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SOME ECOLOGICAL RELATIONSHIPS BETWEEN YELLOW PERCH AND CUTTHROAT TROUT IN THOMPSON LAKES, MONTANA

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Abstract

The relationship between yellow perch and cutthroat trout in Thompson Lakes, Montana, was investigated in the summers of 1952 and 1953. These lakes originally contained cutthroat trout and were later planted with yellow perch. The spawning time of the yellow perch was in early May, and for the cutthroat trout in late May. The population of yellow perch was large and growth was very slow. Although the number of cutthroat trout was small, the growth rate for this species was about average. The food of yellow perch was largely immature aquatic insects and plankton while that of cutthroat trout was mostly mature aquatic insects and small perch. Yellow perch were commonly distributed along the lake margins and concentrations of perch fry and adults were found in these areas in the spring. During this period the salmonid fishes were predominately in the deep water. Spot poisoning of the yellow perch concentrations practically destroyed all of the fish in the treated area. Management suggestions are given.

Introduction

While many studies of the yellow perch (*Perca flavescens* Mitchill) have been made, only a few concern the relationships between yellow perch and trout. Swynnerton and Worthington (1940) examined the food of perch and trout in Haweswater (Westmoreland) and found little competition. Worthington (1949) studied the fishes of Lake Windermere, a perch infested trout lake, and concluded that a reduction of perch would be beneficial to the trout fishery. No studies of this kind are known in the United States. In western Montana there are many lakes which have been contaminated by the introduction of yellow perch. In most cases the trout fishery has apparently suffered from this introduction. An investigation on the ecological relationships of yellow perch, trout, and other fishes in the Thompson Lakes, Lincoln County, Montana (Fig. 1), was initiated in the summer of 1952. Work was renewed in the spring of 1953, and continued through the following summer.

The three lakes selected are perch-infested trout lakes which are readily accessible to fishermen. They are approximately 50 miles west of Kalispell on U. S. Highway No. 2. These lakes are connected by short channels and

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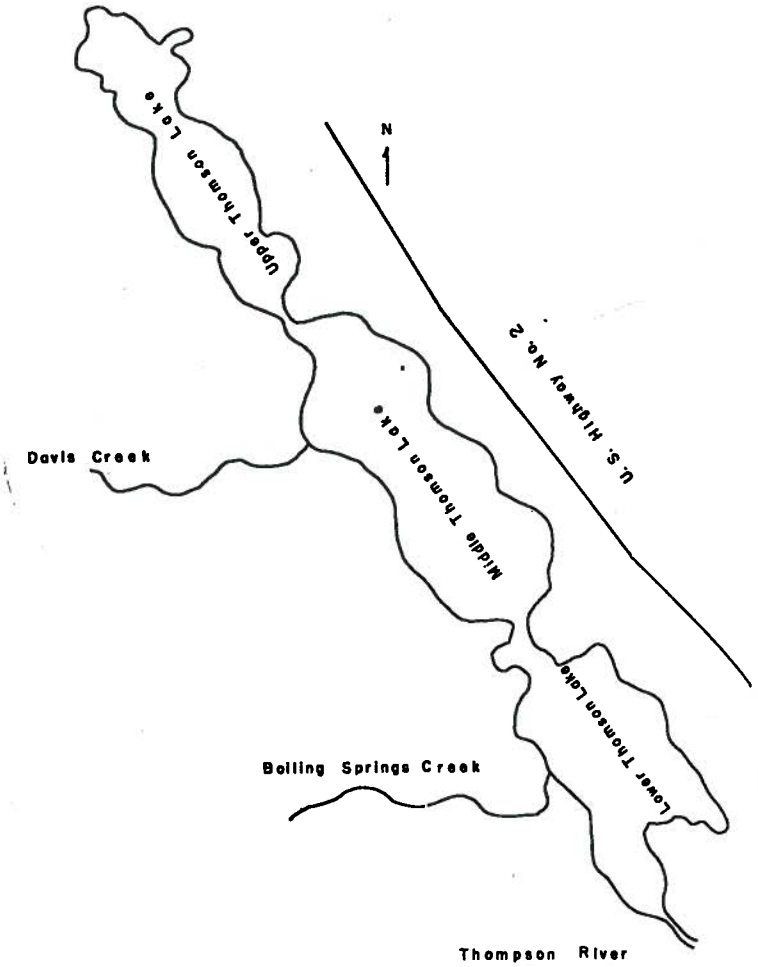

