	1	0.11	2	0.32	0		0	
	g. sunfish	3	0.90	0		1	0.17	0	
Aug. 27	l. bass	3	0.70	2	0.64	0		0	
	g. sunfish	1	0.38	0		0		1	0.24
Aug. 28	l. bass	2	0.70	0		1	0.14	1	0.20
	g. sunfish	1	0.42	3	0.96	0		1	0.13
Aug. 29	l. bass	5	1.39	2	0.79	0		1	0.17
	g. sunfish	2	0.66	1	0.11	0		0	
		Area 1		Area 2		Area 3		Area 4	
Oct. 3 ²	l. bass	3	0.64	2	0.47	0		4	0.93
	g. sunfish	5	0.90	3	1.01	1	0.11	2	0.43
Oct. 7	l. bass	6	1.49	9	1.70	2	0.80	3	0.53
	g. sunfish	13	3.14	7	2.28	3	0.62	19	4.98
Oct. 11	l. bass	7	1.89	2	0.41	0		10	4.56

APPENDIX B (Continued)

		Area 1		Area 2		Area 3		Area 4	
Oct. 11	g. sunfish	26	6.59	6	1.68	1	0.30	25	6.39
Oct. 16	l. bass	3	0.51	5	1.80	0		0	
	g. sunfish	14	3.52	16	4.50	1	0.43	3	0.47
		Area 4		Area 2		Area 3		Area 1	
Oct. 22 ²	l. bass	9	1.95	5	1.36	2	0.46	3	0.96
	g. sunfish	8	2.50	9	2.47	0		6	1.60
	bluegill	0		1	0.53	0		0	
Oct. 28	l. bass	7	2.66	5	1.85	1	0.23	2	0.49
	g. sunfish	7	2.26	4	1.20	0		0	
Nov. 5	l. bass	5	1.65	3	1.43	0		5	0.79
	g. sunfish	12	4.01	9	2.65	1	0.34	4	1.22
Nov. 13	l. bass	4	1.93	4	1.47	0		0	
	g. sunfish	14	4.01	6	2.01	0		1	0.14
TOTAL		300	79.39	150	44.91	61	15.18	149	37.98

¹l. bass = largemouth bass; g. sunfish = green sunfish; g. shiner = golden shiner; h. sunfish = hybrid sunfish; r. sunfish = redear sunfish.

²Feeding changed to area indicated.

APPENDIX C

A COMPARISON OF THE NUMBERS, WEIGHTS, AND RANGES IN LENGTH OF FISH
CAUGHT WITH TRAPS IN FEEDING- AND IN CHECK-AREAS IN POND 1

Species of Fish	Total Numbers in Areas		Total Pounds in Areas		Length Range in Inches	
	Feeding	Check ¹	Feeding	Check ¹	Feeding	Check
largemouth bass	106	128	29.09	37.58	6.0-13.6	6.0-12.4
bluegill	0	1		0.53		8.0
green sunfish	193	228	49.88	58.90	4.8-9.3	4.3-8.8
redeer sunfish	0	2		0.86		7.8
hybrid sunfish	1	0	0.42		7.0	
golden shiner	0	1		0.20		7.5
TOTAL	300	360	79.39	98.07		

¹Includes more than one check-area.

APPENDIX D

FISH CAUGHT WITH SEINES IN POND 2

Date	Feeding Area	Species of Fish ¹	Total Numbers From Areas		Total Pounds From Areas		Length Range in Inches From Areas	
			Feeding	Check	Feeding	Check	Feeding	Check
June 20	1	l. bass	3	1	2.65	0.19	11.5-14.0	7.3
		b. bullhead	11	2	9.36	1.58	10.8-12.8	11.3-11.5
July 13	2	b. bullhead	2	0	1.68		11.5-11.8	
July 18	2	l. bass	2	0	1.37		10.0-11.8	
		b. bullhead	4	0	3.31		10.8-11.5	
Aug. 22 ²	1	l. bass	3	2	1.07	0.13	5.5-11.5	5.5-5.6
		b. bullhead	2	1	1.43	0.80	10.8-11.5	11.3
		g. shiner	7200 ³	33	36.00	0.26	1.5-5.0	1.5-5.0
Sept. 18	2	l. bass	5	0	1.42		6.5-11.5	
		b. bullhead	4	1	3.41	0.94	10.5-12.3	12.0
TOTAL			7236	40	61.60	3.90		

¹l. bass = largemouth bass; b. bullhead = black bullhead; g. shiner = golden shiner.

²1/4-inch mesh seines used.

³Total number estimated by weight-count method.

