RESEARCH REPORT 56

FOOD HABITS AND GROWTH OF YOUNG-OF-THE-YEAR WALLEYES FROM ESCANABA LAKE

Preliminary Report

By
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ABSTRACT

A total of 531 walleye stomachs were examined in 1964-68. The major food item for 3 of the 5 years was fish, most of which were identified as yellow perch. The major invertebrates consumed were Chaoborus, Leptodora and Chironomidae, with their relative importance in the walleye diet fluctuating from year to year.

During the same 5-year period, 2,184 young-of-the-year walleyes and 1,342 young-of-the-year yellow perch were measured. The highest consumption of yellow perch occurred in those years when walleye growth was fastest and the lowest fish consumption occurred in those years when walleye growth was slowest. Years of slow walleye growth corresponded to years when invertebrates predominated in the diet. For most years, the percentage of yellow perch found in walleye stomachs declined in midsummer as a result of the relative growth of the 2 species: yellow perch greater than half the size of the young-of-the-year walleyes were not used as a forage species by the walleyes.

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INTRODUCTION

Information concerning the early life history of the walleye <u>Stizostedion vitreum vitreum</u> (Mitchill), is essential for its effective management, artificial propagation and rearing.

Walleyes in Escanaba Lake spawn in late April. Hatching occurs after about 20 days, and within a day or two the fry move out to open water, where they remain in the pelagic stage until they are about 30 mm long. In late June, young-of-the-year walleyes return to inshore areas of the lake.

The food supply during this post-pelagic stage has been suggested as a factor influencing growth during the critical first season. Smith and Pycha (1960) found some evidence that length of walleyes at the end of the first season was greater in those years in which there was poor growth of young-of-the-year yellow perch, <u>Perca flavescens</u> (Mitchill). Forney (1966) found that growth rate in late summer was greatest in those years that walleyes fed on fish and slower in those years that walleyes fed on invertebrates.

Although walleye and yellow perch growth appears to be related, precise correlation is not known. Furthermore, walleye food habits on one lake may not be the same as on another, emphasizing the continuous need for food habit records for individual lakes. The purpose of this report is to summarize the food habits of post-pelagic young-of-the-year walleyes in Escanaba Lake during 1964-68 and attempt to relate diet to the growth of the walleye and yellow perch during the first growing season.

DESCRIPTION OF THE STUDY AREA

Escanaba Lake is one of five lakes included in the Northern Highland Fishery Research Area. It is a moderately fertile drainage lake having 293 surface acres and a maximum depth of 25 feet. Its walleye population was established through fry stocking during 1933-1942. Walleye fingerlings were stocked in 1954, 1958, 1959 and 1961 as part of a study to determine their survival and contribution to the native walleye population. Since 1962, there have been consecutive, large natural year classes.

METHODS

<u>Fish Collection</u>

Fish were captured by means of 2 techniques: From 1964 through 1968, young-of-the-year walleyes were seined after dark at two locations on opposite shores of the lake. Seining was initiated in late June of each year and was continued until August at intervals of approximately one week. (One exception was 1966 when sampling first began on July 26.) In September and/or October of each year, samples were also collected with an AC boom-shocker operated at night.

All fish captured were preserved in 10 percent formalin.

Food Analyses

The contents of the mouth, esophagus and stomach were removed from each fish and examined under a binocular microscope. All organisms were identified and counted. The results of the stomach analyses* were first expressed as percentage frequency--the percentage of stomachs in which each food item occurred. While this method did reflect the numbers of each food item in the walleye diet, it did not take into account the amount of food present in each stomach. A more quantitative method of expressing the data was thus desired. Commonly used methods to determine percentage biomass from direct volume and weight measurements are difficult to use for analyzing small amounts of planktonic organisms. Besides being difficult to obtain, such precise measurements would be subject to considerable error. Therefore, a simplified form of the method proposed by Wells and Beeton (1963) was used to estimate the relative amount of food per stomach.

Each kind of food item was assigned a permanent index of relative value based on the size of the organisms (Table 1); Chaoborus was arbitrarily designated as the standard organism and assigned the index value of one. The index values for the other organisms were determined in relation to the size of Chaoborus. All fish found in the stomachs were assigned the value of ten regardless of size; error from size variation is minimal since when fish were present they were usually the only item.

For any one stomach the number counted of each item was multiplied by the relative index value for that item in order to determine the relative bulk of each food item in that stomach. When a group of stomachs was considered together, the percentage values were averaged for each stomach where the food item was present.

Growth Measurements

Growth of walleye and yellow perch was determined from the mean total length of fish captured by seining and shocking for the years 1964-68. The number of fish measured per sample varied from 4 to 187 and averaged 39; a total of 2,184 walleyes and 1,342 yellow perch were measured. Because of the variation in sample size and sampling dates, growth curves were used as the basis for comparisons. The curves were drawn to fit the points, taking sample size into account.

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* All references to stomach, stomach contents, etc. in the text refer to the combined contents of the mouth, esophagus and stomach.