FIGURE 1.—Thompson Lakes, Lincoln County, Montana.

comprise the headwaters of the Thompson River. Their approximate areas and maximum depths are: Upper Thompson, 375 acres, 50 feet; Middle Thompson, 730 acres, 160 feet; and Lower Thompson, 240 acres, 150 feet.

About 25 percent of Lower and Middle Thompson Lakes and nearly 90

percent of Upper Thompson Lake is less than 10 feet deep. The maximum surface temperature near the middle of the Lower Lake was 75° F. (July 11, 1953). Lower and Middle Thompson Lakes were found thermally stratified in each year studied. Additional physical and chemical data are given in Table 1.

The game fish (Montana designation) found in Thompson Lakes were: kokanee (*Oncorhynus nerka kennerlyi*), cutthroat trout (*Salmo clarki*), rainbow trout (*Salmo gairdneri*), eastern brook trout (*Salvelinus fontinalis*), dolly varden (*Salvelinus malma*), mountain whitefish (*Prosopium williamsoni*), and largemouth bass (*Micropterus salmoides*). The most abundant of these was the mountain whitefish with kokanee second and cutthroat trout third. Yellow perch (*Perca flavescens*) was the most abundant non-game fish. Pumpkinseed sunfish (*Lepomis gibbosus*) and squawfish (*Ptychocheilus oregonensis*) were common while longnose sucker (*Catostomus catostomus*) and Columbia large scale sucker (*Catostomus macrocheilus*) were abundant. The redside shiner (*Richardsonius balteatus*) was scarce.

TABLE 1.—*Physical and chemical data for Thompson Lakes in 1952 and 1953*

Item	Date	Depth (feet)	Thompson Lakes		
			Lower	Middle	Upper
Temperature (°F.)	June 16, 1952	0	59.0	59.0	60.5
	do.	15	59.0	59.0	60.5
	do.	36	42.0	41.5	43.0
	Sept. 4, 1952	0	65.0	65.0	66.0
	do.	25	54.5	58.0	62.0
	do.	35	45.5	45.0	50.0
	June 26, 1953	2	60.0	60.0	....
	do.	18	54.0	59.5	....
	do.	30	43.5	44.0	....
	Sept. 1, 1953	2	64.5	66.0	....
	do.	22	63.5	65.0	....
	do.	35	45.0	46.5	....
Dissolved oxygen (p.p.m.)	July 21, 1952	15	8.5	8.0	8.4
	do.	35	3.5	4.0	2.5
	Sept. 4, 1952	15	8.0	8.0	8.0
	do.	35	1.8	4.3	6.1
	July 21, 1953	35	3.0	4.2	....
	Sept. 1, 1953	35	2.0	3.5	....
Secchi disc (feet)	June 16, 1952	..	28	23	17
	Sept. 4, 1952	..	32	30	23
	July 21, 1953	..	18	18	....
	Sept. 1, 1953	..	24	25	....
Methyl orange alkalinity (p.p.m.)	Sept. 4, 1952	2	236	220	228
	July 21, 1953	2	230	232	....
pH	Sept. 4, 1952	0	8.4	8.4	8.3

Spawning

An attempt was made to determine the relationships of yellow perch and cutthroat trout at each stage of their life cycles. If yellow perch proved to be vulnerable to control at some life history stage they might be reduced in favor of the trout.

