Observations on the life history of the yellow perch and fish population trends in Canyon Ferry Reservoir, Montana
by Farrell Leroy Bandow

A thesis submitted to the Graduate Faculty in partial fulfillment of the requirements for the degree of MASTER OF SCIENCE in Fish and Wildlife Management
Montana State University

Abstract:
A study of the yellow perch (Perea flavescens) in Canyon Ferry Reservoir, an impoundment on the Missouri River, was conducted in 1967 and 1968. A series of gill-net sets made by the Montana Fish and Game Department between 1955 and 1964 was duplicated during the study. An evaluation of fish population trends for all sampling years was made.' The yellow perch population responded less rapidly than suckers in the new impoundment but exhibited a rapid growth rate. In subsequent years, there was a general increase in numbers of perch but growth rates declined. The largest catches of perch with gill nets were made at depths of 10 to 30 feet during summer. The relationships of population density and temperature to growth rates are discussed. Female yellow perch were more abundant than males in all age groups. They grew more rapidly than males after the first year and generally lived longer. Most spawning occurred during the last week of April and the first 2 weeks of May when water temperatures ranged from 45 to 57 F. Some males matured as yearlings and some females at 2 years. Nearly all males larger than 5.0 inches and nearly all females larger than 7.-0 inches were mature. Growth rates of age group 0 perch from different parts of the reservoir differed. The estimated number of eggs per female ranged from 6,600 for a 5.6 inch perch to 47,500 for a 10.7 inch fish. Based on frequency of occurrence and volume, Cladocera and Copepoda were about equally important as food of age group 0 and yearlings. Cladocera was by far the most important food of perch 5 to 9 inches long. Fish increased in the diet as the perch grew larger and was most important for perch 9 to 11 inches long.

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ABSTRACT

A study of the yellow perch (Perca flavescens) in Canyon Ferry Reservoir, an impoundment on the Missouri River, was conducted in 1967 and 1968. A series of gill-net sets made by the Montana Fish and Game Department between 1955 and 1964 was duplicated during the study. An evaluation of fish population trends for all sampling years was made. The yellow perch population responded less rapidly than suckers in the new impoundment but exhibited a rapid growth rate. In subsequent years, there was a general increase in numbers of perch but growth rates declined. The largest catches of perch with gill nets were made at depths of 10 to 30 feet during summer. The relationships of population density and temperature to growth rates are discussed. Female yellow perch were more abundant than males in all age groups. They grew more rapidly than males after the first year and generally lived longer. Most spawning occurred during the last week of April and the first 2 weeks of May when water temperatures ranged from 45 to 57 F. Some males matured as yearlings and some females at 2 years. Nearly all males larger than 5.0 inches and nearly all females larger than 7.0 inches were mature. Growth rates of age group 0 perch from different parts of the reservoir differed. The estimated number of eggs per female ranged from 6,600 for a 5.6 inch perch to 47,500 for a 10.7 inch fish. Based on frequency of occurrence and volume, Cladocera and Copepoda were about equally important as food of age group 0 and yearlings. Cladocera was by far the most important food of perch 5 to 9 inches long. Fish increased in the diet as the perch grew larger and was most important for perch 9 to 11 inches long.

INTRODUCTION

The yellow perch (*Perca flavescens*) is an important part of the Canyon Ferry Reservoir sport fishery, particularly in winter. Canyon Ferry Dam, located on the Missouri River, was constructed in the early 1950's. The perch population did not increase rapidly but this species exhibited rapid growth during the early years of impoundment (Graham, 1956). Subsequent sampling by the Montana Fish and Game Department indicated an increase in relative abundance of perch with a simultaneous decline in growth rate (Heaton, 1959, 1961).

The primary objectives of this study were to obtain life history information on the yellow perch and to evaluate fish population trends in Canyon Ferry Reservoir. Field work began in June 1967 and continued through February 1969.

DESCRIPTION OF CANYON FERRY RESERVOIR

Canyon Ferry Dam, a multi-purpose unit of the Missouri River Basin Project, is located 17 miles northeast of Helena, Montana. Storage began in 1953 and the reservoir was first filled to capacity in July 1955. Lake Sewell, a 2900 acre reservoir, was engulfed by the new impoundment. The drainage basin above the reservoir encompasses 15,860 square miles.

The southern half of Canyon Ferry Reservoir lies in a broad, flat, valley and is 4 to 5 miles wide. Near the dam, the reservoir is 1 to 2 miles wide. At maximum capacity (3800 feet m.s.l.) it is approximately 25 miles long and has a surface area of 35,200 acres, a volume of 2,051,000 acre-feet, and a maximum depth of 165 feet.

The maximum recorded surface temperatures at the Goose Bay Marina during July, August, and September were, respectively, 78, 77, and 74 F in 1967 and 78, 74, and 69 F in 1968. Ice cover usually forms by January and disappears in April.

Chemical analyses at several points on the reservoir during July and September of 1967 showed methyl orange alkalinity to range from 100 to 110 p.p.m., total hardness from 95 to 115 p.p.m., and pH from 7.6 to 7.8.

Water levels in 1967 and 1968 reached low points in April and were rapidly raised during May and June to peaks in early July (Figure 1). In 1968 the low water level was 22.2 feet below maximum and in 1967 it was 35.3 feet below maximum, the lowest since 1954. At this time the reservoir volume was 1,024,633 acre-feet, about one-half capacity. Since 1955 water levels fluctuated irregularly but during most years low levels