TABLE 1

Indices of Relative Food Value Assigned to Each Food Item in the Diet of Young-of-the-Year Walleyes

Food Item	Index
Fish:	
All Species	10
Crustaceans:	
Ostracoda	.03
Daphnia	.03
Leptodora	1
Copepoda	.01
Hyalella	3
Isopoda	3
Decapoda	10
Insects:	
Ephemeroptera	3
Odonata	3
Chaoborus	1
Culicinae	1
Chironomidae	1

RESULTS

Food Habits

A total of 531 walleye stomachs ranging in size from 35-166 mm were examined during the period 1964-68 (Table 2). Forty-eight stomachs were empty (9 percent).

In the stomachs containing food, fish were the major food item in 1964, 1965 and 1966 with the consumption of fish decreasing toward the end of the summer in 1964 and 1966. In 1967, fish were not important in

TABLE 2

Food of Young-of-the Year Walleyes in Percent
Frequency of Occurrence and (in Parenthesis Below Each Item) Percent Relative Bulk[1]

Food Items and Walleye Stomachs Analyzed	1964 July	1964 Aug.	1964 Sept.	1964 Total	1965 July	1965 Aug.	1965 Sept.	1965 Total	1966 July	1966 Aug.	1966 Sept.	1966 Total	1967 July	1967 Aug.	1967 Sept.	1967 Total	1968 July	1968 Aug.	1968 Sept.[2]	1968 Total
WALLEYE STOMACHS																				
No. containing food	35	27	12	74	45	25	0	70	19	30	44	93	25	44	21	90	54	61	41	156
No. empty	5	4	1	10	5	3	0	8	1	1	7	9	7	3	0	10	6	4	1	11
FOOD ITEMS																				
Fish:																				
All species	94 (91)	81 (75)	33 (28)	80 (76)	100 (100)	88 (81)		94 (93)	100 (100)	53 (53)	30 (29)	52 (51)	4 (1)	4 (3)		3 (2)	61 (61)	5 (4)	12 (10)	26 (25)
Crustaceans:*																				
Ostracoda														2 (tr.)		1 (tr.)				
Daphnia			8 (tr.)**	1 (tr.)							2 (tr.)	1 (tr.)	24 (tr.)	36 (tr.)	38 (tr.)	34 (tr.)	20 (5)	64 (7)	66 (5)	49 (6)
Leptodora	6 (5)	4 (4)	50 (36)	12 (9)						37 (35)	32 (13)	27 (18)	68 (32)	79 (29)	52 (24)	70 (29)	26 (23)	85 (71)	80 (44)	64 (47)
Copepoda													8 (tr.)	4 (tr.)		6 (tr.)	11 (3)	26 (tr.)	7 (tr.)	16 (1)
Hyalella										3 (1)	2 (1)	2 (tr.)	8 (3)			2 (1)				
Decapoda			8 (4)	1 (1)																
Insects:																				
Ephemeroptera			25 (20)	3 (3)							2 (tr.)	1 (tr.)			5 (tr.)	1 (tr.)	2 (tr.)	7 (tr.)	7 (3)	5 (1)
Odonata															5 (1)	1 (tr.)				
Chaoborus			8 (4)	1 (1)						3 (2)	57 (51)	28 (25)	84 (54)	91 (56)	95 (63)	90 (57)	6 (1)	39 (11)	44 (22)	29 (11)
Culicinae											2 (tr.)	1 (tr.)						5 (1)	20 (1)	7 (1)
Chironomidae	11 (4)	33 (21)	25 (7)	22 (10)		56 (19)		20 (7)		30 (9)	34 (6)	27 (6)	64 (10)	68 (12)	81 (11)	64 (11)	19 (6)	43 (5)	71 (15)	42 (8)

[1]The data are grouped into 30 day time periods. The July period includes June 30-July 29, the August period includes July 30-August 28, and the September period includes August 29-September 27.

[2]The September period for this year extends to October 10.

*Although Isopoda is listed as a food item in Table 1, it is not included here because it appeared in only a few stomachs in relative bulks amounting to less than 0.5 percent.

**(tr.) = less than 0.5 percent.

the diet and in 1968, fish were important only in July. Of the 252 fish found in the walleye stomachs for all years, 96 were identified as yellow perch and one as a largemouth bass, Micropterus salmoides (Lacepede). All others were unidentifiable.

Forage fish other than yellow perch (such as minnows and young centrarchids) which were small enough to be utilized by young-of-the-year walleyes were not abundant in Escanaba Lake. Furthermore, seine records for young-of-the-year walleyes and yellow perch indicate that in most years yellow perch were very abundant and inhabited the same areas as walleyes (Table 3). Therefore, the majority of the unidentified fish found in the walleye stomachs were probably yellow perch.

The major invertebrates consumed were Chaoborus, Leptodora and Chironomidae, with their relative importance varying from year to year. Chaoborus was the most important food item in 1967, whereas Leptodora was the dominant item in 1968. Chironomidae, though they occurred frequently, seldom occurred in large numbers; this accounts for the relatively large difference between the occurrence and index values.

The other food items were unimportant except in isolated cases.

