

Report of Fisheries Development  
Experimental Attraction and Repulsion of Fish Population as a  
Means of Fishery Management

by

Lawrence S. Campbell  
Project Leader

Dingell-Johnson Project F-5-R-7, Job E-3  
April 16, 1959 - April 1, 1960

H. D. Dodgen - Executive Secretary

Texas Game and Fish Commission  
Austin, Texas

Marion Toole  
Coordinator

Kenneth C. Jurgens and William H. Brown  
Assistant Coordinators

## A B S T R A C T

Most of the procedures specified for the year's work were not completed. This was because of additional duties or circumstances that were unanticipated at the time that project planning was done. Development activities, such as fish eradication work at Champion Creek, Moss Creek, and at Mountain Creek Reservoir, plus vegetation control work at Lake Nasworthy required more than 400 man-days effort or about 25 percent of the total time available. Unfortunate occurrences such as the flood in the fall of 1959 that destroyed structures built to complete field procedures, also contributed to the slow progress of the work plan.

Some progress was made in an examination of the existing literature. Forty chemical companies and a number of other organizations were contacted for information and approximately 1,200 chemicals were listed that may have attractive or repulsive effects on some species of fish under specific conditions.

Systematic netting in Lake Nasworthy resulted in some evidence of a distribution pattern of the species of fish present while not being influenced by significant flow through the reservoir during warm weather. Intensive netting at Lake Colorado City revealed that currents created by circulation of the lake's water through the thermo-electric plant were in a general sense attractive to fish, although specific attraction, if that occurs, was not clearly defined or understood.

Laboratory tests with toxaphene and emulsifiable rotenone indicated that fish were repelled by these chemicals.

## Job Completion Report

State of TEXAS

Project No. F-5-R-7

Name: Fisheries Investigations and Surveys  
of the waters of Region 3-B.

Job No. E-3

Title: Experimental Attraction and Repulsion  
of Fish Populations as a Means of  
Fishery Management.

Period Covered:

April 16, 1959 - April 1, 1960

### OBJECTIVES

The purpose of this work was and is to determine if certain natural or man-made phenomena may be employed to concentrate by attraction or repulsion the various fish populations to small rather than large areas within bodies of water in order that control measures may be used to bring about effective management of the fishery resource.

In region 3-B of Texas, gizzard shad (Dorosoma cepedianum), carp (Cyprinus carpio), river carpsucker (Carpionodes carpio), white crappie (Pomoxis annularis), bluegill (Lepomis macrochirus), green sunfish (Lepomis cyanellus), white bass (Roccus chrysops), channel catfish (Ictalurus punctatus), and yellow bullheads (Ameiurus natalis) are nine species that often must be considered in controlling the fish populations. For that reason these fish will be the species for which means of attraction or repulsion will be sought.

It was recommended that the following generally described conditions or variables be tested either individually or in combination in whatever manner appears to be the most suitable and logical. This work is to be done in the future either within Region 3-B or in other regions of the state as the coordinators for the state shall direct or as the prevailing circumstances may dictate as desirable:

1. Physical movement of Water
  - (a) Currents and stream flow
    - (1) Naturally induced stream flow from run-off and similar flow into reservoirs.
    - (2) Springs and movements of water from seepage or ground waters.
    - (3) Water movements induced by man-made devices.
  - (b) Thermal movements of water
    - (1) Movements of water resulting from a difference in density, convection currents.
  - (c) Movements of water induced by the movement of air
    - (1) Waves
    - (2) Drift and tides of rises from atmospheric force (Seich currents).
2. Physical Properties of Water as a Force for Attraction or Repulsion
  - (a) Temperature - amount of heat in water (not to be confused with movement resulting from temperature).
  - (b) Dissolved gases - primarily oxygen and carbon dioxide; however, nitrogen and possibly other gases might be tested.

(c) Suspended and dissolved matter (inert matter and naturally occurring dissolved chemical compounds, such as salts, etc.).

3. Chemicals

In conjunction with water movements resulting from the above forces and/or independently of those forces procedures will include an effort to determine if a chemical means of attraction can be found.

4. Mechanical Devices

Mechanical means of luring or congregating fish as attractors and possibly many others.