Yellow perch.—The first ripe males and nearly ripe females of yellow perch were caught near a known spawning area in Lower Thompson Lake in late April, 1953. On May 5, several ribbons of eggs were found on the branches of a submerged pine tree in this area (surface water temperature 57° F.). On May 6, eggs were found to be common in the littoral zones of all three lakes. Clusters were observed from the surface to a depth of about five feet; usually near three feet. Yellow perch deposited their eggs on the following substrata in the Thompson Lakes: conifers (*Pinus ponderosa* and *Pseudotsuga taxifolia*), birch (*Betula fontinalis*), bulrush (*Scirpus validus*), and stonewort (*Chara*). In the order named the largest number of egg clusters was found on the submerged conifers and the smallest on *Chara*. A few eggs were seen directly on the bottom in areas without vegetation. The trees noted in the above observations were, in most cases, those that had fallen over from the shore into the lake.

An experiment was conducted to determine whether female yellow perch showed preference in the type of substrata used for spawning. Two likely areas were selected in Lower Thompson Lake and three structures; an 8-foot fir tree, a 10-foot birch tree without leaves, and a 2 by 8 foot chicken-wire grid were placed in each. These structures were located in a favorable spot near the bottom. Egg clusters were removed daily. The experiment continued from May 2 to May 29, and in this interval the conifers received 19 egg masses, the birches 2, and the chicken wire none.

Eggs containing well developed embryos were first noticed on May 10. No new egg deposits were found after May 17, and all eggs were hatched by May 29. Newly hatched yellow perch were about 0.3 inch in total length. When they reached a length of about 0.6 inch they appeared near the surface in schools of a few to several hundred. These schools appeared over the spawning areas 3 to 6 feet deep, and moved in short spurts which rippled the surface of the water. Schools of fry were first seen on June 12, 1952, in Lower Thompson Lake, and on June 29, 1953, in Middle Thompson Lake. On July 6, 1952, a large school estimated to have an area of 20 by 300 feet and containing many thousands of fry was observed over the shoal area in Lower Thompson Lake. What was believed to be this same school remained intact for three days. On July 23, 1953, there was observed an almost continuous band of yellow perch fry estimated to be approximately four feet wide and extending nearly a mile along the margin of Middle Thompson Lake. On the following day this school had dispersed into the littoral vegetation.

Cutthroat trout.—A nearly ripe (13.2-inch) female cutthroat trout was caught in Lower Thompson Lake on April 16, 1953. On May 7, what was presumed to be a pair of spawning cutthroat trout was observed on a small riffle about three miles up Davis Creek, a tributary to Middle Thompson Lake. One was captured; a ripe male 13.7 inches in total length. Eleven cutthroat trout were seen in this area on April 17 and 18. They were estimated to average about 13 inches long. In the previous year on July 29, a census was taken in a 150-foot section of this area by the electric shock method and 140 cutthroat trout averaging 3.8 inches in total length were captured. No other species were found. From May 21 to June 11, 1953, 21 adult cutthroat trout were removed from a sucker trap at the mouth of Boiling Springs Creek, a tributary to Lower Thompson Lake. These were spent spawners and averaged approximately 13 inches long. On May 16, 1953, numerous fingerling trout were seen approximately one mile up Boiling Springs Creek and on June 17 and 18, about 25 to 50 fingerling trout were observed in the vicinity of the sucker trap. They disappeared from this area on June 19. No trout fry or young-of-the-year were found in the lakes.

During May, 1953, schools of approximately 20 to 70 suckers, either Columbia large scale suckers or longnose suckers or both, were seen in the spawning area used by the perch. Smaller schools of squawfish were here also. No aggressive behavior on the part of one species toward another was observed. Suckers were trapped in the tributary streams beginning May 20, 1953. The largest number was trapped on June 2, after which their number declined. Ripe squawfish were caught in the lake near the stream mouths during this period but were never taken in the traps.

No apparent competition for spawning sites between the yellow perch, cutthroat trout or any of the other fishes was found in Thompson Lakes. Yellow perch eggs were distributed very widely over the entire shoal area. Cutthroat trout undoubtedly confine their spawning to suitable areas of the tributary streams.