APPENDIX E

FISH CAUGHT WITH TRAPS IN POND 2

Date	Species of Fish ¹	Feeding-Area		Check-Areas					
		Number	Pounds Total Weight	Number	Pounds Total Weight	Area 3	Area 4	Area 3	Area 4
				Area 1	Area 2	Area 3	Area 4		
June 28	l. bass	3	1.82		0	no trap	no trap		
	b. bullhead	2	1.47		1	0.80	no trap	no trap	
June 29	l. bass	2	1.78		0	no trap	no trap		
	b. bullhead	3	2.31		0	no trap	no trap		
June 30	b. bullhead	3	2.57		0	no trap	no trap		
July 2	l. bass	1	0.83		0	no trap	no trap		
	b. bullhead	3	2.42		1	0.84	no trap	no trap	
July 3	l. bass	3	2.60		0	no trap	no trap		
	b. bullhead	2	1.51		1	0.83	no trap	no trap	
				Area 2	Area 1	Area 3	Area 4		
July 4	b. bullhead	1	0.70		0	no trap	no trap		
July 5	l. bass	0			1	1.62	no trap	no trap	

APPENDIX E (Continued)

		Area 2		Area 1		Area 3		Area 4	
July 5	b. bullhead	3	2.41	0		no trap		no trap	
July 6	b. bullhead	3	2.60	0		trap set		trap set	
July 7	l. bass	0		2	1.52	0		0	
	b. bullhead	4	3.10	0		0		1	0.68
July 9	l. bass	0		0		0		1	0.90
	b. bullhead	3	2.51	0		0		0	
July 10	l. bass	3	2.50	0		2	2.09	0	
	b. bullhead	4	2.98	0		0		0	
July 11	l. bass	1	0.86	0		1	0.24	4	4.94
	b. bullhead	7	6.05	1	0.70	0		0	
July 12	b. bullhead	4	3.01	0		4	3.31	0	
July 13	l. bass	4	1.95	0		0		1	0.81
	b. bullhead	1	0.77	2	1.97	0		0	
		Area 1		Area 2		Area 3		Area 4	
Sept. 3	l. bass	6	0.94	1	0.16	no trap		2	1.43
	b. bullhead	2	2.44	0				0	
Sept. 5	l. bass	3	2.34	0		no trap		1	0.86

APPENDIX E (Continued)

		Area 1		Area 2		Area 3		Area 4	
Sept. 5	b. bullhead	2	1.72	0		no trap		0	
Sept. 7	l. bass	4	2.46	1	0.24	no trap		1	0.18
	b. bullhead	2	1.72	0				0	
Sept. 9		0		0		no trap		0	
		Area 2		Area 1		Area 3		Area 4	
Sept. 11	b. bullhead	1	0.95	0		no trap		0	
	g. shiner	1	0.13	0				0	
Sept. 13	l. bass	6	0.91	0		no trap		0	
Sept. 15	b. bullhead	0		1	0.85	no trap		0	
Sept. 17	l. bass	7	1.13	0		no trap		0	
	b. bullhead	2	1.20	0				0	
Sept. 19	l. bass	2	0.40	0		no trap		0	
	b. bullhead	2	2.39	0				2	0.32

APPENDIX E (Continued)

		Area 2		Area 1		Area 3		Area 4	
Sept. 21	l. bass	5	1.12	1	0.21	no trap		0	
	b. bullhead	2	2.29	0				0	
TOTAL		107	68.89	13	9.74	7	5.64	13	10.12

l. bass = largemouth bass; b. bullhead = black bullhead; g. shiner = golden shiner.

APPENDIX F

A COMPARISON OF THE NUMBERS, WEIGHTS, AND RANGES IN LENGTH OF FISH
CAUGHT WITH TRAPS IN FEEDING- AND IN CHECK-AREAS IN POND 2

Species of Fish	Total Numbers in Areas		Total Pounds in Areas		Length Range in Inches	
	Feeding	Check ¹	Feeding	Check ¹	Feeding	Check
largemouth bass	50	19	21.64	15.20	5.3-15.3	6.3-15.0
black bullhead	56	14	47.12	10.30	10.5-13.0	6.4-12.6
golden shiner	1	0	0.13		6.5	
TOTAL	107	33	68.89	25.50		

¹Includes more than one check-area.

