PRODUCTION AND HARVEST OF FARM POND FISH

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This is to certify that the

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PRODUCTION AND HARVEST OF FARM POND FISH

By

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INTRODUCTION

Pond and lake cultivation of fish is increasing throughout the world, particularly in those countries in which there is an acute shortage of protein foods. (Compton, 1953).

Russia has established four fish-breeding stations on Kuibyshev Lake, and five above Stalingrad. Fish are reared at these stations for introduction into suitable waters, chiefly as eggs and fry. The fish being used for these introductions and experiments are said to include six varieties of salmon, two species of trout, and sturgeon.

Israel's annual consumption of fish amounts to 22,000 tons. Of this amount 4,000 tons is obtained from carp-breeding ponds. The carp-breeding ponds probably have reached the limit of their capacity because they compete with agriculture for land and water. However, the country's climate has proved suitable for rapid growth of carp, and it has been possible to obtain two-and-a-half fish harvests a year. It is planned to extend pond culture to rainbow trout, tench, and grey mullet.

The Chinese have had extensive pond fish culture since 2,000 B.C., but their methods have shown little change. The chief species cultivated are the common carp and oriental perch.

The present annual Hungarian pond yield of carp is about 2,500 tons. The shallow ponds range from a few hundred yards to a mile or more in length. In November, the large waters are drained, the marketable fish removed, and the young and breeding fish separated and put into smaller winter stockponds.

The Italians have established the largest eel farms in the world, with a catch of 500,000 kilograms or more annually. The farms actually consist of large traps to catch migrating eels.

Holland and Denmark have both established sizable export markets for rainbow trout. Denmark alone has exports valued at some 2 million kroner.

The giant carp or Catla of India is of great value because of the great size attained and the rapidity with which it grows. Under ideal conditions, Catla carp have grown from fry to a length of 26 to 29 inches and a weight of 6 to 9 pounds in the first year. Full grown these fish will reach a length of more than 6 feet and a weight of 140 pounds.

In Malaya, a supply of fresh-water fish has been built up by transporting Chinese carp-fry by air and establishing them in farm ponds.

In the United States the practice of preserving water by impoundment for soil conservation, water storage, stock watering, irrigation and fire protection has been recognized as an important part of our economy with less importance given to fish production for food purposes. Interest in farm ponds for fish production was noted as far back as 1900 (Dyche, 1914; Townsend, 1941) and increased during World War I (Meehean, 1952).

Hardy (1952) states that over 300,000 farm and ranch fish ponds were being used for raising fish in the United States with an area of

360,000 acres and a potential yield of 18,000,000 pounds of edible fish per year.

The Agricultural Conservation Programs Branch of Production and Marketing Administration, a government agency that makes conservation payments to farmers and ranchers for construction of ponds that are to be used primarily for soil and water conservation, estimates that assistance is given ranchers and farmers to construct ponds at the rate of 59,000 a year. An unknown number have been built without assistance from PMA.

In the summer of 1950, the Fish and Wildlife Service of the United States Department of the Interior conservatively estimated that there were about 1,666,000 farm and ranch ponds present in the United States.

From the calculations used by Hardy (1952) the potential yield of edible fish from these ponds per year could be 133,280,000 pounds. Even though the potential yield is this great, fish as a protein food and as an important crop of farm ponds is not seriously considered by most pond owners. In Michigan, except for commercial trout hatcheries and State Fish Hatcheries, the actual propagation of fish in ponds is left to chance and frequently the results are far from encouraging. This condition leaves much to be desired and of consequence much work has been recently directed toward farm pond management.

Several workers (Bennett, 1948; Swingle, 1950; Ball, 1952) have investigated various fish combinations in farm ponds and have proposed several recommendations which when followed give good yields of harvestable fish.

Closely related to proper species combination is the problem of determining the most suitable ratio of these fish for a given area of water. Another problem is that of harvesting the edible-sized fish from the population. Many farm ponds are not being utilized to their greatest capacity because, although they produce fish, the owner may be at a loss to know how best to harvest the desired portion of the fish crop.

Experiments were organized to establish stock recommendations for Michigan farm ponds and to find suitable methods for harvesting fish. The first part of this report is concerned with ratios of fish species in combination and the second part is concerned with methods of harvesting edible-sized fish from the fish-crop and includes designing a fish trap suitable for this purpose. Emphasis is placed on the construction of home-made wire fish traps designed specifically for operation in farm ponds. The relative efficiency, cost of materials and plans for construction are given. As far as is known, at the time these traps were devised no information regarding home-made wire fish traps was available and it is hoped that the information found within this report will help the pond owner utilize a fish crop more fully and efficiently.

DESCRIPTION OF EXPERIMENTAL PONDS

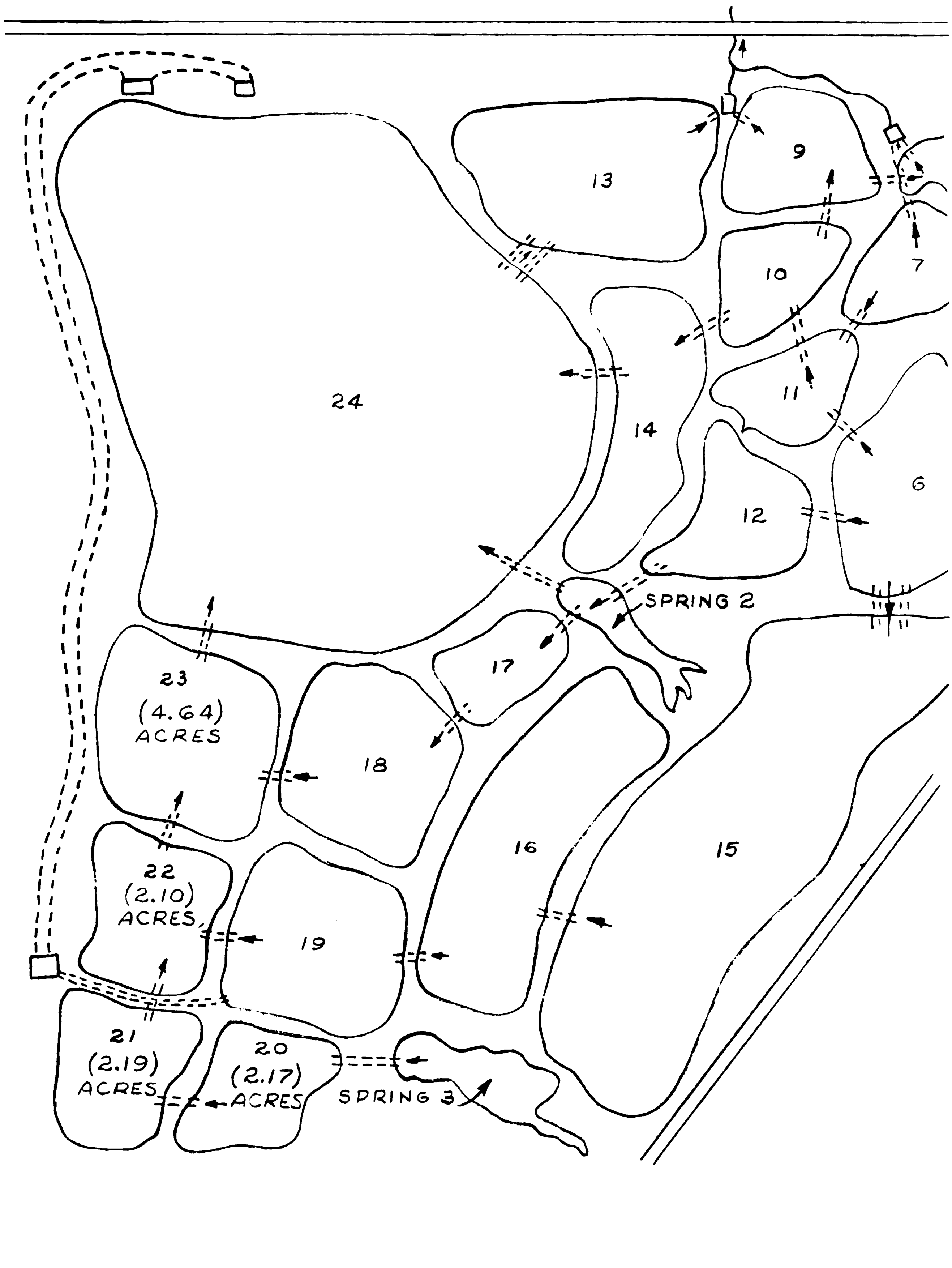
The experiments described in this report were conducted at Wolf Lake State Fish Hatchery near Kalamazoo, Michigan.

Three springs supply the water for the hatchery ponds and have an average annual water temperature of 50 degrees F. Chemical analysis showed that the spring water was high in carbonate hardness, having a methyl orange alkalinity of 160 parts per million. Water was maintained at or near overflow levels in the ponds.

