

1301.

14.0
44.0
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FINAL REPORT

As required by

FEDERAL AID IN FISHERIES RESTORATION ACT

TEXAS

Federal Aid Project No. F-3-R-15

Region 3-B Fisheries Studies

Job No. 13 Experimental Use of Copper Sulphate as a Fish Toxicant

Project Leader: Joe E. Toole

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April 18, 1968

ABSTRACT

Preliminary work on the experimental use of copper sulphate as a selective fish toxicant consisted of several series of bioassays in the laboratory to determine lethal thresholds for various rough and game fish species.

These early tests failed to provide exact toxicity criteria for given water quality. To provide more accurate optimum dosages for actual field experiments on area lakes, bioassays were conducted in the laboratory prior to each chemical application.

Extensive evaluation of alkalinity, pH and other unknown factors influencing the toxicity of copper sulphate chemically was not achieved in this study. It was concluded that in waters of lower alkalinity copper sulphate could be an effective management tool in controlling bullhead catfish, suckers and shad with minimal damage to game fish populations.

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FINAL REPORT

State of Texas

Project No. F-3-R-15

Name: Region 3-B Fisheries Studies

Job No. 13

Title: Experimental Use of Copper Sulphate
in Killing Undesirable Fish Species

Period Covered: February 1, 1967 - January 31, 1968

OBJECTIVES:

To analyze data from all segments and prepare a final report on the evaluation of copper sulphate as a fish toxicant in the waters of eastern Texas.

INTRODUCTION:

Preliminary work was begun on this study in 1956 to determine toxicity levels of copper sulphate on fish in the waters of East Texas. During the initial phases of this work, laboratory techniques were planned to evaluate temperature, total alkalinity and pH as factors influencing the toxicity of copper sulphate on various fish species.

These evaluations were attempted through bioassays on ten species of fish: white crappie (Pomoxis annularis), golden shiner (Notemigonus chrysoleucas), bluegill sunfish (Lepomis macrochirus), warmouth (Chaenobryttus gulosus), largemouth bass (Micropterus salmoides), black bullhead catfish (Ictalurus melas), yellow bullhead catfish (Ictalurus natalis), chubsuckers (Erimyzon sucetta), spotted suckers (Minytrema melanops), spotted bass (Micropterus punctatus) and redear sunfish (Lepomis microlophus).

Early experiments were conducted with four 40 gallon capacity aquaria filled to 25 gallon level. In order to more nearly simulate field conditions, the water was taken from area lakes. Methyl orange alkalinity and pH were taken at the time the copper sulphate was added. One tank was used as a control for each series of tests. These tests were run for a period of 72 hours.

During the 1956-57 segment, twenty-five separate tests were conducted. The concentration of $CuSO_4$ ranged from 0.1 p.p.m. to 1.5 p.p.m. with the majority of the tests made at the 1.0 p.p.m. concentration. pH values for this group of tests ranged from 6.0 to 7.0. Methyl orange alkalinity ranged from 8 p.p.m. to 46 p.p.m. The temperature ranged from 58°F to 73°F with the temperature for a unit test not varying over 6° during the 72 hour test period.

Bullhead catfish and various centrarchids were placed in each aquaria in an effort to determine toxic concentrations for each species. Table 1 contains specific data for this group of tests. All test specimens survived the 0.1 p.p.m. concentration of $CuSO_4$. Bullhead catfish were killed at 0.3 and 0.5 p.p.m. concentrations with no harm to the sunfish. As contained in Table 1, 13 tests were made at a 1.0 p.p.m. concentration and with few exceptions proved lethal to bullheads without harming the centrarchids.

Five tests from this group were run at 1.5 p.p.m. copper sulphate. All of the bullhead catfish were killed within 36 - 48 hours but only a few sunfish were killed.

Table 1

Notes on Toxicity of Copper Sulphate to Bullhead Catfish at Various pH and Temperatures

EXPERIMENT NO. 1 Feb. 6 through 9, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
65 to 67	6.0	46 p.p.m.	1.0 p.p.m.

SPECIES

Largemouth bass	1
Bullhead catfish	2
Bluegill sunfish	2
Redear sunfish	1

REMARKS:

Both bullhead catfish dead after 43 hours. All other fish appeared normal.

EXPERIMENT NO. 2 Feb. 6 through 9, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
65 to 67	6.0	46 p.p.m.	1.0 p.p.m.

SPECIES

Largemouth bass	1	Bluegill sunfish	1
Bullhead catfish	2	White crappie	1
Redear sunfish	1	Warmouth	1

REMARKS:

Both bullhead catfish in distress after 3 hours. Both bullheads dead after 43 hours. All other fish appeared normal.

EXPERIMENT NO. 3 Feb. 28 through March 2, 1957 (72 hrs.)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
59 to 63	6.2	18 p.p.m.	0.1 p.p.m.

SPECIES

Largemouth bass	2	Bluegill sunfish	2
Bullhead catfish	2	Redear sunfish	2

REMARKS:

All fish including bullheads, alive and normal after 72 hours.

Table 1 (Continued)

EXPERIMENT NO. 4 Feb. 28 through March 2, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
59 to 63	6.2	18 p.p.m.	0.1 p.p.m.

SPECIES

Largemouth bass	1	Black crappie	2
Bullhead catfish	2	Warmouth	1

REMARKS:

All fish including bullheads, alive and normal after 72 hours.

EXPERIMENT NO. 5 March 5 through March 7, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
58 to 61	6.0	10 p.p.m.	1.0 p.p.m.

SPECIES

Bullhead catfish	2	Bluegill sunfish	3
Redear sunfish	3	Warmouth	1

REMARKS:

The two bullheads were dead after 24 hours. All remaining fish alive after 72 hours.

EXPERIMENT NO. 6 March 5 through March 7, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
57 to 61	6.2	10 p.p.m.	1.0 p.p.m.

SPECIES

Bullhead catfish	2	Warmouth	1
Redear sunfish	3	Black crappie	1
Bluegill sunfish	4	Largemouth bass	1

REMARKS

1 bullhead dead after 30 hours. 1 bullhead remained alive through the 72 hour period.
 3 bluegill sunfish died within 24 hours, probably due to injury in catching and handling.

EXPERIMENT NO. 7 March 5 through March 7, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
57 to 62	6.4	10 p.p.m.	1.0 p.p.m.

SPECIES

Bullhead catfish	2	Bluegill sunfish	4	Largemouth bass	1
Redear sunfish	3	Black crappie	1		

REMARKS

2 bullhead died after 24 hours. All other fish alive and normal after 72 hours.

Table 1 (Continued)

EXPERIMENT NO. 8 March 18 through March 20, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
62 to 65	6.0	8 p.p.m.	1.0 p.p.m.

SPECIES

Bullhead catfish	2	Redear sunfish	3
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REMARKS:

First bullhead died within 24 hours. Second bullhead died within 48 hours. 1 redear sunfish died from unknown causes.

EXPERIMENT NO. 9 March 18 through March 20, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
62 to 65	6.9	40 p.p.m.	1.0 p.p.m.

SPECIES

Bullhead catfish	2	Redear sunfish	3
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REMARKS:

2 bullheads died within 72 hours. All other fish remained alive and normal.

EXPERIMENT NO. 10 March 18 through 20, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
62 to 65	7.0	37 p.p.m.	1.0 p.p.m.

SPECIES

Bullhead catfish	2	Redear sunfish	2	Bluegill sunfish	1
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REMARKS:

1 bullhead catfish appeared to be in distress after 72 hours. All other fish alive and normal.

EXPERIMENT NO. 11 March 25 through 27, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
58 to 64	6.2	9 p.p.m.	1.5 p.p.m.

SPECIES

Bullhead catfish	2	Bluegill sunfish	1
Redear sunfish	1	Black crappie	1

REMARKS:

Crappie died after 24 hours. Bluegill died after 30 hours. Both bullheads died after 36 hours. Redear sunfish remained alive through the 72 hour period.

Table 1 (Continued)

EXPERIMENT NO. 12 March 25 through 27, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
57 to 62	6.2	9 p.p.m.	1.0 p.p.m.

SPECIES			
Bullhead catfish	2	Redear sunfish	2
		Black crappie	1

REMARKS:
1 crappie died within 24 hours. Both bullheads and 1 redear sunfish died within 72 hours.

EXPERIMENT NO. 13 March 25 through 27, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
57 to 64	6.2	9 p.p.m.	0.5 p.p.m.

SPECIES			
Bullhead catfish	2	Redear sunfish	2
		Black crappie	1

REMARKS:
1 redear died within 24 hours. Both bullheads died within the 72 hour period.

EXPERIMENT NO. 14 March 28 through April 1, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
61 to 64	6.2	12 p.p.m.	1.5 p.p.m.

SPECIES			
Bullhead catfish	2	Redear sunfish	3

REMARKS:
Both bullheads died after 24 hours. 2 redear died after the 72 hour period.

EXPERIMENT NO. 15 March 28 through April 1, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
60 to 64	6.2	12 p.p.m.	1.0 p.p.m.

SPECIES			
Bullhead catfish	2	Redear sunfish	2
		Warmouth	1

REMARKS:
Both bullheads died after 24 hours. 1 redear died after the 72 hour period.

Table 1 (Continued)

EXPERIMENT NO. 16 March 28 through April 1, 1957 (72 hours)			
TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
61 to 64	6.2	12 p.p.m.	0.3 p.p.m.
SPECIES			
Bullhead catfish	2	Warmouth	1
Redear sunfish	2	Black crappie	1
REMARKS:			
Both bullhead catfish and one crappie died after 72 hours. All other fish remained alive and normal.			