APPENDIX G

FISH CAUGHT WITH SEINES IN POND 3

Date	Feeding Area	Species of Fish ¹	Total Numbers From Areas		Total Pounds From Areas		Length Range in Inches From Areas	
			Feeding	Check	Feeding	Check	Feeding	Check
June 21	4	l. bass	3	0	1.86		9.0-12.0	
		bluegill	17	5	2.28	0.51	3.8-8.0	2.3-5.1
		b. crappie	4	3	0.65	0.43	5.5-7.0	5.3-7.0
		r. sunfish	1	0	0.32		7.5	
July 19	1	l. bass	2	0	1.13		8.3-11.5	
		bluegill	53	7	6.93	0.69	1.3-6.5	2.0-5.5
		b. crappie	1	1	0.21	0.25	7.3	7.8
Aug. 20	4	l. bass	2	1	1.20	0.30	9.5-11.5	8.1
		bluegill	10	3	1.54	0.41	4.3-6.5	4.5-5.8
		b. crappie	5	2	0.89	0.26	4.9-7.6	5.5-7.0
		g. sunfish	2	0	0.16		4.5-4.8	
		r. sunfish	3	0	0.51		5.1-6.3	
TOTAL			103	22	17.68	2.85		

¹l. bass = largemouth bass; b. crappie = black crappie; r. sunfish = redear sunfish; g. sunfish = green sunfish.

APPENDIX H

FISH CAUGHT WITH TRAPS IN POND 3

Date	Species of Fish ¹	Feeding-Area		Check-Areas					
		Number	Pounds Total Weight	Number	Pounds Total Weight	Number	Pounds Total Weight	Number	Pounds Total Weight
		Area 1		Area 2		Area 3		Area 4	
July 18	bluegill	11	1.32	0		0		2	0.15
	b. crappie	3	0.36	1	0.10	5	0.72	3	0.24
July 19	bluegill	8	0.75	0		1	0.10	0	
	b. crappie	8	1.11	0		3	0.44	6	0.52
July 20	l. bass	2	2.21	2	1.08	0		1	1.02
	bluegill	8	0.97	1	0.09	1	0.08	2	0.33
	b. crappie	6	0.92	1	0.26	3	0.34	2	0.35
	r. sunfish	2	0.67	0		0		0	
July 21	l. bass	2	1.41	0		1	0.30	0	
	bluegill	11	1.30	1	0.12	2	0.19	1	0.15
	r. sunfish	1	0.10	0		0		0	
	b. crappie	0		0		3	0.36	4	0.51
July 22	l. bass	0		1	0.32	0		0	
	bluegill	5	0.68	1	0.09	2	0.34	1	0.11
	b. crappie	3	0.41	0		2	0.35	2	0.32

APPENDIX H (Continued)

		Area 4		Area 2		Area 3		Area 1	
July 23	l. bass	1	0.06	0		0		0	
	bluegill	0		0		0		3	0.31
	b. crappie	3	0.49	1	0.08	5	1.03	2	0.29
July 24	bluegill	12	0.95	0		1	0.17	1	0.08
	b. crappie	2	0.16	0		3	0.28	1	0.06
July 25	l. bass	2	1.82	2	0.43	0		1	0.70
	bluegill	13	1.37	0		0		1	0.07
	b. crappie	5	0.75	0		0		2	0.30
July 26	l. bass	0		1	0.82	0		0	
	bluegill	11	0.97	0		0		0	
	b. crappie	3	0.42	0		2	0.24	1	0.06
July 27	l. bass	0		0		1	0.80	0	
	bluegill	5	0.51	0		0		0	
	b. crappie	0		2	0.32	1	0.07	1	0.07
July 28	bluegill	8	0.75	0		0		1	0.11
	b. crappie	2	0.27	1	0.10	1	0.04	0	
July 30	l. bass	3	1.63	1	0.30	0		2	1.16
	bluegill	4	0.63	1	0.08	1	0.09	1	0.08
	b. crappie	3	0.59	3	0.32	3	0.43	0	
	r. sunfish	1	0.15	0		2	0.31	0	

APPENDIX H (Continued)