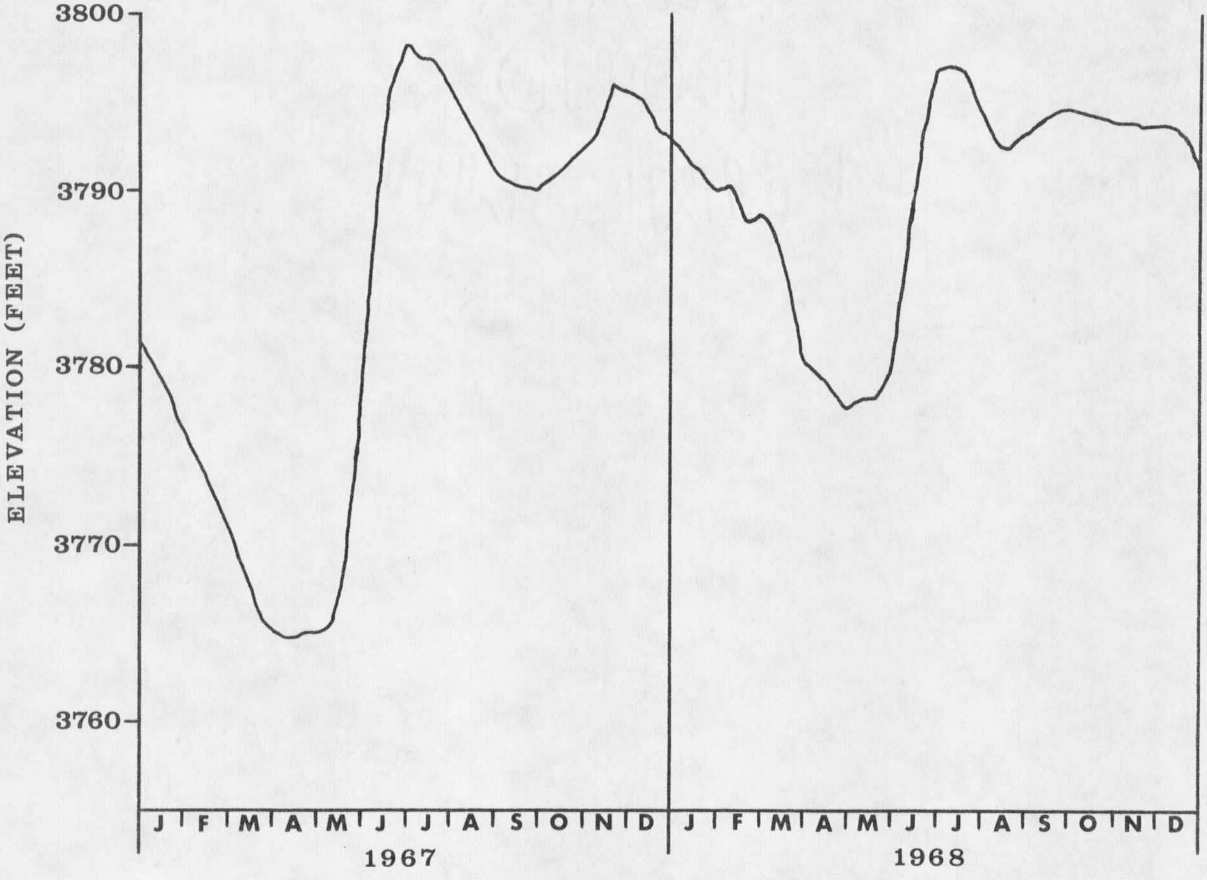

Figure 1. Water level elevations of Canyon Ferry Reservoir during 1967 and 1968.

were reached in the spring and the reservoir was filled to near capacity by July. In 1961 and 1966 the peak levels were 12.1 and 12.9 feet below capacity, respectively.

Rainbow trout (*Salmo gairdneri*) provide the most important sport fishery in Canyon Ferry Reservoir and are stocked annually. Brown trout (*Salmo trutta*) rank next and were last stocked in 1952. Kokanee (*Oncorhyncus nerka*) fry were stocked in 1966-68 but few adults have been observed. Channel catfish (*Ictalurus punctatus*) were stocked in 1964 and 1966 but no returns have been reported. Carp (*Cyprinus carpio*), white sucker (*Catostomus commersoni*), and longnose sucker (*Catostomus catostomus*) were the abundant rough fishes. Other fishes caught less frequently were mountain whitefish (*Prosopium williamsoni*), Utah chub (*Gila atraria*), flathead chub (*Hybopsis gracilis*), golden shiner (*Notemigonus crysoleucas*), longnose dace (*Rhinichthys cataractae*), mountain sucker (*Catostomus platyrhynchus*), stonecat (*Noturus flavus*), burbot (*Lota lota*), bluegill (*Lepomis macrochirus*), largemouth bass (*Micropterus salmoides*), and mottled sculpin (*Cottus bairdi*).

METHODS

Most collections of adult fish were made with 6 x 125 foot experimental gill nets graded 3/4-2 inch square mesh. Total lengths of fish were measured to the nearest 0.1 inch and weights to the nearest 0.01 pound. Collections of small yellow perch were made with dip net, fish toxicant, and seine. Total lengths of small perch were measured after preservation in 10 percent formalin to the nearest millimeter and converted to inches.

In 1967 and 1968 I duplicated a series of gill net sets initiated by the Montana Fish and Game Department in 1955 and duplicated by them in 1958, 1960, and 1964. The series consisted of 17 sets in June and 16 in August distributed around the periphery of the reservoir (Figure 2). They were overnight sets of approximately 18 to 24 hours duration and were duplicated as closely as possible with respect to date and location. All were bottom sets ranging in depth from 5 to 90 feet but mostly from 10 to 30 feet. Nearly all trout and most whitefish were measured during each sampling year. All yellow perch were measured in 1967 and 1968. Among the rest of the fish, measurements were obtained from about 30 percent. The total weight of each species for each year was estimated by projecting the average weight of the fish measured to the total catch. Population and growth trend information for 1955, 1958, and 1960 were obtained from Graham (1956), Heaton (1959, 1961), and from the original data. Information for 1964 was obtained from the original data.

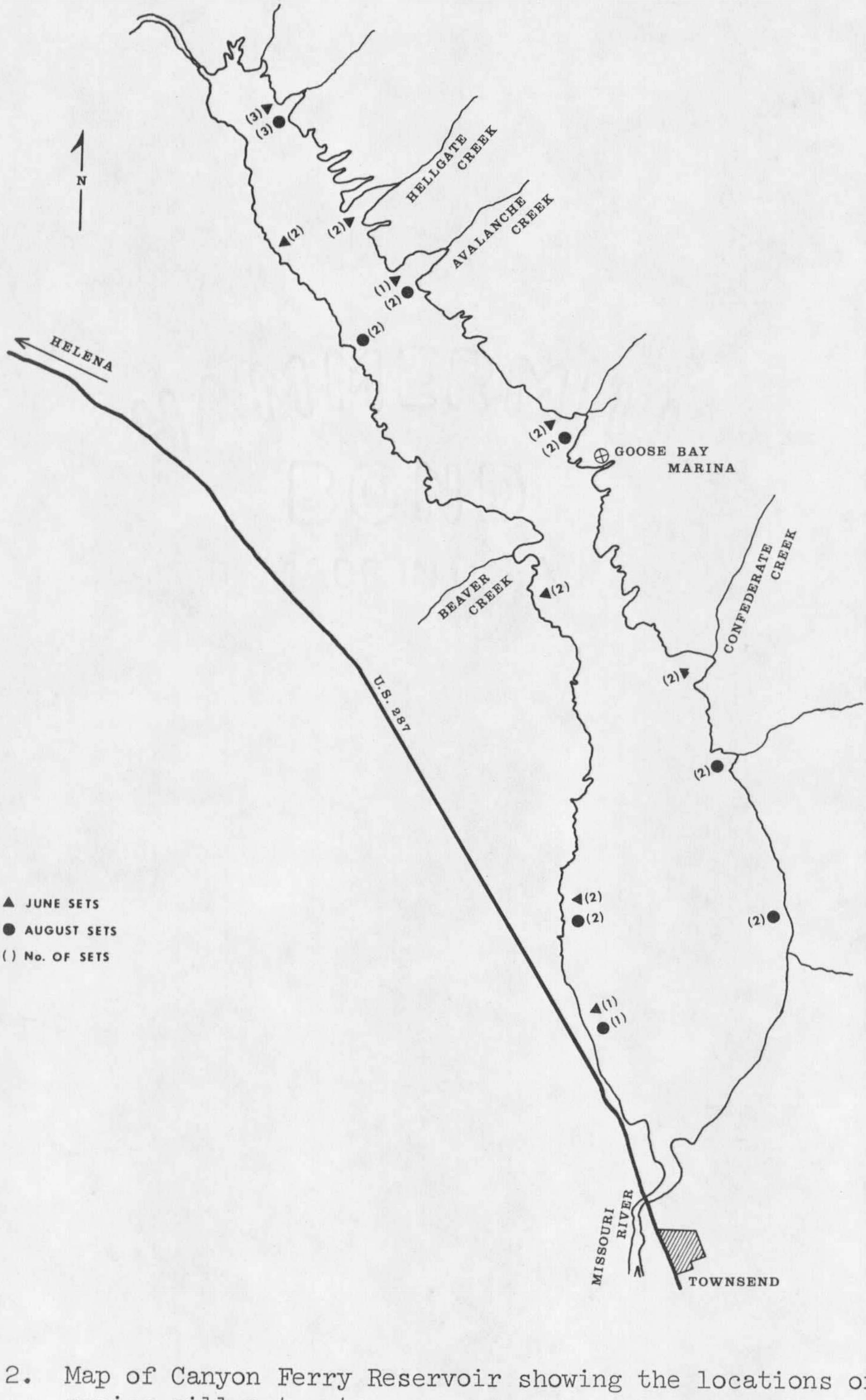

Figure 2. Map of Canyon Ferry Reservoir showing the locations of series gill-net sets.

