(8 p.p.m.). More applications of copper sulfate and Delrad are usually needed as their effect often is of short duration. As many as 10-15 applications of Delrad have been required for *Pithophora* control in a pond doring one season.

CONCLUSIONS

Study of the experience gained in using abietylamine acetate (Delrad) for control of *Hydrodictyon* and *Pithophora* in warmwater hatchery ponds over a period of four years indicates that the chemical has possibilities as an algicide in warmwater hatchery ponds provided that its limitations are taken into consideration. It is highly toxic to fishes and recently hatched fry appear especially susceptible to its action. However, it is also toxic to objectional species of algae while being relatively non toxic to phyto and zooplankton. Concentrations should be determined accurately and amounts applied uniformly. Where either copper sulfate or sodium arsenite have proven unsatisfactory as algicides, use of abietylamine acetate is suggested in warmwater hatchery pond management.

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OBSERVATIONS ON THE INFLUENCE OF THE NEW JOHNSONVILLE STEAM PLANT ON FISH AND PLANKTON POPULATIONS

By WILLIAM DRYER and NORMAN G. BENSON
Tennessee Game and Fish Commission

As potential hydroelectric power sources are diminishing in Tennessee, the construction of steam plants for generation of electricity is increasing to satisfy expanding industrial power demands. The Tennessee Valley Authority has constructed five steam plants and more are being considered. The relationships of these plants to the fish populations of reservoirs or rivers should be understood by fishery biologists. Engineers who design these plants are also interested in their influence on the recreational uses of the water.

The present study was carried out at the New Johnsonville Steam Plant, 12 miles west of Waverly, Tennessee on Kentucky Lake from October, 1955 to August, 1956. The purposes were to determine: (1) seasonal fish concentrations, (2) seasonal food availability, and (3) the extent of influence of this plant beyond the immediate discharge harbor.

The New Johnsonville Steam Plant was completed in 1953 and has a total capacity of 750,000 kilowatts. The steam used to propel the turbines comes from distilled water and is reused after passing over condensers. Water required to cool the condensers is taken from Kentucky Lake through an inlet channel above the steam plant. This water is pumped at the rate of 633,000 gallons

per minute through the condensers and is released into a rectangular discharge harbor of 82 acres (Figure 1). Water is released from the discharge harbor through a wide channel into Kentucky Lake. The entire cooling process raised the temperature of the water approximately 10° F. during the winter months of the study.

METHODS

The following data were collected to determine the influence of the steam plant on fish populations: (1) concentrations of fish throughout the winter and spring season in the discharge harbor, (2) plankton production both in the main lake and the discharge harbor, (3) temperatures in the lake and in the discharge harbor, and (4) creel census. To sample the fish populations, two-inch bar measure gill nets (150′ x 6′) were used. The time of sets ranged from 6 to 24 hours, but all data were compiled on a 24-hour set basis. All fish were measured and weighed and all game fish were tagged. Small fish, particularly Mississippi threafin shad, *Signalosa petenensis atchafaylae* were unusually abundant at certain periods but only estimates of their abundance were made on this species. One gallon water samples were collected monthly from one foot below the water surface from four stations (Figure 1). The