Age and Growth

Yellow perch.—Scale samples from 150 yellow perch were taken during the study period. Age was determined by the usual method and calculations assumed a straight line relationship between the length of scale and length of fish (Table 2). The average calculated mean total length in inches for the year classes I through V were: 1.9, 3.4, 4.4, 5.6, 6.6. The average total length of 900 yellow perch taken by hook and line was 6.2 inches.

The grand average of 3,200 fish captured by all means (angling, gill nets, poison) was 6.4 inches, and only one percent was over 7.5 inches. There is no doubt that this population is slow growing and stunted. Carlander (1950), Hile (1942), and Eschmeyer (1938), in their studies of yellow perch, report few instances of such poor growth.

Cutthroat trout.—Scale samples of 41 cutthroat trout caught by trolling in Middle and Lower Thompson Lakes during the summer of 1953 were analyzed. Calculations assumed a straight line relationship between the length of scale and that of fish (Table 3). The average calculated mean total lengths in inches for the year classes I through IV were: 5.1, 7.8, 10.3, 12.5. The largest fish captured was 23.7 inches in total length, and the average of all cutthroat trout taken was 10.6 inches. This growth is as

TABLE 2.—*Mean total lengths and annual length increments (inches) calculated from scales of yellow perch at Lower Thompson Lake, 1952 and 1953*

Age group	Number of fish	Length at capture	Calculated total length at end of year of life				
			1	2	3	4	5
I	35	2.1	1.8	...	...	...	...
II	30	3.5	2.0	3.6	...	...	...
III	11	4.4	1.9	3.2	4.3	...	...
IV	32	5.8	1.8	3.2	4.4	5.6	...
V	42	6.7	2.0	3.3	4.5	5.6	6.6
Average length			1.9	3.4	4.4	5.6	6.6
Increment			1.9	1.5	1.0	1.1	1.0

TABLE 3.—*Mean total lengths and annual length increments (inches) calculated from scales of cutthroat trout at Middle Thompson Lake, 1953*

Age group	Number of fish	Length at capture	Calculated total length at end of year of life			
			1	2	3	4
I	6	5.6	5.3	...	....	....
II	18	8.2	4.9	7.7	....	....
III	10	11.0	4.9	7.7	10.4	....
IV	7	14.3	5.3	7.9	10.3	12.5
Average length			5.1	7.8	10.3	12.5
Increment			5.1	2.7	2.5	2.2

good or better than that found for other lakes within the drainage, and only slightly less than that reported by Calhoun (1944) in Blue Lake, California.

Food Relationships

A total of 900 yellow perch stomachs were examined from specimens collected by hook and line in the areas of greatest adult concentration in Lower Thompson Lake. A sample of 50 fish was taken every 10 days during the period from June to September in 1952, and from May to September in 1953. Captured fish were preserved immediately in formalin and stomach analyses were made at a later time. The stomachs of 83 cutthroat trout were examined at the time of capture. Specimens were taken by trolling in the Middle and Lower Thompson Lakes during the summers of 1952 and 1953.

Only those food items occurring in more than one percent of the specimens were considered. Ninety percent of the yellow perch and 98 percent of the cutthroat trout had eaten some identifiable food organism. Small fish were eaten by 2 percent of the yellow perch and by 40 percent of the cutthroat trout. Yellow perch fry made up 99 percent of these while the remaining one percent consisted of sucker fry and unidentified fish. The maximum number of yellow perch fry found in cutthroat trout stomachs was 21, with an average of 7.5. The smallest cutthroat trout containing these fry was 6.5 inches in total length and the largest specimen contained three yellow perch and one sunfish all of which were more than 4 inches in length.

Immature aquatic insects were present in 28 percent and adults in 4 percent of the yellow perch stomachs. Cutthroat trout had immature aquatic insects in 24 percent and adults in 43 percent of their stomachs. About one-half of the aquatic insects were dipterans. Damselflies were second in abundance and mayflies third. Yellow perch apparently showed preference for immature forms while the cutthroat trout ate more adults. Crustacea (*Daphnia, Leptodora,* and *Gammarus*) were found in 82 percent of the yellow perch stomachs and in 23 percent of the cutthroat trout. Snails appeared in only two percent of the yellow perch stomachs and in none of the cutthroat trout.