Additional gill netting was done throughout the study to collect perch and to determine distribution. Gill netting in April and May 1968 was confined mostly to depths less than 10 feet in an effort to catch spawning fish. Mature females were examined and classified as gravid or spent. To determine fecundity, ovaries were sectioned into 4 nearly equal parts and egg counts were made of 0.2 gram samples from each section. The total number of eggs was estimated from the average count-weight relation of the samples.

Age and growth was determined by the scale method. Nearly all scale samples of yearling and older perch were collected from fish captured in gill nets. Scales were obtained from the left side of the body between the pectoral fin and the lateral line. Back calculations of growth were made on projected scales assuming a linear relationship between body length and anterio-lateral scale radius.

Food analyses of perch larger than 5.0 inches were made from digestive tract contents of fish captured by gill nets and angling. The tracts were removed soon after capture and preserved in 10 percent formalin. Food of age group 0 perch was determined from stomach analyses of fish captured with fish toxicant. The percentage volume of each type of food in each fish was estimated by visual examination. Percentages were then aggregated to compute percent of total volume.

During the 1968 spawning season, water temperatures were recorded near each sampling site with maximum-minimum thermometers suspended 2 feet below the surface where depths were about 15 feet. During July, August, and September of 1967 and 1968 maximum and minimum water temperatures were recorded 2 feet below the surface at the Goose Bay Marina. Temperature profiles were measured at 2 locations at irregular times throughout the spring and summer of 1968 with an electrical resistance thermometer. The locations were situated about mid-way between the east and west shores directly out from the northern points of Avalanche and Confederate Bays.

RESULTS

Fish Population Trends

Although gill nets are selective in capturing fish and may not show relative abundance, they do provide an index for determining population trends.

Figure 3 shows the number and Figure 4 the estimated total weight of fish captured in the combined series samples for each of the 6 years that the reservoir was sampled. "Other species", in order of decreasing abundance, included longnose sucker, carp, brown trout, rainbow trout, and whitefish. Also included, but together never making up more than 1 percent of the total catch, were flathead chub, stonecat, Utah chub, mountain sucker, burbot, and kokanee.

Changes in abundance of white suckers most influenced the total catch through 1960, after which abundance of yellow perch was most influential. In 1955, white suckers comprised 73.0 percent of the total catch by number and 65.8 percent by weight. The number of white suckers captured was markedly lower in 1958 and 1960, but there was no appreciable change in percent of total catch or total weight of this species because the total catch decreased and the average weight of suckers increased. The 1955 catch of white suckers was comprised mostly of 2-year-old fish while 4- and 5-year-olds in 1958 and 5- and 6-year-olds in 1960 were most numerous. After 1960, percent of total catch and total weight of white suckers continually declined. In 1968 they comprised only 25.9 percent of the number and 39.0 percent of the weight of the total catch.

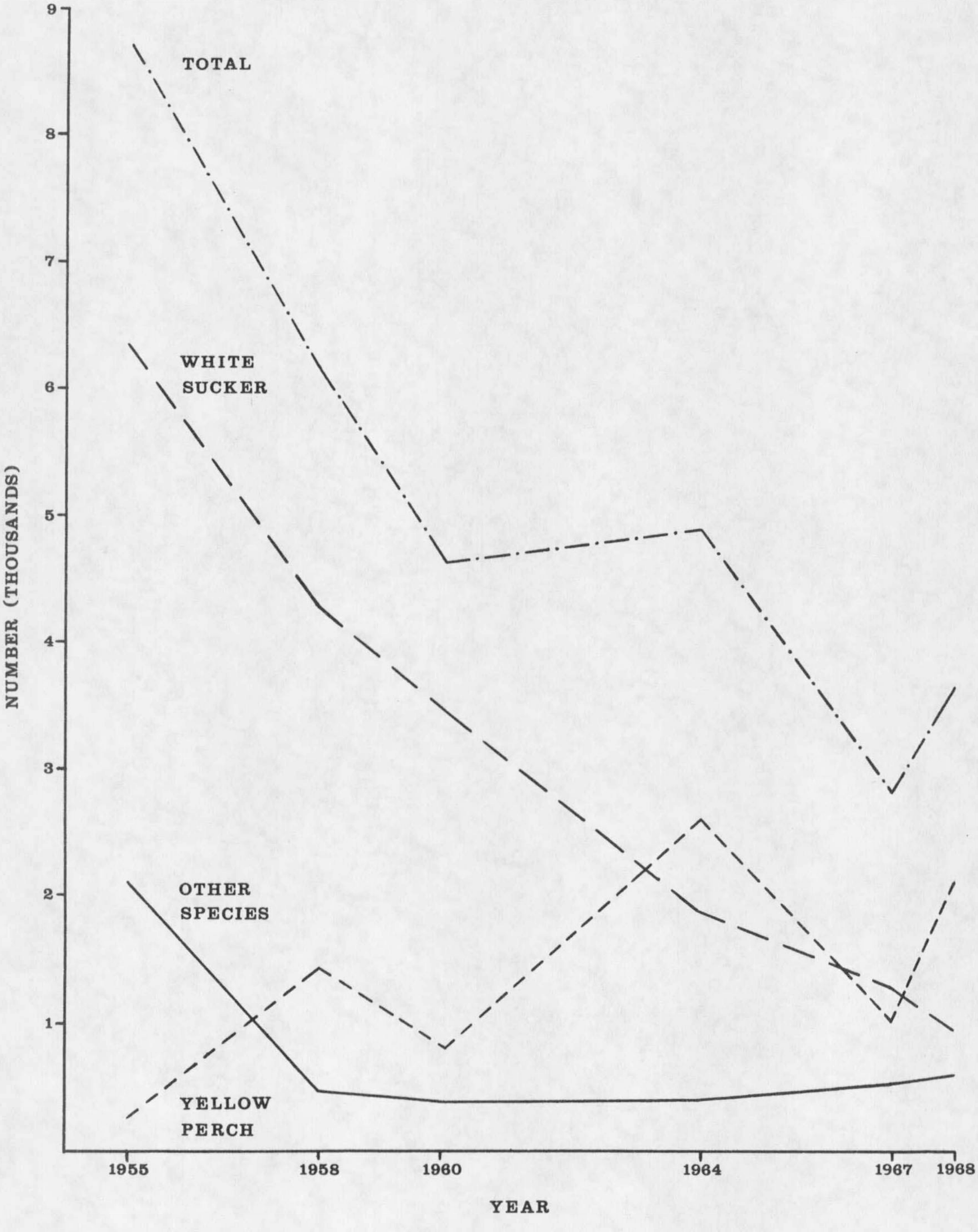

Figure 3. Number of fish in the gill-net catch during 6 sampling years, 1955 through 1968.