		Area 4		Area 2		Area 3		Area 1	
July 31	l. bass	0		1	0.45	0		1	0.88
	bluegill	7	0.42	0		0		1	0.14
	b. crappie	4	0.36	2	0.30	1	0.11	0	
	r. sunfish	2	0.25	0		0		0	
Aug. 1	l. bass	1	0.68	1	0.41	0		0	
	bluegill	7	0.69	0		2	0.27	0	
	b. crappie	2	0.26	2	0.17	0		1	0.08
Sept. 3	bluegill	3	0.46	1	0.06	0		0	
	b. crappie	0		0		2	0.17	1	0.35
	g. sunfish	4	0.64	0		2	0.26	0	
	r. sunfish	3	0.46	0		0		0	
Sept. 5	bluegill	4	0.28	0		0		0	
	b. crappie	5	1.05	0		0		0	
	g. sunfish	5	0.88	0		6	0.93	0	
	r. sunfish	4	0.62	0		0		0	
Sept. 7	l. bass	2	1.83	0		0		0	
	bluegill	1	0.10	0		0		0	
	b. crappie	5	1.26	1	0.17	0		3	0.90
	g. sunfish	2	0.35	1	0.19	2	0.40	0	
	r. sunfish	1	0.17	0		1	0.16	1	0.23
Sept. 9	bluegill	3	0.20	0		1	0.11	0	
	b. crappie	3	0.41	1	0.10	0		0	
	g. sunfish	1	0.06	0		0		0	

APPENDIX H (Continued)

		Area 4		Area 2		Area 3		Area 1	
Sept. 11	bluegill	4	0.15	0	0	0	1	0.04	
	b. crappie	6	0.69	0	0	0	0		
	g. sunfish	2	0.12	0	0	0	0		
		Area 1		Area 2		Area 3		Area 4	
Sept. 13	l. bass	1	0.88	0	0	0	0	0	
	bluegill	0		0	0	1	0.07	2	0.12
	b. crappie	2	0.48	0	0	0	0	1	0.32
	r. sunfish	1	0.15	0	0	0	0	0	
Sept. 15	l. bass	0		0	0	0	0	1	0.39
	bluegill	5	0.77	0	0	0	0	0	
	b. crappie	3	0.38	0	0	1	0.12	2	0.23
Sept. 17	l. bass	2	1.10	0	0	0	0	0	
	b. crappie	2	0.38	0	0	1	0.35	2	0.14
	g. sunfish	1	0.15	0	0	0	0	0	
	r. sunfish	5	0.79	0	0	0	0	0	
Sept. 19	l. bass	2	1.24	0	0	0	0	0	
	b. crappie	2	0.39	0	0	0	0	0	
	r. sunfish	1	0.26	0	0	0	0	0	
Sept. 21	l. bass	2	1.76	0	0	0	0	0	
	bluegill	5	0.68	0	0	0	0	0	
	b. crappie	1	0.32	0	0	0	1	0.20	

APPENDIX H (Continued)

		Area 1		Area 2		Area 3		Area 4	
Sept. 21	g. sunfish	1	0.18	0		0		0	
	g. shiner	1	0.13	0		0		0	
Oct. 3	l. bass	1	0.32	0		0		0	
	bluegill	2	0.15	1	0.05	0		0	
	b. crappie	2	0.20	0		0		0	
	g. sunfish	3	0.48	0		0		0	
Oct. 7	bluegill	2	0.09	0		0		0	
	g. sunfish	2	0.34	0		0		0	
	r. sunfish	1	0.16	0		0		0	
Oct. 10	all traps were moved into feeding area								
Oct. 11		0		0		0		0	
Oct. 13		0		0		0		0	
Oct. 22	bluegill	1	0.07	0		0		0	
TOTAL		280	47.97	31	6.41	63	9.63	59	11.01

¹l. bass = largemouth bass; g. sunfish = green sunfish; r. sunfish = redear sunfish; g. shiner = golden shiner; b. crappie = black crappie.

APPENDIX I

A COMPARISON OF THE NUMBERS, WEIGHTS, AND RANGES IN LENGTH OF FISH
CAUGHT WITH TRAPS IN FEEDING- AND IN CHECK-AREAS IN POND 3

Species of Fish	Total Numbers in Areas		Total Pounds in Areas		Length Range in Inches	
	Feeding	Check ¹	Feeding	Check ¹	Feeding	Check
largemouth bass	21	17	14.94	9.06	4.8-14.3	6.8-13.0
bluegill	140	35	14.26	3.60	3.5-7.1	3.5-6.5
black crappie	75	86	11.66	11.91	4.3-8.6	4.0-8.0
green sunfish	21	11	3.20	1.78	4.8-6.4	4.9-6.0
redeer sunfish	22	4	3.78	0.70	4.3-7.5	5.0-6.4
golden shiner	1	0	0.13		6.1	
TOTAL	280	153	47.97	27.05		

¹Includes more than one check-area.