Moffett and Hunt (1943) reported *Perca flavescens* showed a change in diet from plankton and insects to forage fish after reaching about five inches in length. Allen (1935) had previously recognized this for *Perca fluviatilis*. The yellow perch in Lower Thompson Lake showed no marked shift to a diet of fish since only two percent had fish in their stomachs.

The stomach contents of mountain whitefish and kokanee was exclusively plankton. Thirty suckers taken from tributary streams had empty stomachs while 25 specimens captured in the lake contained only detritus and no recognizable food items.

Fish Distribution

Experimental gillnets of graded meshes and trolling were used to determine fish distribution. Gillnet sets were made in Lower Thompson Lake during the periods from June to August 1952, and from March to July 1953. These were of 24-hours duration and were made in the following areas (Table 4): 26 sets in deep water (35 to 70 feet), 22 on open shoals (5 to 10 feet), and 24 in weed beds (10 to 15 feet). Yellow perch were caught predominantly in deep water in March and April. Beginning April 29, 1953, heavy catches were made in shoal and weed bed areas in Lower Thompson Lake and continued throughout the summer. Cutthroat trout were never taken by gillnets in deep water or in the open shoal areas. Three specimens were captured in the weed beds in April.

Additional information on distribution was secured by 28 gillnet sets made over deep water. In this area, surface catches of kokanee and cutthroat trout were common during May, and gradually declined until June 10, when the last kokanee was caught. Trolling catches of kokanee and cutthroat trout also declined in June. Floating gillnets were set from the surface or hung from floats to a depth of 30 feet and failed to catch any of these fish during July and August.

Experiment to Reduce the Numbers of Yellow Perch

Schools of yellow perch fry along the shoals were treated with poison (Derris root or Fish-Tox) using an aqueous solution and power pump or towing the sack of the dry poison behind the boat. The towed sack method

TABLE 4.—*Catch of 72 gill-net sets from Lower Thompson Lake during the summers of 1952 and 1953*

[Expressed as catch per gill-net day for species and depth range]

Species	Depth range (feet)	Number of fish caught per gill-net lift		
		March–April	May–June	July–August
Yellow perch	35–70	13	8	3
	10–15	10	46	11
	5–10	8	19	6
Cutthroat trout	35–70	0	0	0
	10–15	1	0	0
	5–10	0	0	0
Mountain whitefish	35–70	7	8	8
	10–15	2	7	3
	5–10	1	0	3
Suckers[1]	35–70	2	2	3
	10–15	6	7	1
	5–10	11	6	3

[1] Longnose sucker and Columbia large scale sucker

disturbed the perch too much to be effective and was discontinued. A tank of solution and a power pump was carried by boat to a position out beyond (lakeward) a school of yellow perch fry. Poison was introduced slightly below the surface in a line parallel to the school of fry. When this barrier of poison was complete the entire area containing fry was sprayed. The minimum amount of poison necessary to get good results in Thompson Lakes was abut 8 parts per million of Derris root (5 percent rotenone) or 4 parts per million of Fish-Tox for the immediate areas treated. These high concentrations were necessary to maintain effective levels because of dilution by surrounding water. Fifty pounds of Fish-Tox or 100 pounds of Derris root was sufficient to treat about 1,000 feet of lake margin.

Yellow perch fry usually showed distress within 15 minutes. Although some fish swam through the poison barrier out into clear water most of these died. Dead fry were seen as far as 500 feet from the toxic area. Practically all of the fish in these schools treated were destroyed.