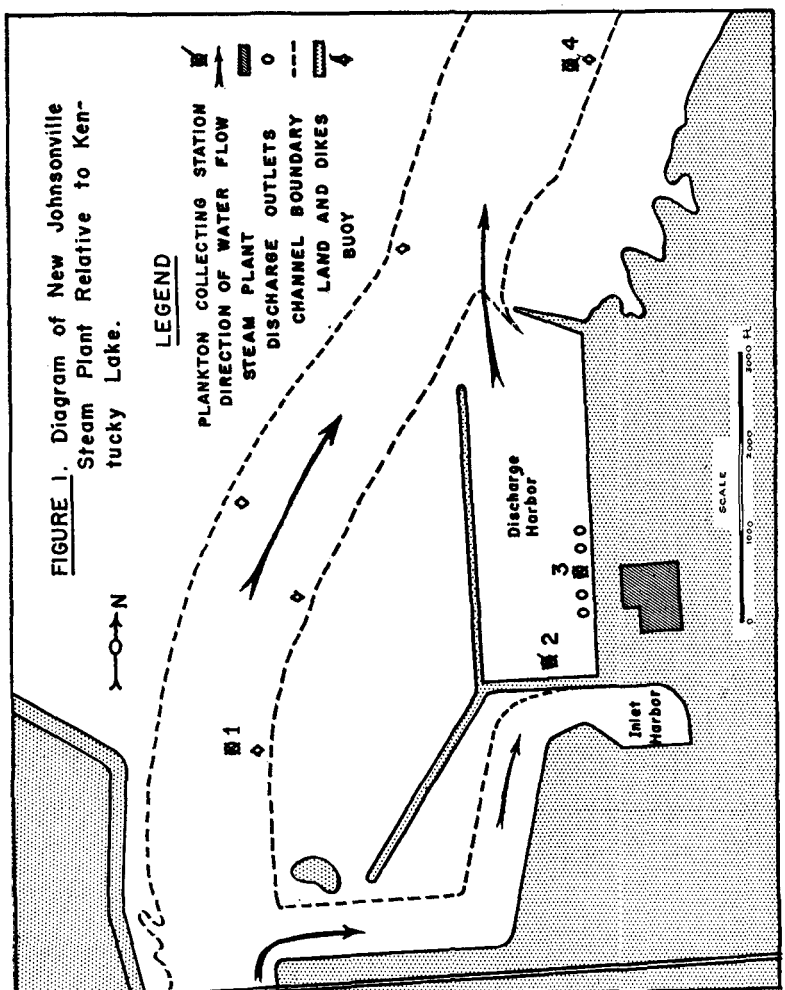

FIGURE 1. Diagram of New Johnsonville Steam Plant Relative to Kentucky Lake.

samples were analyzed for plankton in fresh condition both quantitatively and qualitatively by Dr. Woodrow Jones of Fisk University. Temperatures were taken when the water samples were collected. Creel census information was collected from March through June, 1956.

TEMPERATURES AND PLANKTON PRODUCTION

Temperatures in Kentucky Lake above the steam plant were 72° F. in October and reached 41° F. in January (Table I). After this period, there was a gradual warming until May when the temperatures reached 75° F. Temperatures in the steam plant discharge harbor were 10° F. above the lake temperatures from October to March. In April and May they were only 5° or 6° above the corresponding lake temperatures. Temperatures in the river below the steam plant harbor (Station 4) were 1° or 2° warmer than lake temperatures above the plant (Station 1) during the winter months.

TABLE I

PLANKTON PRODUCTION IN NUMBERS PER LITER AND TEMPERATURES OF WATER SAMPLES FROM NEW JOHNSONVILLE STEAM PLANT HARBOR AND KENTUCKY LAKE, TENNESSEE, OCTOBER, 1955, TO MAY, 1956

Date of Collection	*Station Number and Location*			
	Station 1 Main Lake Above Steam Plant Harbor	*Station 2 Steam Plant Harbor*[1]	*Station 3 Steam Plant Harbor*[1]	*Station 4 Main Lake Below Steam Plant Harbor*
Oct. 13, 1955				
No.	97	159	—[2]	28
Temp.	72°	82°	—	—
Nov. 20, 1955				
No.	1,521	2,475	2,286	1,864°
Temp.	57°	66°	67°	59°
Dec. 7, 1955				
No.	2,160	941	2,398	3,316
Temp.	45°	55°	55°	48°
Jan. 18, 1956				
No.	1,142	2,041	618	2,056
Temp.	41°	51°	51°	42°
Feb. 1, 1956				
No.	1,872	1,722	439	1,361
Temp.	45°	55°	55°	46°
Feb. 6, 1955				
No.	1,399	971	596	605
Temp.	52°	62°	62°	52°
Mar. 26, 1955				
No.	3,323	3,449	2,834	2,689
Temp.	52°	62°	62°	55°
Apr. 23, 1956				
No.	3,945	2,952	1,423	4,769
Temp.	63°	69°	69°	62°
May 14, 1956				
No.	8,602	1,202	1,254	1,529
Temp.	75°	80°	80°	75°