EXPERIMENT NO. 17 April 2 through April 4, 1957 (72 hours)			
TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
67 to 72	6.4	12 p.p.m.	0.3 p.p.m.
SPECIES			
Bullhead catfish	2	Redear sunfish	3
REMARKS:			
1 bullhead died within 24 hours. Second bullhead died after 72 hours. 1 redear died after 72 hours. (injured) Other fish remained alive and normal.			

EXPERIMENT NO. 18 April 2 through April 4, 1957 (72 hours)			
TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
67 to 72	6.4	12 p.p.m.	1.0 p.p.m.
SPECIES			
Bullhead catfish	2	Redear sunfish	3
REMARKS:			
Both bullheads died after 24 hours. All remaining fish alive and normal after the 72 hour period.			

EXPERIMENT NO. 19 April 2 through April 4, 1957 (72 hours)			
TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
66 to 73	6.4	12 p.p.m.	1.5 p.p.m.
SPECIES			
Bullhead catfish	2	Redear sunfish	2
		Warmouth	1
REMARKS:			
1 bullhead died within 9 hours. Second bullhead died within 24 hours. 1 redear died after 24 hours. (injured) All other fish alive and normal after the 72 hour period.			

Table 1 (Continued)

EXPERIMENT NO. 20 April 8 through 10, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
64 to 66	7.0	22 p.p.m.	0.3 p.p.m.

SPECIES

Bullhead catfish 2	Redear sunfish 2	Warmouth 1
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REMARKS:

Both bullheads died after 24 hours. All other fish remained alive and normal.

EXPERIMENT NO. 21 April 8 through 10, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
64 to 66	6.6	19 p.p.m.	1.0 p.p.m.

SPECIES

Bullhead catfish 2	Redear sunfish 3	
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REMARKS:

1 bullhead died after 30 hours. Second bullhead died within 48 hours. All other fish remained alive and normal.

EXPERIMENT NO. 22 April 8 through 10, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
64 to 67	7.0	22 p.p.m.	1.5 p.p.m.

SPECIES

Bullhead catfish 2	Bluegill sunfish 2	Redear sunfish 1
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REMARKS:

Both bullheads died within 24 hours. All other fish remained alive and normal.

EXPERIMENT NO. 23 April 15 through 17, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
60 to 65	6.2	22 p.p.m.	0.3 p.p.m.

SPECIES

Bullhead catfish 2	Redear sunfish 3	
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REMARKS:

1 bullhead died within 72 hours. Second bullhead and three redear remained alive and normal.

Table 1 (Continued)

EXPERIMENT NO. 24 April 15 through 17, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
58 to 65	6.4	18 p.p.m.	1.0 p.p.m.

SPECIES

Bullhead catfish 2	Bluegill sunfish 2	Redear sunfish 1
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REMARKS:
 1 bluegill sunfish died within 4 hours. (injured) Both bullheads died within 48 hours. All other fish remained alive and normal.

EXPERIMENT NO. 25 April 15 through 17, 1957 (72 hours)

TEMPERATURE RANGE °F.	pH	M. O. Alkalinity	CuSO ₄
58 to 65	6.4	18 p.p.m.	1.5 p.p.m.

SPECIES

Bullhead catfish 2	Redear sunfish 3	
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REMARKS:
 1 bullhead died within 24 hours. Second bullhead and 1 redear died within 48 hours. Second redear died before end of period. One redear remained alive and normal.

The need for determining more precise toxicity levels and the correlation of alkalinity influence warranted further experimentation in the laboratory before actual field testing would be feasible. Tests ranging from 0.1 p.p.m. to 4.0 p.p.m. at .1 p.p.m. increments were planned.

Wide mouthed jars were utilized in place of the large aquaria to facilitate a larger number of tests in each series. Nineteen of these large jars holding 16 liters of water each were used. Seven series of bioassays were made, consisting of 108 separate tests. A standard solution of copper sulphate was prepared by dissolving 10 grains of CuSO₄ in one liter of distilled water. This solution was used to bring each test jar to the desired concentration. The test period was extended from 72 to 96 hours. Test species were limited to bullhead catfish and bluegill sunfish.

Methyl orange alkalinity for this group of tests ranged from 73 p.p.m. to 104 p.p.m., considerably higher than that of previous experiments. Temperature range was 59°F. to 78°F. Specific data for these experiments are contained in Table 2. The fact that calcium carbonate and bicarbonate react with the copper sulphate to precipitate insoluble basic copper carbonate is substantiated by these tests. Versene, (tetrasodium salt of ethylenediaminetetraacetic acid) is a chelating agent manufactured by Dow Chemical Company. It was hoped that the copper ions could be held in solution by making them a part of chelate ring compounds. While the Versene did hold the copper in solution in waters of higher alkalinity, it greatly reduced the toxicity of copper sulphate to fish so this test was abandoned in the laboratory and was not field tested.

Table 2

Results of Laboratory Experiments Using CuSO_4 as a Possible Selective Control for Bullhead Catfish

Series No.	Jar No.	Temp. Range °F	Total Alk. ppm	pH	CuSO ₄ ppm	Condition of bluegills after 96 hours		Condition of bullheads after 96 hours	
						Dead	Alive	Dead	Alive
1	1	54 - 54	12	6.3	0.1		X		X
	2				0.2		X		X
	3				0.3		X		X
	4				0.4		X		X
	5				0.5		X		X
	6				0.6		X		X
	7				0.7		X		X
	8				0.8	X			X
	9				0.9	X			X
	10				1.0	X			X
	Cont.							none	
2	1	65 - 70	12	6.2	0.6		X		X
	2				1.0		X		X
	3				1.6	X			X
	4				1.8		X		X
	Cont.							none	
3	1	58 - 65	13	6.6	0.1		X		X
	2				0.2		X		X
	3				0.6		X		X
	4				1.2	X			X
	5				1.4		X		X
	6				1.6	X			X
	7				2.0	X			X
	8				2.5	X			X
	9				3.0	X			X
	10				4.0	X			X
	Cont.							none	
4	1	58 - 58	15	6.8	0.1		X		X
	2				0.3		X		X
	3				0.4		X		X
	4				0.5		X		X
	5				0.6		X		X
	6				0.8		X		X
	7				0.9	X			X
	8				1.0	X			X
	9				1.1	X			X
	10				1.2	X			X
	Cont.							none	

Table 2 (Continued)

Series No.	Jar No.	Temp. Range °F	Total Alk. ppm	pH	CuSO ₄ ppm	Condition of bluegills after 96 hours		Condition of bull-heads after 96 hours	
						Dead	Alive	Dead	Alive
5	1	49 - 49	21	7.0	0.1		X		X
	2				0.4		X		X
	3				0.5		X	X	
	4				0.6		X	X	
	5				0.7		X	X	
	6				0.8		X	X	
	7				0.9		X	X	
	8				1.0		X	X	
	9				1.1		X	X	
	10				1.2		X	X	
	Cont.				none		X		
6	1	65 - 70	36	7.0	0.4		X		X
	2				0.6		X	X	
	3				1.0		X	X	
	4				1.4		X	X	
	5				1.8		X	X	
	Cont.				none		X		
7	Fish used in this series were infected with fungus and all died before 96 hours.								
8	1	58 - 58	55	7.5	0.3		X		X
	2				0.4		X		X
	3				0.5		X		X
	4				0.6		X		X
	5				0.7		X		X
	6				0.8		X		X
	7				0.9		X		X
	8				1.0		X		X
	9				1.1		X		X
	10				1.2		X		X
	Cont.				none		X		
9**	1	57 - 57	60	7.5	1.0		X	X	
	2				1.1		X	X	
	3				1.2		X		X
	4				1.4		X	X	
	5				1.6	X		X	
	6				1.8		X	X	
	7				2.0		X	X	
	8				2.2	X		X	
	9				2.5	X		X	
	10				2.8		X	X	
	Cont.				none	X	X		

Cont. - Control Jar

9** - The results of this series are very erratic and could be due to the fact that the water was very turbid. The death of the control animals indicates that some other factor was involved.

From these laboratory experiments it was concluded that the minimum lethal dose for bullhead catfish ranged from 0.4 p.p.m. in waters of lower alkalinity to 2.3 p.p.m. in waters of higher alkalinity. The minimum lethal dose for bluegill sunfish varied from 0.8 p.p.m. to no deaths at 4.0 p.p.m., the maximum concentration tested.

In analysis of these data, it was concluded that copper sulphate could successfully be used in certain waters to selectively control bullhead catfish and possibly other undesirable fish species. However, the bioassay results failed to produce an accurate correlation for a given combination of temperature, pH, and alkalinity. Within the ranges tested, temperature did not appear to be an important factor, but pH and alkalinity were indicated to be influencing factors although no definite correlation between pH and alkalinity and toxicity at a definite concentration of treatment was established.

The simple test used in this study for the determination of alkalinity expressed only equivalent amounts of bicarbonate, carbonate or hydroxide ions. Other ions that could influence alkalinity such as silicate, phosphate, borate and fluoride could not be evaluated.

At this point in the study, it appeared that field trials in area lakes with suitable fish populations were needed. During project segment F-3-R-7 five small lakes were selected for treatment with copper sulphate as a selective toxicant. Bioassays were conducted in the laboratory prior to each field experiment to determine proper dosage for given water quality. Water samples were hauled to the laboratory from each lake for these tests. Bluegill sunfish and bullhead catfish were used as test animals.