The surface areas of the ponds range from 2.1 acres to 4.6 acres, and the basins slope gradually to a maximum depth of six feet at the overflow basin. Several collecting ditches fan over the bottom from the drainage outlet to the periphery of each pond. The pond bottom consists of sand and marl overlain by a layer of muck in the deeper areas. A detailed description of the ponds is given by Patriarche and Ball (1949).

In September 1949, two ponds were stocked with 83 large-mouth bass fingerlings and 11 adult bluegills per acre and two ponds were stocked with 100 fingerling largemouth bass and 100 adult bluegills per acre. One of the four ponds (No. 20) had been fertilized in 1947 and 1948. Figure I shows location and size of the several ponds used in this experiment.

Figure I. Diagram of Ponds at Wolf Lake State Fish Hatchery



13
9
10
7
24
14
11
6
12
SPRING 2
17
23
(4.64)
ACRES
18
16
15
22
(2.10)
ACRES
19
21
(2.19)
ACRES
20
(2.17)
ACRES
SPRING 3

METHODS

Stocking Ratios

The ponds were stocked with adult bluegills (*Lepomis macrochirus*) and yearling largemouth black bass (*Micropterus salmoides*). Table I shows the total number per acre and average total length of each species stocked in 1949.

TABLE I

Stocking Ratios

Pond number (acres)	Species	Total number	Number per acre	Average total length in inches
20	Bass	180	83	3
(2.2)	Bluegills	22	10	7
21	Bass	230	105	3
(2.2)	Bluegills	28	13	7
22	Bass	210	100	3
(2.1)	Bluegills	210	100	7
23	Bass	464	100	3
(4.6)	Bluegills	464	100	7

Draining Operations

In September 1952 four ponds were drained, (Figure I). Water flows from the ponds though outlets into concrete seining boxes which are so constructed that they can be divided into three separate compartments by means of screens. One seining box serves as a catch basin for several ponds with control of water maintained by valves at the outlet box in each pond.

In ponds containing dense growths of aquatic plants the vegetation was piled and channeled to facilitate movement of fish toward the outlet. This procedure reduces the number of fish stranded in collapsed vegetation. The rate at which the ponds were drawn was largely determined by the amount of aquatic vegetation present.

In previous years the water level lowered slowly during draining operations and the fish netted in the seining box below the pond.

They were then transferred to tank trucks and moved to holding tanks in the hatchery building. Considerable mortality of fish occurred due to the change in temperature from relatively warm pond water (79°F) to the cold water in the holding tanks (52°F).

In the draining operations of 1952 the water from each pond was drawn rapidly through the seining basin. Approximately one half of the total number of fish coming through the drain pipe were collected immediately, loaded on tank trucks and transferred to another seining basin supplied with water of the same temperature. The fish entering the basin during the final stages of draining operations were usually in distress due to the high silt content carried by the water. This condition was alleviated by diverting a large amount of water into the seining basin from another pond which at the time was not included in draining operations.

Weight and Length Computation

The fish were separated into size groups by the use of sorting boxes. Weights and measurements of the fish were taken at the seining basin and processed fish returned to a separate division of the seining box. All fish were weighed by size classes. Random samples of known weight were counted to find the number per pound with the total number of fish calculated from the total weight. Even though some mixing of yearling and young of the year fish occurred in the sorting boxes separation of the two classes was possible in most cases. Upon completion of draining operations all live fish were returned to the ponds from which they came. The mortality of the fish after their return to the ponds will be considered in a later section of this report.

MORTALITY DURING DRAINING OPERATIONS, 1952

Mortality after return to the ponds is included here merely to show economic losses when pond draining is used as a harvesting method and has no bearing on results of this experiment. Since the ponds were drawn quickly and nearly all aquatic plants piled as the water receded few fish were stranded in the vegetation. It was possible therefore, to obtain a fairly accurate estimate of total mortality from the losses occurring in the seining basins and after return to the ponds where the dead fish were recovered and weighed.

Table 2 shows the mortality of each size group in the fish population for each pond after draining operations in 1952. At the time of draining the losses of small bluegills (1-3 inches) ranged from 26 to 60 per cent and the losses of the larger bluegills (4-9 inches) ranged from 10 to 32 per cent of total weight. As seen in Table 2, the recorded loss was less in Pond 20, which was due to incomplete collections of fish after return to pond and to the fact that there was no loss of bass in the holding tanks. In all other ponds recording of dead fish continued until none were found. The high loss of bass in Pond 22 was due to crowding in the seining box during a rapid rise in water temperature.

TABLE 2

Mortality of fish during draining operations in 1952.

Data in percentage of total weight.

Pond number	Bluegills			Bass	Combined loss
	small	large	total		
20	26	26	52	0.0	29
21	47	32	79	0.1	57
22	60	16	76	40.0	52
23	45	10	55	15.0	51

In Ponds 21 and 23 the large bass preceded the small bluegills into the seining basin and were removed as they entered. There was very little mixing of small and large fish. Possibly the lower mortality of small fish in these two ponds, as indicated in Table 2, was due to removal of large bass.

In Pond 22 the fish passed into the seining basin without segregation of size groups or species. Here many small fish were injured by the crowding action of the large bass. The highest mortality (60 percent) of small bluegills occurred in Pond 22.

From the observations made during draining operations of 1952 the following conditions were found to influence mortality.

a. Draining a pond quickly tends to separate the large from the small fish. Removing the large fish eliminates the

a. Draining a pond quickly tends to separate the large from the small fish. Removing the large fish eliminates the crowding hazard and lowers mortality in small size groups.

b. Handling large numbers of small fish in a scap net with a deep bag increases mortality by crushing those near the bottom of the lift.

c. When carrying small fish from seining basin to tank truck mortality is lowered by using containers filled with water for the complete transfer.

d. Small bluegills withstand a change in temperature greater than 4 degrees F per hour better than large bluegills and large largemouth bass (10-12 inches) withstand a change greater than 4 degrees F per hour better than small bass. At the Wolf Lake Hatchery bass removed from a water temperature of 74 degrees F and held overnight in water temperature of 52 degrees F showed no ill affects and all survived the change while the small bass showed a 50 per cent mortality. Under the same conditions bluegills suffered greater losses in the large size groups than in the small size group.

EXPERIMENTAL STOCKING RATIOS OF ADULT BLUEGILLS IN COMBINATION WITH FINGERLING LARGEMOUTH BLACK BASS

The success of a farm pond in producing a crop of harvestable sized bluegills and bass is closely allied to the initial stocking ratios and combinations. As determined by Ball and Tait (1952), the age at stocking of each species in a combination has a large bearing on the length of time necessary to produce harvestable sized fish. Stocking ratios have considerable influence on rate of growth of fish and on the degree of success of a species to reproduce.

Many combinations of fish have been tested in various parts of the country. Meehean (1952) in a survey of the combinations used in ponds throughout the United States pointed out that, although bass and bluegills are most widely used, there are as many as 1[illegible] other species used alone or in various combinations.

In Alabama, as many as 29 species have been tested or are in various stages of testing for suitability for pond culture (Swingle, 1952).

Where the water temperatures are below 74 degrees F. the bass-bluegill combination can be replaced by cold water fish such as trout. In Montana, where most waters are considered too cold for warm water fish, 13 species have been tested (Thoreson, 1952). The bass-bluegill combination even though recommended for the few warm water ponds present, has been unsatisfactory except in a very few instances.

In Michigan (Ball, 1952) 9 species have been tested to determine the more practical combinations for waters of this latitude. However, it is doubtful that any combination or any species alone will prove satisfactory for every body of water.

Since primary emphasis on fishing in Michigan is often directed to capture of large fish, fish populations containing only small or medium sized fish are less attractive to fishermen. Combinations of bass and bluegills, regardless of rate of stocking, usually result in an overpopulation of bluegills. Therefore, it is desirable to determine the rate of stocking that will give good fishing for large fish in the shortest time after stocking and maintain it for as long as possible.

It has been established by Bell and Tait (1952) that adult bluegills and fingerling bass when stocked in combination give better fishing in a shorter time than fingerling bluegills and fingerling bass.

As a part of the experiment to determine stocking rates for ponds in Michigan, four ponds at Wolf Lake State Fish Hatchery were stocked with adult bluegills and fingerling bass in the proportions shown in Table I. These ponds were stocked in September, 1949 and drained in September, 1952. Data were obtained on the growth, numbers and weights of fish at the time of draining.

Pond 20. This pond was stocked with 10 adult bluegills and 83 fingerling bass per acre. The average length of the bluegills was 7 inches and the average length of the bass was 3 inches. There was more open water and growth of vegetation was more sparse through out the last summer of this experiment than in any of the other ponds.

Upon draining in September, 1952 a total of 387 pounds of fish per acre was recovered. The weight of each size group is shown in Table 3. The large bass present at the time of draining were quite uniform in size. It was impossible to separate the original fish stocked from the following year class. Adventitious fish present consisted of 28 large suckers (<u>Catostomus commersoni</u>) averaging 2.1 pounds.