A method was developed for poisoning schools of adult yellow perch. A concentrated solution of Derris root or Fish-Tox was taken by boat to the poison area. The boat was anchored and bait (chopped fish or hamburger) was distributed until a large number of yellow perch had accumulated in the area. Then poison was poured gently into the water over the school of yellow perch. This solution was poured also into the wake of the boat as it slowly circled the yellow perch concentration. Ten pounds of Derris root or 5 pounds of Fish-Tox was sufficient to kill yellow perch in a 100-foot circle over 15 feet of water. Approximately one-half of the solution was used in the baited area and the other half to form the barrier.

The kill of fish in the treated area was almost complete. In 1940, Greenbank experimented with selective fish poisoning and Swingle (1953) evaluated partial poisoning on known populations of bluegills and largemouth bass in small ponds. He concluded that this was effective in eliminating fish of small or intermediate size. It is believed that intensive partial poisoning in Thompson Lakes would be effective in reducing the yellow perch population.

SUGGESTED MANAGEMENT RECOMMENDATIONS

Total poisoning of the entire Thompson Lake chain is not economically feasible. During the spring months yellow perch are concentrated on the shoal areas and kokanee and cutthroat trout are in deep water. Partial poisoning along the lake margins and in the bays at this time should be effective in reducing the yellow perch population. The hope of such a program should be to reduce the yellow perch population to a level where this species will show good growth and attain useful size. Such a reduction should also make conditions more favorable for an increase in the number of salmonids. A combination method of poisoning yellow perch fry and baiting and poisoning the larger perch is recommended for Lower Thompson Lake. This should be initiated about June 20 and be continued as long as concentrations of yellow perch are found. It is believed that with further study an effective method might be developed for the reduction of yellow perch by concentration and destruction of spawn. An age and growth study should be made at the end of the first year to check the effectiveness of this program.

As soon as the treated areas in Lower Thompson Lake are non-toxic, cutthroat trout fry at the rate of 300 or more per acre should be planted along the littoral zone.

Since the cutthroat trout are known to feed rather extensively on yellow perch fry it is recommended that heavy plantings of cutthroat trout, 7 inches long or over be made in Middle Thompson Lake. To prevent fish movement between Middle and Lower Thompson Lake a screen barrier should be installed in the connecting channel.

A careful check should be made on all plantings in both lakes by creel census and gill netting.

Fishermen should be encouraged to harvest yellow perch by furnishing them with all information on effective fishing methods and perch distribution. Means should also be developed whereby the mountain whitefish, which is relatively abundant and very poorly utilized, can be harvested.

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EARLY LIFE HISTORY OF THE YELLOW PERCH, *PERCA FLAVESCENS* (MITCHILL), IN THE RED LAKES, MINNESOTA [1]

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Abstract

The early life history of the yellow perch, an important commercial species in the Red Lakes, Minnesota, has been studied with special reference to length at scale formation, growth rate during first season of life, and food habits as they relate to growth and survival. Scales are fully imbricated in the area of 12th to 14th lateral line scales at 24 millimeters total length. There is a wide annual varition in first season's growth which is not correlated with growth in older fish. Body-scale relationship is rectilinear from 24 to 280 millimeters. Length-weight relationship during the first year is expressed by the equation $W = 0.6198 \times 10^{-5} L^{3.1251}$ which is very similar to that describing the relationship in later years. Stomach analysis indicates food is primarily plankton but in some seasons fish may be strongly dependent on bottom forms. Variations in food availability appear to be associated with changes in growth and may have a major influence on survival.

Introduction

The yellow perch, *Perca flavescens* (Mitchill), is an important commercial species in the Red Lakes, Minnesota (Smith and Krefting, 1954). Six years' investigation of the fishery has shown that fluctuations in abundance are caused primarily by differences in strength of individual year classes. To evaluate the factors influencing these changes a series of studies on the early life history of the perch and other associated species has been carried on. From 1952 through 1954 particular attention has been given to the growth rates, food relationships, and mortality of perch during the first season of life. In the present paper first-year growth in length and weight, food habits, and size of fish at time of scale formation have been described together with certain implications of these data in connection with the problems of year-class strength. Mortality rates during the first year will be discussed in a subsequent paper dealing with interrelations between yellow perch and associated fish species.

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