APPENDIX J

FISH CAUGHT WITH TRAPS IN POND 4

Date	Species of Fish ¹	Feeding-Area		Check-Area	
		Number	Pounds Total Weight	Number	Pounds Total Weight
		Area 1		Area 2	
Aug. 8	b. bullhead	1	0.85	0	
	bluegill	8	0.61	0	
	r. sunfish	1	0.13	0	
Aug. 9	b. bullhead	2	1.87	1	0.90
	b. crappie	1	0.12	0	
Aug. 10	b. bullhead	1	0.85	0	
	bluegill	1	0.10	0	
	b. crappie	2	0.63	0	
Aug. 11	bluegill	1	0.13	0	
	b. crappie	2	0.21	0	
Aug. 13	b. bullhead	2	1.77	0	
		Area 2		Area 1	
Aug. 14	b. bullhead	0		2	1.77

APPENDIX J (Continued)

		Area 2		Area 1	
Aug. 14	bluegill	1	0.08	2	0.19
	b. crappie	0		2	0.41
Aug. 15	b. bullhead	0		1	0.88
	bluegill	0		3	0.35
	g. sunfish	0		1	0.08
Aug. 16		0		0	
Aug. 17	b. bullhead	1	0.80	1	0.89
	b. crappie	2	0.23	0	
	g. sunfish	2	0.37	0	
	r. sunfish	1	0.14	0	
Aug. 18	b. bullhead	2	1.75	0	
	bluegill	2	0.20	0	
Aug. 20	b. bullhead	1	0.82	0	
	b. crappie	1	0.51	1	0.14
	g. sunfish	1	0.14	0	
Aug. 21	b. bullhead	4	3.30	0	

APPENDIX J (Continued)

		Area 2		Area 1	
Aug. 21	g. sunfish	1	0.18	0	
	r. sunfish	1	0.18	0	
TOTAL		42	15.97	14	5.61

¹b. bullhead = black bullhead; g. sunfish = green sunfish; r. sunfish = redear sunfish; b. crappie = black crappie.

APPENDIX K

A COMPARISON OF THE NUMBERS, WEIGHTS, AND RANGES IN LENGTH OF FISH
 CAUGHT WITH TRAPS IN FEEDING- AND IN CHECK-AREAS IN POND 4

Species of Fish	Total Numbers in Areas		Total Pounds in Areas		Length Range in Inches	
	Feeding	Check	Feeding	Check	Feeding	Check
bluegill	13	5	1.12	0.54	4.0-5.8	4.5-5.5
black bullhead	14	5	12.01	4.44	11.0-12.0	10.8-11.8
black crappie	8	3	1.70	0.55	5.0-9.5	5.0-8.0
green sunfish	4	1	0.69	0.08	5.0-6.3	4.3
redeer sunfish	3	0	0.45		5.3-5.5	
TOTAL	42	14	15.97	5.61		

APPENDIX L

FISH CAUGHT WITH SEINES IN POND 5

Date	Feeding Area	Species of Fish ¹	Total Numbers From Areas		Total Pounds From Areas		Length Range in Inches From Areas	
			Feeding	Check	Feeding	Check	Feeding	Check
July 24	1	l. bass	4	0	4.46		9.3-16.1	
		b. bullhead	2	0	1.71		10.0-11.3	
		b. crappie	12	3	2.41	0.23	4.8-9.3	4.2-4.8
		g. sunfish	0	1		0.11		5.0
Aug. 24	4	l. bass	1	0	0.43		9.3	
		b. bullhead	0	1		1.37		12.0
		b. crappie	9	2	1.95	0.60	4.3-10.0	4.5-9.0
TOTAL			28	7	10.96	2.31		

¹l. bass = largemouth bass; b. bullhead = black bullhead; b. crappie = black crappie; g. sunfish = green sunfish.

APPENDIX M

FISH CAUGHT WITH TRAPS IN POND 5

Date	Species of Fish ¹	Feeding-Area		Check-Areas					
		Number	Pounds Total Weight	Number	Pounds Total Weight	Number	Pounds Total Weight	Number	Pounds Total Weight
		Area 1		Area 2		Area 3		Area 4	
Aug. 8	l. bass	3	6.17	0		0		0	
	b. crappie	2	1.19	0		0		0	
	b. bullhead	0		1	1.22	0		0	
Aug. 9	b. crappie	4	0.95	1	0.08	0		0	
	b. bullhead	1	0.70	0		0		1	1.19
Aug. 10	b. crappie	4	0.80	1	0.07	1	0.11	0	
	b. bullhead	1	1.30	0		0		0	
Aug. 11	l. bass	1	0.39	0		0		0	
	b. crappie	3	0.77	0		0		1	0.07
Aug. 13	b. crappie	5	1.10	2	0.18	0		0	
Aug. 14	b. crappie	5	0.59	1	0.51	0		1	0.07
	g. sunfish	1	0.10	0		0		0	
Aug. 15	b. crappie	8	1.76	0		1	0.12	1	0.10