The bass spawned successfully each summer, as evidenced by three size groups. However, in 1952 there was a survival of only 75 young-of-the-year from 348 large parent bass. The bass stocked in 1949 spawned late in 1950. This year class produced the large bass recovered in 1952. These bass averaged less than one pound in their fourth summer. (See Table 4).

None of the 22 bluegills originally stocked were recovered during draining operations in 1952. Several fish of the size of this group were removed from the population during the experiment. The removal of these fish (bluegills) early in the experiment may have altered the reproduction potential in the pond for there was a greater number surviving from the 1950 spawning season than from the 1951 spawning season.

As shown in Tables 3 and 4, Pond 20 produced 136 pounds of edible-sized bluegills per acre during the period from September, 1949 to September, 1952. The standing crop of edible size bluegills was higher and the standing crop of young-of-the-year was lower than in any of the other ponds studied. This was the only pond which contained bass of every year class.

From an angler's viewpoint the combination in Pond 20 was satisfactory.

The presence of suckers in Pond 20 may have influenced the ratio of edible and small bluegills. It is an assumption that their presence played a part in this respect, however, reports by Hubbs (1933), and Weibe (1935) indicated that the presence of golden shiner minnows and other forage fish interfered with reproduction of species in a population and that fish with similar habits might be expected to do the same. The removal of many large bluegills early in the experiment for food studies may have altered the usual trend toward overpopulation of this species.

Table 3

Production of bass and bluegills in four Michigan ponds.

Data in pounds per acre.

Species	Pond 20	Pond 21	Pond 22	Pond 23
Large bluegills	136	45	63	82
Medium bluegills	20	60	66	49
Small bluegills	35	219	200	269
Large bass	98	151	200	63
Medium bass	62	-	-	-
Small bass	-	-	14	2
Suckers	36	-	-	-
Total	387	475	543	465

Pond 21. Pond 21 was stocked with 105 bass fingerlings and 13 adult bluegills per acre. Nearly the entire pond surface was covered with floating higher aquatic vegetation early each summer of the experiment.

The original bass stocked were not identified at draining in 1952. The absence of intermediate and small bass size groups indicated that the original bass stocked in 1949 reproduced successfully one season only (1950). There were 75 young-of-the-year bass produced in 1952 which survived to draining. It should be noted that the weight of large bass recovered from Pond 21 was considerably higher than the weight from

Pond 20 which produced an intermediate size group.

Seventy per cent (20) of the original adult bluegills stocked, survived to draining in 1952. The average length at time of stocking was 7.0 inches and at recovery in 1952 was 9.5 inches. These fish spawned during each summer of the experiment.

There were three size groups of bluegills present at draining and one size group of bass. Approximately 151 pounds of large bass and 45 pounds of edible-size bluegills per acre were recovered. The large bass averaged 11.8 inches and the large bluegills averaged 6.2 inches (Table 4). This is slightly less than the average for bluegills and slightly higher than the average for bass in Pond 20. In Pond 20, even though the bass were very nearly the same average length as those in other ponds, they weighed 2.1 ounces less.

Pond 22 and 23. Ponds 22 and 23 were stocked with 100 bass fingerlings and 1 0 adult bluegills per acre. In Pond 22, except for a small area near the main drain box, dense mats of detached floating higher aquatic plants covered the entire surface. Pond 23, the larger of the two ponds, had fewer aquatic plants and afforded more open water for hook and line fishing.

Pond 22 produced the greatest poundage of fish of this experiment yielding approximately 543 pounds of fish per acre when the pond was drained in 1952. The bass showed the best growth in this pond and produced young in 1950 and 1952 and none in 1951. Also, this pond yielded 14 pounds of small bass (young-of-the-year) per acre at draining,

Table 4. Average length and weight of fish harvested from four Michigan ponds

Species	Pond 20		Pond 21		Pond 22		Pond 23	
	inches	ounces	inches	ounces	inches	ounces	inches	ounces
Bluegills								
large	7.8	4.0	6.2	2.4	5.8	1.2	6.3	2.4
medium	4.3	0.8	5.0	0.9	5.2	1.1	5.4	1.4
small	2.1	0.1	2.5	0.1	3.0	0.1	2.9	0.2
Bass								
large	11.2	9.7	11.8	12.4	11.2	11.6	11.5	12.4
medium	6.5	1.6	....	....	....	....	....	....
small	2.8	0.2	2.9	....	2.5	0.2	2.8	0.2
Suckers								
large	...	32.0	...	....	...	...	...	...

whereas all the other ponds produced very few of this year class.

Of the 210 adult bluegills originally stocked in Pond 22, 88 were recovered at draining with an average length of 8.2 inches (See Table 5).

Table 5

Data concerning bluegills stocked in 1949 and recovered at draining, 1952.

Pond	1949 Number	1949 Length (inches)	1952 Number	1952 Length (inches)	Percent Survival
20	18	7.0	0	0.0	0
21	28	7.0	20	9.4	70
22	210	7.0	88	8.2	42
23	464	7.0	52	8.1	12

The combination of 100 fingerling bass and 100 adult bluegills per acre tested in these two ponds showed a composition and yield in Pond 22 very nearly the same as in Pond 21 which was stocked with 105 fingerling bass and 13 adult bluegills. Even though stocked at the same rate as pond 22, only 63 pounds per acre of bass were recovered at draining from Pond 23 as compared to 200 pounds per acre of bass from Pond 22. (See table 3).

BALANCE OF TWO SPECIES OF FISH IN A POPULATION

Ponds stocked at equal rates show a great deal of variation in population composition even when as few as two species of fish in a combination are considered. A part of this variation is due to the pond conformation and fertility. It is therefore not feasible to attempt analysis of these variations but rather of the population in respect to inter-relationships between species and between groups within species.

Management of Michigan ponds is relatively new, and as yet criteria for differentiating between balanced and unbalanced populations have not been established.

In the South, through the efforts of Swingle et. al., criteria have been set up which show limits for what is assumed to be a favorable balance in a population. Swingle considers a population in balance when year after year satisfactory amounts of harvestable fish are present in accordance with the basic fertilities of the bodies of water containing these populations.

The following interpretation of results will partly come from the criteria of pond balance proposed by Swingle, which are:

F/C ratio - ratio of forage to carnivorous fish.

Y/C ratio - ratio of food available to carnivorous fish.

A_t value - percent of total weight of population composed of fish of harvestable size.

E value - percent of weight of a population composed of that species

A, I, S values - percent of total population of a species of large, intermediate and small fish.

Production in Michigan Ponds over a Five year Period.

The following information concerned with the 1948 and 1949 production in Ponds 20 and 21 comes from the publication by Ball and Tait (1952). Table 6 shows the relationships between species and within species in Ponds 20 and 21 for the years 1948 through 1952 and the data for Ponds 22 and 23 are also included.

In the spring of 1947 Ponds 20 and 21 were stocked each with 150 bass fingerlings and 18 adult bluegills per acre. After draining and recording of data in September 1948 all live fish were returned to the ponds from which they came. In September 1949 these ponds were again drained. At this time Pond 20 was restocked with 105 bass fingerlings and 13 adult bluegills. The weight and number of fish per acre recovered in ponds in successive years are shown in Table 7.

The F/C ratio, which is a ratio of the total weight of all forage fish to the total weight of all carnivorous fish, is derived from dividing the weight of bluegills by the weight of bass recovered from the pond.

Table 6

Relationships between species and between groups in fish populations in experimental ponds in Michigan

Pond	Year	F/C Ratio	Y/C Ratio	A_t Value	E Values Bass	E Values Bluegill	A Bluegill	I Bluegill	S Values
20	1948	4.0	4.0	20.3	19.8	80.2	1.6	....	98.5
	1949	3.5	2.2	46.2	22.6	77.4	34.5	65.5	....
	1952	1.4	0.2	69.0	45.0	54.0	71.0	10.8	18.2
21	1948	2.0	1.7	26.6	34.8	65.1	5.3	....	94.7
	1949	2.0	0.3	62.5	32.0	67.9	54.3	31.7	14.0
	1952	2.5	1.7	37.4	28.7	71.3	12.0	16.1	71.9
22	1952	1.5	0.9	40.0	39.4	60.6	19.6	20.5	59.9
23	1952	6.1	4.1	31.2	13.9	86.1	20.5	12.3	67.2

Swingle found the desirable range for F/C values to be between 3.0 and 6.0 with values below 3.0 indicating overcrowding of bass and values above 10.0 indicating a large population of medium and small bluegills. In Michigan Ball (1945) summarizing data from three natural lakes considered to have fish populations in which all game-fish components were growing at an average rate found the F/C range to be between 1.3 and 1.6.

