Loss in Weight of Sunfish Following Aquatic Vegetation Control Using the Herbicide Silvex[1]

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Three species of sunfishes from two ponds experienced decreasing condition indexes during two years following the application of Silvex, a herbicide which gave excellent control of dense growths of submersed rooted aquatic plants. An overabundance of aquatic plants in ponds has long been recognized as a major factor associated with stunted fish populations and poor fishing. Among the many problems experienced in managing farm ponds, that of excessive aquatic plant growth occurs as one of the most common. As the number of ponds in Oklahoma continues to increase, the demand for some method to control aquatic plant growth also increases.

In response to this demand a program of testing various herbicides for use in ponds was conducted by the Oklahoma Fishery Research Laboratory and the Samuel Roberts Noble Foundation, Inc., Ardmore, Oklahoma, during 1960 and 1961 (Houser and Gaylor, 1962). Fish population studies were conducted in two ponds which had been treated with a liquid Silvex preparation containing six pounds acid equivalent of the potassium salt of 2(2,4,5 - trichlorophenoxy) propionic acid. On 3 May, 1960, Noble Pond 13 was treated with 1.5 ppm and Noble Pond 14 with 2.0 ppm.

Dense growths of *Naias guadalupensis* and *Ceratophyllum demersum* were in both ponds and *Zannichellia palustris* was common in Pond 13. Unidentified species of *Chara* were also common in both ponds. Immediate control was achieved for all vegetation except algae but additional treatments using copper sulfate also controlled them. Without further treatment both ponds remained clear of rooted aquatic plants throughout the summer of 1962.

Both ponds are normally clear and support populations of sunfish including largemouth bass. Pond 13 measures 3.5 acres and Pond 14 measures 2.7 acres.

METHODS

Since 1957, when both ponds were used for standing crop studies (Jenkins, 1957), fish population estimates in both ponds have been conducted each year during January and February. Fish sampled in Pond 14 during 1962 were taken with electrofishing gear. All other collections in 1960, 1961, and 1962 were made with barrel traps.

[1]Contribution No. 84 of the Oklahoma Fishery Research Laboratory, a cooperative unit of the Oklahoma Department of Wildlife Conservation and the University of Oklahoma Biological Survey.

All fish measurements were taken as total lengths in inches and weights in grams. Measurements were recorded from daily collections made during a three-week sampling period chosen to occur at the same time each year. A coefficient of condition C(TL) was derived from these measurements and is expressed as the ratio of 100,000 $\times$ weight in pounds to the cube of the length in inches. The values used for comparison were derived by calculating average lengths and weights for one-half inch groupings.

RESULTS

Population studies revealed little change in numbers and weight of the standing crop in either pond. Rates of growth had been expected to change; however, no clear trend could be found which would indicate either decrease or increase. Length-weight relationships calculated each year did provide evidence that progressive changes had occurred in the condition of sunfishes. A definite decline in condition index of green sunfish in both ponds was seen; also for bluegill and warmouth in Pond 14, it clearly had decreased (Tables 1-4). Collections of largemouth bass and other sunfish also present in both ponds were to small to provide a sufficient number of measurements to justify comparisons.

DISCUSSION

There is some evidence that fish production is closely related to the amount of rooted aquatic plant growth in a pond. When dense stands of vegetation develop, fewer fish can be supported in the pond (Bennett, 1962). Nutrient materials required for production of phytoplankton are bound in the plants and production of both phytoplankton and the organisms which feed upon them is decreased. The production of food organisms of sunfishes may therefore be decreased when gowth of these plants become overabundant.

In the presence of beds of aquatic plants bluegill as well as other sunfishes utilize various insect larvae whose abundance is closely associated with plants (Ball, 1948, and Richardson, 1921). Preferred food items become less abundant with the destruction of the plants and these fishes are then forced to utilize other less desirable forms. In the presence of other species competition may also develop. Loss of weight could then be attributed to a forced diet change to less desirable food which may also be accompanied by competition for the alternate food supplies.

Aside from the effects resulting from ecological changes, the loss of weight could have also refelected a toxic effect of the herbicide on the sunfishes. The 1.5 and 2.0 ppm rates of application are near the minimum for effective control of submersed aquatic plants and have been considered well within tolerable limits for warmwater species (Surber and Pickering, 1962). In a series of tests by Houser and Gaylor (1962) no mortalities were observed in ten additional ponds which were treated at a rate of 2.0 ppm. A closely related compound, Kuron, which is the propylene glycol butyl ether ester of Silvex was listed by Lawrence (1958) as safe for fish when used at 3 ppm; however, in current studies conducted by the Fish-Pesticide Research Laboratory of the Bureau of Sport Fisheries and Hatcheries a definite pathology developed in bluegill exposed to 2,4,-D, another closely related compound, at concentrations of 0.1 to 10 ppm and was recognized for as long as 112 days (personal communication with Dr. Oliver Cope). Residue analysis of whole fish indicated that concentrations of 2,4,-D appeared in the fish exposed to the highest levels but did not last beyond a week or so.

TABLE 1. COMPARISON OF CALCULATED CONDITION INDEX C(TL) OF GREEN SUNFISH FROM NOBLE POND 13 DURING AQUTIC VEGETATION CONTROL TESTS WITH THE USE OF SILVEX.