Nineteen five-gallon, wide-mouth jars equipped with one airstone each were used as test vessels. The volume of water used in each jar was sixteen liters. Nine of the test solutions were prepared over a wider range of concentrations (e.g. 1.0, 1.5, 2.0, 2.5 and 3.0 p.p.m.). If bullhead catfish were killed at 2.5 p.p.m. and not at 1.0 p.p.m. intermediates were set up within that range (e.g. 1.0, 1.2, 1.4, 1.6, 1.8, 2.0, 2.2, and 2.4 p.p.m.). Then from the intermediate tests a dosage was selected for field testing. The dosage selected was that which killed the maximum number of bullhead catfish and the minimum number of bluegill sunfish while leaving a broad enough margin in both directions to allow for reasonable error in field application. This margin or tolerance spread between the two species was found to be wide enough so that the dosage selected usually approached LD 100 for the bullheads and LD 00 for the bluegills.

Bluegill sunfish were selected as test animals because previous work proved them to have the lowest tolerance to copper sulphate of the centrarchids. Bullhead catfish were selected because they are one of the more problematic noxious species. Also, it has been determined by exploratory work that concentrations of copper sulphate that are lethal for bullhead catfish are also lethal for threadfin shad (Dorosoma petenense), gizzard shad (Dorosoma cepedianum), lake chubsuckers and possibly other rough fish species.

Each series of bioassays were terminated after 96 hours. Two bluegill sunfish and two bullhead catfish were placed in each jar. One jar was used as a control. Water analyses included phenolphthalein and methyl-orange alkalinity, dissolved chlorides, dissolved carbon dioxide, and dissolved oxygen determinations. An attempt was made to keep the temperatures near the outside air temperatures. No attempt was made to control daily temperature fluctuations since it would be impossible to control them in the field.

Field Procedure

Each lake selected for a field test site was mapped and sounded to determine the water volume. Some of the lakes were sounded by means of a recording fathometer while others were sounded with a pole marked at one foot and one-fourth foot intervals. Lakes having large variations in depth were marked off in sections and volumes calculated for each section. After the proper dosage had been determined in the laboratory, concentrations were calculated for each section of the lake or in some instances for the entire lake. The copper sulphate was applied to the lakes in solution. The crystals were dissolved by pumping lake water through a hopper mounted inside a 55 gallon drum (Figure 1). The centrifugal pump delivered 50 gallons per minute into the hopper dissolving the crystals at the rate of approximately 1,600 pounds per hour. The hopper was built of expanded metal with a 14 by 18 mesh plastic screen liner and held 150 pounds of copper sulphate crystals. The solution left the drum by gravity flow through a 2 3/4 inch rubber hose connected to a pipe fitting which passed through the transom of the boat. The intake foot valve on the pump was streamlined and equipped with two horizontal fins that held it under water while the boat was in motion. The two feet of intake line immediately above the foot valve was made of heavy duty rubber hose to allow the foot to deflect when struck by an underwater object. Thus, the distribution of copper sulphate was an uninterrupted operation. The only stops required were to pick up additional copper sulphate.

Field Results

Lindale Club Lake

Lindale Club Lake is located three miles northeast of Lindale, Smith County, Texas. It is a man made lake, impounded by an earthen dam, and was built primarily for fishing. The lake covers 50 acres and contains 388 acre-feet of water. It was built in 1914 and rebuilt in 1946, after the spillway broke in 1944. A fishery survey conducted in 1958 revealed that the lake contained large numbers of yellow bullhead catfish (Ictalurus natalis), lake chubsuckers (Erimyzon sucetta) and large golden shiners (Notemigonus crysoleucas). These three species made up 71.26 per cent of the total number and 61.2 per cent of the total weight of the fish taken in 1,000 feet of gill net.

On August 12, 1959, the lake was treated with 1,677 pounds of copper sulphate crystals which brought the concentration to 1.61 p.p.m. The only fish noted in distress on August 12th were a few madtoms (Schilbeodes gyrimus). Water temperatures reached 90°F. during the day.

On August 13, dead and distressed golden shiners, yellow bullhead catfish, madtoms and a few small bluegill sunfish began to appear. On August 18, a good kill of golden shiners, bullheads, madtoms and chubsuckers was evident. A very few bluegill and crappie (Pomoxis sp.) were found dead. Also, two large flathead catfish (Pylodictus olivaris) and one large smallmouth buffalo, (Ictiobus bubalus) were found dead.

On September 9, 1959, a follow-up survey was conducted to determine the effectiveness of the treatment as well as the effect, if any, the treatment had on the physical condition of the remaining fish. (Tables 3, 4, and 5). Cost of chemical for this treatment was \$0.73 per acre foot or a total of \$283.24 for the entire lake.

Pharris Lake

Pharris Lake is a 38 acre man-made lake located four or five miles south of Larue, Henderson County, Texas. It is impounded by an earthen dam and contains 238 acre-feet of water. A fishery survey was conducted in July 1957, at which time the lake was found to contain bullhead catfish and lake chubsuckers. In the spring of 1958, the lake was stocked with 400 threadfin shad. No shad were present in the survey collections of 1957.

1. 55-gallon drum with 9- by 27-inch cutaway intake.
2. Hopper opening
3. Expanded metal hopper with 14 X 18 mesh plastic screen liner
4. Valve to regulate pump output
5. Four cycle, 1 1/2-horsepower gasoline engine for driving centrifugal pump
6. Centrifugal pump
7. Priming plug
8. Heavy duty rubber hose
9. Streamlined foot valve with horizontal fins.
10. Rubber hose (2 3/4-inch)
11. Outlet

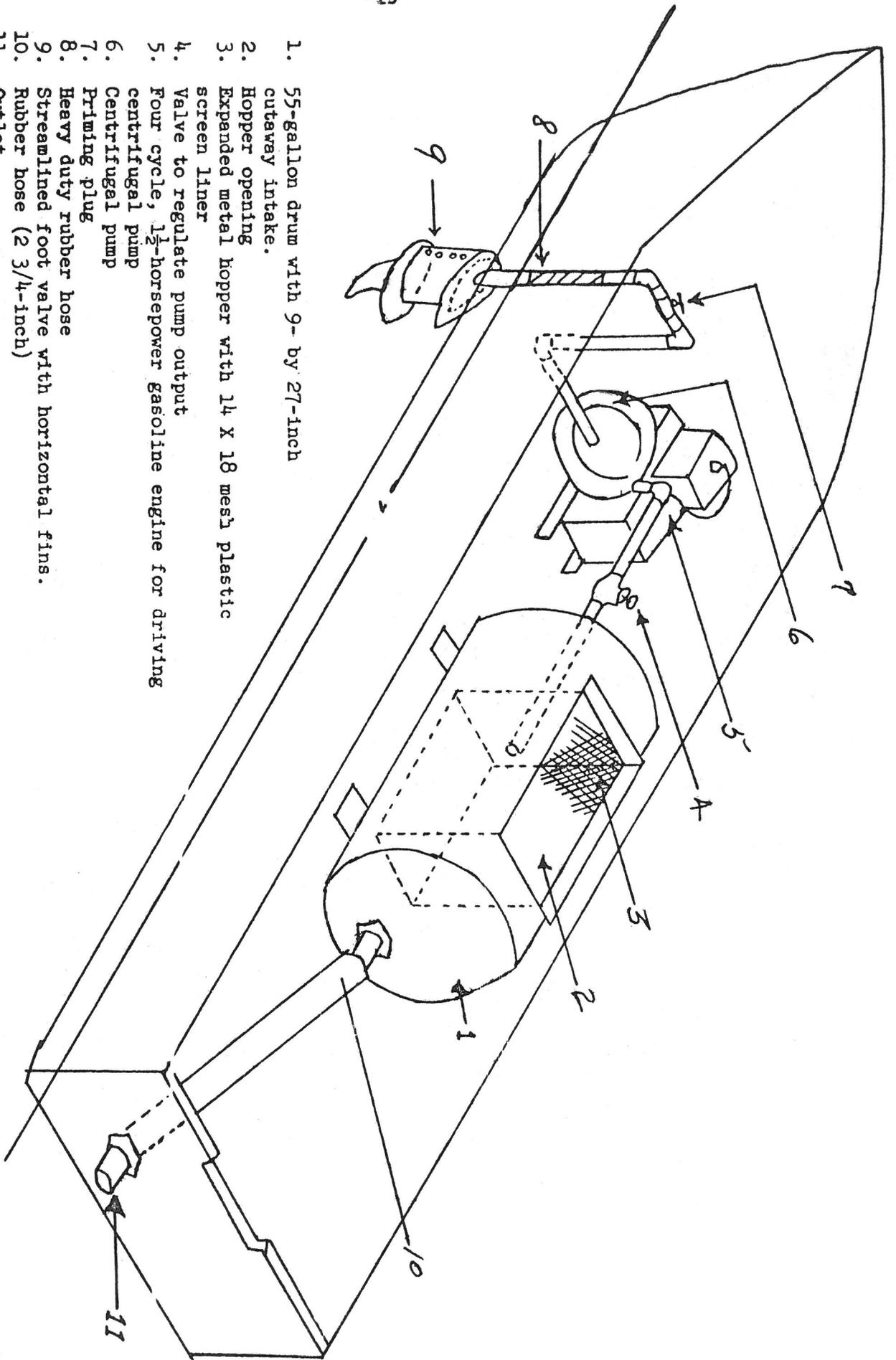


Figure 1. - Diagram of equipment for dissolving and distributing copper sulphate crystals