Judged by the F/C ratios alone most ponds were crowded with bass with the exception of Pond 23. Although the ponds used in this experiment generally had a higher ratio of carnivorous fish to forage fish than what is presumed desirable in a balanced population, there is every reason to believe that in the near future conditions would favor a large production of bluegills. This is borne out by the summary of 32 lakes poisoned in

Table 7

Weight and number of fish per acre in ponds in successive years

	1948			1949			1952		
	Pond 20								
	Blue gill	Bass	Total	Blue gill	Bass	Total	Blue gill	Bass	Total
Pounds	584	137	721	518	151	669	222	160	382
No. Large	16	138		1,590	116		530	161	
No. Medium	..	..		..	..		415	598	
No. Small	44,500	275		8,160	1,160		5,225	34	
	Pond 21								
Pounds	178	88	266	161	76	237	324	151	475
No. Large	17	155		480	133		291	192	
No. Medium	..	..		692	..		964	..	
No. Small	8,700	390		2,800	193		35,441	..	

Michigan (Ball, 1945) of which only one lake had a stunted bass population but lakes containing populations of slow growing and stunted bluegills were common in the state.

Ponds 22 and 23, even though stocked at the same rate (Table 1) showed a wide difference in F/C values. It may be that spawning success influenced the difference in values rather than predation. From observations made during the summer of 1952, Pond 22 was found to contain very little area around its periphery that offered ideal spawning beds for bluegills. The banks sloped so that there was a rapid drop off to a maximum depth of 6 feet and were covered by a relatively deep layer of silt. This condition and the presence of a dense growth of aquatic vegetation prevented the fish from uncovering a nest down to clean sand. The small areas of clean sand available for spawning were under more than 3 feet of water. Swingle and Smith (1943) found that nests usually occurred in water from 6 inches to 4 feet deep, however, where dense growth of weeds occupied the shallower areas, nests have been found in 8 to 10 feet of water. In Pond 22 the aquatic vegetation completely covered the pond bottom. Had the bluegills moved into deeper water for spawning activities the condition would have been no better than in the shallower areas.

In Pond 23, the northern bank sloped gradually to the maximum depth of the pond and offered an excellent area for spawning. This slope was relatively free of silt with many sections of clean sand. Here adult bluegills were observed spawning early in the spring of 1952. The majority of nests examined contained eggs. At this time the few nests present in Pond 22 were in deeper water than in Pond 23, and did not contain eggs. Water temperatures were not taken directly over the nests in deep water in Pond 22. However, the temperature readings taken in Pond 23 showed surface temperatures equal to those directly over the nests. Possibly the nests in deeper water in Pond 22 did not reach the temperature required to initiate the spawning activities and few if any eggs were deposited.

Another of the criteria used by Swingle is the Y/C ratio. This is the total weight in pounds of all those individuals in the "F" group that are small enough to be eaten by the average size adults in the "C" species divided by the total weight in the pounds in the "C" group. The young-of-the-year are usually considered the "F" group.

Swingle found the F/C ratios in balanced ponds ranged from 0.02 to 4.8 and that between 0.02 and 0.5 all populations should be considered "temporarily balanced". This situation existed in Pond 20 in 1952 and in Pond 21 in 1949. During the three year period, Pond 23 was the only pond that produced a population which was above the desirable range, 1.0 to 3.0.

The harvestable sized fish present in the four ponds studied ranged from 20 to 69 percent of the total population. In the South, Swingle found the average range to be between 60-85 percent. This range suggested by Swingle is based on minimum sizes of .4 pounds for bass and .1 pounds for bluegills. In this experiment bass 8 inches long and bluegills 5 inches long were considered minimal edible sizes therefore direct comparisons cannot be made. Data gained from three draining operations over a five year period in two Michigan Ponds indicate that a range from 25 to 55 percent of harvestable size fish might be expected in populations considered in balance.

HARVESTING FARM POND FISH

Up to the present time more attention has been given to production in farm ponds than to adequate methods of harvesting fish from such ponds. Since these waters in Michigan are perhaps more important for food than for recreational fishing it is important that methods of harvest be considered as a major part of farm pond management. Adequate methods would encourage a pond owner to harvest a crop that is often not utilized and at the same time decrease the chance for over-population by removing many of the fish which produce the most young.

This section of the report presents a method adaptable to farm ponds, whereby edible-sized fish may be harvested when desired and with some assurance of success.

The methods of harvesting fish generally involve one of the following: (1) Hook and line, (2) a spear or related tool, (3) removal of water in pond draining, and (4) nets and traps which may serve to trap them in an enclosure or entangle them in webbing.

Hook and line are usually used for recreational fishing and as a method of taking large numbers of fish in ponds is time consuming. This method is inadequate for removing the number required at the time a pond owner is prepared to process the edible-sized fish by freezing, smoking, canning or for removing a desired number of fresh fish on short notice for table use.

Even though draining a pond is the most effective and often the only means for harvesting the total crop of fish the pond owner is not justified in using this method. Draining a pond usually results in heavy fish mortality and the incurred loss would defeat the purpose of the operation. Indirectly, the loss of suspended nutrients necessary in the food chain could delay the growth of the small fish returned to the ponds.

Another method often considered is that which employs a net or related device. Commercial fishermen and bait dealers use this method extensively and usually have several different types to select from. Of the great variety in use only a few of the more common types are suitable for farm ponds. The gill net, fyke net, seine and trap net are, to a certain extent, applicable for harvesting fish in farm ponds. However, as will be pointed out, undesirable qualities tend to reduce operation efficiency.

A gill net is a wall of webbing hanging vertically in the water and entangles the fish in mesh openings as they attempt to pass through. Gill nets are expensive and when improperly cared for deteriorate rapidly. Control over the numbers to be captured in a well-populated pond is difficult and since most of the gilled fish die a short time after entanglement, an appreciable amount of waste results. Gill nets are practical for use in farm ponds only when large numbers of fish are removed over a short period of time.

Fyke nets are constructed of cord webbing over hoops with leads extending outward from the entrance. A fyke net has a funnel shaped entrance leading to the inside of the trap. Much of the efficiency of this trap depends on skill in setting. However, qualities which limit its use in farm ponds are evident in the cumbersome size, comparatively high purchasing cost and the inability of the pond owner to manage setting operations from the shore of the pond.

A sein may be used in small areas of water where fish are concentrated and where relativ ly little growth of aquatic vegetation occurs. Since these conditions seldom occur in farm ponds and since one man alone cannot operate a sein: a pond owner would consider it inadequate as a means for harvesting a fish crop. Seines are also cumbersome, expensive, and are subject to rapid deterioration when improperly cared for.

A trap net is an impounding device and may be constructed of cord webbing over a hoop frame. The fyke net with the long leads removed is often regarded as a trap net. The qualities that limit its use in farm ponds are similar to those of the fyke net and need not be considered here. However, of the several methods described the principle of capturing fish by impoundment appears to be the most practical for farm pond use. In order that this could be determined by experimentation, a necessary part of the procedure was to design a trap appropriate for gaining the desired information. Wire poultry netting was selected as the basic material and sev ral wire fish traps were constructed.

Design and Construction of Wire Fish Traps

The experiments were carried out at the Wolf Lake State Fish Hatchery in Southern Michigan. First attention was given to designing fish traps of poultry netting incorporating the desired qualities for efficient and practical use in farm ponds. The following factors were considered. (1) Expense, (2) weight, (3) simplicity of design, (4) selectivity for edible-sized fish and species, (5) ability to retain sizable numbers of fish without harm for several hours, (6) maintenance and, (7) ability to operate in water of various depths.

Information regarding efficiency was gained by testing each trap in hatchery ponds which were considered similar to the average farm pond. Immediately following the design and construction, each trap was tested for the desired qualities before designing the next. By this trial and error method undesirable qualities were eliminated and a wider range of adaptability under several different pond conditions was possible. Seven types of wire traps were made during the summer of 1952 and of these, four of the most practical are described in detail.