TABLE 3

Number of Young-of-the-Year Walleyes and Yellow Perch Caught per Unit of Seining Effort, 1964-68.*

Seining Dates	1964		1965		1966		1967		1968	
	Walleyes	Yellow Perch	Walleyes	Yellow Perch	Walleyes	Yellow Perch	Walleyes	Yellow Perch	Walleyes	Yellow Perch
June 24-30			83	>100**						
July 1-7			3	>100			2	41	18	0
July 8-14	24	>100	22	>100					30	28
July 15-21	57	>100	4	>100			116	290	11	79
July 22-28	187	>100			21	>100	121	19	83	>100
July 29-Aug.4	41	>100	13	>100			39	3	53	>100
Aug. 5-11	35	>100	4	>100	16	>100	6	4	158	>100
Aug. 12-18	9	>100	1	>100	9	>100			124	>100
Aug. 19-25	18	>100	21	>100	7	>100	37	7	68	>100
Aug.26-Sept.1	10	>100					11	1	28	>100

*One unit of effort equals two hauls, one at each of two locations.

**Yellow perch were so abundant in most cases that they were not counted.

Growth of Walleyes and Yellow Perch

The growth of young-of-the-year walleyes and yellow perch for the years 1964-68 is presented in figure 1. In 1964, 1965 and 1966 the growth rate of walleyes was clearly faster than that for yellow perch. In 1967, the growth rates were nearly alike and in 1968 virtually parallel. The length of walleyes on August 31 decreased from 1964 to 1968 and the length of yellow perch increased from 1965 to 1968, suggesting a possible inverse relationship between the growth of walleyes and the growth of yellow perch (Fig. 2).

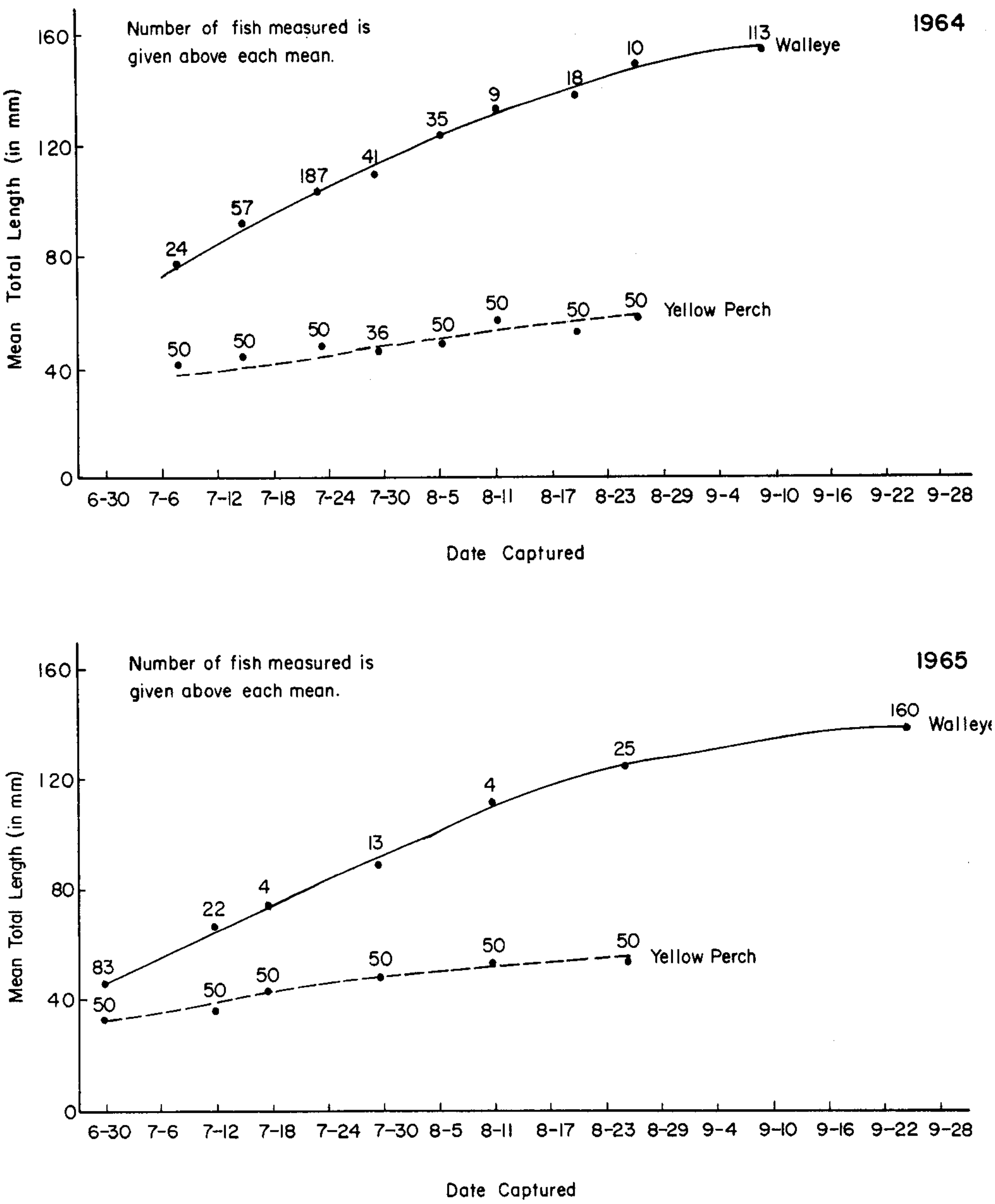

Figure 1. Growth of young-of-the-year walleyes and yellow perch.