Specific Limitations for Segment's Work

Other work commitments were known to be prohibitive to the testing of any except possibly a few devices and/or forces or conditions. Selections of specific procedures were made on the basis of how investigational effort could be carried out in conjunction with other work; upon how information and data obtained might be utilized in secondary objectives should the primary purpose be unachieved; and because they were regarded by the project leader as being the forces or devices that, at least superficially, appeared to be those most likely to prove fruitful.

PROCEDURE AND FINDINGS

Extensive development work such as the watershed eradication work on Champion Creek, and other chemical treatments at Moss Creek Reservoir and at Robert Lee required more than 400 man-days time during the year. That work and other unanticipated work including moving into new quarters, setting up a different system of filing reference material, equipping a laboratory, and other work has prevented completion of the experimental plans for this job. Virtually all findings obtained during the year are of negative quality and are such that they can not be presented in the form of statistical data.

With a few exceptions it may be stated that the bulk of experimentation failed in its primary purpose but was important in that it provided a better understanding of the mechanical needs for doing this work and provided better knowledge for planning future experiments.

Laboratory Work

Search of literature

A search of the literature has yielded little information of immediate and practical use. In all, at least 1,200 chemicals have been considered, at least superficially, to offer some potentiality of having attractive or repulsive properties on some of the nine species of fish to be considered. Forty chemical companies were written in an attempt to obtain information to be used in selecting chemicals for testing. Means of quantitatively analyzing the chemicals during testing is either unavailable or beyond the skills of the present regional staff with the equipment

now on hand at the laboratory. The necessity of such analytical work is regarded as being primary in importance, if not absolutely essential. The review and study of chemicals must be continued and expanded before a logical and organized direction for systematic testing can be selected. It is concluded that this portion of the investigation has served to broaden possibilities for testing rather than to serve its intended purpose of narrowing the selection to a few chemicals with a high potential for meeting the need. Chlorine and copper acetate, with nigrosine dye, in a soluble wax is being used by the armed forces and other agencies of the federal government for repelling sharks. Although records are contradictory and inconclusive, this substance is probably effective in specific instances. Other substances such as fish oils and complex baits have been used as a means of attraction under specific conditions with varying results being reported. However, nothing found in the literature from work completed has a proven ability to attract fish in a specified and measurable manner. A study of the literature will be continued as time permits.

#### Simulated flow

An attempt was made to set up experimental procedures as was originally outlined in the job description in the Plans, Specifications and Estimates. However, unforeseen circumstances and a lack of apparatus prevented that procedure from being performed as planned. Extensive effort was made but only six species were secured in sufficient quantities to be used in tests, and suitable facilities for holding these fish were not available at the time when the work had to be done.

Further complication was encountered when it was discovered that oxygen depletion occurred under the testing conditions in spite of aeration with "home made" equipment. Two attempted initial tests were ruined because water had to be added to provide aeration and thus prevent death of the test fish from oxygen deficiency. Pumps were not ordered until more facts and a better understanding of what was needed could be obtained. For that reason simulated flow was created and controlled within the tanks only by the use of valves. Tanks used in the tests were those ordinarily required as holding tanks belonging to the fish hatchery, and experimental work was necessarily of secondary importance when any decisions were made pertaining to the availability of the tanks for immediate use. For that reason, and because of the difficulties encountered when planning this work, a better planning and coordination of testing when the tanks are available must be worked out or additional tanks purchased.

Observations provide the only knowledge gained from these experiments. However, a much better understanding of equipment and the facilities needed was gained. These observations failed to reveal any tendencies of intra-specific or inter-specific gregariness under cool water, lack of flow conditions. Nor was there any discernible pattern of species distribution. All fish used in the tests appeared to be attracted by the flow and circulation of water created by release of water through the valves. It was obvious that the degree of this attraction was greatly influenced by a number of variables that are as yet undefinable.

Procedure for tests in water from Lake Nasworthy - Four metal tanks 30-inches wide, 36-inches deep and 12-feet in length were filled with water from Lake Nasworthy. It was initially intended to use six tanks but only four were available at the time needed. Eight yellow bullheads (Ameiurus natalis), four river carpsuckers (Carpiodes carpio), two carp (Cyprinus carpio), 12 green sunfish (Lepomis cyanellus), seven bluegills (Lepomis macrochirus), and three white crappie (Pomoxis annularis) were placed in each tank. As fish died in the acclimation process they were replaced by

living fish of the same species to maintain the total number of fish per tank at 36 during the experiment. The results were as discussed above. Another alteration in the planned procedure for testing simulated flow was the use of six rather than nine species. This was done because the desired numbers of fish for each species were not obtained or maintained during the tests. Temperature and intensity of flow could not be tested since the equipment available for use would not permit controlling these variables. The rate or velocity of flow could not be measured because the flow meter had not been purchased at the time the experiments were attempted. Statistical analysis was impossible under the circumstances.