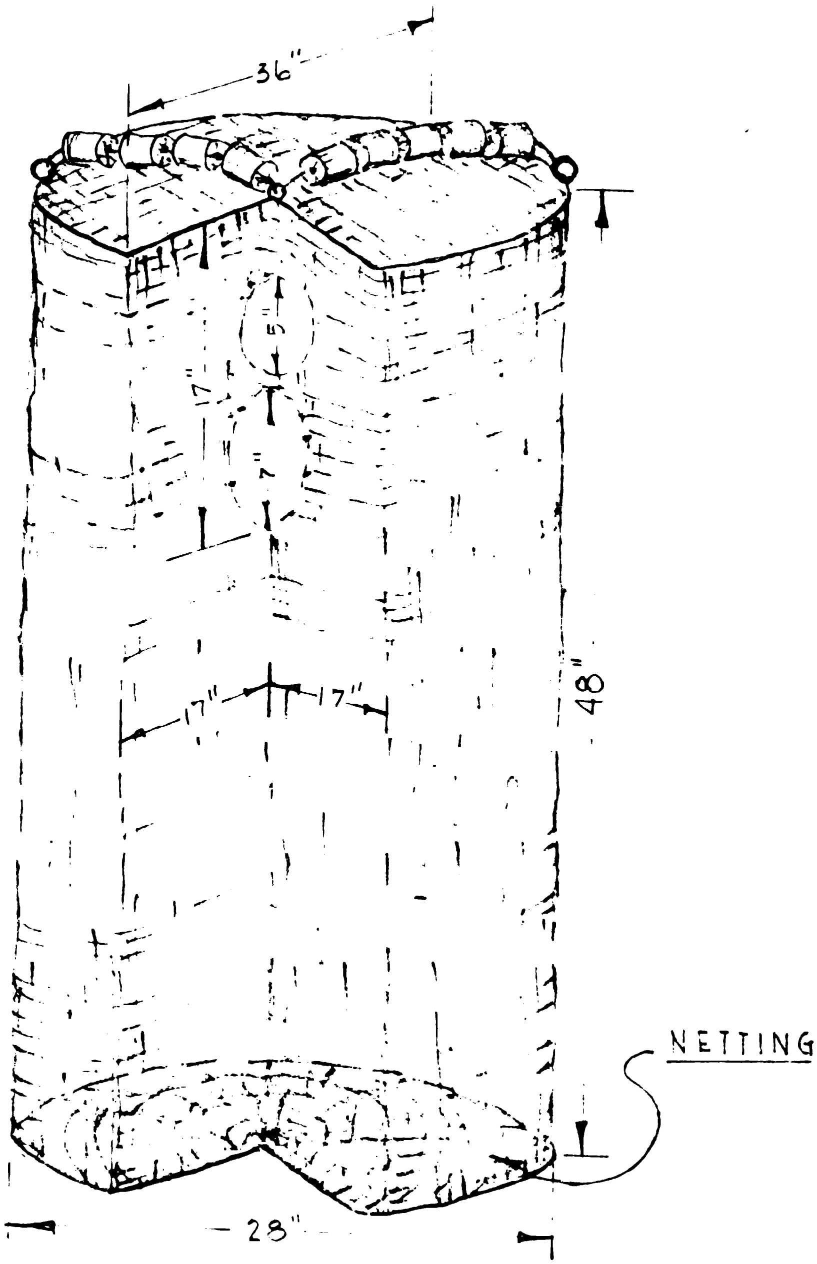
Figures 2, 3, 4 and 5 show the four traps under consideration. The following names; Wedge, Tri-Ro, Bicog, and Drum, were given the traps at the time of construction and are original. The names were derived from the shape of each trap or from the condensation of two words describing parts of a trap. For example: Tri-Ro is a condensation of the words triangle and round which describe the shape given the wire at the two ends of the trap.

The basic material required for construction of wire fish traps consist of 20 gauge one inch hexagon poultry netting four feet high, a roll of stout cord and several square feet of one inch mesh, No. 24 twine fish netting. The poultry netting should be of galvanized wire one inch mesh size to allow escape of nonedible-size fish and retain the edible-size fish. Any less resistant material would deteriorate too rapidly by continual exposure to water. Stainless steel might be just as good or better but the cost may be too high.

Wedge trap. (Figure 2). The trap consists essentially of a cylinder of one inch hexagon poultry netting four feet high and 28 inches in diameter. An indentation 17 inches deep extending the full length of the trap anywhere on the periphery of the cylinder serves as the lead to the entrance. Eight inches from one end and at the base of the indentation an opening 5 inches long and 3 inches wide is cut from the wire and allows entrance to the inside of the trap. In the end opposite the entrance an oval shaped section of wire eight inches by four inches is removed and cotton webbing laced over the opening. The center of the webbing when cut and stitched with stout cord may be opened and closed much as a string purse and is a means for removing the trap contents. A stout line twenty feet long attached to the end nearest the entrance facilitates setting and retrieving from shore without entering the water. A single row of cork buoys laced across the trap top assists in maintaining an upright position when the trap is placed in the water.

Tri-Ro trap. (Figure 3). The trap body may be made in any reasonable size depending on the desires of the pond owner. Basically,

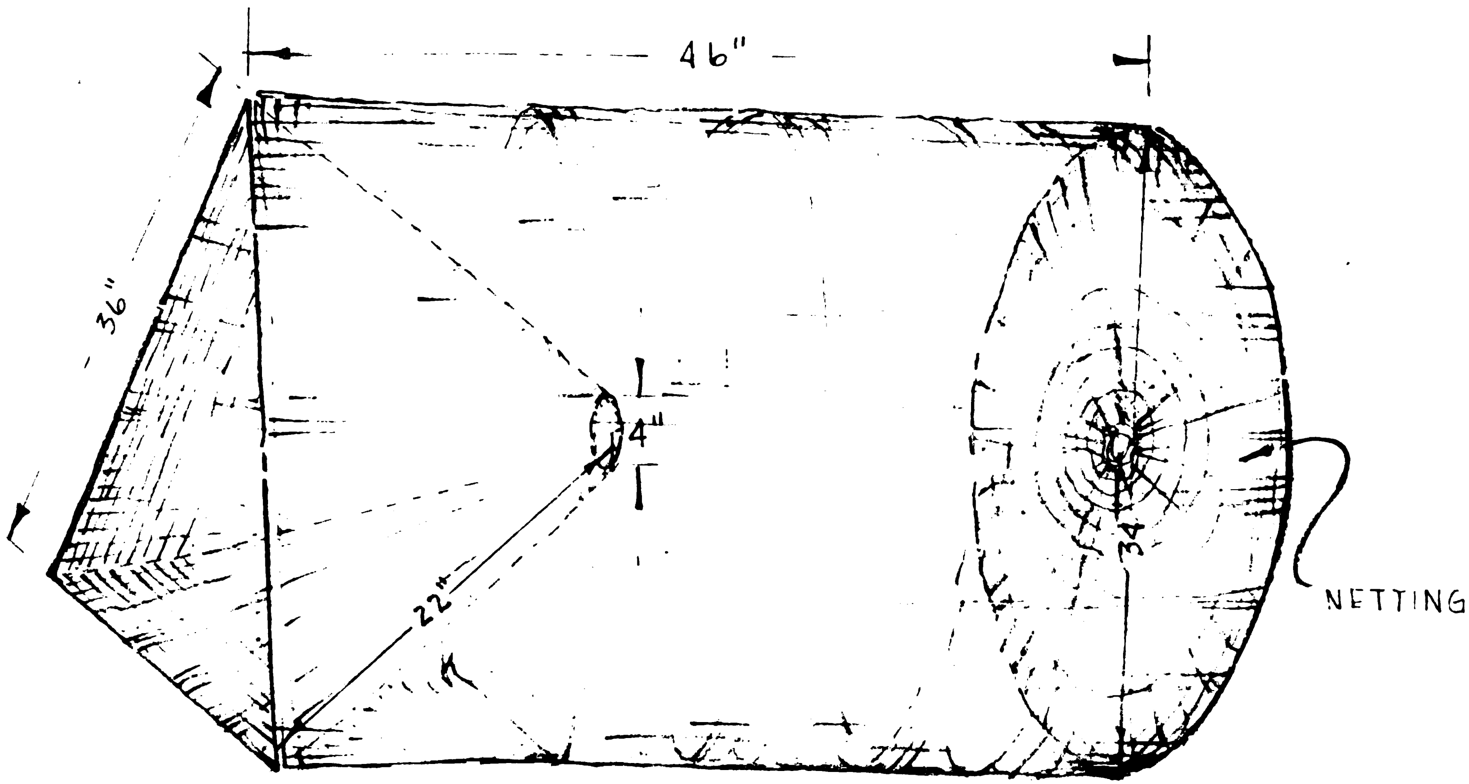
Figure 2. Wedge trap



WEDGE TRAP

the form taken by all the traps in this experiment are cylindrical. The foundation is produced by cutting a length of poultry netting 8 feet long and 4 feet high. The two free ends are brought together and fastened by weaving the individual strands of wire formed by cutting through hexagon shaped mesh. This forms a cylinder 48 inches high and 34 inches in diameter. One end is made into an equalateral triangle by drawing a length of one eighth inch reinforcement wire through the last row of meshes. The fyke or funnel which forms the entrance to the trap is constructed by cutting a length of poultry wire 22 inches long and 8 feet wide. From two corners of a wide side two diagonal cuts are made to the other side so as to produce a section of wire netting 8 feet by 22 inches by 1 foot and six inches. When the two diagonal cuts are brought together a funnel 22 inches long is produced with an inside opening 4 inches in diameter and an outside opening 34 inches in diameter. This funnel, when inserted in the trap, takes on the same shape as the triangular end of the cylinder where reinforcement wire serves as an anchor for attachment of the large end of the funnel. The end opposite the entrance is round and when covered by one inch No. 24 twine fish netting containing a purse string opening allows easy removal of trapped fish. Due to the triangular shape of the trap a set position is almost always taken regardless of the manner by which it is placed in the water and cork buoys are not necessary for maintaining an upright position. A long line attached to the fyke end enables the operator to control the manner in which it falls in the water when thrown from shore and allows retrieving without use of a boat.