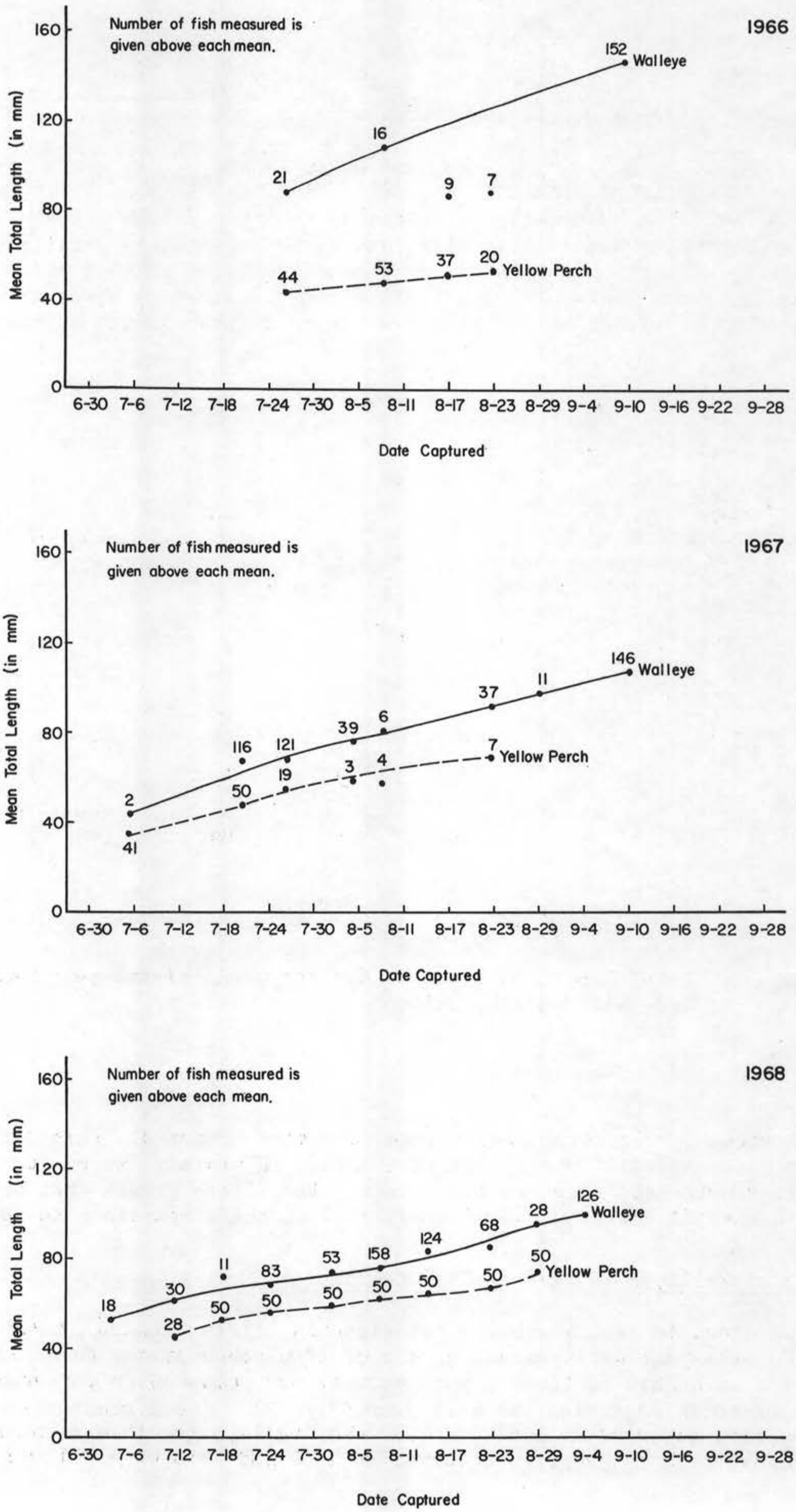

Figure 1. continued

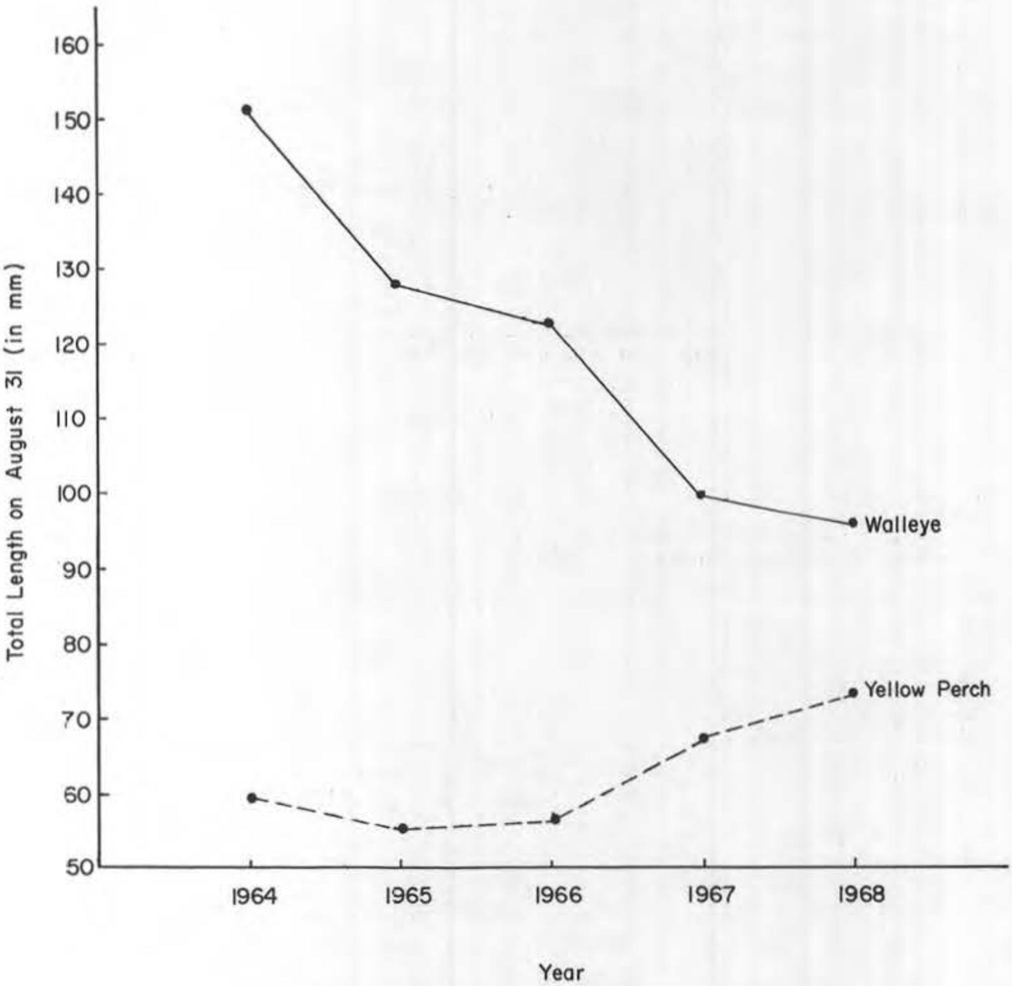

Figure 2. Total length on the same day for young-of-the-year walleyes and yellow perch, 1964-68.

Although the growing season extends beyond August 31, this date was chosen as an index of yearly growth in order to minimize error due to the erratic growth data later in the season. The little growth that occurred after August 31 would not significantly alter the comparisons in this study.

Growth of Walleyes Related to Fish Consumption

In order to test whether a relationship exists between growth of young-of-the-year walleyes and extent of fish consumption, total length of walleyes on August 31 (from growth curves) was compared to percentage of stomachs containing fish for each year (Fig. 3). The highest fish consumption occurred in 1964 and 1965 when walleye growth was the fastest; the lowest fish consumption occurred in 1967 and 1968 when walleye growth