Table 3

Netting Results, Lindale Club Lake, November 11, 1958
Before Copper Sulphate Treatment, 1,000 feet of Gill Net

Species	Number	Percent of Number	Weight	Percent of Weight
Lake chubsucker	5	5.74	3.5	12.1
Golden shiner	53	60.92	11.8	40.8
Yellow bullhead	4	4.60	2.4	8.3
Largemouth bass	1	1.15	0.8	2.8
Warmouth	1	1.15	0.3	1.0
Bluegill sunfish	15	17.24	4.9	17.0
Redbreast sunfish	1	1.15	0.3	1.0
White crappie	1	1.15	0.9	3.1
Black crappie	6	6.90	4.0	13.9
Totals	87	100.00	28.9	100.0

Table 4

Netting Results, Lindale Club Lake, September 9, 1959
After Copper Sulphate Treatment, 1,000 feet of Gill Net

Species	Number	Percent of Number	Weight	Percent of Weight
Lake chubsucker	0	--	--	--
Golden shiner	2	1.10	0.50	0.72
Yellow bullhead	12	6.59	7.37	10.65
Largemouth bass	2	1.10	0.75	1.09
Warmouth	5	2.75	1.50	2.17
Bluegill sunfish	138	75.82	40.31	58.27
Redbreast sunfish	1	0.56	0.50	0.72
White crappie	10	5.49	9.25	13.37
Black crappie	12	6.59	9.00	13.01
Totals	182	100.00	69.18	100.00

Table 5

Lindale Club Lake Coefficients of Condition Before and After Copper Sulphate Treatment

Species	November 11, 1958			September 9, 1959		
	Number	Range	Average	Number	Range	Average
Yellow bullhead	4	1.65 - 1.88	1.74	7	1.99 - 2.67	2.22
Largemouth bass	1	1.95	1.95	2	2.19 - 2.21	2.20

Table 5 (Continued)

Species	November 11, 1958			September 9, 1959		
	Number	Range	Average	Number	Range	Average
Warmouth	1	3.43	3.43	5	3.60 - 4.16	3.86
Bluegill sunfish	15	3.36 - 4.85	4.12	25	3.51 - 5.01	4.27
White crappie	1	2.70	2.70	7	2.73 - 3.64	3.18
Black crappie	6	3.02 - 3.52	3.22	9	2.99 - 3.66	3.37

On June 23, 1959, the lake was treated with copper sulphate crystals at the rate of 1.55 p.p.m. Water analysis values at the time of treatment were: Methyl orange alkalinity - 18 p.p.m., pH - 7.2, dissolved chlorides - 21.28 p.p.m., and water temperature (surface) - 84°F.

Immediately after the copper sulphate was applied to the water, uncountable thousands of threadfin shad from $\frac{1}{2}$ to 2 inches in length began to flounce on the surface and die. Several hours after the treatment, golden shiners and chubsuckers began to come to the surface in distress. The next day, June 24, larger numbers of bullheads, golden shiners, and chubsuckers were observed dead or in distress. A few redear and bluegill sunfish and crappie succumbed to the treatment. It was estimated that less than two per cent of the fish killed were game species.

The cost of chemicals for treatment of Pharris Lake was \$0.71 per acre foot of water or a total of \$168.98 for the entire lake.

Tables 6 and 7 are the before and treatment netting results. Table 8 shows condition coefficients after treatment. No threadfin shad were taken during the after-treatment netting which indicates the treatment eradicated this species.

Table 6

Netting Results, Pharris' Lake, July 9, 1957
Before Copper Sulphate Treatment, 500 feet of Gill Net

Species	Number	Percent of Number	Weight	Percent of Weight
Lake chubsucker	1	0.55	0.56	0.82
Yellow bullhead catfish	17	9.39	10.94	16.03
Warmouth	15	8.29	2.31	3.38
Largemouth bass	2	1.10	5.00	7.33
Redear sunfish	24	13.26	8.31	12.18
Bluegill sunfish	97	53.59	26.13	38.29
White crappie	5	2.77	3.62	5.31
Black crappie	20	11.05	11.37	16.66
Totals	181	100.00	68.24	100.00

Table 7

Netting Results, Pharris' Lake, September 17, 1959
After Copper Sulphate Treatment, 500 feet of Gill Net

Species	Number	Percent of Number	Weight	Percent of Weight
Lake chubsucker	1	1.53	0.37	1.32
Yellow bullhead catfish	11	16.93	5.00	17.94
Warmouth	2	3.07	0.25	0.90
Redear sunfish	5	7.70	1.50	5.38
Bluegill sunfish	31	47.68	7.50	26.91
White crappie	5	7.70	5.25	18.84
Black crappie	10	15.39	8.00	28.71
Totals	65	100.00	27.87	100.00

Table 8

Pharris' Lake Coefficients of Condition Three Months After Copper Sulphate Treatment

Species	Number	Range	Average
Yellow bullhead catfish	10	1.88 - 2.37	2.07
Warmouth	2	2.55 - 2.81	2.68
Redear sunfish	4	2.21 - 2.96	2.68
Bluegill sunfish	30	2.25 - 4.49	3.53
White crappie	5	2.10 - 3.16	2.54
Black crappie	10	2.15 - 3.02	2.73

Tomlin Lake

Tomlin Lake is located two miles northwest of Lindale, Smith County, Texas. It is impounded by an earthen dam on Duck Creek which flows north to the Sabine River. The lake covers 24.29 acres and contains 98.17 acre-feet of water at spillway level. It was built in 1934. A fishery survey conducted in January 1959 produced a large number of gizzard shad, spotted suckers (*Minytrema melanops*), lake chubsuckers and a lesser number of river carpsuckers (*Carpionoxys carpio*), carp (*Cyprinus carpio*), golden shiners, black bullheads and yellow bullheads. Table 9 contains these data.

On June 10, 1959, the lake was treated with 345 pounds of copper sulphate crystals, or a concentration of 1.3 p.p.m. Late in the day eight carp averaging four pounds each had died. On June 11, 1959, due to the lack of distressed and dead fish, it was suspected that the lake had been under treated and an additional 55 pounds of copper sulphate were applied to the lake. The total amount of copper sulphate applied would have brought the lake to 1.5 p.p.m. concentration. However, it is believed that a large amount of the copper sulphate applied the first day had precipitated in non-toxic forms before the second dosage was applied. The copper residual in water two days after treatment was only 0.1 p.p.m.

Table 9

Netting Results, Tomlin Lake January 29, 1959
Before Copper Sulphate Treatment, 950 feet of Gill Net

Species	Number	Percent of Number	Weight	Percent of Weight
Spotted gar	4	1.31	7.5	3.7
Gizzard shad	66	21.64	18.0	8.9
Spotted sucker	77	25.24	89.8	44.4
Lake chubsucker	93	30.49	52.4	25.9
Bigmouth buffalo	2	0.66	3.9	1.9
River carpsucker	1	0.33	5.5	2.7
Carp	1	0.33	4.1	2.0
Golden shiner	10	3.27	1.8	0.9
Channel catfish	1	0.33	0.6	0.3
Black bullhead	4	1.31	3.7	1.8
Yellow bullhead	10	3.28	6.1	3.0
Bluegill sunfish	7	2.30	0.7	0.4
Redear sunfish	7	2.29	1.9	0.9
Longear sunfish	1	0.33	0.3	0.2
White crappie	21	6.89	6.0	3.0
Totals	305	100.00	202.3	100.00

Table 10 contains the after treatment netting data for Tomlin Lake. According to these data a sharp reduction was obtained in gizzard shad and spotted sucker populations. The fact that the before treatment netting survey was made in January and the after treatment survey in August could have greatly influenced the number of suckers netted, as this species is more active in the winter months.

Table 10

Netting Results, Tomlin Lake, August 13, 1959
After Copper Sulphate Treatment, 950 feet of Gill Net

Species	Number	Percent of Number	Weight	Percent of Weight
Spotted gar	4	10.00	8.00	28.36
Gizzard shad	3	7.50	0.88	3.12
Bigmouth buffalo	2	5.00	5.44	19.30
Spotted sucker	12	30.00	11.25	39.89
Black bullhead	1	2.50	---	---

Table 10 (Continued)

Species	Number	Percent of Number	Weight	Percent of Weight
Yellow bullhead	3	7.50	0.88	3.12
Redear sunfish	1	2.50	0.25	0.89
Bluegill sunfish	9	22.50	0.69	2.44
White crappie	3	7.50	0.31	1.10
Black crappie	2	5.00	0.50	1.78
Totals	40	100.00	28.20	100.00

Water analyses values at the time of treatment were: water temperature 82° F, pH 7.0, methyl orange alkalinity 18 p.p.m., chlorides 21.28 p.p.m., turbidity 30 inches secchi disc.

Cost of chemical for this treatment was \$0.69 per acre foot of water or \$67.75 for the entire lake.

Table 11 contains before and after treatment coefficients of condition for some species netted from Tomlin Lake. These data indicate a decline in physical condition after treatment, possibly due to a lack of plankton and small forage fish following treatment.