Figure 3. Tri-Ro Trap

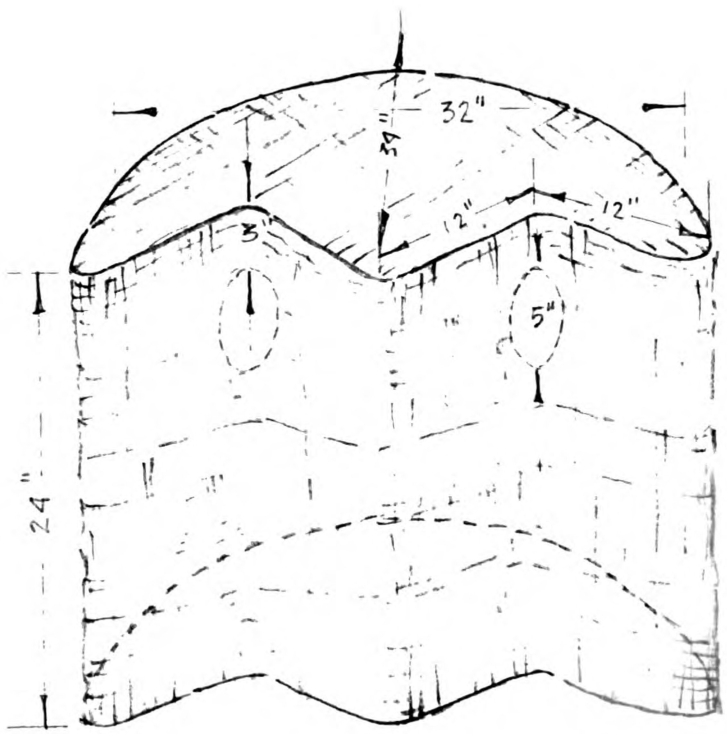


TRI - RO TRAP

Bicog trap. (Figure 4.) The trap may be of any size but for practical purposes should not be less than 24 inches high and 24 inches in diameter. Basically the materials and shape are the same as the wedge trap except that instead of one indentation or throat the bicog has two indentations side by side extending the full length of the trap. The dimensions are such that a wedge trap cut transversely into two equal parts will produce two bicog traps. An opening in each indentation 5 inches long and 3 inches wide, 8 inches from one end allows entrance to the inside. The end opposite the entrance contains a purse string opening of cord webbing for fish removal. Cork buoys are not recommended for this type trap because of its small size which brings the buoys too near the entrance and may stop fish from entering.

Drum trap. (Figure 5). This trap differs from the wedge and bicog traps only in the means by which fish enter the trap. The cylinder and ends may be the same dimensions as the wedge trap. Instead of the indentation, a hole is cut 18 inches long and 9 inches wide and 8 inches from the top of the trap. Through this opening a funnel of poultry netting extends inward and downward with an inner opening $3\frac{1}{2}$ inches in diameter. Opposite this entrance on the periphery of the net, another hole is cut 12 inches long and 8 inches wide 4 inches from the top of the trap through which a funnel extends inward and downward with an inner opening $3\frac{1}{2}$ inches in diameter. As with the other traps a stout cord attached to the top end of the trap facilitates handling when placing the trap in and out of the water. A row of cork buoys may be attached to the top end to help maintain an upright position when set.

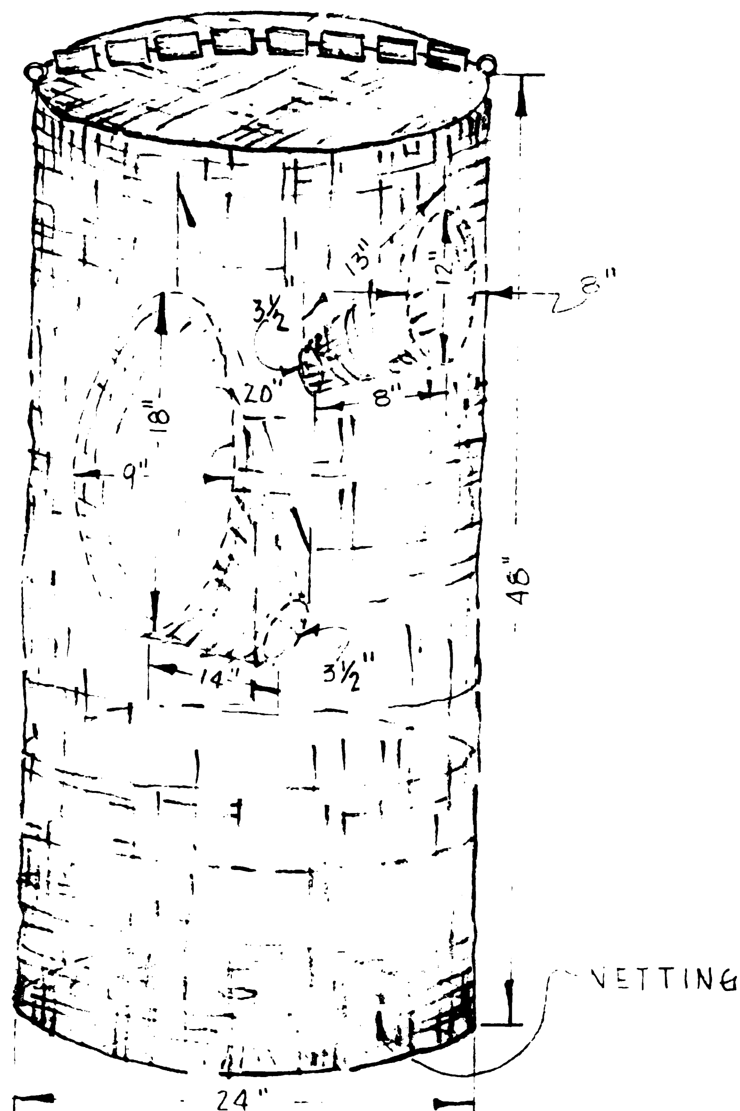
Figure 4. Bicog trap.



BICOG TRAP

The weight, cost of construction and time required to manufacture each trap is shown in Table 8. The Tri-Ro trap is more expensive than the others mainly because more material was used for construction. Cord webbing was used to cover one end of the trap which also added to the expense and increased the time of construction. Assembling any one of the traps requires less than 6 hours of work.

Figure 5. Drum Trap.



DRUM TRAP

Table 8. Weight, Cost and Time Required to

Construct Wire Fish Traps

Trap Name	Materials, cost Dollars	Weight pounds	Construction time. Hours.
Tri-Ro	1.90	10	6
Wedge	1.00	6	4
Bicog	.50	4	2
Drum	1.50	8	6

The weight of each trap is low enough so that one man is able to handle setting and retrieving operations from shore by throwing the trap through the air the desired distance from the bank of a pond and by hauling in a trap to remove the fish by means of a line attached to one end of the trap. The smaller trap, Bicog, may be transported from one pond to another by placing it in the trunk of a car or may be carried easily.

Trap Location in Ponds

In ponds with basin conformation that slope to a depth of 6 feet sets may be made anywhere on the periphery provided that there is sufficient depth of water to completely cover the traps.

Near an inlet to a pond where the depth is less than 4 feet offers a good location for setting the Micog and Tri-Ro traps. The movement of the water entering the pond seems to attract fish and localize them. As a result more fish enter the traps. Drum and Wedge traps should be set from a dock or boat in water more than 4 feet deep. Figure 6 shows relative positions of two traps set in water of varying depths.

Ordinarily during summer months, a pond bottom is covered with dense growths of aquatic vegetation. This obstacle to catching fish is eliminated when setting operations are properly carried out. As the trap is lowered into the water the aquatic plants are either brushed to one side or are pushed beneath the trap leaving the entrance unobstructed and easily found by the fish. Since the entrance is near the top some caution is necessary in setting to avoid tipping the trap into the vegetation and covering the opening to the inside. All but the Tri-Ro may be set directly in dense vegetation. This trap requires an area relatively free of aquatic vegetation for efficient operation.

Sets may be made anywhere in the pond, however, the most convenient sets are made from shore or from a dock without using extra equipment such as a boat.

Maintenance of traps. A small amount of extra attention after use will insure season after season of dependable service. Wire traps should

Figure 6. Diagram of a pond showing traps in a set position.

be thoroughly cleaned with a stiff brush as soon as trapping operations are completed for the year. If a trap is allowed to dry for a length of time before cleaning it must be soaked in water, then scrubbed and rinsed. Certain materials in the water when dried on the meshes are resistant to cleaning and tend to corrode the wire where sharp bends in weaving occur. When corrosion is evident a coat of bright aluminum paint may be applied to restore the original galvanized appearance and prevents further deterioration. Aluminum paint is recommended rather than copper naphthanate or net tar because it is believed that the brightness of the trap attracts fish and produces a larger catch. It was observed that when the brightness of the galvanized paint on each strand of wire was masked by an algal like coating fish tended to avoid the traps but while they were new and clean the fish congregated in the area of the trap.