1 See Figure 1 for location of Stations 1 and 2.
2 Dash (—) indicates no data collected.

The fish food chain in main stream reservoirs in Tennessee is directly related to plankton production. It was important to know whether fish concentrations in the harbor were attracted by an increased food production or by warmer temperatures. Plankton samples were collected in the harbor and the main reservoir from October to May to determine if the warm discharge water in the steam plant harbor increased plankton production. No significant increase in plankton production could be associated with the steam plant discharge water (Table I). During October and November the plankton counts in the discharge harbor were slightly above those of the main lake but during the remaining months the counts were similar or lower. During May plankton production in the steam plant harbor was lower than in the main reservoir. The sampling station on the main lake below the steam plant did not show any consistent differences in plankton production from the station above the steam plant. Organisms were identified to genera but will be reported on in a later report.

FISH CONCENTRATIONS

Tremendous numbers of shad, predominately Mississippi threadfin, have previously been observed in the steam plant harbor during the winter months. Information from several sources indicates that the shad were almost entirely threadfin with few gizzard shad. All shad observed dead have been threadfin. Cast net samples showed all threadfin and no gizzard shad. Sauger stomachs showed a 100 per cent threadfin shad diet. Shad have occurred in such large numbers that outboard motors could not be operated at certain times. Water pumps in outboard motors would become clogged with shad. Every year several hundred gulls winter near the steam plant utilizing the shad as food. In November, 1955, large numbers of shad had already concentrated in the steam plant harbor. They were most abundant in the harbor around January 1, 1956, and were rare after March 15.

The abundance of sauger, *Stizostedien canadense,* and skipjack *Alosa chryso chloris,* was related directly to the numbers of threadfin shad (Table II). Stomach samples of sauger showed a 100 per cent shad diet. Both skipjack and sauger were present in moderate numbers in November. They reached their maximum abundance in late December, and were rare after March. An examination of the gonads of sauger taken in the steam plant harbor showed that they had spawned at least one week prior to the sauger in the main lake. This condition was probably due to the combined effect of additional food and higher temperatures. The presence of large numbers of sauger in the steam plant harbor was undected by sport fishermen. Although the sauger concentration was given much publicity, few fishermen were successful in catching sauger probably because of the abundance of shad as natural food.

Both the blue catfish, *Ictalurus furcatus,* and channel catfish, *Ictalurus lacustris,* started to concentrate in the harbor in late February and were abundant from March 15, 1956 to June, 1956. Commercial fishermen crowded the harbor during the spring months with hoop nets and set lines. The heavy concentration of catfish had left the harbor around July. The presence of catfish was not closely related to the numbers of threadfin shad present since they appeared after the largest concentrations of shad had left. Gill netting in August showed only a few channel catfish, flathead catfish, durm and smallmouth buffalo. No game species were found at this time.

A creel census was conducted one day a week from March to June in the steam plant harbor. The results showed a consistant catch of channel catfish and bluegill with occasional catches of blue catfish, carp, drum and sauger (Table III). The fishing was principally bait fishing for channel catfish and bluegill and the catch per man hour reached a peak of 1.15 fish in April and declined to 0.42 in June. During the summer months practically no fishing occurred in the steam plant harbor, probably because water temperatures were more desirable for fishing in the main lake.

