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AGE-SIZE RELATIONSHIPS AND FOOD HABITS OF FISH SAMPLED FROM THE KEJIMKUJIK CALIBRATED WATERSHED

by

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ABSTRACT

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Food habits and age-size relationships of brown bullheads, yellow perch, white perch and golden shiners from the three lakes of the Kejimkujik calibrated watershed study (Nova Scotia) are compared with these parameters for the same species in less acidic New Brunswick lakes. Brown bullheads from the Kejimkujik Park lakes had less in their stomachs, grew more slowly, and were in poorer condition than were those sampled from New Brunswick populations.

Key words: Kejimkujik, Beaverskin, Pebbleloggitch, white perch, yellow perch, brown bullhead, golden shiner, age size, diet

RÉSUMÉ

Peterson, R. H., D. J. Martin-Robichaud, and J. J. Kerekes. 1983. Age-size relationships and food habits of fish sampled from the Kejimkujik calibrated watershed. Can. MS Rep. Fish. Aquat. Sci. 1743: iii + 15 p.

Nous avons comparé les moeurs alimentaires et les relations âge-taille de barbottes brunes, perchaudes, barsperches et chattes de l'est de trois lacs échantillonnés au cours de l'étude du bassin hydrographique calibré de Kejimkujik (Nouvelle-Ecosse) avec les paramètres des mêmes espèces dans des lacs moins acides due Nouveau-Brunswick. Les barbottes brunes du parc Kejimkujik ont moins de nourriture dans leurs estomacs, croissent plus lentement et sont en moins bon état physique que celles des populations du Nouveau-Brunswick.

INTRODUCTION

The Kejimkujik calibrated watershed study was initiated in 1978 as one of a number of watershed studies by Canada's Department of the Environment (Kerekes et al. 1982). These watershed studies form an important component of the Department of Environment's acid rain research. In support of this study, Canada's Department of Fisheries and Oceans, St. Andrews, N.B., agreed to analyze fish samples which had been collected in September 1978 from the three lakes forming the watershed study: Kejimkujik, Beaverskin, and Pebbleloggitch. The fish species which are known to occur in these lakes are listed in Appendix 1. Their distribution as it relates to pH in Kejimkujik National Park is given by Kerekes (1982). To compare the characteristics of fish in these samples with fish from less acidic lakes, some data are included from lake surveys performed in southern New Brunswick in 1978 (Peterson 1980; Peterson and Martin-Robichaud 1982, 1983). The New Brunswick lakes are characterized by higher pH levels and considerably higher levels of dissolved solids, although none of the lakes would be classified as eutrophic (Appendix 2).

MATERIALS AND METHODS

Fish were sampled with gillnets. The nets used in the Kejimkujik Park lakes were of monofilament nylon and were 2.4 x 15 m with stretched mesh of 1, 1½, 2, 2½ cm. The gillnet characteristics used to net the New Brunswick fish are given in Peterson and Martin-Robichaud (1982).

All fish were identified to species, weighed (nearest 0.1 g), measured (fork length, nearest mm), and numbered in increasing order of size for each species in each collection. Lengths and weights were not corrected for possible changes due to storage in 10% formalin. If the number of fish collected totaled 10 or fewer, the stomachs of all fish were analyzed. For collections up to 100 fish, one additional fish was chosen for stomach analysis for each additional 10 fish. If the collection exceeded 100 fish, one additional fish was chosen for each additional 100 fish in the collection. Fish used for stomach analyses were selected randomly over the entire size range in the collection. Further details of the stomach analyses and subsequent treatment of data may be found in Peterson and Martin-Robichaud (1982). The yellow perch were separated into three size groups (<10 cm, >10-15 cm, >15 cm) for analyses of diets, since Peterson and Martin-Robichaud (1983) found diets to differ among these size groups.

White perch (Morone americanus) and brown bullheads (Ictalurus nebulosus) were aged by examination of otoliths, whereas yellow perch (Perca flavescens) and golden shiners (Notermigonus crysoleucas) were aged by examination of scales. The data for fish collected from New Brunswick lakes are reported in more detail in Peterson and Martin-Robichaud (1983).

The food habits have been analyzed, using the percent occurrence of the various taxa in the diet (Holmes and Pitelka 1968). Indices of fullness (C_F = (wt of food in stomach/wt of fish) x 100; Gascon and Leggett 1977) were also calculated in some instances.

Length-age and weight-length relationships were analyzed for most of the species examined. The length-age data give an indication of the growth rate of a species, while the weight-length relationships provide a measure of the condition of the fish.

The fish collected from Kejimkujik Park lakes were netted in early September. The fish collections from New Brunswick lakes which were used for comparisons were netted from mid-August to late September.

RESULTS

FOOD HABITS

The stomachs of golden shiners from Kejimkujik Lake contained very little (Fig. 1) with three of the five organisms being cladocera. The stomach contents of Mud Lake shiners also indicated cladocera as the primary items in the diet at this time of year, although larger organisms, such as Trichoptera, are important earlier in the summer (Peterson and Martin-Robichaud 1983). The Mill Lake shiners had eaten mostly terrestrial adult Diptera. The single golden shiner (12.7 cm) collected from Pebbleloggitch Lake had consumed 80 adult chironomidae and one cladoceran. The indices of fullness averaged less for Kejimkujik shiners than for Mill Lake shiners (Fig. 2).