Experimental Trapping Procedure

The netting period extended from late June to early September, 1952. Trapping was carried out in Ponds 20, 21, 22, and 23, (Figure 1), and was confined to two general areas, one near shore in shallow water and the other near the inlets and outlets (Figure 6).

The trap nets were generally fished in one location for several days though they were always lifted daily. Some were examined as often as 6 times during a 24 hour period to note the differences in the catch at different periods of the day but in these instances data were combined for the several lifts to determine the total daily catch. It was found that most fish were caught from 7 P.M. to 9 P.M. and 3 A.M. to 7 A.M. and that very few fish entered the traps between late morning and early afternoon (11 A.M. to 4 P.M.). All changes of nets to new locations generally took place at this time and differences of a few hours in length of the sets were therefore ignored.

Efficiency of Traps

Since each trap was designed to be operated in a specific area of water a direct comparison of efficiency cannot be made in respect to numbers captured. For example, the Wedge and Dicog traps fished equally well depending on the movement of the fish. The Wedge trap required deep water whereas the Dicog could be set in shallow water and did not operate efficiently unless so set. Also, the fish moved through deeper water only at certain times of the day (late forenoon and early afternoon) and did not trap well whereas the shoal areas seemed to have fish moving continually through them.

Table 9. Average number of fish captured per day by traps and by ponds

Trap	Pond 20			Pond 21			Pond 22			Pond 23		
	Bluegills	Days Fished	Bass	Bluegills	Days Fished	Bass	Bluegills	Days Fished	Bass	Bluegills	Days Fished	Bass
Tri-Ro	0	0	0	7.0	4	6.5	8.4	13	5.9	15.5	2	0.5
Wedge	0	0	0	0	0	0	4.5	4	0	15.0	6	2.9
Total number edible-size fish in ponds	2050		1644	2749		422	2600		551	5045		376
Dicog	0	0	0	0	0	0	0	0	0	21.3	9	2.8
Drum	11.2	0	6.0	6.0	3	0	4.8	14	0.5	1.6	3	0

The catch is indicated in Table 9 showing average number of fish of each species captured in a 24 hour period by traps and by ponds. Table 11 shows the catch per day by traps as compared to the total number of harvestable-size fish present in the ponds at draining. From these tables the Tri-Ro trap appears to be more effective in capturing large numbers of fish during a given time than the other traps, however analysis of variance indicated no significant differences and each trap had an equal chance of catching the same number of fish in the ponds used for this experiment (Table 10). Due to the method in which the experiment was conducted correlation between trap efficiency and number of edible-size fish present in each pond was impossible. However, as indicated in Table 9 and 11 the Tri-Ro and Wedge traps captured the largest number of fish when placed in Pond 23 which contained the largest population of harvestable-size fish.

Smith and Miller (1942) in comparing abundance of fish in Wheeler Reservoir and in the river before impoundment found that the abundance of fish reflected on the number caught per hoop trap. They also found that because of net selectivity, the relative abundance of various species in the population differed from the relative abundance of these species in the catch.

Table 10. Significance of difference in the catch of traps by ponds

Pond number	Trap	Number of days fished	Average catch	Significance of difference	F Values
23	Drum	3	1.6	none	0.72
	Tri-Ro	2	15.5		
	Bicog	9	21.3		
	Wedge	10	15.0		
22	Drum	14	4.8	none	1.76
	Tri-Ro	13	8.4		
21	Drum	3	6.0	none	0.01
	Tri-Ro	4	7.0		

Table 11. Catch per day by traps as compared to total number of harvestable-size fish present in ponds

Pond	Trap	Average per day	Percent of total number	Total number harvestable-size fish in ponds
23	Tri-Ro	15.5	0.29	5421
22	Tri-Ro	8.4	0.27	3151
21	Tri-Ro	7.0	0.22	3171
23	Drum	1.6	0.03	5421
22	Drum	4.8	0.15	3151
21	Drum	6.0	0.19	3171
20	Drum	11.2	0.30	3694
23	Wedge	15.0	0.28	5421
22	Wedge	4.5	0.14	3151
23	Bicog	21.3	0.39	5421

Table 12. Average length and weight of fish captured by traps in four ponds

	Bluegills		Bass	
Trap	Average length (inches)	Average weight (grams)	Average length (inches)	Average weight (grams)
Drum	5.41	49.0	10.67	261.0
Wedge	5.65	60.9	11.30	308.6
Tri-Ro	5.70	72.1	10.60	302.3
Bicog	5.40	46.9	11.10	279.2

From Table 12 it can be seen that the average length of the fish caught by four traps did not vary a great deal. However, the average weight of the fish caught by the Wedge and Tri-Ro was 20 per cent higher than those caught by the other two traps. It might be expected that the size of the trap would influence the average size of the fish caught. The Bicog which is the smallest of the four traps caught fish of the same average length as those caught by the large Tri-Ro and Wedge traps but were not the same average weight.

The Tri-Ro appeared to be a good device for capturing a number of different species. These include bass, bluegills, redears, suckers, and bullheads. Due to the small amount of data available capture of redears, suckers, and bullheads will be discussed only briefly. Redears and suckers readily entered the trap when set in water 5 feet deep or more but did not enter when set in water less than 5 feet deep. The bullheads usually entered only after a bag of raw meat was suspended inside the trap. Bullheads were trapped over a two-day period during the hours of darkness and was carried out merely to determine whether or not bullheads would enter wire trap nets.

Theory of Fish Capture in Trap Nets

Hansen (1944) in his comprehensive report on how fish are caught by hoop nets pointed out that some fish are caught because the entrance funnel happens to stand in the exact path of movement, whereas others are taken when they attempt to get past one of the wings which has interfered with forward movement. There is also the possibility that certain species, for example, members of the catfish family, are actually attracted by the enclosure just as they are attracted by hollow logs and bank holes. For certain other species the net might have the same attraction as brush or submerged tree tops. To a certain extent the fish within the net may decoy others. Also a "sheep reaction", in which one fish entering the net is followed in closely by others, may be important.

Since wire traps used in this experiment were constructed without long wings leading from the entrance, fish must have been induced to enter by other means. From observations of fish activity in and around the traps it was noted that the brightness of the galvanized wire attracted the majority of the fish for when algae or corrosive materials covered the wire very few fish were seen in or around the traps. Several bluegills were noted entering the traps when hard pressed by large bass and may have used the trap as a means for escape much as they might submerged brush or tree tops.

Usually after several small bluegills (4 5 inches) had entered the trap large bass would congregate in the vicinity. These captured bluegills often acted as a decoy for large bass which would then enter the trap to feed on the small bluegills. Stomachs of several large bass examined contained 5 inch bluegills. None of the stomachs from bass taken by hook and line contained bluegills this size and apparently the close confines of the trap enabled the bass to capture this size bluegill which, when free, could evade capture. In open water no bass were observed preying on bluegills over 3-4 inches in length.

The "sheep reaction" mentioned by Hansen was evident at times usually during the period from 7 P.M. to sundown, when large numbers of bluegills were usually seen moving around the shoreline in scattered schools.

The fish showed little indication of excitement inside the traps until a shadow passed over the water or the trap was moved during lifting operations. When quietly observed from shore both species usually were undisturbed by confinement, however, when disturbed the bass created much more commotion than the bluegills. Hansen (1944) observed that fish trapped in hoop nets were usually calm but when disturbed by the presence of large numbers of voracious species of fish or by moving the net preparatory to lifting, considerable activity was aroused. In observing fish in wire trap nets, charging of fish against the sides of the net occurred for a short time immediately following capture and when preparations were made for removing the traps from the water.

Factors Influencing Capture of Fish in Wire Trap Nets

During this experiment the numbers of fish which entered the traps varied with the time of day. During the period between 11 A.M. and 4 P.M. very few fish were captured. The majority of fish were trapped late in the afternoon and early in the morning usually between the hours of 6 and 10 P.M. and between the hours of 4 and 7 A.M. More bass were captured during the evening period than during the morning period. Bluegills usually entered the trap at approximately the same rate during either period.

Larger numbers of bluegills could be taken from a population during a 24 hour period by removing the fish from a trap at short intervals than when left undisturbed for the same period. It was found that when traps were emptied at 3 hour intervals more fish could be taken than when emptied at 8 hour intervals. Also larger numbers of fish were taken during a 24 hour period when traps were emptied at 8 hour intervals than when emptied once during a 24 hour period. In one instance a trap was allowed to fish undisturbed for 24 hours and captured 28 fish. During another period of the same length the trap was emptied at 3 hour intervals and captured an average of 6 fish per lift or 48 fish during a 24 hour period. More bass were taken when traps were allowed to fish 24 hours undisturbed.

Smith and Miller (1942) when using hoop nets for capturing fish noted that more fish were taken when water was muddy or above normal level. Turbidity had the opposite influence on the catch in wire fish traps. During the summer of 1952 Pond 21 produced a very heavy algal bloom.