TABLE II

CATCH PER 24-HOUR SET OF 150 BY 6 FOOT GILL NET (2-INCH BARMESH), NOVEMBER, 1955, TO OCTOBER, 1956, NEW JOHNSONVILLE STEAM PLANT HARBOR, TENNESSEE

Species *	Number of Fish and Weight in Pounds																			
	Nov. 22, '55		Dec. 29, '55		Dec. 30, '55		Feb. 8, '56		Feb. 9, '56		Feb. 26, '56		Mar. 14, '56		Mar. 15, '56		Aug. 29, '56		Aug. 30, '56	
	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.	No.	Wt.
Gizzard Shad	..	...	3	2.4	..	...	..	...	10	7.5	8	6.4	4	3.3	1	0.8	..	...	..	...
Skipjack	8	13.4	333	612.3	159	246.0	317	532.3	303	553.2	8	7.2	11	19.7	6	12.4	..	...	..	...
Blue catfish	1	0.6	..	...	3	8.4	19	15.0	64	43.0	88	76.0	37	31.2	21	8.5	..	...	..	...
Channel catfish	6	12.8	..	...	..	...	..	...	7	4.7	16	16.0	2	3.3	7	11.5	3	5.3	1	1.8
Flathead catfish	..	...	..	...	..	...	..	...	3	0.4	..	...	..	...	1	1.5	..	...	..	...
River carp sucker	..	...	..	...	..	...	5	4.8	..	...	..	...	..	...	..	...	3	3.1	3	3.2
Carp	1	1.3	..	...	7	23.1	..	...	..	...	..	...	..	...	7	10.8	1	1.0	..	...
Drum	1	1.1	..	...	..	...	5	0.4	..	...	..	...	..	...	..	...	3	2.6	1	0.2
Sauger	44	100.8	75	160.5	108	237.7	24	44.6	31	54.7	24	36.8	9	14.2	20	35.3	..	...	..	...
White crappie	..	...	3	5.7	10	8.4	..	...	..	...	..	...	..	...	1	1.4	..	...	..	...
Spotted bass	..	...	..	...	7	10.2	..	...	..	...	..	...	..	...	1	1.2	..	...	..	...
White bass	..	...	..	...	..	...	..	...	..	...	..	...	1	0.8	2	1.7	..	...	..	...
Smallmouth buffalo	..	...	..	...	..	...	..	...	..	...	..	...	..	...	..	...	11	9.5	3	2.2
TOTAL	6	130.0	414	780.9	294	533.8	370	597.1	418	663.5	144	142.4	64	72.5	67	95.1	21	21.5	8	7.4

TABLE III

ANGLING HARVEST, MARCH THROUGH JUNE, 1956
NEW JOHNSONVILLE STEAM PLANT HARBOR, TENNESSEE

	Month of Creel Census				
	March	*April*	*May*	*June*	*Total*
No. of fishermen contacted.....	72	32	56	41	201
No. of man hours sampled.....	150.3	91.0	225.8	160.1	827.2
Per Cent of successful fishermen	41	19	42	27	129
Catch of fish per man hour.....	.97	1.15	.77	.42	..
Catch by Species:					
Channel catfish	91	67	86	18	262
Blue catfish	1	..	4	2	7
Bluegill	39	1	29	30	99
Carp	2	7	7	5	21
Drum	1	..	14	6	21
Sauger	..	..	2	1	3