APPENDIX M (Continued)

		Area 4		Area 2		Area 3		Area 1	
Aug. 16	b. crappie	7	0.35	0		0		2	0.10
	g. sunfish	3	0.21	0		0		0	
Aug. 17	l. bass	2	3.44	0		0		0	
	b. crappie	6	0.86	1	0.09	2	0.14	1	0.05
Aug. 18	b. crappie	16	1.54	2	0.08	0		1	0.10
	g. sunfish	2	0.21	0		0		0	
	b. bullhead	1	0.73	0		0		0	
Aug. 20	b. crappie	10	1.05	1	0.13	1	0.10	2	0.22
	g. sunfish	2	0.31	0		0		0	
	b. bullhead	1	1.20	0		0		0	
Aug. 21	b. crappie	21	1.17	5	0.20	1	0.04	3	0.12
	b. bullhead	0		0		1	1.40	0	
TOTAL		109	26.89	15	2.56	7	1.91	13	2.02

		Area 1		(no traps used in area 2 and area 3)				Area 4	
Sept. 24	l. bass	3	4.65					0	
	b. crappie	3	0.93					1	0.12
Sept. 25	b. bullhead	1	1.05					0	
	b. crappie	1	0.16					0	

APPENDIX M (Continued)

		Area 1		(no traps used in area 2 and area 3)		Area 4	
Sept. 26	l. bass	1	0.46			0	
	b. crappie	3	0.66			1	0.14
		Area 4		(no traps used in area 2 and area 3)		Area 1	
Sept. 27	l. bass	0				1	0.46
	b. crappie	2	0.50			2	0.66
Sept. 28	l. bass	1	2.87			0	
	b. crappie	1	0.12			0	
Sept. 29	b. crappie	2	0.66			0	
TOTAL		18	12.06			5	1.38

¹l. bass = largemouth bass; b. bullhead = black bullhead; b. crappie = black crappie; g. sunfish = green sunfish.

APPENDIX N

A COMPARISON OF THE NUMBERS, WEIGHTS, AND RANGES IN LENGTH OF FISH
CAUGHT WITH TRAPS IN FEEDING- AND IN CHECK-AREAS IN POND 5

Species of Fish	Total Numbers in Areas		Total Pounds in Areas		Length Range in Inches	
	Feeding	Check ¹	Feeding	Check ¹	Feeding	Check
largemouth bass	11	1	17.98	0.46	9.0-16.5	9.5-12.3
black bullhead	5	3	4.98	3.81	10.0-12.0	11.5-12.3
black crappie	103	36	15.16	3.60	3.6-11.0	3.5-10.0
green sunfish	8	0	0.83		4.8-5.0	
TOTAL	127	40	38.95	7.87		

¹Includes more than one check-area.

APPENDIX O

FISH CAUGHT WITH SEINES IN POND 6

Date	Feeding Area	Species of Fish ¹	Total Numbers From Areas		Total Pounds From Areas		Length Range in Inches From Areas	
			Feeding	Check	Feeding	Check	Feeding	Check
July 9	3	l. bass	3	0	3.59		9.3-16.0	
		bluegill	38	11	2.88	0.95	4.3-6.3	4.0-5.8
		g. sunfish	4	2	0.72	0.14	4.5-7.3	5.0-5.1
		g. shiner	3	1	0.32	0.10	6.5-7.0	7.0
Aug. 7	1	l. bass	2	0	1.43		11.0-11.3	
		bluegill	12	7	0.91	0.38	4.3-5.4	4.0-4.5
		g. sunfish	9	2	0.74	0.22	5.0-5.8	5.1-5.8
		g. shiner	1	0	0.11		7.0	
TOTAL			72	23	10.70	1.79		

¹l. bass = largemouth bass; g. sunfish = green sunfish; g. shiner = golden shiner.

APPENDIX P

FISH CAUGHT WITH TRAPS IN POND 6

Date	Species of Fish ¹	Feeding-Area		Check-Areas			
		Number	Pounds Total Weight	Number	Pounds Total Weight	Number	Pounds Total Weight
		Area 1		Area 2		Area 3	
Aug. 3 ²	bluegill	150	16.50	75	7.50	80	9.40
	g. shiner	10	1.60	6	0.84	6	0.84
Aug. 4 ²	l. bass	1	0.70	0		0	
	bluegill	53	6.36	15	1.52	20	1.83
	g. shiner	0		0		1	0.18
Aug. 6 ²	bluegill	128	14.36	46	3.45	62	6.10
	g. shiner	0		0		1	0.17
Aug. 7	bluegill	56	3.41	27	1.40	17	1.16
	g. sunfish	10	0.75	12	0.85	16	1.48
	g. shiner	0		0		1	0.10
Aug. 8	bluegill	58	4.24	5	0.45	29	2.16
	g. sunfish	11	1.06	6	0.50	7	0.77
	g. shiner	2	0.24	2	0.28	0	