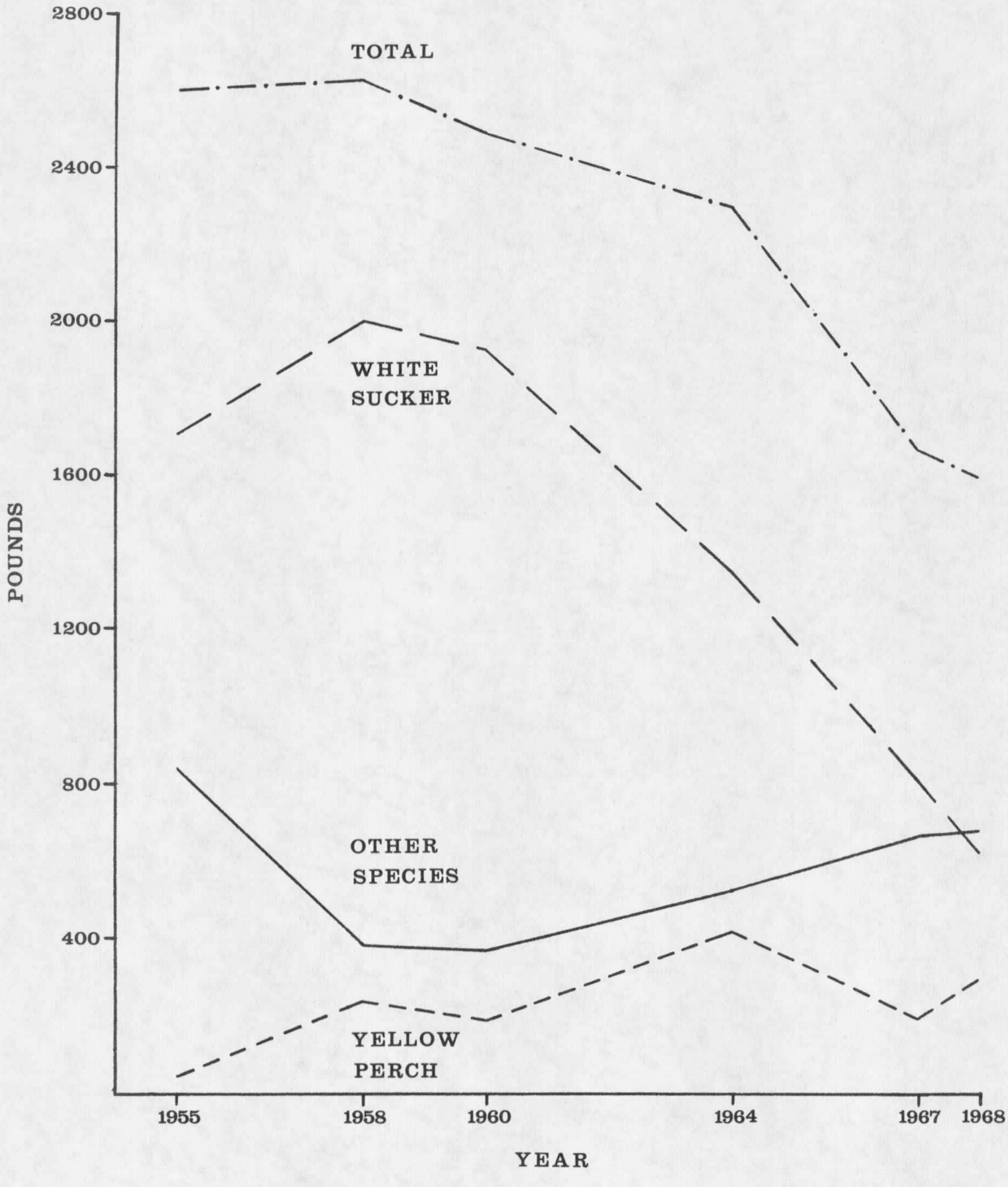

Figure 4. Estimated total weight of fish in the gill-net catch during 6 sampling years, 1955 through 1968.

Although each of the species in the group "other species" showed similar trends over the entire period, the abrupt decline between 1955 and 1958 was due primarily to the decrease in number of longnose suckers from 1328 to 105. "Other species" changed little in number through 1964 and little in weight through 1960, after which this group showed an increase in both categories in the face of a generally decreasing total catch.

The yellow perch population of Lake Sewell expanded less rapidly than suckers in the new reservoir. In 1955, they comprised only 2.9 percent of the total catch and in 1958, 23.1 percent (Table I).

TABLE I. Number and estimated total weight of yellow perch in 33 gill-net sets duplicated in each of 6 sampling years, 1955 through 1968. (Number of fish from which measurements were obtained in parentheses).

	1955	1958	1960	1964	1967	1968
June						
Number	109	581	313	1216	339	1093
Pounds	21	99	75	195	61	143
August						
Number	141	841	483	1397	677	1012
Pounds	27	143	116	224	127	152
Total						
Number	250	1422	796	2613	1016	2105
Percent of total catch	2.9	23.1	17.2	53.5	36.0	57.7
Pounds	48	242	191	419	188	295
Percent of total weight	1.8	9.2	7.7	18.2	11.6	18.5
Average weight	0.19 (107)	0.17 (487)	0.24 (309)	0.16 (511)	0.19 (all)	0.14 (all)

This was an increase from an estimated 48 pounds in 1955 to an estimated 242 pounds in 1958. Although there was a general increase in number of perch caught over the 6 sampling years, samples fluctuated widely. The average size of perch tended to vary inversely with the number captured which made fluctuations less pronounced in terms of weight. This is shown by the 1960 data when the number decreased 44 percent from the 1958 catch while the total weight decreased only 21 percent. Perch numbers accounted for more than 50 percent of the total catch in 1964 and 1968, but made up only about 18 percent of the total weight both years.

The 1955 catch of yellow perch was heavily dominated by 2-year-old fish. In 1958, 3- and 4-year-olds and in 1960, 4- and 5-year-olds were most numerous. The 1964 and 1967 catches were mostly 3-year-olds, while in 1968, 2-year-olds were dominant.

Distribution

Summer depth distribution of yellow perch at 10 foot intervals was determined from 41 gill net sets distributed as follows: 9 in July 1967, 5 in August 1967, 13 in June 1968, and 14 in August 1968 (Table II). All were bottom sets of approximately 18 to 24 hours duration.

TABLE II. The catch of yellow perch with gill nets at various depths during the summers of 1967 and 1968.

Depth interval	1-10	10-20	20-30	30-40	40-50	50+
Number of sets	8	11	9	5	4	4
Average number of perch per set	27.9	106.7	66.3	31.4	2.0	0.5
Range	0-61	7-577	7-150	7-88	1-5	0-1
Percent of total average catch	11.9	45.4	28.2	13.4	0-9	0.2

The greatest average catch occurred with nets in the 10-20 foot interval, which accounted for 45.4 percent of the total average catch. Catches within the intervals 10-20 and 20-30 feet together accounted for 73.6 percent of the total average catch. Sets deeper than 40 feet caught few perch. An unusually large catch of 577 perch was made within the 10-20 foot interval in June 1968. If this catch is excluded from the data the average catches at the 10-20 and 20-30 foot intervals were very similar (59.7 and 66.3, respectively) and together accounted for 67.1 percent of the total average catch. Similar summer depth distributions of yellow perch were reported by Horak and Tanner (1964) and others.

Gill netting during the winter revealed no depth distribution pattern. Eleven sets were made beneath the ice (3 in January 1968, 4 in March 1968, and 4 in February 1969). The sets ranged in depth from 9 to 87 feet and the most perch taken in a net was 15 while 5 nets caught none. In Lake Mendota, during winter, the greatest number of yellow perch were caught with gill nets at 24 meters, the deepest point of the lake (Hasler, 1945).