#### Chemicals and gases

It was impossible to test gases or chemicals for reasons already stated. Only information pertaining to the repelling effect of chemicals was obtained as a by-product of conducting bio-assay type experiments with toxaphene and rotenone. Tests with toxaphene were to determine the residual properties of toxaphene in water from Lake Sweetwater.

Procedures for tests in water from Lake Sweetwater were as follows: Six jars containing five gallons of water, taken from Lake Sweetwater, were set up in the laboratory and aerated. Approximately two inches of mud, taken from the lake bottom, was placed in each jar. Bullheads and several other species of fish were placed in the jars. Toxaphene was added at a concentration of about 0.125 p.p.m. in the first jar, 0.250 p.p.m. in the second jar, 0.350 p.p.m. in the third jar, and 0.70 p.p.m. in the fourth jar. The fifth and sixth jars were used as controls. The chemical was added in minute quantities at the bottom of the jars where most of the fish were concentrated. The exact concentration in the immediate area of the jar where the toxaphene was added could not be determined, and it was discovered that even the minimum concentration of 0.125 p.p.m. was much greater than required to kill the fish.

Apparently the toxaphene repelled the test fish since they all moved to the surface in the four jars when toxicant was added. In the two control jars, where toxaphene was not added, the fish remained near the bottom. These are, of course, inconclusive tests since the amounts of toxicant or chemical added were in all instances lethal, and the actions of the fish could have been meaningless under the circumstances.

At Lake Sweetwater similar tests were conducted. The procedure was as follows: Three barrels were placed in the lake with about two-thirds their depth below the surface. They were then filled to near capacity with water. This was done so that near identical temperatures would be maintained for the water in the barrels with that of the water in the lake. Bullheads and other species of fish were placed in the barrels. Aeration was supplied and the fish were given several days time to adjust.

Water in the first two barrels were treated with toxaphene at concentrations of about 0.125 p.p.m. and .350 p.p.m. The third barrel was used as a control.

Reactions similar to those observed in the laboratory occurred. Fish in the treated water moved to the top and fish in the untreated water remained near the bottom.

In addition to the tests with toxaphene, emulsifiable rotenone was released in

the fish hatchery tanks of fish described in the section results pertaining to simulated flow. The rotenone was added in a manner similar to that described for toxaphene and the fish reacted in an identical manner in that they were repelled. Future study to determine the concentration necessary and the best means of applying these chemicals as repellants will require considerable time. However, there is some basis for assuming that a means for repulsion of several species is now available.

Other procedures outlined in the job description that could not be accomplished, either because of lack of time and equipment or because circumstances beyond our control, were statistical analyses of data for influences exerted or for tests involving combinations of forces to determine the combined influence.

#### Specific Field Experimentation

For the reasons set forth under laboratory work and because of an unfortunate flood in the fall of 1959, specific field procedures outlined in the approved job description were not completed.

#### Lake Nasworthy

At Lake Nasworthy a systematic netting program was started, but the other procedures and devices such as the semi-permanent traps and floating platforms described under items numbered 2 through 5 of the job description were not used.

Construction had begun on two traps when a ruinous flood swept through the lake and destroyed the structures. Pumps were not purchased in time for their use in experimentation in the lakes and no other work was done in the field except the making of gill net sets for securing data on the fish populations.

Data from netting served the initial purpose of providing up-to-date information to be used as a basis for considering changes in the populations since the last sampling was done. This work also provided some evidence of distribution of species under the existing conditions, when no flow through the lake was taking place. To date, these data are regarded as inadequate when attempting to predict any distribution pattern by species, but future netting and sampling is expected to provide data that will make such prediction within the ability of those responsible for the lake's future management. Comparison of the distribution patterns would be essential in considering future management employing means of attraction and repulsion. The netting data are presented in Figure 1.