Table 11

Tomlin Lake Coefficients of Condition Before and After Copper Sulphate Treatment

Species	January 29, 1959			August 13, 1959		
	Number	Range	Average	Number	Range	Average
Spotted gar	4	0.51 - 0.87	0.65	-	-	--
Gizzard shad	15	1.84 - 2.09	1.96	-	-	--
Spotted sucker	15	1.73 - 2.60	2.25	-	-	--
Lake chubsucker	15	2.32 - 2.93	2.25	-	-	--
Bigmouth buffalo	2	3.84 - 3.86	3.85	-	-	--
River carpsucker	1	3.27	3.27	-	-	--
Carp	1	3.38	3.38	-	-	--
Golden shiner	10	1.95 - 2.31	2.09	-	-	--
Channel catfish	1	1.31	1.31	-	-	--
Black bullhead	4	2.44 - 3.98	2.90	1	2.06	2.06
Yellow bullhead	10	2.00 - 2.66	2.15	3	1.98 - 2.44	2.15
Bluegill sunfish	7	3.85 - 5.15	4.39	9	3.18 - 4.24	3.70
Redear sunfish	9	3.42 - 4.12	3.75	1	2.78	2.78
Longear sunfish	1	4.01	4.01	-	-	--
White crappie	15	2.35 - 4.16	3.05	3	2.38 - 2.67	2.50
Black crappie	-	-	--	2	2.55 - 2.60	2.57

Rainbow Lake

Rainbow Lake is located approximately 15 miles southeast of Athens, Henderson County, Texas. The area of the lake at the time of treatment was 65 acres with an average depth of 4.25 feet and contained 276.9 acre-feet of water. A fishery survey conducted in October, 1959, revealed that the lake contained a rather large population of gizzard shad, black bullhead catfish and yellow bullhead catfish. These data are contained in Table 12. On March 11, 1960, the lake was treated with 1,196 pounds of copper sulphate crystals, which was a calculated concentration of 1.6 p.p.m. Water conditions at the time of treatment were: temperature - 53°F, methyl orange alkalinity - 15 p.p.m., pH - 6.2, turbidity - 11 inches secchi disc.

On March 15, four days after treatment, thousands of gizzard shad from eight to twelve inches in length were found dead and floating. Good numbers of bullhead catfish and chubsuckers were also noted. Many fish could be seen lying on the bottom.

Table 12

Netting Results, Rainbow Lake, October 20, 1959,
Before Copper Sulphate Treatment, 750 Feet of Gill Net

Species	Number	Per Cent of Number	Weight	Per Cent of Weight
Spotted gar	9	4.36	18.25	13.11
Bowfin	7	3.40	33.19	23.86
Gizzard shad	66	32.04	24.25	17.43
Lake chubsucker	2	0.97	1.50	1.08
Black bullhead	14	6.80	14.50	10.42
Yellow bullhead	15	7.28	10.88	7.82
Largemouth bass	1	0.48	0.81	0.58
Redear sunfish	4	1.95	1.00	0.72
Bluegill sunfish	10	4.85	2.13	1.53
White crappie	34	16.51	2.31	1.66
Black crappie	44	21.36	30.31	21.79
Totals	206	100.00	139.13	100.00

On April 26, a follow-up netting survey was made (Table 13). According to these netting data, gizzard shad, chubsucker and black bullhead populations had been reduced but yellow bullheads had not been significantly affected. Table 14 contains comparison data on condition coefficients for largemouth bass, crappie and several sunfish species. These data reflect little change in physical condition after treatment.

Table 13

Netting Results, Rainbow Lake, April 26, 1960
After Copper Sulphate Treatment, 750 Feet of Gill Net

Species	Number	Percent of Number	Weight	Percent of Weight
Spotted gar	17	11.04	48.37	31.21
Bowfin	7	4.54	31.43	20.29
Gizzard shad	22	14.29	5.56	3.59
Lake chubsucker	0	---	---	---
Black bullheads	3	1.95	4.25	2.74
Yellow bullheads	24	15.58	18.75	12.10
Largemouth bass	5	3.24	10.25	6.61
Warmouth	4	2.60	1.37	0.88
Redear sunfish	17	11.04	5.75	3.71
Bluegill sunfish	22	14.29	5.12	3.30
White crappie	11	7.14	10.19	6.58
Black crappie	22	14.29	13.94	8.99
Totals	154	100.00	154.98	100.00

Table 14

Rainbow Lake Coefficients of Condition Before and After Copper Sulphate Treatment

Species	October 20, 1959			April 26, 1960		
	Number	Range	Average	Number	Range	Average
Largemouth bass	1	2.46	2.46	4	2.14 - 2.68	2.37
Redear sunfish	3	3.45 - 4.04	3.70	5	3.35 - 4.00	3.63
Bluegill sunfish	3	4.24 - 4.46	4.34	5	4.00 - 4.91	4.40
White crappie	10	2.51 - 3.26	2.86	5	2.36 - 3.46	3.06
Black crappie	10	2.37 - 3.88	3.30	5	2.96 - 3.49	3.26

Roundhouse Lake

Roundhouse Lake is located one mile south of Commerce, Hunt County, Texas. It covers 10.4 acres and contains 63.49 acre-feet of water. The lake was netted in February 1959, and was found to contain large numbers of black bullhead catfish and a few golden shiners (Table 15).

Table 15

Netting Results, Roundhouse Lake, February 20, 1959
Before Copper Sulphate Treatment, 500 Feet of Gill Net

Species	Number	Percent of Number	Weight	Percent of Weight
Bigmouth buffalo	1	2.23	4.50	16.67
Golden shiner	2	4.44	0.30	1.11
Black bullhead catfish	26	57.77	4.27	15.81
Channel catfish	1	2.23	3.50	12.96
Largemouth bass	5	11.11	8.21	30.41
Bluegill sunfish	2	4.44	0.12	0.45
White crappie	8	17.78	6.10	22.59
Totals	45	100.00	27.00	100.00

On November 10, 1959, the lake was treated with 274 pounds of copper sulphate, which is a calculated concentration of 1.6 p.p.m. Due to a depletion of standard solution, an alkalinity determination was not obtained at the time of treatment. However on February 11, 1960, the methyl orange alkalinity was 100 p.p.m. and the pH was 7.6. At treatment, the water temperature was 53°F. Observations made on November 12 and 13, 1960, indicated that very few fish had succumbed to the treatment. However the lake owner reported that an undetermined number of bullhead catfish and golden shiners died as much as two weeks after treatment.

On July 20, 1960, a netting and seining sample was taken from the lake. (Table 16) The seining sample indicated that a very heavy population of golden shiners still existed in the lake.

Table 16

Netting Results, Roundhouse Lake, July 20, 1960
After Copper Sulphate Treatment, 500 Feet of Gill Net

Species	Number	Percent of Number	Weight	Percent of Weight
Bigmouth buffalo	0	---	---	---
Black bullhead	1	5.26	0.56	4.38
Channel catfish	2	10.53	1.94	15.21
Largemouth bass	2	10.53	4.94	38.71
Green sunfish	1	5.26	0.13	1.02
Bluegill sunfish	2	10.53	0.31	2.43
White crappie	5	26.32	1.44	11.29
Black crappie	6	31.57	3.44	26.96
Totals	19	100.00	12.76	100.00

With the completion of the first annual segment of actual field experiments the following conclusions were made:

1. The before and after treatment netting results were not consistent in indicating a great reduction of undesirable species. However, a single netting effort is not completely conclusive and the fact that large numbers of dead bullhead catfish, chubsuckers, carp, carpsuckers, golden shiners and shad were observed after treatment is irrefutable evidence that these species were reduced to some extent.

2. The carbonates and bicarbonates in waters of higher alkalinity precipitate the copper very rapidly as copper carbonate which is non-toxic to fish. Exploratory work indicates that the critical alkalinity for successful use of this technique is somewhere between 60 and 100 p.p.m.

3. Field tests conducted during this segment indicate that selective control of rough fish species with copper sulphate can be an effective management technique with certain limitations.

Due to a change of segment beginning and ending dates no field work was conducted during segment six of this job. However, five additional lakes were chosen for test sites for Project F-3-R-9 segment in 1961.

Three of the lakes were selected for selective kills with copper sulphate and two for complete fish kills. As during the previous field studies, water was brought to the laboratory from each lake and bioassays were conducted to determine lethal concentrations for the respective lakes. Each lake was netted before and after treatment to obtain comparison data for treatment evaluation.

Hitts Lake

Hitt's Lake located near Tyler in Smith County, Texas, covers 175 acres and contained 953 acre-feet of water at the time of treatment. On July 12, 1961, the lake was treated with 5100 pounds of copper sulphate for a calculated concentration of 2.00 p.p.m.

On July 11, the day before treatment, 12 gill nets (1500 feet) were set in the lake and left over night. Table 17 contains data compiled from this netting sample. Twelve nets were again set after treatment on July 18. Results of this netting are contained in Table 18. Mesh sizes of all nets ranged from 1 to 3 inches.