The largest catches of perch during the summers of 1967 and 1968 were made north of Beaver Creek while a greater number of large perch were captured south of Beaver Creek. Of 1089 perch caught south of Beaver Creek, 33.9 percent were longer than 7.5 inches and 10.9 percent were longer than 9.0 inches while of 2471 perch caught north of Beaver Creek, only 18.0 and 1.9 percent were over 7.5 and 9.0 inches, respectively. The catches north of Beaver Creek do not necessarily reflect a larger total population. This part of the reservoir is much deeper and slopes much more abruptly into deep water. Therefore, fish inhabiting water 10 to 30 feet deep in the northern part are probably more concentrated and larger catches should be expected.

In early summer, age group 0 yellow perch were observed swimming in large schools near the surface over shoal areas in widely scattered parts of the reservoir. As summer progressed they moved nearer the bottom and into deeper water. By mid-August they were only occasionally observed and usually near the bottom. By early September they were rarely observed, but on September 6, 1968 several hundred were captured with fish toxicant in 5 to 10 feet of water. On September 25, several areas as deep as 15 feet were sampled with toxicant but few young perch were captured.

Age and Growth

Scale collections made during the sampling series through 1967 were made without regard to sex. The annual growth increments (Table III) for the 1968 collection are averages of combined sexes weighted in proportion to the sex ratio of the series catch. Lee's phenomenon was quite marked in much of the data (Table IV), therefore, growth trend comparisons between years were made only with the same age groups. The most valid comparisons were with age groups I through IV because some older fish were difficult to age accurately.

Growth of perch was quite rapid before and during early years of impoundment as indicated by the 1953 year class of age group II fish (Table III) and the 1952 year class of age group III fish (Table III, Figure 5). The growth curves for the 1954 and 1956 year classes of age

TABLE III. Average calculated annual growth increments of yellow perch captured during 6 sampling years, 1955 through 1968.

Age Group	Collection	Year Class	No. of Fish	Annual Growth Increment 0-1	1-2	2-3	3-4
I	1968	1967	45	3.4**			
II	1955	1953	49	3.7	3.3		
	1958	1956	21	2.3	2.5		
	1960	1958	22	2.9	2.3		
	1964	1962	31	2.0+	2.7		
	1967	1965	12	2.2	2.8*		
	1968	1966	184	2.3*	3.6**		
III	1955	1952	8	3.5	3.2	2.0	
	1958	1955	28	2.2	2.5	2.0	
	1960	1957	49	2.1	2.7	1.8	
	1964	1961	40	2.0	2.0+	2.3	
	1967	1964	65	1.9++	2.2	2.3*	
	1968	1965	87	2.0	2.6*	2.4**	
IV	1958	1954	32	2.7	2.7	1.9	1.1
	1960	1956	22	2.3	2.4	2.2	1.1
	1964	1960	9	2.0	2.2	1.9+	1.2
	1967	1963	31	2.2	1.9++	2.3	1.6*
	1968	1964	129	1.9++	2.1	2.3*	1.4**

+ Growth during 1962
++ Growth during 1964
* Growth during 1966
** Growth during 1967

group IV fish (Figure 6) indicate decreasing growth rates. By 1960, the growth of perch appeared to stabilize. With the exception of the 1965 year class, which grew rapidly during 1966 and 1967, only minor differences occurred among growth rates of year classes arising in 1960 and after.

Growth of perch during 1962 and 1964 was relatively poor as compared with that of the same age groups during other years (Table III). Growth

TABLE IV. Average calculated total lengths at each annulus of yellow perch collected in 1968.

Year Class	Age Group	Sex	No. of Fish	Calculated length at each annulus 1	2	3	4	5	6	7
1967	I	♀	30	3.4						
		♂	15	3.5						
1966	II	♀	49	2.3	5.9					
		♂	102	2.5	5.7					
1965	III	♀	64	2.0	4.6	7.1				
		♂	23	2.0	4.3	6.4				
1964	IV	♀	92	1.9	4.0	6.3	7.8			
		♂	37	2.0	4.1	6.0	7.4			
1963	V	♀	46	2.1	4.0	5.9	7.4	8.6		
		♂	19	2.3	3.7	5.4	6.6	7.6		
1962	VI	♀	10	2.1	3.9	5.9	7.0	8.2	9.1	
		♂	3	2.0	3.9	6.1	7.2	8.4	9.3	
1961	VII	♀	8	2.2	4.2	6.1	7.4	8.5	9.4	10.3
		♂	2	2.0	4.1	5.6	6.5	7.5	8.5	9.3

during 1966 and 1967 was relatively good. In 1964, the total catch of perch was the highest of the 6 sampling years, while the 1967 catch was low (Figure 3). Jobes (1952) could not relate growth rate of yellow perch in Lake Erie to the abundance of a strong year class. Le Cren (1958) noted that reduction of the population density had no effect on first-year growth and little effect on second-year growth of the European perch (*Perca fluviatilis*) in Lake Windemere.

Monthly mean air temperatures from the U. S. Weather Bureau Climatological Station in Helena, Montana show warmer summers existed in 1966 and 1967 than in 1962 and 1964. Although water temperatures are available only for 1967 and 1968, an approximation of temperature conditions