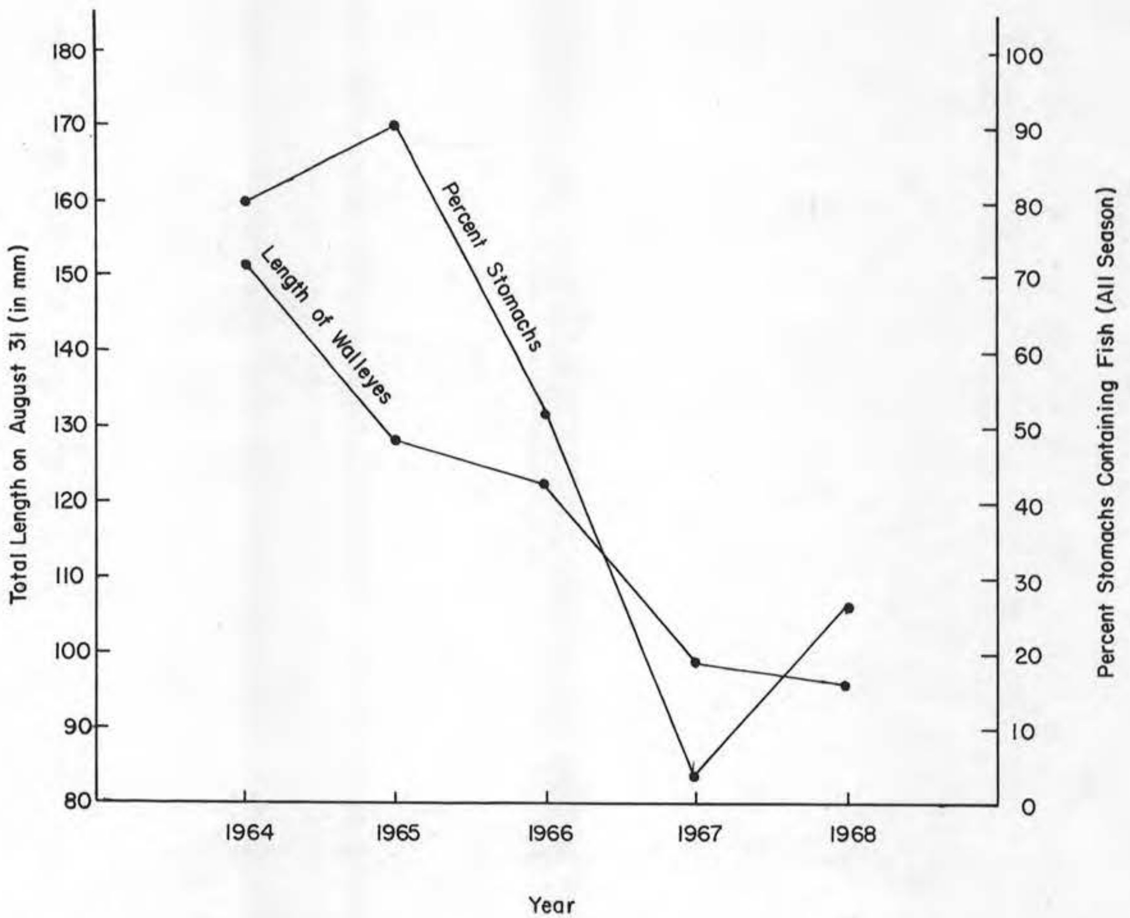

Figure 3. Relationship of total length of young-of-the-year walleyes to percentage of stomachs containing fish for the whole season, 1964-68.

was the poorest. In some years the fish consumption declined in midsummer, therefore, the August growth increment was compared to August fish consumption (Fig. 4). Graphically, walleye growth is more directly related to fish consumption in this figure than in Figure 3.

Walleye-Yellow Perch Comparative Growth Related to Fish Consumption

The length frequency distribution was plotted for 279 young-of-the-year walleyes caught on September 8 and September 23, 1966 (Fig. 5). Growth was negligible between these two dates. The length frequency shows an unusual bimodal distribution. Thirty-five of these fish were examined for stomach contents. Nine out of 11 walleyes greater than 129 mm consumed fish, whereas one out of 24 walleyes less than 130 mm consumed fish. These data