#### Lake Colorado City

Specific but incomplete distribution of species data were obtained from this reservoir for the winter months. A complete description of the thermo-electric plant and the hydrological condition that results from its use is presented in the completion report for Job B-27. Briefly, the effect of this plant on the lake may be described as a circulation of the lake's water through the plant for cooling that results in a water temperature rise during parts of the year of about four degrees F. in the lower half of the reservoir. The rate of flow of the discharge which varies up to 600 c.f.s. or 1,190 acre-feet daily is increased in velocity by a 10 foot drop over a weir at the end of the canal. A current is thus created which is visible for about 200 yards. It is believed that a circulating effect through the entire lower

of the reservoir may result and that a warm water current flows from the discharge toward the plant intake. The exact course of this movement is not known. It apparently does not conform with any specific depth or topographic feature of the lake basin. There is, however, a great concentration of fish near the point where the discharged water enters the lake.

Other variables undoubtedly contribute to the attraction effect and in the following statistics and in those included in Figure 2, circulation of water and other physical factors are probably augmented by the policy of the Texas Electric Service Company that prohibits access and thus affords protection for fish life.

Over sixty-three percent of all gizzard shad netted were captured within the restricted area and 76.72 percent of all channel catfish were taken from only six gill nets set in the immediate area of the discharge. Of all fish captured by gill netting, 52.01 percent were captured in 13.95 percent of the total number of nets set. These fish were captured in less than 5 percent of the area covered by the lake.

In addition to the statistics provided by netting, observations included witnessing intense and active milling or congregating of channel catfish, shad, and river carpsuckers in and about the race created by the fall of discharged water from the weir. Schools of shad and other unidentified fish were also seen moving around the shoreline in a definite pattern.

As shown in Figure 2, the attraction of fish populations is somewhat less during winter months and all evidence indicates that channel catfish and shad are not concentrated near the discharge during that period. This permits the tentative deduction that perhaps the gizzard shad is the primary species attracted by the current and that possibly channel catfish congregate to feed on them. Stomach contents of catfish supported this. Although no proof is available, this observer was inclined to conjecture that perhaps fish are attracted to the environment afforded by the discharge current, and certainly the time required for feeding by these species could only partially account for their presence in this area.

#### Other Aspects of Conditions to be Studied During Inventory and Resurvey

Dissolved Salts - For the reasons already presented no work was done on this part of the designated procedure.

Suspended Inert Matter - No work was done on this phase of the work for the previously stated reasons and also because the required conditions were not encountered while doing other work.

Prepared by Lawrence S. Campbell  
Project Leader

Approved by Marion Toole  
Director Inland Fisheries Division

Date January 26, 1961

Figure 1. Results of gill netting in Lake Nasworthy, 1959-60.

Species	Number	Percent of number	Total Weight		Percent of Weight	Avg. Weight	
			Lbs.	Ozs.		Lbs.	Ozs.
Longnose gar	59	8.44	21	1	4.57		5.7
Gizzard shad	376	53.79	83	12	18.17		3.6
River carpsucker	112	16.02	176	6	38.27	1	9.2
Carp	36	5.15	49	3	10.68	1	5.9
Channel catfish	34	4.86	26	5	5.71		12.4
Flathead catfish	7	1.01	46	13	10.16	6	11
White bass	22	3.14	30	10	6.64	1	6.3
Largemouth bass	2	0.29	1	13	0.40		14.5
Sunfishes	17	2.43	2	2	0.46		2
White crappie	31	4.44	18	14	4.09		9.7
Freshwater drum	3	0.43	3	14	0.85	1	4.7
<b>Totals</b>	<b>699</b>	<b>100.00</b>	<b>460</b>	<b>13</b>	<b>100.00</b>		

Figure 2. Comparison of summer and winter netting near discharge weir, Lake Colorado City, 1959-60.

Species	Summer		Winter	
	Number*	Percent of number	Number**	Percent of number
Gizzard shad	91	21.36	29	12.71
River carpsuckers	46	10.79	66	28.95
Carp	8	1.88	2	0.88
Channel catfish	244	57.28	61	26.76
Flathead catfish	-	-	4	1.75
Largemouth bass	5	1.18	50	21.93
White crappie	4	0.94	16	7.02
White bass	26	6.10	-	-
Freshwater drum	2	0.47	-	-
Total	426	100.00	228	100.00

\* fish captured in six experimental gill nets.

\*\*fish captured in 14 experimental gill nets.