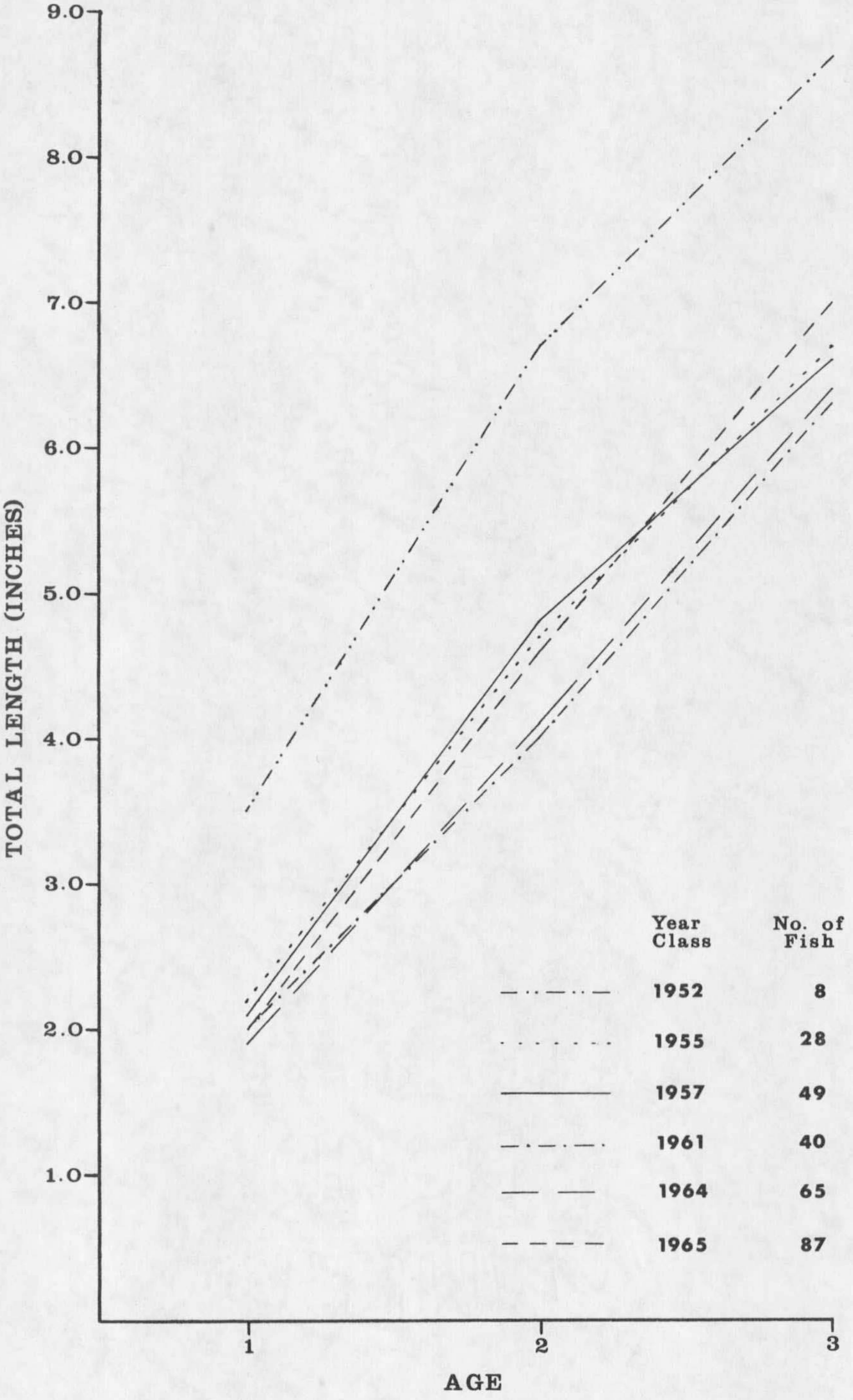

Figure 5. Average calculated growth rates of age group III yellow perch collected during 6 sampling years, 1955 through 1968.

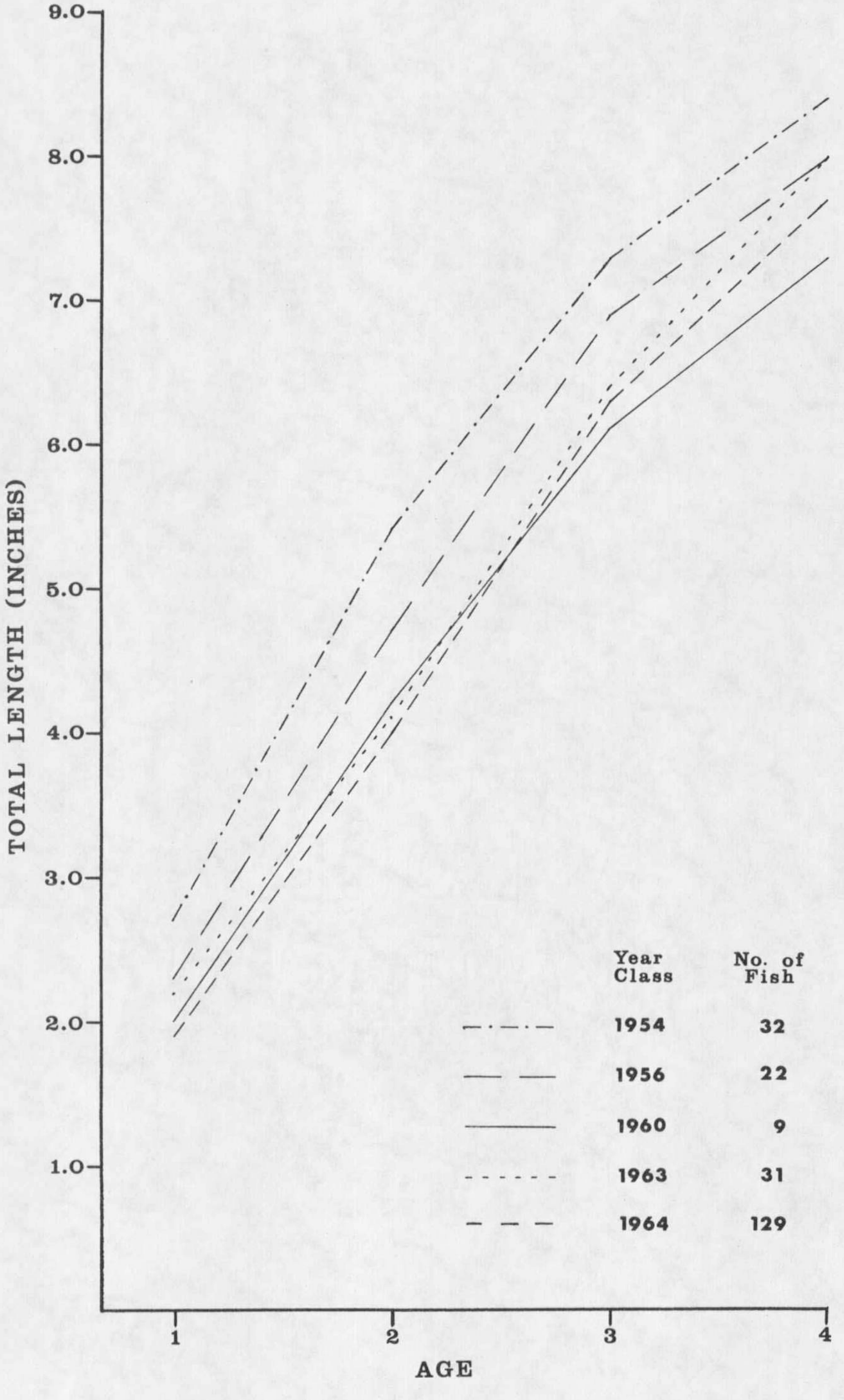

Figure 6. Average calculated growth rates of age group IV yellow perch collected during 6 sampling years, 1955 through 1968.

during other years can be obtained from air temperatures. For example, in July, August, and September 1968 mean air temperatures at Helena were, respectively, 0.2, 3.0, and 1.0 F below normal, while in 1967 they were 2.1, 5.2, and 5.9 F above normal, respectively. As noted in the introduction, maximum water temperatures in August and September were, respectively, 3 and 5 F higher in 1967 than in 1968. Mean air temperatures at Helena for June, July, and August averaged 1.0 and 0.5 F below normal in 1962 and 1964, respectively, while in 1966 and 1967 they averaged 1.1 and 2.6 F above normal, respectively. The mean temperature for September was 1.0 F below normal in 1962 and 2.2 F below normal in 1964. In 1966 and 1967 September temperatures were 6.7 and 5.9 F above normal, respectively. September might be a critical month because the water is generally cooling quite rapidly and the growing season is drawing to a close. High air temperatures during September, such as existed in 1966 and 1967, might extend the growing season considerably. However, intermediate growth during 1965 (a year when poor growth would be expected on the basis of air temperature) indicates that other factors are involved. Although there was an inverse relationship between numbers in the catch and growth of perch in 1964 and 1967, the growth rate may have been influenced more by differences in temperature than differences in population density. Le Cren (1958) concluded that year to year variations in growth of the European perch could be largely attributed to temperature differences.

After the first year, the average calculated length at each annulus was usually greater for female yellow perch than for males (Table IV).

The oldest female and male perch were both aged as 7 years, but there was an increasing preponderance of females in the catch with increasing size of the fish (Table V). Apparently females grow faster after the first year and generally live longer than males. This has been reported by others (e.g. Eschmeyer, 1937).

TABLE V. Sex ratio of yellow perch in the gill-net catch, October 1967-August 1968.