suggest that the comparative growth rates of walleyes and yellow perch may affect the ability of walleyes to consume perch. The walleye-yellow perch length ratio may reach a critical point where yellow perch are too large to be preyed upon by young-of-the-year walleyes.

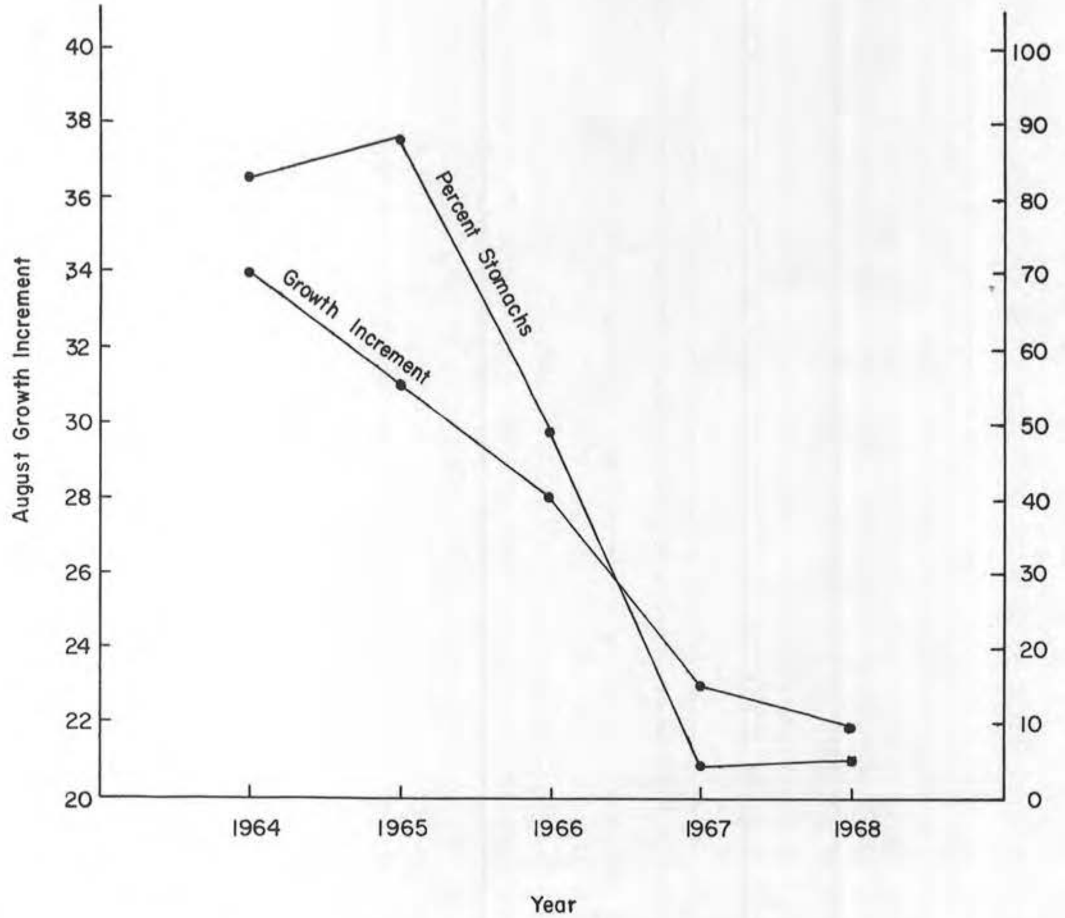

Figure 4. Relationship of August growth increment of young-of-the-year walleyes to percentage of stomachs containing fish in August, 1964-68.

This ratio was determined on the basis of the average length of both species on August 31 of each year and was compared to total seasonal fish consumption and August fish consumption (Fig. 6). The walleye-yellow perch length ratio decreased from 1964 to 1968. The total fish consumption shows a general trend of decrease from 1964 to 1968 but is not consistent for all years. The trend of the August fish consumption agrees more closely than total fish consumption with the walleye-yellow perch length ratio.