APPENDIX P (Continued)

		Area 3		Area 2		Area 1	
Aug. 9	bluegill	26	1.83	8	0.49	18	1.47
	g. sunfish	8	0.74	1	0.16	9	1.01
	g. shiner	1	0.12	1	0.15	0	
Aug. 10	bluegill	32	2.88	21	1.32	16	1.00
	g. sunfish	10	0.89	6	0.66	8	0.90
	g. shiner	2	0.33	1	0.14	0	
Aug. 11	bluegill	46	3.06	3	0.43	16	1.20
	g. sunfish	6	0.76	6	0.60	2	0.22
Aug. 13	bluegill	39	3.22	16	1.14	19	1.36
	g. sunfish	4	0.44	5	0.61	3	0.25
Aug. 14	bluegill	23	1.77	7	0.53	10	0.57
	g. sunfish	2	0.19	2	0.25	4	0.65
Aug. 15	bluegill	34	2.20	12	0.82	11	1.07
	g. sunfish	13	1.66	8	0.78	13	1.26
	g. shiner	1	0.12	0		0	

APPENDIX P (Continued)

		Area 3		Area 2		Area 1	
Aug. 16	bluegill	33	2.04	5	0.28	10	0.59
	g. sunfish	8	0.64	2	0.16	1	0.10
TOTAL		767	72.11	298	25.31	380	35.84

¹1. bass = largemouth bass; g. sunfish = green sunfish; g. shiner = golden shiner.

²Almost all of the fish captured on these dates were dead.

APPENDIX Q

A COMPARISON OF THE NUMBERS, WEIGHTS, AND RANGES IN LENGTH OF FISH
CAUGHT WITH TRAPS IN FEEDING- AND IN CHECK-AREAS IN POND 6

Species of Fish	Total Numbers in Areas		Total Pounds in Areas		Length Range in Inches	
	Feeding	Check ¹	Feeding	Check ¹	Feeding	Check
largemouth bass	1	0	0.70		11.0	
bluegill	678	548	61.87	47.24	3.5-6.0	2.8-5.8
green sunfish	72	111	7.13	11.21	4.4-6.0	4.3-7.3
golden shiner	16	19	2.41	2.70	6.0-7.0	6.0-6.5
TOTAL	767	678	72.11	61.15		

¹Includes more than one check-area.

APPENDIX R

FISH CAUGHT WITH SEINES IN POND 7

Date	Feeding Area	Species of Fish ¹	Total Numbers From Areas		Total Pounds From Areas		Length Range in Inches From Areas	
			Feeding	Check	Feeding	Check	Feeding	Check
June 25	1	l. bass	2	0	1.60		10.5-11.0	
		b. bullhead	1	0	0.70		10.5	
July 21	2	l. bass	5	0	4.89		10.5-12.5	
		b. crappie	4	1	1.89	0.29	8.3-9.3	7.0
		g. sunfish	3	1	0.57	0.25	4.8-7.0	6.5
Aug. 14 ²	1	l. bass	2	0	1.54		10.5-11.5	
		b. crappie	1	1	0.30	0.63	8.0	9.5
		g. sunfish	27	2	1.51	0.18	1.8-7.0	3.5-4.8
		g. shiner	9600 ³	20	48.00	0.15	2.5-6.5	2.5-6.0
TOTAL			9645	25	61.00	1.50		

¹l. bass = largemouth bass; b. bullhead = black bullhead; b. crappie = black crappie; g. sunfish = green sunfish; g. shiner = golden shiner.

²1/4-inch mesh seines used.

³Total weight estimated by weight-count method.