Table 17

Results of Gill Net Sets, Hitt's Lake, Before Copper Sulphate Treatment

Species	Number	Percent of Number	Weight	Percent of Weight
Spotted gar (<u>Lepisosteus oculatus</u>)	16	7.59	25.00	28.49
Lake chubsucker (<u>Erimyzon sucetta</u>)	9	4.26	4.37	4.98
Golden shiner (<u>Notemigonus crysoleucas</u>)	1	.48	.19	.22

Table 17 (Continued)

Species	Number	Percent of Number	Weight	Percent of Weight
Yellow bullhead (<u>Ictalurus natalis</u>)	9	4.26	9.31	10.61
Warmouth (<u>Chaenobryttus gulosus</u>)	3	1.43	.50	.57
Redear sunfish (<u>Lepomis microlophus</u>)	17	8.05	38.37	43.75
Bluegill sunfish (<u>Lepomis macrochirus</u>)	154	72.99	8.00	9.12
White crappie (<u>Pomoxis annularis</u>)	2	.94	2.00	2.28
Totals	211	100.00	87.74	100.00

Table 18

Results of Gill Net Sets, Hitt's Lake, After Copper Sulphate Treatment

Species	Number	Percent of Number	Weight	Percent of Weight
Spotted gar (<u>Lepisosteus oculatus</u>)	19	2.78	46.00	21.23
Largemouth bass (<u>Micropterus salmoides</u>)	13	1.89	15.50	7.16
Redear sunfish (<u>Lepomis microlophus</u>)	15	2.19	7.06	3.50
Bluegill sunfish (<u>Lepomis macrochirus</u>)	616	89.79	137.00	63.23
Yellowbelly sunfish (<u>Lepomis auritus</u>)	13	1.89	6.62	3.07
White crappie (<u>Pomoxis annularis</u>)	10	1.46	3.88	1.81
Totals	686	100.00	216.06	100.00

Bioassays conducted in the laboratory revealed a concentration of 1.8 p.p.m. copper sulphate in Hitt's Lake water would provide a good kill of undesirable species with a minimum danger to the desirable species. However, the concentration used in the lake treatment was increased 0.2 p.p.m. to compensate for the reaction of copper sulphate with carbonate and bicarbonate ions to precipitate copper carbonate. It is also suspected that absorption of the copper sulphate by phytoplankton and higher aquatic plants may account for the more rapid loss of copper sulphate in some lakes.

Water analyses were run at 2 to 4 foot intervals from the surface down to 16 feet. Table 19 contains these data.

Table 19

Water Analysis, Hitt's Lake, July 12, 1961

Depth in Feet	Temperature °F	Dissolved Oxygen ppm	Methyl Orange Alkalinity ppm	Dissolved Carbon Dioxide ppm	pH
0	83	4.4	22	3.0	7.2
1	83				
2	83				
3	83	4.4	22	3.0	7.2
4	83				
5	83				
6	83	3.0	22	3.0	6.6
7	81				
8	78	2.0	25	15.0	6.2
9	76				
10	74	0.4	28	17.0	6.2
11	73				
12	72	0.2	35	22.0	6.4
13	70				
14	70	trace	74	48.0	6.4
15	68				
16	67	trace	107		6.4
17	67				

Turbidity = 42 inches secchi.

Observations made one day after treatment revealed large numbers of yellow bullheads and lake chubsuckers were dead and in distress. Moderate numbers of spotted gar (Lepisosteus oculatus), golden shiners and bluegill sunfish were also found dead and in distress. These observations, plus the comparison of the before and after treatment netting data, indicates that the populations of undesirable species were appreciably reduced. Since 616 bluegill sunfish were netted after treatment, the reduction of this species was likely beneficial.

This lake is the second treated during these experiments in which gar were present and it is interesting to note that some of the spotted gar were killed by the copper sulphate.

Spring Lake

Spring Lake is located just above Hitt's Lake on the same stream. It covers an area of 19.28 acres and contained 146 acre-feet of water. On July 13, 1961, the lake was treated with 700 pounds of copper sulphate crystals for a calculated concentration of 1.7 p.p.m., the optimum concentration indicated by bioassay. No correction factor was applied as in the treatment of Hitt's Lake. Before and after treatment netting samples were taken on July 11 and July 18, 1961. Tables 20 and 21 contain these netting data. Water analyses were again made at 2 to 4 foot intervals from the surface to 14 feet. Table 22 shows the results of these analyses.

Table 20

Results of Gill Net Sets, Spring Lake, Before Copper Sulphate Treatment

Species	Number	Percent of Number	Weight	Percent of Weight
Lake chubsucker	11	9.91	7.25	16.38
Golden shiner	2	1.81	0.50	1.13
Yellow bullhead	21	18.91	15.25	34.46
Largemouth bass	1	0.90	2.00	4.52
Warmouth	4	3.60	0.50	1.13
Redear sunfish	4	3.60	2.19	4.94
Bluegill sunfish	64	57.66	15.75	35.60
White crappie	4	3.61	0.81	1.84
Totals	111	100.00	44.25	100.00

Table 21

Results of Gill Net Sets, Spring Lake, After Copper Sulphate Treatment

Species	Number	Percent of Number	Weight	Percent of Weight
Golden shiner	1	0.32	0.50	0.61
Yellow bullhead	7	2.23	7.13	8.69
Warmouth	7	2.23	1.06	1.29
Redear sunfish	12	3.84	4.13	5.04
Bluegill sunfish	275	87.86	66.00	80.48
White crappie	11	3.52	3.19	3.89
Totals	313	100.00	82.01	100.00

Table 22

Water Analysis, Spring Lake, July 13, 1961

Depth in Feet	Temperature °F	Dissolved Oxygen ppm	Methyl Orange Alkalinity ppm	Dissolved Carbon Dioxide ppm	pH
0	84	9.0	8.0	4.0	6.2
1	84				
2	84				
3	84				
4	84	8.0	14.0	4.0	6.0
5	84				
6	83	2.0	20.0	5.0	6.0
7	78				
8	75	2.0	25.0	12.0	6.0
9	72				
10	71	2.0	30.0	13.0	6.0
11	70				
12	68	3.0	45.0	22.0	6.2
13	67				
14	66	4.0	40.0	72.0	6.0
15	65				
16	64				

A comparison of Tables 20 and 21 indicates that bullhead catfish and golden shiners were still present after the treatment. However, observations made after treatment revealed that good numbers of these species had been killed. No chubsuckers were netted after treatment. It is felt that this lake could have been treated with a heavier concentration of copper sulphate with little or no damage to the desirable species.

Soutter's Lake

Soutter's Lake is located 15 miles southeast of Athens in Henderson County, Texas. The water covers 20 acres and contained 160 acre-feet at the time of treatment. On June 13, 1961, the lake was treated with 777 pounds of copper sulphate crystals which resulted in a concentration of 1.8 p.p.m. The lake was netted with eight gill nets before and after treatment. Results of these netting collections are contained in Tables 23 and 24. Water analyses were run in conjunction with these netting activities. Results of these analyses are contained in Tables 25 and 26.

Table 23

Results of Gill Net Sets, Soutter's Lake
Before Copper Sulphate Treatment, June 12, 1961

Species	Number	Percent of Number	Weight	Percent of Weight
Golden shiner	1	1.04	0.25	1.12
Black bullhead	18	18.55	3.69	16.55

Table 23 (Continued)

Species	Number	Percent of Number	Weight	Percent of Weight
Yellow bullhead	22	22.68	7.94	35.62
Largemouth bass	4	4.13	4.62	20.73
Bluegill sunfish	46	47.42	4.13	18.53
Black crappie	6	6.18	1.66	7.45
Total	97	100.00	22.29	100.00

Table 24

Results of Gill Net Sets, Soutter's Lake
After Copper Sulphate Treatment, June 20, 1961

Species	Number	Percent of Number	Weight	Percent of Weight
Warmouth	3	1.78	0.62	4.08
Green sunfish	1	0.59	0.25	1.64
Bluegill sunfish	159	94.08	13.50	88.88
Black crappie	6	3.55	0.82	5.40
Total	169	100.00	15.19	100.00

Table 25

Water Analysis, Soutter's Lake, June 13, 1961

Depth in Feet	Temperature °F	Dissolved Oxygen ppm	Methyl Orange Alkalinity ppm	Dissolved Carbon Dioxide ppm	pH
0	84	5.4	29	3.0	7.2
2	84				
3	84				
4	84	5.6	29	3.0	7.2
5	84				
6	84	5.2	29	2.5	7.2
7	84				
8	81	5.6	29	3.0	7.2
9	80				

Table 25 (Continued)

Depth in Feet	Temperature °F	Dissolved Oxygen ppm	Methyl Orange Alkalinity ppm	Dissolved Carbon Dioxide ppm	pH
10	78	4.0	25	4.5	6.8
11	76				
12	72	2.0	33	17.50	6.8
12.5	70.5				

Table 26

Water Analysis, Soutter's Lake, After Copper Sulphate Treatment, June 20, 1961

Depth in Feet	Temperature °F	Dissolved Oxygen ppm	Methyl Orange Alkalinity ppm	Dissolved Carbon Dioxide ppm	pH
0	76	4.0	14	90	6.6
2	75	4.0	25	90	6.4
4	75	3.2	28	90	6.4
6	75	3.6	32	90	6.6
8	75	3.2	35	100	6.6
10	74	2.8	25	90	6.4
12	73	2.8	35	130	6.4
14	68				

Comparison of netting data on Soutter's Lake indicates that a good kill of bullhead catfish was obtained. On June 19, six days after the treatment a total of 6,376 dead bullhead catfish were counted on the shoreline.

Total Kill Treatments

Douphrate's Lake

Douphrate's Lake is located six miles east of Gilmer in Upshur County, Texas. This lake was selected as a site to attempt a complete eradication of the fish population by a heavy dosage of copper sulphate. It covered 11.28 acres and contained 64.94 acre-feet of water at the time of treatment.

On August 15, 1961, the lake was treated with 876 pounds of copper sulphate to obtain a calculated concentration of 5 parts per million in the water. The lake was netted on December 7, 1959, and the results of this netting were used to compare with the after treatment netting conducted on September 29, 1961. Tables 27 and 28 contain these netting data respectively. Table 29 shows the results of water analyses made on the day of the treatment. Although comparison of Tables 27 and 28 shows a marked reduction of the number of fish present, it is felt that the concentration of copper sulphate used was not great enough to obtain the desired results. Although a "complete kill" is seldom actually obtained, a successful "complete kill" should leave few survivors.