Traps placed in this pond did not capture fish during the period of bloom but when these traps were placed in an adjacent pond which contained no bloom fish readily entered the traps. Also, after the bloom had dissipated in Pond 21, fish again entered the traps.

TAKING OF FISH FROM PRIVATE WATERS

The following is an account published by the Attorney General's Department on an opinion as to what constitutes a private lake, when a lake may be so classified, and several questions pertaining to taking and possessing of fish from private waters.

"Classified for the purpose of regulation, a private lake of less than 250 acres with no inlet or outlet and not planted with public fish, the riparian owners may, by reason of constitutional rights, take fish therefrom without restraint from legislative enactment. They may keep the public from fishing in said lake. Their lessees and licensees have equal rights."

"The taking of fish by the riparian owners is lawful in a private lake but that the possession is unlawful. However, the situation that results is somewhat similar to a person possessing intoxicating liquors in his home. Under his constitutional rights, unless he made a sale of same or manufactured same, it would be impossible to get a search warrant and convict the person of illegal possession. In the case of his taking fish from his own property, the situation would be similar. The conservation officers would have no right to search his premises for the fish without a proper search warrant."

The only privilege the owners of private waters have is that of taking the fish out of season. The same reasoning that makes the possession unlawful would make the prohibited sale unlawful.

The sentiments expressed by the Attorney General's Department is such that the Legislature, at some future date, should enact that the possession of fish out of season when legally taken from a private lake is an exception to the general law.

The foregoing information is not to be construed as authoritative on legal rights. An attorney should be consulted for legal advice and assistance in all matters which may require court determination.

From the opinions published by the Attorney General's Department, farm ponds appear to come under the same regulations as private lakes less than 250 acres with no inlet or outlet and not planted with public fish. Under these circumstances a pond owner would have legal right to take fish at any time but would not be legally right in possessing these fish at all times. However, this is similar to the possession of intoxicating liquor, therefore, even though the possession of fish is illegal by general law, a search warrant would be required to convict a pond owner and search warrants are usually not issued for this specific purpose.

A pond owner propagating fish solely for personal use could at any time remove as many fish as desired and process them for storage by freezing, smoking or canning without fear of prosecution so long as there was proof that all processed fish were removed from a pond on the owners property.

Before using any fish traps in a private lake, a riparian owner must be certain to (1) obtain Michigan fishing license, (2) notify the conservation officer of the county in which traps are to be used, (3) mark or identify the traps with owner's name and address. Because of possible objections, permission should first be obtained from frontage owners for setting traps in front of shore property.

DISCUSSION

Experiments at Wolf Lake State Fish Hatchery were concerned with management practices for farm ponds and were conducted in order to determine fish mortality during draining operations, proper ratios of species for stocking ponds, carrying capacity of farm type ponds, and to determine a method for harvesting edible-size fish.

Observations made during the summer of 1952 indicated that draining a pond quickly tends to separate the large from the small fish and that a high loss of small fish occurs after fish have been returned to ponds. This information is important to the pond owner who considers pond draining as a method for harvesting the desired portion of a fish crop. Since the mortality ranged from 52 to 79 percent of the total weight with the greatest losses in the small bluegill size group a pond owner would not be justified in using this method unless reconstitution of the existing population were necessary. However, because of the losses in the small size-group this method may be a means for delaying an overpopulation of bluegills which usually occurs in farm ponds in this latitude. This in some cases may mean sacrificing the crop of edible-size fish for the year following draining but the crop after this first year may be large enough to more than compensate for the initial loss.

Ponds containing bluegills and bass were drained three years after stocking to compare the population at draining with the ratio of parent stock used. It was found that the two ponds stocked with 10 adult bluegills and 83 fingerling bass produced a population somewhat more favorable than the two ponds stocked with 100 fingerling bass and 100 adult bluegills. The former stocking ratio produced a higher standing crop of edible-size bluegills and a lower standing crop of young-of-the-year at draining than the latter stocking ratio.

It is assumed that the presence of large suckers and the removal of many large bluegills early in the experiment for food studies may have altered the usual trend toward overpopulation of this species in the pond stocked with 10 adult bluegills and 83 fingerling bass. More experimentation might prove that removing as many as possible of adult bluegills by hook and line fishing immediately after one successful spawning season is a sound practice in farm pond management.

It may be worthy of mention here that regardless of the numbers stocked, when the weight of large bluegills per acre was high the weight of large bass per acre was low and vice versa.

When ponds are expected to yield favorable hook and line fishing or a crop of food fish for at least a three year period without draining and all other conditions are favorable for growth, stocking more than 10 adult bluegills and 83 fingerling bass is not necessary.

A practical method for harvesting edible-size fish from a population was found in the use of wire fish traps. Constructing and testing these traps over a three month period showed that they could be constructed of inexpensive materials, they were light in weight, and when operated properly caught sufficiently large numbers of fish to warrant placing them with other essential practices for farm pond management.

Even though only galvanized wire poultry netting was used for this experiment other webbing materials such as cotton fish netting or stainless steel netting may be considered. The cotton webbing requires a foundation frame for reinforcement which would increase the cost by increasing the time required for construction. The main objection to stainless steel netting is the relatively high cost.

Analysis of variance showed no significant difference among the traps and each trap had an equal chance of catching the same number of fish in ponds. However, from the tables (9 and 11) the Tri-Ro appears to be more effective in capturing large numbers of fish during a given time than the other traps.

Smith and Miller (1942) in comparing the abundance of fish in Wheeler Reservoir and in the river before impoundment found that the abundance of fish reflected on the number caught per hoop trap. Due to the nature of this experiment correlation between trap efficiency and numbers of edible-size fish present in each pond was impossible. However, the Tri-Ro and Wedge traps captured the largest number of fish when placed in Pond 23 which contained the largest population of harvestable-size fish.

A pond owner propagating fish solely for personal use could at any time remove as many fish as desired and process them for storage by freezing, smoking, and canning without fear of prosecution so long as there was proof that all processed fish were removed from a pond on the owner's property.

Besides functioning as a means for removing a desired number of fish from a pond for human consumption several other benefits may be derived from the proper use of these traps. Periodic removal of large fish from a population, especially bluegills, would have a tendency to delay overpopulation by removing the fish which produce the most young. Also, their removal would reduce competition for available food for those fish nearing edible-size and so give some assurance of a steady supply of this size fish. It is doubtful whether the other extreme would be reached. Since Smith and Miller (1942) found that the abundance of fish reflected on the number caught per trap, it might be expected that a balance between number caught and number present in the population would be reached and maintained by the number of fish entering the edible-size group from the smaller group.

SUMMARY

1. Experiments were conducted at the Wolf Lake Fish Hatchery to determine the total fish mortality during draining operations, the ratios of fish species for stocking farm ponds, and a harvesting method for removing edible-size fish from a fish crop.
2. Ponds containing bluegills and bass were drained three years after stocking to compare the population at draining with the ratio of parent stock used and to determine mortality during draining operations and after return to the ponds.
3. Draining a pond quickly tends to separate the large from the small fish whereby large fish usually precede the small fish into the seining box.
4. Losses as high as 79 percent of the total weight may be expected during draining operations with the highest losses in the small size groups. Larger losses occur after return to the ponds than during actual draining operations.
5. Ponds stocked with 10 adult bluegills and 83 fingerling bass produced a population somewhat more favorable than the two ponds stocked with 100 fingerling bass and 100 adult bluegills. The lower ratio produced a higher standing crop of edible-size bluegills and a lower standing crop of young-of-the-year at draining than the higher stocking ratio.
6. The presence of large suckers and the removal of many large bluegills stocked early in the experiment for food studies may have altered the usual trend towards overpopulation of this species in the pond stocked with 10 adult bluegills and 83 fingerling bass.

7. When ponds are expected to yield favorable hook and line fishing or a crop of food fish for a period of at least three years without draining and all other conditions are favorable, stocking more than 10 adult bluegills and 83 fingerling bass is not necessary.

8. Wire fish traps were found to be a practical means for harvesting edible-size fish from a farm pond. They may be constructed of poultry wire netting for a cost of materials less than 2.00 dollars. The time required for construction was less than 6 hours.

9. Analysis of variance showed no significant difference between the traps and each trap tested had an equal ability to catch the same number of fish during a given time.

10. A pond owner propagating fish solely for personal use could at any time remove as many fish as desired and process them for storage by freezing, smoking, and canning without fear of prosecution so long as there was proof that all processed fish had been removed from a pond on the owner's property.

11. Several other advantages might be recognized in the use of wire fish traps for farm pond management. Periodic removal of large fish from the population, especially bluegills, would have a tendency to delay overpopulation by removing the fish which produce the most young. Also, their removal would reduce competition for available food for those fish nearing edible-size and so give some assurance of a steady supply of this size fish. It might be expected that a balance between numbers caught and numbers present in the population would be reached and maintained by the number of fish entering the edible-size group from the smaller size group.

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