	Over 4.5 inches	Over 5.0 inches	Over 6.0 inches	Over 7.0 inches	Over 8.0 inches	Over 9.0 inches
No. of Fish	2460	2440	1648	795	236	55
Females	1959	1944	1393	709	222	53
Males	501	496	255	86	14	2
Ratio, ♀:♂	3.9:1	3.9:1	5.5:1	8.2:1	15.9:1	26.5:1

Only 2 collections of age group 0 perch were made in 1967. The first was at the Goose Bay Marina and the second in a small cove on the west side of the reservoir opposite Avalanche Bay. The samples included 20 and 80 fish, respectively. Sampling during the summer of 1968 was confined to 3 general areas: (1) on the west side opposite Hellgate Bay; (2) at the Goose Bay Marina; (3) on the west side opposite Confederate Bay. Samples ranged from 144 to 398 fish and averaged 212. Collections of 114 age group 0 perch in 1958 and 60 in 1960 were made but sample sites were not given.

The 1967 year class grew exceptionally well during its first summer compared to other year classes (Figure 7). This is further shown by yearling fish captured in 1968. A sample of 257 yearlings captured on June 21, 1968 with fish toxicant averaged 3.2 inches. Scales from 79 of these

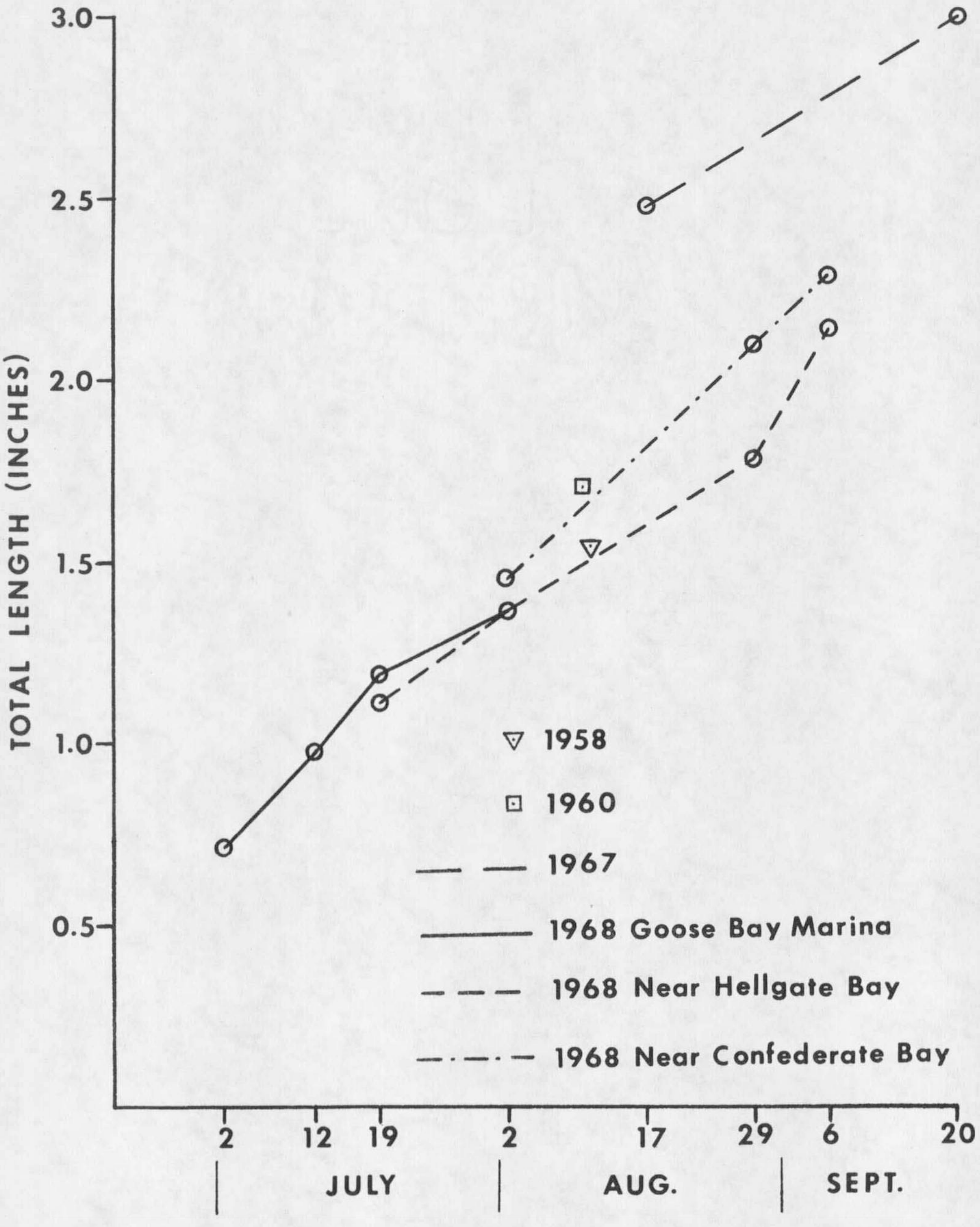

Figure 7. Growth rates of age group 0 yellow perch collected in 1958, 1960, 1967, and 1968.

showed some with an annulus and a small amount of growth beyond while for others no annulus was apparent. Computed lengths at the annulus averaged with lengths of the fish without an annulus gave an average size close to 3.0 inches. Computed first-year lengths of 45 yearlings captured with gill nets in August averaged 3.4 inches (Table III). This figure is probably high because no yearlings were taken with gill nets in June and it is likely that only the fastest growing individuals were large enough to be captured with gill nets in August. First-year growth in 1967 was comparable to first-year growth during the early years of impoundment (Table III).

The first sample of age group 0 perch in 1968 was collected on July 2 at the Goose Bay Marina. At this time they ranged from 0.43 to 0.96 and averaged 0.72 inches. The majority of perch spawning in Canyon Ferry Reservoir occurred during the last week of April and the first 2 weeks of May and if an incubation period of 8 to 10 days is assumed (Pearse and Achtenberg, 1921) these fish would have been about 5 to 8 weeks old.

In 1968, the average length of young perch collected in the northern part of the reservoir (opposite Hellgate Bay) was always less than that of fish taken in the southern part (opposite Confederate Bay) on the same date (Figure 7). This was probably due to a combination of factors related to water temperature. During the month of May water temperatures to a depth of 30 feet near Confederate Bay were 4 to 5 F warmer than those near Hellgate Bay. These higher temperatures may have resulted in earlier spawning, a shorter incubation period, and more rapid growth either directly or through greater food production in the southern part of the reservoir. During early summer the southern part was only 1 to 2 F warmer than the northern part while in late summer the northern part was 1 to 2 F warmer. This might partly account for the smaller difference in average lengths of young perch from the 2 areas on the last sampling date.

Spawning

The ice left the reservoir during the first week of April in 1968. Only a few females were captured at this time and throughout the spawning season. Gill net catches averaged about 13 perch and males were nearly twice as abundant as females. All females collected from April 10 to 24 were gravid. Thirty-six percent of 61 mature females captured on May 4 and 5 and 67 percent of 24 taken on May 15 were spent. All collected on May 19 and after were spent. The majority of spawning probably occurred during the last week of April and the first 2 weeks of May. Water temperatures during this period ranged from 45 to 57 F.

Females released all their eggs during spawning and the ovaries began regression soon after. Testes of mature males captured during the spawning season and for a period thereafter contained milt, a few as late as June 25. Throughout most of the summer of 1968 the gonads of both sexes were very inconspicuous and only a fraction of their former sizes. By the first week in September ovaries had begun to enlarge and eggs were clearly visible. No males were captured at this time. By September 25 the ovaries and testes were large and conspicuous. On October 7, 1967 the gonads of both sexes were nearly as large and had the appearance of gonads just prior to spawning. Le Cren (1951) observed that the ovaries of the European perch in Lake Windemere shrunk from about 20 to 1 percent of the body weight and the testes from about 8 to 1 or 2 percent by the middle of June. He noted that development of both began in August. In the present study the testes appeared to shrink much more. Turner (1919) noted that by the latter part of September the testes weights of yellow perch in Lake Mendota were 30 to 35 times greater than 6 weeks earlier.