Table 27

Results of Gill Net Sets, Douphrate's Lake
Before Copper Sulphate Treatment, December 7, 1959

Species	Number	Percent of Number	Weight	Percent of Weight
Spotted gar	24	12.6	62.0	35.6
Lake chubsucker	116	60.8	92.0	52.8
Golden shiner	5	2.6	1.1	0.6
Yellow bullhead	2	1.0	1.8	1.0
Largemouth bass	2	1.0	6.4	3.7
Redear sunfish	14	7.3	3.7	2.1
Bluegill sunfish	8	4.2	1.3	0.7
Black crappie	20	10.5	6.1	3.5
Totals	191	100.00	174.4	100.00

Table 28

Results of Gill Net Sets, Douphrate's Lake
After Copper Sulphate Treatment, September 29, 1961

Species	Number	Percent of Number	Weight	Percent of Weight
Redear sunfish	8	34.78	1.62	37.07
Bluegill sunfish	12	52.17	1.62	37.07
Black crappie	3	13.05	1.13	25.86
Totals	23	100.00	4.37	100.00

Table 29

Water Analysis, Douphrate's Lake, August 18, 1961

Depth in Feet	Temperature °F	Dissolved Oxygen ppm	Methyl Orange Alkalinity ppm	Dissolved Carbon Dioxide ppm	pH
0	86	5.6	20	7	6.2
1	86				
2	86				
3	86				
4	86	5.6	5	6	6.0
5	86				
6	82				
7	79	trace	70	60	6.2

Attoyac Club Lake

Attoyac Club Lake is located in the southwest corner of Shelby County, Texas. It covers 23.1 acres and contains 100.25 acre-feet of water. This lake was selected as a test site for an attempted complete kill of the fish population. On August 16, 1961, the lake was treated with 1,354 pounds of copper sulphate for a calculated concentration of 5 p.p.m. Tables 30 and 31 show the results of before and after netting surveys. Comparison of these data reveals that this treatment was completely unsuccessful in obtaining a total kill. It is unfortunate that water analyses were not made for this test due to a depleted chemical supply. Apparently something unusual occurred during this treatment. Gizzard shad are usually susceptible to a concentration of 1.8 p.p.m. copper sulphate, yet large numbers of shad survived this treatment of 5.0 p.p.m.

Table 30

Results of Gill Net Sets, Attoyac Club Lake
Before Copper Sulphate Treatment, May 10, 1961

Species	Number	Percent of Number	Weight	Percent of Weight
Spotted gar	7	6.25	20.44	28.29
Gizzard shad	66	58.93	21.50	29.75
Smallmouth buffalo	1	0.89	12.62	17.48
Golden shiner	1	0.89	0.19	0.26
Black bullhead	1	0.89	2.44	3.38
Yellow bullhead	1	0.89	0.50	0.69
Largemouth bass	2	1.79	8.00	11.07
Warmouth	1	0.89	0.31	0.42
Redear sunfish	8	7.14	3.25	4.50
Bluegill sunfish	17	15.19	1.75	2.42
Black crappie	7	6.25	1.25	1.74
Totals	112	100.00	72.25	100.00

Table 31

Results of Gill Net Sets, Attoyac Club Lake
After Copper Sulphate Treatment, August 31, 1961

Species	Number	Percent of Number	Weight	Percent of Weight
Spotted gar	3	0.79	10.00	12.58
Gizzard shad	65	17.25	20.00	25.16
Black bullhead	1	0.26	0.62	0.78
Largemouth bass	10	2.65	19.12	24.05
Warmouth	1	0.26	0.19	0.24
Spotted sunfish	2	0.54	0.19	0.24
Redear sunfish	27	7.16	9.00	11.32
Bluegill sunfish	267	70.83	20.00	25.16
Black crappie	1	0.26	0.37	0.47
Totals	377	100.00	79.49	100.00

During the F-3-R-10 segment in 1962, two additional lakes in Region 3-B were treated with copper sulphate for selective fish kills.

Pine Lodge Lake

Pine Lodge Lake is located 11 miles south of Palestine, Anderson County, Texas. It contains 42.9 surface acres and 240 acre-feet of water at the time of treatment. On July 18, 1962, 1,300 pounds of copper sulphate was applied to Pine Lodge Lake. This was a concentration of 1.5 p.p.m. It was originally planned to treat this lake with a 2.4 p.p.m. concentration which would have required approximately 1,800 pounds of copper sulphate. However, a mix-up in the chemical order caused a 500 pound shortage at the scheduled time of treatment. On July 19, following the treatment, numerous dead chubsuckers and bullhead catfish were observed. Comparison of the before and after netting data as contained in Tables 32 and 33 indicate only a limited control of bullhead catfish, however. It is interesting to note the comparison of bluegill sunfish netted after the treatment. As reflected in several of the previous after treatment netting tables, copper sulphate greatly increases the activity of sunfish.

Table 32
Netting Results of Pine Lodge Lake Before Copper Sulphate Treatment
August 21-22, 1962

Species	Number	Percent of Number	Weight	Percent of Weight
Chubsucker	10	13.16	4.25	14.13
Yellow bullhead	21	27.63	12.50	41.57
Largemouth bass	5	6.57	8.88	29.53
Redear sunfish	7	9.22	0.94	3.13
Bluegill sunfish	31	40.79	2.88	9.58
Black crappie	2	2.63	0.62	2.05
Totals	76	100.00	30.07	100.00

Table 33
Netting Results of Pine Lodge Lake After Copper Sulphate Treatment
July 23-24, 1962

Species	Number	Percent of Number	Weight	Percent of Weight
Chubsucker	24	4.28	10.25	12.28
Black bullhead	1	0.18	0.56	0.68
Yellow bullhead	13	2.33	8.12	9.72
Largemouth bass	13	2.33	21.44	25.68

Table 33 (Continued)

Species	Number	Percent of Number	Weight	Percent of Weight
Warmouth	2	0.35	0.31	0.37
Redear sunfish	34	6.07	3.00	3.59
Bluegill sunfish	459	81.96	35.56	42.59
Black crappie	14	2.50	4.25	5.09
Totals	560	100.00	83.49	100.00

3-H Club Lake

The 3-H Club Lake is located ten miles west of Carthage, in Panola County, Texas. The lake contains 27 surface acres and 200 acre-feet of water. A netting survey in December, 1961, indicated this lake was overpopulated with bluegill sunfish and bullhead catfish.

3-H Club Lake was treated with 1,000 pounds of copper sulphate on August 22, 1962. This was a concentration of 2.2 p.p.m. Many dead bullheads were observed after treatment. Tables 34 and 35 contain before and after netting data from 3-H Club Lake. Again a great increase in the activity of bluegill sunfish was noted as 88 bluegills were netted before treatment as compared to 354 after treatment.

Table 34

Netting Results of 3-H Club Lake Before Copper Sulphate Treatment
August 21-22, 1962

Species	Number	Percent of Number	Weight	Percent of Weight
Blacktail redhorse	1	0.92	0.19	0.48
Black bullhead	5	4.59	4.50	11.32
Yellow bullhead	10	9.18	7.75	19.49
Redear sunfish	3	2.75	1.13	2.84
Bluegill sunfish	88	80.73	25.44	63.98
Black crappie	2	1.83	0.75	1.89
Totals	109	100.00	39.76	100.00

Table 35

Netting Results of 3-H Club Lake After Copper Sulphate Treatment
August 28-29, 1962

Species	Number	Percent of Number	Weight	Percent of Weight
Largemouth bass	2	0.54	1.88	2.15
Warmouth	5	1.36	1.31	1.50
Redear sunfish	3	0.82	1.19	1.35
Bluegill sunfish	354	96.20	81.34	92.85
Black crappie	4	1.09	1.88	2.15
Totals	368	100.00	87.60	100.00

Conclusions and Recommendations:

Preliminary bioassays in the laboratory did not provide dependable criteria concerning the influence of temperature, alkalinity, pH and other factors on copper sulphate treatments. Through these early tests however, general susceptibility levels were established for various species.

In waters with total alkalinity not exceeding 100 p.p.m., selective kills were generally successful with a copper sulphate concentration of 1.6 to 2.0 p.p.m. This concentration range proved, in most tests, lethal to bullhead catfish, suckers, golden shiners and shad with minimum losses of game fish species. Attempted total fish kills with 5.0 p.p.m. copper sulphate were not successful as total kills but proved valuable as an indicator that higher concentrations of copper sulphate could be used safely as a selective toxicant on rough fish.

This study did not entail an evaluation of the effects of copper sulphate on fish food organisms other than the coefficient of condition factors comparisons made from before and after treatment surveys. These comparisons revealed very little change in condition that could be attributed to copper sulphate.

With a more complete knowledge of the unknown factors influencing copper sulphate chemically, a more concise set of criteria for given water quality should be possible. This would greatly improve the value of copper sulphate as an effective management tool in the control of rough fish species.