Considering that 1964 and 1965 were the years of fastest walleye growth, it is apparent from the length ratio portion of Figure 6 that for optimum growth, young-of-the-year walleyes must be at least twice as long as the yellow perch.

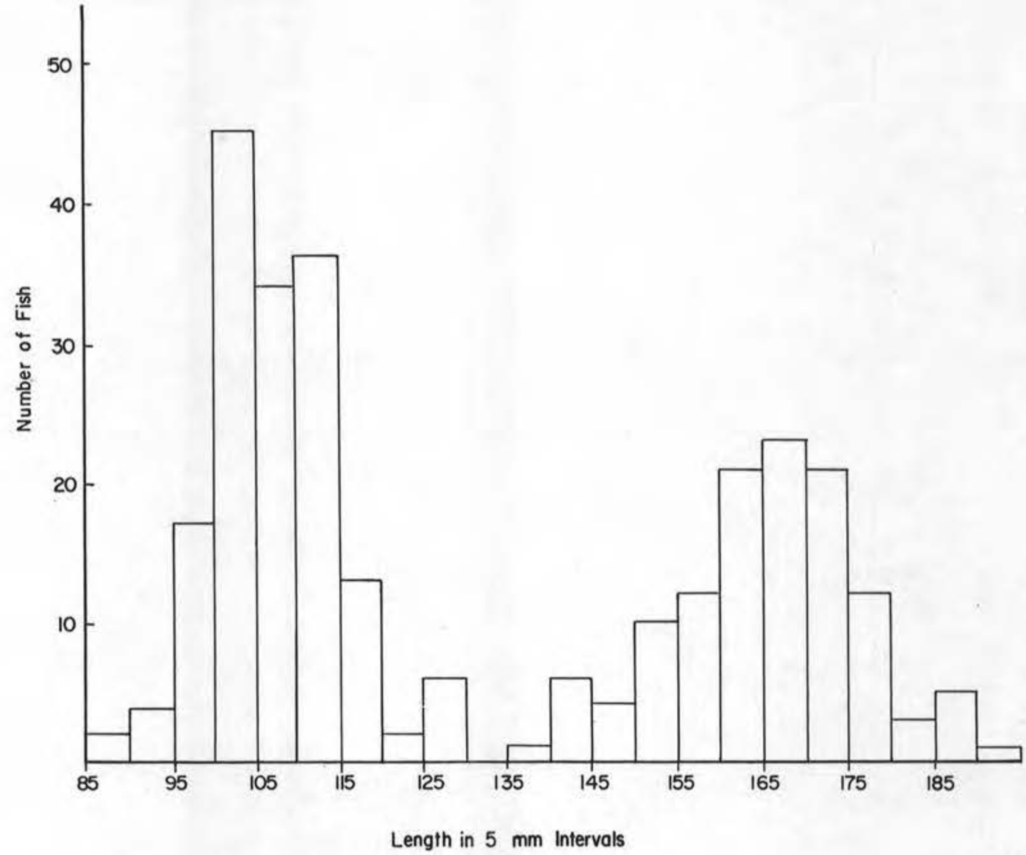

Figure 5. Length frequency distribution of young-of-the-year walleyes caught in September, 1966.

DISCUSSION

The yellow perch is clearly an important food of young-of-the-year walleyes in Escanaba Lake and appears to be selected over invertebrate food items. When invertebrates are consumed, Chaoborus and Leptodora are preferred. Smith and Moyle (1943) found that young-of-the-year walleyes in rearing ponds ate Copepoda, Cladocera and insect larvae (Chaoborus and chironomids); fish were important food only for the larger fingerlings (>70 mm). In Lake Gogebic, Michigan young-of-the-year walleyes ate 88 percent fish, mostly yellow perch (Eschmeyer, 1950). Maloney and Johnson (1955) found that in two Minnesota lakes young-of-the-year walleyes fed almost entirely on yellow perch throughout the summer and fall. In the Red Lakes, Minnesota, young-of-the-year walleyes up to 50 mm in length ate copepods and cladocerans; the larger walleyes relied on yellow perch and other forage fishes (Smith and Pycha, 1960). Forney (1966) studied