Length Range	1960 Average Length Inches	1960 Average Weight Pounds	1960 C(TL)	1961 Average Length Inches	1961 Average Weight Pounds	1961 C(TL)	1962 Average Length Inches	1962 Average Weight Pounds	1962 C(TL)
2.3-2.7							2.54	.010	58.6
2.8-3.2							3.02	.016	59.2
3.3-3.7							3.48	.026	61.5
3.8-4.2							3.98	.040	62.7
4.3-4.7	4.52	.073	78.7	4.48	.072	80.4	4.52	.063	67.9
4.8-5.2	4.99	.098	78.7	5.02	.106	83.7	5.01	.083	66.4
5.3-5.7	5.53	.1422	84.1	5.53	.137	80.9	5.57	.120	69.4
5.8-6.2	6.04	.1863	84.6	6.01	.179	82.5	6.01	.153	70.7
6.3-6.7	6.42	.2194	82.9	6.48	.234	85.9	6.53	.201	72.3
6.8-7.2	6.90	.2709	82.5	6.94	.287	85.9	6.95	.246	73.3
7.3-7.7				7.47	.363	87.0	7.48	.321	76.7
7.8-8.2				7.86	.421	86.6	7.84	.380	78.8
Number of Fish		233			578			292	

TABLE 2. COMPARISON OF CALCULATED CONDITION INDEX C(TL) OF GREEN SUNFISH FROM NOBLE POND 14 DURING AQUATIC VEGETATION CONTROL TESTS WITH THE USE OF SILVEX.

Length Range	1960 Average Length Inches	1960 Average Weight Pounds	C(TL)	1962 Average Length Inches	1962 Average Weight Pounds	C(TL)
3.3-3.7				3.47	.024	58.4
3.8-4.2	3.93	.040	65.2	3.96	.035	55.9
4.3-4.7	4.51	.066	71.8	4.43	.051	59.1
4.8-5.2	4.98	.088	71.2	4.93	.072	60.2
5.3-5.7	5.52	.121	71.8	5.30	.096	64.4
5.8-6.2	5.93	.142	68.1	6.00	.133	61.5
6.3-6.7	6.35	.180	70.1	6.60	.182	63.4
6.8-7.2				7.20	.238	63.7
Number of Fish		123			67	

The series of tests at Ardmore, of which the two ponds considered here are only two out of 14 where liquid Silvex was used, gave evidence of extended residual effect upon the vegetation. Although its lingering presence seemed evident, no attempt was made to determine the manner in which it persisted.

In their food-gathering activities fish-food organisms consume both plant and other animal materials which might be expected to contain residues of Silvex. Fish in turn consume large quantities of these organisms. Through this process there may may developed accumulations within the fish bodies to the extent that a pathology developed which was reflected in the loss of weight. Even though the amounts accumulated may have been well below those levels presently recognized as lethal, too little is known about the effects of long-term exposure to discount that it could have produced the gradual erosion in the general condition of these fishes.

The adverse conditions which developed and affected the condition of these fishes were not studied during these tests; however, there is little doubt that the weight loss was a result of the herbicide whether its action was direct or indirect.

In response to an increasing demand for better methods to control aquatic vegetation in ponds and lakes, numerous new chemicals have been offered by manufacturers for testing. Extensive testing programs throughout the United States have revealed that some are quite effective and some of these are presently being recommended for general use. Their effectiveness for plant control has been adequately demonstrated but very little has been done to determine their effects on fishes and fish populations. Results observed in tests on the Noble Ponds indicate a need for further investigation since there exists a possibility that some chemicals may, in the process of removing vegetation, actually suppress fish growth and the maintenance of healthy fish populations.

TABLE 3. COMPARISON OF CALCULATED CONDITION INDEX C(TL) OF BLUEGILL FROM NOBLE POND 14 DURING AQUATIC VEGETATION CONTROL TESTS WITH THE USE OF SILVEX.

Length Range	1960 Average Length Inches	1960 Average Weight Pounds	1960 C(TL)	1961 Average Length Inches	1961 Average Weight Pounds	1961 C(TL)	1962 Average Length Inches	1962 Average Weight Pounds	1962 C(TL)
2.8-3.2	2.87	.016	68.5	3.12	.017	56.3			
3.3-3.7	3.50	.033	76.3	3.50	.025	57.6	3.54	.021	48.4
3.8-4.2	4.02	.046	71.3	3.98	.039	61.3	4.01	.034	52.6
4.3-4.8	4.45	.063	72.0	4.52	.059	63.4	4.50	.050	54.9
4.9-5.2	5.00	.087	61.8	5.00	.081	64.4	4.95	.067	55.2
5.3-5.8	5.48	.114	69.5	5.47	.109	66.5	5.47	.093	56.8
5.9-6.2	6.01	.155	71.4	5.89	.138	67.2	5.98	.121	56.5
6.3-6.7	6.47	.201	74.0	6.40	.192	73.1	6.40	.148	56.3
Number of Fish		219			544			210	

TABLE 4. COMPARISON OF CALCULATED CONDITION INDEX C(TL) OF WARMOUTH FROM NOBLE POND 14 DURING AQUATIC VEGETATION CONTROL TESTS WITH THE USE OF SILVEX.

Length Range	1960 Average Length Inches	1960 Average Weight Pounds	1960 C(TL)	1962 Average Length Inches	1962 Average Weight Pounds	1962 C(TL)
2.3-2.7				2.59	.010	57.4
2.8-3.2				2.93	.013	52.5
3.3-3.7				3.60	.026	55.1
3.8-4.2	3.97	.041	65.7	3.90	.037	61.6
4.3-4.7	4.59	.069	71.5			
4.8-5.2	4.98	.087	70.6	5.20	.086	61.1
5.3-5.7	5.37	.109	70.4	5.45	.106	65.3
5.8-6.2	6.03	.155	70.8	6.20	.154	64.7
6.3-6.7	6.46	.195	72.3	6.56	.194	68.7
6.8-7.2	7.00	.264	77.1	7.07	.228	64.4
7.3-7.7	7.50	.308	73.1	7.50	.245	58.0
Number of Fish		86			56	

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