APPENDIX S

FISH CAUGHT WITH TRAPS IN POND 7

Date	Species of Fish ¹	Feeding-Area		Check-Areas			
		Number	Pounds Total Weight	Number	Pounds Total Weight	Number	Pounds Total Weight
		Area 1		Area 2		Area 3	
Aug. 17	l. bass	3	3.39	0		0	
	b. bullhead	0		0		1	0.65
	b. crappie	4	1.66	0		1	0.38
	g. sunfish	1	0.18	2	0.27	1	0.04
		Area 2		Area 1		Area 3	
Aug. 18	l. bass	1	0.70	3	3.02	0	
	b. bullhead	0		1	0.72	0	
	b. crappie	0		2	0.79	0	
	g. sunfish	0		1	0.28	2	0.32
Aug. 20	l. bass	0		1	0.74	1	0.71
	b. crappie	2	0.66	0		0	
	g. sunfish	0		1	0.20	0	
Aug. 21	l. bass	2	2.13	2	2.08	4	3.37
	b. bullhead	1	0.72	0		0	
	b. crappie	6	3.95	0		0	

APPENDIX S (Continued)

		Area 2		Area 1		Area 3	
Aug. 21	g. sunfish	2	0.46	0		0	
Aug. 22	l. bass	2	1.74	0		1	1.22
	b. crappie	2	1.00	0		0	
	g. sunfish	2	0.13	1	0.18	0	
Aug. 23	b. bullhead	1	0.70	0		0	
	b. crappie	2	0.84	0		0	
	g. sunfish	1	0.43	1	0.09	1	0.20
	g. shiner	0		0		1	0.06
	c. catfish	1	1.22	0		0	
Aug. 24	g. sunfish	4	0.36	1	0.10	1	0.16
		Area 1		Area 2		Area 3	
Aug. 25	l. bass	0		1	1.02	0	
	b. crappie	0		2	0.72	0	
	g. sunfish	1	0.13	1	0.08	0	
Aug. 27	l. bass	1	0.96	1	0.80	0	
	b. crappie	0		1	0.50	0	
	g. sunfish	0		1	0.27	0	
Aug. 28	l. bass	2	1.79	0		0	
	b. crappie	1	0.57	0		0	
	g. sunfish	0		1	0.05	0	

APPENDIX S (Continued)

		Area 1		Area 2		Area 3	
Aug. 28	c. catfish	1	3.26	0		0	
Aug. 29	b. crappie	1	0.31	0		0	
	g. sunfish	6	0.52	1	0.06	0	
	r. sunfish	0		0		1	0.23
Aug. 30	l. bass	2	2.47	0		0	
	b. bullhead	0		1	0.81	0	
	b. crappie	2	0.98	0		0	
	g. sunfish	2	0.13	0		0	
		Area 2		Area 1		Area 3	
Sept. 24	l. bass	4	2.86	1	0.79	0	
	b. crappie	3	1.40	0		0	
	g. sunfish	0		1	0.17	0	
Sept. 25	l. bass	2	1.99	0		0	
	b. bullhead	0		1	0.78	1	0.83
	b. crappie	2	1.06	0		0	
	g. sunfish	0		1	0.24	0	
Sept. 26	b. crappie	2	0.78	0		0	
	g. shiner	1	0.10	0		0	

APPENDIX S (Continued)

		Area 1		Area 2		Area 3	
Sept. 27	l. bass	2	1.56	0		0	
	b. crappie	1	0.40	0		0	
	g. sunfish	1	0.32	2	0.47	0	
Sept. 28	l. bass	3	2.65	0		0	
	b. crappie	2	0.86	0		0	
	b. bullhead	0		2	1.65	0	
	g. sunfish	3	0.70	1	0.18	1	0.16
Sept. 29	l. bass	1	0.88	0		0	
	b. crappie	1	0.47	0		0	
TOTAL		84	47.42	35	17.06	17	8.33

l. bass = largemouth bass; b. bullhead = black bullhead; b. crappie = black crappie; g. sunfish = green sunfish; r. sunfish = redear sunfish; g. shiner = golden shiner; c. catfish = channel catfish.

APPENDIX T

A COMPARISON OF THE NUMBERS, WEIGHTS, AND RANGES IN LENGTH OF FISH
CAUGHT WITH TRAPS IN FEEDING- AND IN CHECK-AREAS IN POND 7

Species of Fish	Total Numbers in Areas		Total Pounds in Areas		Length Range in Inches	
	Feeding	Check ¹	Feeding	Check ¹	Feeding	Check
largemouth bass	25	15	23.12	13.75	10.3-12.9	10.5-12.3
black bullhead	2	7	1.42	5.44	10.5-10.8	10.3-11.5
black crappie	31	6	14.94	2.39	7.5-13.0	7.5-8.5
green sunfish	23	22	3.36	3.52	3.8-7.5	3.8-7.0
redeer sunfish	0	1		0.23		6.0
golden shiner	1	1	0.10	0.06	6.0	5.5
channel catfish	2	0	4.48		15.0-20.1	
TOTAL	84	52	47.42	25.39		

¹Includes more than one check-area.

VITA

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