DISCUSSION

The warm water that was discharged during the winter months was probably responsible for the abundance of threadfin shad that concentrated in the steam plant harbor. Although shad are plankton feeders, there was no evidence that plankton production in the steam plant harbor during the winter months attracted the shad. Other evidence supports the fact that temperature was the important factor. Parsons and Kimsey (1954) found that threadfin shad survived best for transportation when water temperatures were between 50° and 60° F. High mortality occurred when the temperatures were below 45° F., and few fish survived when temperatures were below 40° F. Threadfin shad were most abundant in the steam plant harbor when Kentucky Lake was 45° F. and the discharge harbor temperature was 55° F. Shad left the harbor in March when lake temperatures were 52° F. and the harbor temperature, 62° F. Threadfin have been stocked in several reservoirs in Tennessee, and winter mortalities occur regularly. Enough usually survive, however, to restock the reservoir after spawning. Certain reservoirs have to be stocked every year in the spring to assure a sufficient spawning population. In Kentucky Lake, threadfin shad were not present in great numbers prior to 1950 according to populations studies conducted by Tennessee Valley Authority biologists. This fact suggests that the warm water from the steam plant may serve as a winter refuge for shad and may have influenced the shad population in the entire lake. During the winter months heavy threadfin shad mortalities have frequently been observed in Kentucky Lake in sloughs and areas which are not affected by the steam plant. Thus it is possible that the threadfin shad which enter the steam plant harbor may serve as a spawning stock for the entire lake and natural mortalities formerly killed much of the standing population.

The numbers of sauger and skipjack in the steam plant harbor was closely related to the numbers of shad. The sauger is a highly desirable game fish and such a concentration should be welcomed by sport fishermen. The value of this fishery will remain small until fishermen have learned how to catch sauger when lures are competing with thousands of threadfin shad.

The concentration of catfish during April, May, and June, may be partially attributed to the excellent spawning habitat available as a result of rip-rap on

dikes enclosing the harbor. A conflict developed when commercial gear interfered with sport fishing in the harbor. Since this area is easy to fish from either a boat or the bank, regulations were set to exclude commercial fishermen from this 82-acre harbor during the months of April, May, and June.

In 1954 many threadfin shad concentrated in the inlet harbor of the steam plant. These shad were so thick that the screen over the inlet line became obstructed. The cost of cleaning out the shad and the loss in power generation amounted to $18,000.00. The temperature of the water in the steam plant inlet harbor is the same as the lake proper. No reason for this concentration is offered although dead shad may have been sucked into the harbor during a regular winter mortality.

Fish populations in the steam plant harbor during the winter differed greatly from those in the main lake. Gill netting studies were conducted four miles downstream from the steam plant harbor in connection with another phase of this project. From November through February, 96 sets of 24-hours each were made. Only three sauger and six skipjacks were captured. Species commonly collected were river carpsucker, blue catfish, drum and carp. The fish populations of steam plant harbor during the winter months consisted pricipally of those species which feed principally on shad. The regular lake fish populations consisted of species with varied feeding habits. White crappie, largemouth bass, and white bass were not active during the winter months and were not commonly captured at any location.

Creel census information collected in the main lake during the spring months showed predominant catches of white bass, white crappie, and largemouth bass. The catch in the steam plant harbor consisted of principally channel catfish and bluegill. This variance in catch occurred because fishermen in the steam plant harbor were fishing with minnows and artificial lures. Other steam plants in Tennessee are being investigated and observations indicate they are also important as fishing areas during the winter and spring months.

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TECHNICAL EDUCATION SESSION

SOME OBSERVATIONS OF INTRA- AND OUTRA-PERSONNEL DIFFICULTIES IN AUDIO-VISUAL RELATIONSHIPS BETWEEN DEPARTMENTAL AND PUBLIC VARIETIES OF THE HOME SAPIENS

By DAN SAULTS
Missouri Conservation Commission

Dear Fellow-Sufferers in This Vale of Exploitation:

I assume that I am here addressing a bunch of pros. We all work in the field of conservation, so I'm going to talk about conservation in the fish and game field—with some side glances at the timber problems—without trying to kid myself, delude you, or get mystical about good sportsmanship. There are so many cute phrases, so much tried and true triteness, in the hunting and fishing departments that we need to be strictly professional when we get together away from the public. We ought to be like baseball players—talk about how to pitch to Mantle rather than go into inky ecstasies about baseball being part of the American way of life. Are hunting and fishing "the American way?" Are they repositories of special virtues? Maybe. But . . .