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Date April 18, 1968

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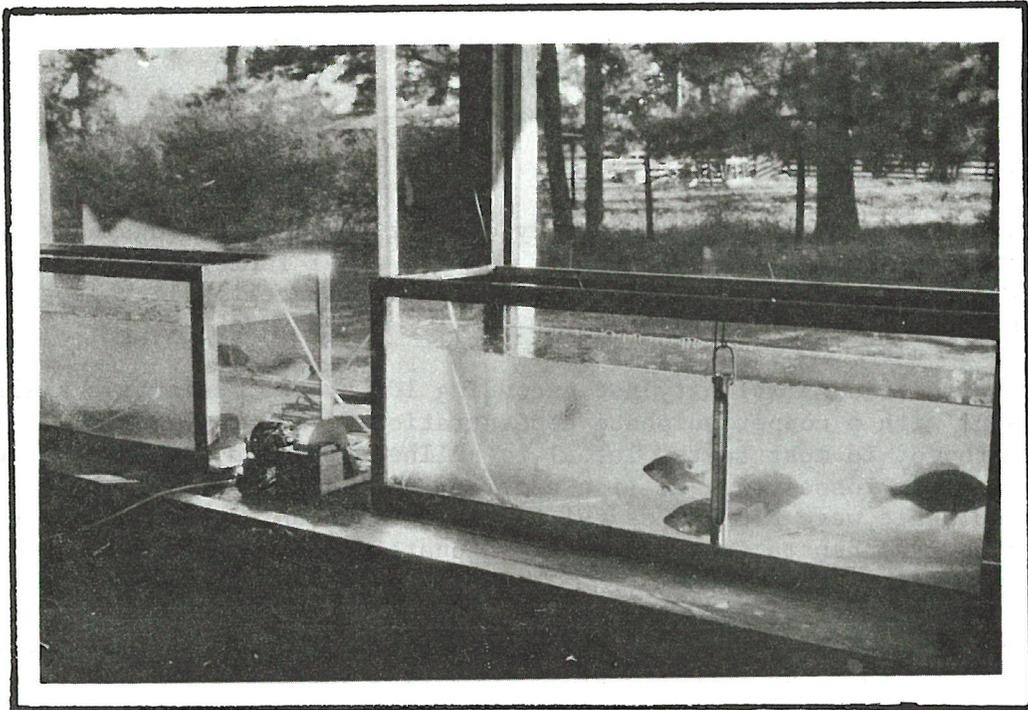


Figure 2. Aquaria used in early bioassay tests

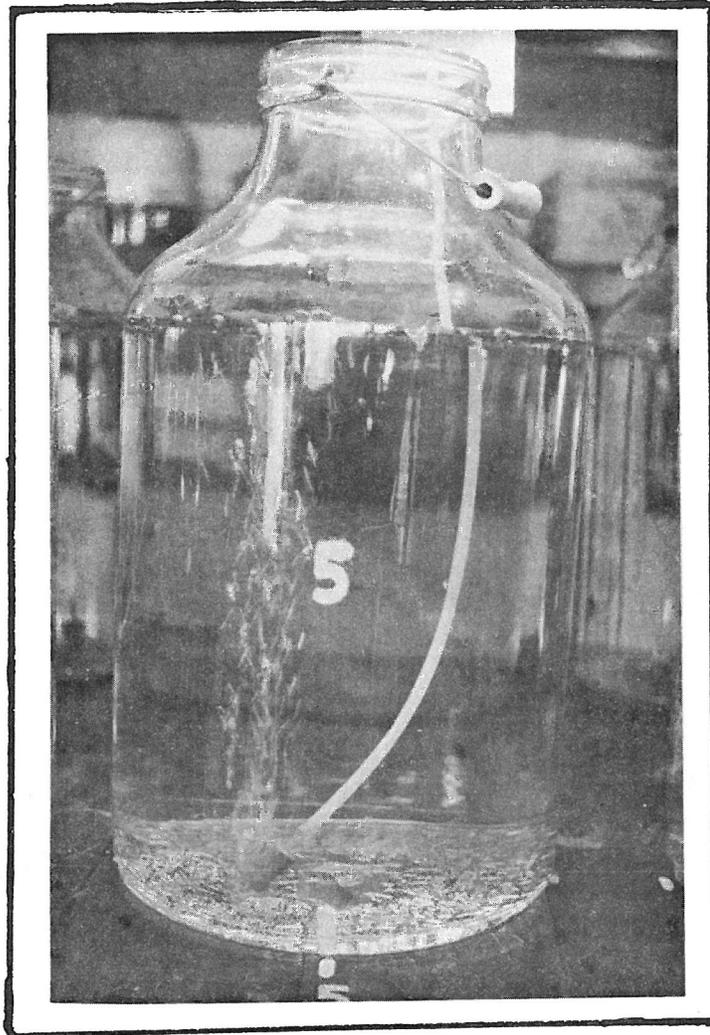


Figure 3. Five gallon jar used in later bioassays

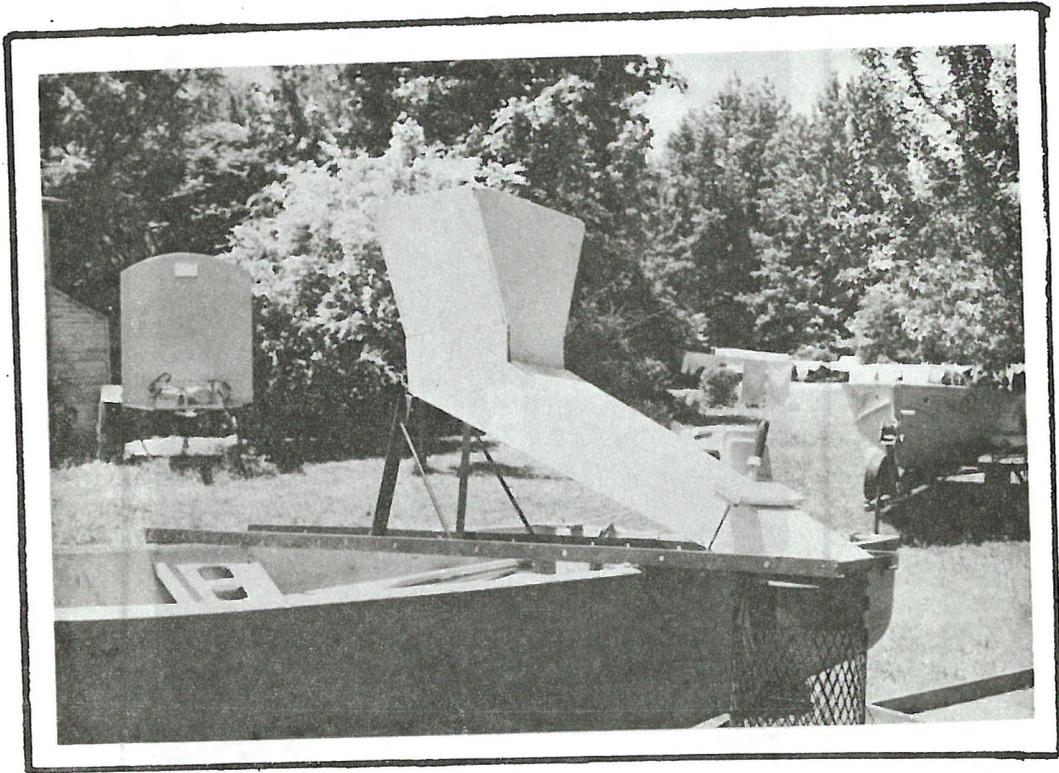


Figure 4. Distributor used for small applications of copper sulphate

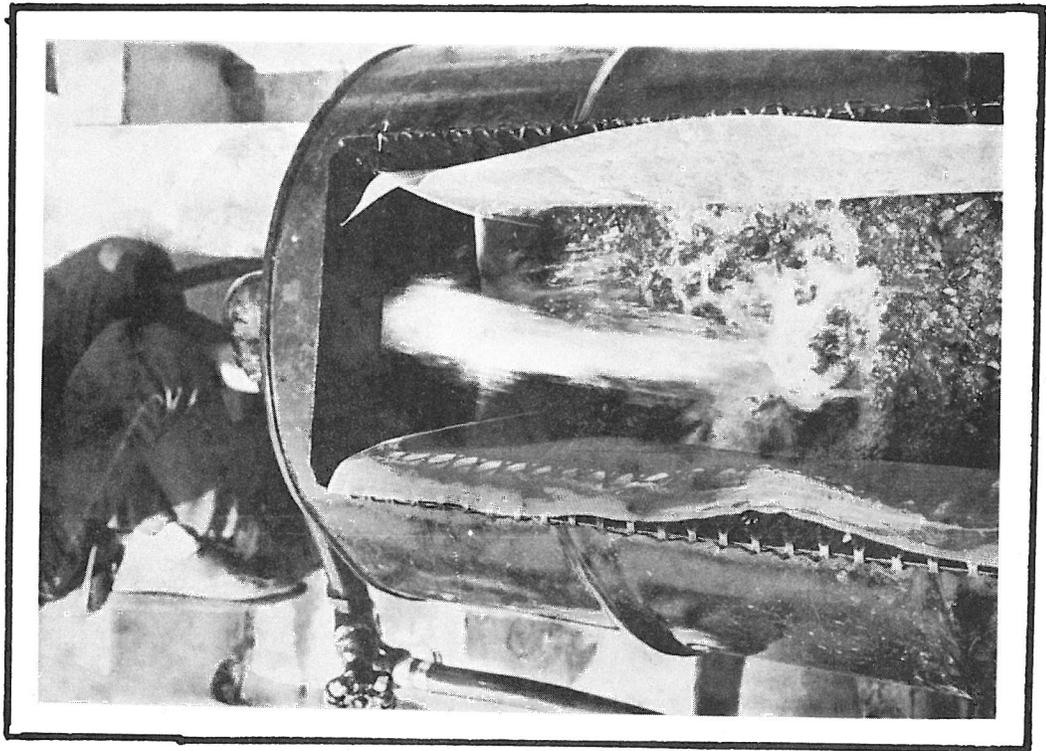


Figure 5. Mixing barrel of larger copper sulphate distributor (Figure 1.)