Males appear to mature a year earlier than females. In May 1968, 11 males ranging in length from 3.3 to 3.9 inches contained milt. All were aged as yearlings. The smallest gravid female collected was 5.3 inches long and 2 years old, however, few yearling females were actually observed during the period September-May. Other workers have reported that male yellow perch mature at an earlier age than females (e.g. Muncy, 1962). In the present study nearly all males larger than 5.0 inches were mature. Only one of 17 females between 5 and 6 inches long collected during the period October 7 to April 20 was mature. Eight of 9 collected from April 24 to May 12 were mature, while none of 14 collected from May 15 to May 25 was mature. Sixty-eight percent of 38 females 6 to 7 inches long collected during the period October 7 to April 20, 85.7 percent of 14 collected from April 24 to May 12, and 28.6 percent of 42 collected from May 15 to May 25 were mature. Nearly all females larger than 7.0 inches were mature. The percentage of mature females from October 7 to April 20 is probably most representative of the population because during the period April 24 to May 12 most sampling was done in shallow water where spawning fish would be expected to occur. The high incidence of immature females from May 15 to 25 may have resulted from error in classification of fish that had spawned and regression of the ovaries was complete. This was not a problem with females larger than 7.0 inches as their ovaries were still slightly larger and more reddish in color than completely regressed ovaries.

Females predominated in each gill net catch during late spring, summer, and fall and were about 5 times as abundant as males overall. During the period April 10 to May 15 males were nearly twice as abundant in the catch. Muncy (1962) and others have noted that male yellow perch arrive first on the spawning grounds and remain longer than females. The female:male ratios of 257 yearling perch captured in June 1968 and 116 age group 0 perch taken in September 1968 with fish toxicant were 1.6:1 and 1.9:1, respectively. Twenty-six of the yearlings and 16 of the age group 0 perch were not sexed. The majority of those were probably males because testes were small and often difficult to find, particularly if the peritoneum, to which they adhered, was broken. The ratio was probably more nearly balanced than indicated, but females still predominated.

The total number of eggs for each of 15 females was estimated and ranged from 6,600 in a 5.6 inch fish to 47,500 in a 10.7 inch fish (Table VI).

TABLE VI. Estimated number of eggs in the ovaries of 15 yellow perch.

Total Length	No. of eggs	Total Length	No. of eggs
5.6	6,600	8.7	25,500
6.7	11,500	9.0	27,100
6.7	13,900	9.3	28,900
7.1	14,900	9.7	30,500
7.5	16,200	10.0	43,500
7.9	17,900	10.6	41,300
8.2	21,800	10.7	47,500
8.5	21,000		

Food Habits

Digestive tracts of 229 yellow perch over 5 inches in length were collected at irregular intervals throughout the year. Seventy-two were collected during July and August, 33 during October and November, 79 during ice cover (January, February, and March), and 45 during April. Sixty-eight percent were captured with gill nets and 32 percent by angling.

Fifteen percent of the digestive tracts were empty and 29 percent contained identifiable material only in the intestine. Twenty-three of the 34 (68 percent) empty tracts were collected in April and represented 51 percent of the April collection. This high incidence of empty tracts might be related to the approaching spawning season. A decline in feeding activity near or during the time of spawning has been noted for many species.

Cladocera, primarily Daphnia sp., was the most abundant food item in the diet of yellow perch 5 to 7 inches long, comprising 86.5 percent of the total volume (Table VII). Cladocera occurred in 95 of the 96 tracts from fish in this size group that contained identifiable material and in

TABLE VII. Percentage frequency of occurrence and percentage of total volume of food items in the digestive tracts of 229 adult and the stomachs of 32 age group 0 yellow perch.

	1.6-3.0 in. (age 0) (32)*		5.1-7.0 in. (103)		7.1-9.0 in. (97)		9.1-11.0 in. (29)	
Item	Freq.	Vol.	Freq.	Vol.	Freq.	Vol.	Freq.	Vol.
Cladocera	78.1	40.2	92.2	86.5	64.9	60.9	27.6	31.4
Copepoda	84.4	44.1	-	-	-	-	-	-
Chironomidae	31.3	14.4	6.8	2.8	17.5	7.3	3.4	0.5
Isopoda	-	-	11.7	4.4	4.1	2.4	-	-
Fish	-	-	1.9	0.3	19.6	19.4	48.3	52.3
Crayfish	-	-	-	-	2.1	2.3	10.3	9.1
Algae	-	-	1.0	tr.**	3.1	tr.	-	-
Unidentified	9.4	1.4	17.5	6.0	17.5	7.7	13.8	6.8
Empty	-	-	6.8	-	20.6	-	24.1	-

* Sample size in parentheses
** tr. = trace

73 it was the only item.

Although less abundant in tracts of 7 to 9 inch perch where it constituted 60.9 percent of the total volume, Cladocera remained the most important item. Here it occurred in 60 of the 73 tracts that contained identifiable material and was the only item in 38. As the size of perch increased, fish became increasingly abundant in the diet and was the most important food item of perch 9 to 11 inches long. Fish occurred in 48.3 percent of the tracts in this size group and comprised 52.3 percent of the total volume. Fourteen of the 22 tracts containing identifiable material contained fish. Sixteen of the ingested fish were young perch and 19 were unidentified. Increasing frequency of fish in the diet as yellow perch get larger has been reported by Moffet and Hunt (1945), Langford and Martin (1941), and others. Echo (1955) found no such relationship in Thompson Lakes, Montana. The data from Table VII indicate a differential utilization of Chironomidae and Isopoda by different size groups over 5 inches but this resulted from predominance of a size group in one sample of fish that had been extensively feeding on one of these items. For example, Chironomidae occurred in 69.2 percent of the tracts in a collection that was 77 percent 7 to 9 inch fish.

Cladocera was as frequent in digestive tracts in winter as other seasons but comprised less of the total volume. No seasonal difference was found in the occurrence of fish in tracts. Seventy-six percent of the digestive tracts containing Chironomidae and 88 percent of those containing Isopoda were from perch collected beneath the ice. This may indicate a change in diet during winter, however, 18 of the 19 tracts collected during winter that contained Chironomidae were from one sample.

The stomachs of 32 age group 0 perch captured with fish toxicant on September 6, 1968 all contained food. Fifteen were from the northern part of the reservoir near Hellgate Bay and 17 were from the southern part near Confederate Bay. Copepoda, not found in digestive tracts of perch longer than 5 inches, occurred in 84.4 percent of the stomachs and comprised 44.1 percent of the total volume. Cladocera was nearly as abundant. There was a difference in percent of total volume of different food items between fish from the northern and southern parts of the reservoir. Cladocera, Copepoda, and Chironomidae comprised 67.3, 24.7, and 6.3 percent, respectively, of the total volume of stomach contents from the northern part and 16.2, 61.2, and 22.1 percent of the total volume from the southern part.

The stomachs of 13 yearling perch (2.4 to 3.8 inches long) were collected on June 21, 1968. Copepoda occurred in all stomachs and comprised 37.7 percent of the total volume. Cladocera occurred in 12 of the stomachs and comprised 58.5 percent of the total volume. A 3.4 inch perch had eaten an unidentified 0.7 inch fish.

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