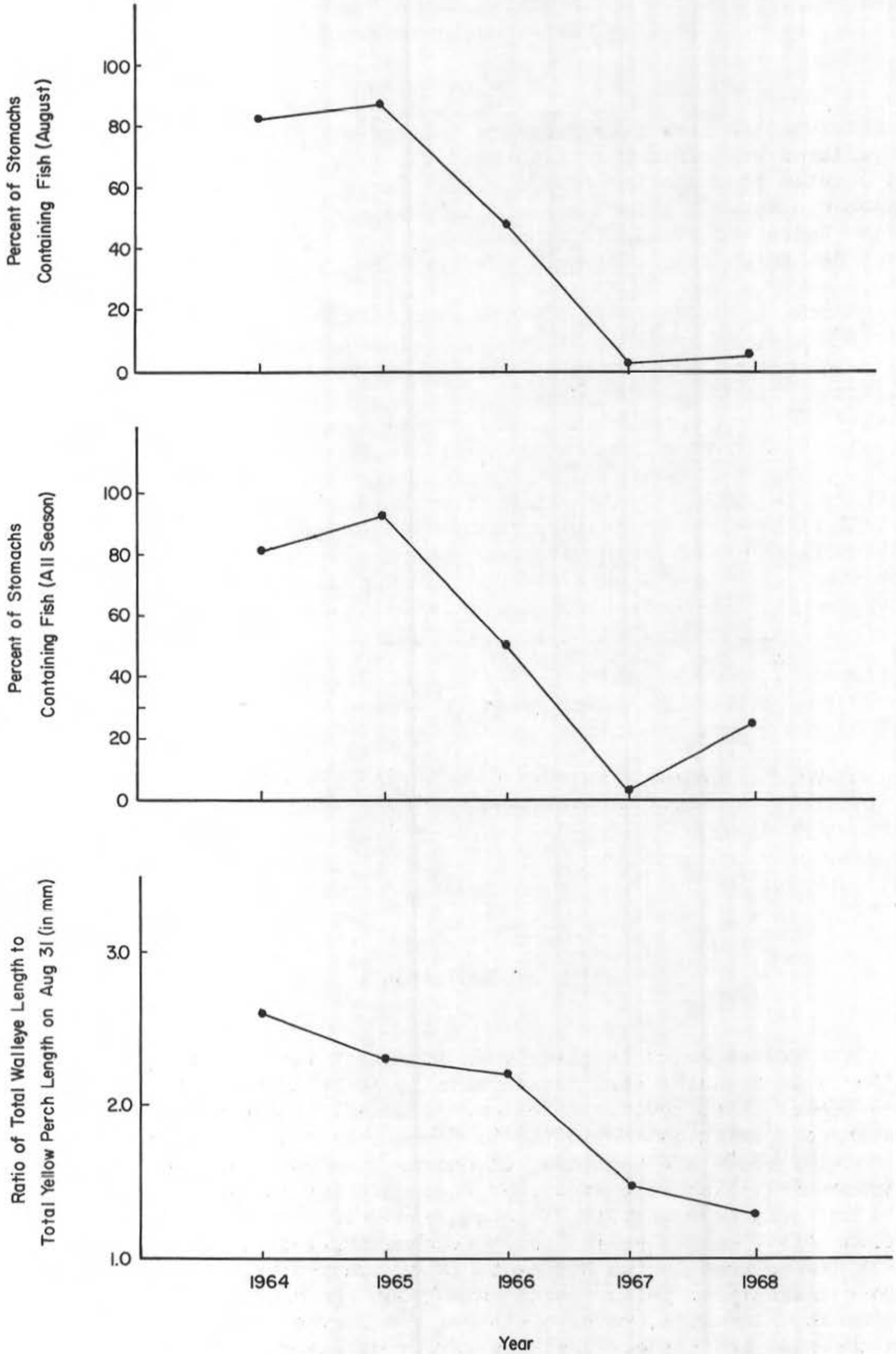

Figure 6. Relationship of walleye-yellow perch length ratio to percentage of stomachs containing fish for August and for the whole season.

young-of-the-year walleyes in Oneida Lake, New York over a six-year period and found walleyes feeding almost exclusively on fish in some years and invertebrates in others.

The Escanaba Lake data suggests that growth rate of young-of-the-year walleyes was rapid when fish were the main food and slower when invertebrates predominated in the diet. Forney (1966) found a similar relationship between growth rate in late summer and fish consumption; whereas, Smith and Pycha (1960) concluded that extent of fish utilization did not determine rate of growth or total growth.

In both Oneida (Forney, 1966) and Escanaba Lakes, for most years the percentage of fish found in walleye stomachs declined in midsummer. This could be caused by a decrease in the numbers of yellow perch, by the inability of the walleye to consume yellow perch or by preference of walleyes for another food item. Preference seems unlikely since in 1964 and 1965 consumption of yellow perch did not decline midsummer, but was high throughout the season. The almost complete lack of fish in the diet of walleyes in 1967 probably reflects low abundance of yellow perch; seine records for this year indicate the poorest catch of yellow perch fingerlings of all years studied. Seine records for the other years indicate that young-of-the-year yellow perch were abundant throughout the summer, suggesting that the decline in fish consumption was not due to a change in prey abundance.

The most probable cause of the decline of percentage of yellow perch taken by walleyes in midsummer seems to be dependent on the relative growth of the 2 species. This hypothesis is supported by the 1966 length frequency distribution and the comparisons of walleye-yellow perch length ratios with fish consumption, and by similar skewed length distributions found by Forney (1966). Accordingly the maximum size forage fish that would be efficiently utilized by young-of-the-year walleyes may be critical in rearing pond operations. Such growth differential may also be a significant factor influencing survival of stocked walleyes.

CONCLUSION

During 1964-68, the food habits and growth of young-of-the-year walleyes from Escanaba Lake varied greatly from year to year. This emphasizes the importance of long-term research, since one year of study could lead to false conclusions.

Other research (Smith and Pycha, 1960) has found a relationship between years of very good young-of-the-year walleye growth and years of slow yellow perch growth. This conclusion is supported by data from Escanaba Lake, but the evidence is limited. More years of data are needed to statistically confirm or deny this relationship in Escanaba Lake.

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