The diets of brown bullheads from each of the three lakes of the study area were different (Fig. 3). The most abundant item in the diet of Beaverskin Lake bullheads was the isopod, Asellus, with other aquatic insects present as well. Brown bullheads from Kejimkujik Lake contained few organisms in their stomachs, with fish (probably ninespine sticklebacks Pungitius pungitius) probably the most important item. Pebbleloggitch Lake bullheads' diet consisted primarily of zooplankton, with a few aquatic insects present. The lesser numbers and generally smaller sizes of organisms ingested by the bullheads of the Kejimkujik lakes, compared with diets of bullheads from Mill and Mud Lakes, are reflected in the smaller indices of fullness (Fig. 4).

The Beaverskin Lake white perch (from the stomachs analyzed) appear to incorporate larger numbers of fish in their diets than do the white perch of Bolton and Wheaton Lakes (Fig. 5). Isopods were prominent in the Beaverskin white perch diets as they were in the diets of bullheads from that Lake. The index of fullness for Beaverskin white perch is comparable to values obtained for white perch in the two New Brunswick lakes (Fig. 6).

The diets of yellow perch in the three Kejimkujik Park lakes are comparable to those of yellow perch in Mill Lake (Figs. 7, 8, 9), consisting primarily of larger aquatic insects and small fish. The smallest size-class of yellow perch (Fig. 7) also ingested considerable numbers of cladocerans and copepods.

The indices of fullness for yellow perch in the Park lakes are also comparable to those obtained for perch in New Brunswick lakes (Fig. 10).

AGE-SIZE RELATIONSHIPS

The length-age data for bullheads sampled from the three lakes of the watershed study indicate that the growth of these fish was slower than those of bullheads sampled from New Brunswick lakes (Table 1). This is most evident for the age 2, 3, and 4 year-classes which contain most of the specimens sampled. The weight-length relationships indicate that bullheads from the watershed study lakes were in somewhat poorer condition than were those sampled from New Brunswick lakes, with no differences in condition among bullheads sampled from the three Park study lakes (Fig. 11).

From the few white perch sampled, it would appear that this species grows more rapidly in Beaverskin Lake than it does in Wheaton Lake (New Brunswick) (Table 2). Caution is required, however, until more samples are analyzed. It is also worth mentioning that the most frequent ages of fish sampled in Wheaton Lake were 5-10 yr (the same is true of Bolton Lake white perch (Peterson and Martin-Robichaud 1983)), while no perch in Beaverskin older than 4 were collected.

The data from the few golden shiners aged indicate no difference between the length-age relationships of this species from lakes of the watershed study and shiners in Mud Lake, New Brunswick (Table 2).

Growth of yellow perch in Beaverskin and Pebbeloggitch Lakes seems to be slightly repressed for ages 1-4, but is comparable to the Mill Lake population thereafter (Fig. 12; Table 3). The condition of yellow perch from Beaverskin and Pebbloggitch Lakes is practically identical to that of Mill Lake yellow perch, as judged from the weight-length relationships (Fig. 13).

DISCUSSION

Brown bullheads sampled from Beaverskin, Pebbleloggitch, and Kejimkujik Lakes had little in their stomachs, were smaller and in poorer condition than were bullheads of similar age collected from Mill and Mud Lakes in New Brunswick, all indicating that the nutritional status of the bullheads in the Park lakes is not equal to that of bullheads in New Brunswick lakes. The pH is probably sufficiently low in Kejimkujik and particularly Pebbleloggitch Lakes to subject these bullheads to acid-related stresses, i.e., osmotic stress. Density-related factors, i.e. overcrowding, may also be responsible for some of these observed differences.

There are no indications, either from growth rates or stomach analyses, that the biology of the golden shiners in the three Park lakes differs from that of this species in New Brunswick. The fish sample size, however, was very small.

The growth of white perch in lakes of the Park study area was apparently more rapid than that of white perch in Wheaton Lake. The ages of the perch sampled in these acid lakes, however, did not exceed 4 yr, compared to 14-15 yr for Wheaton Lake perch. This aspect deserves further investigation. Possibly mortality related to reproduction in the acidic enviroment is responsible for the lack of older white perch in the samples.

The yellow perch food habits do not seem to be affected by the acidity of lakes in the calibrated watershed. The samples collected indicate some repression of growth in the earlier years, more probably due to population densities rather than acidity. Yellow perch are particularly prone to high population densities and suppressed growth in the absence of top predator species (Scott and Crossman 1973; LeCren 1958). The increase in growth rate of older and larger yellow perch may result from cannabalism of smaller perch.

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Table 1. Length (cm) at age for brown bullheads; standard deviations are given where the numbers of fish are sufficient to warrant the calculation. Numbers of fish are given in parentheses. Brown bullheads from New Brunswick lakes were collected throughout the summer; those from Park lakes in early September.

Lake	Brown bullhead (age) (yr)						
	0	1	2	3	4	5	6
New Brunswick	-	10.0(2)	16.1±2.6(14)	17.8±1.2(21)	19.6±2.3(9)	21.4±1.4(7)	-
Kejimkujik	7.5±1.3(7)	9.1±0.4(12)	10.4±0.5(21)	12.2±0.6(39)	15.3±1.5(102)	19.6±0.8(28)	22.5(1)
Beaverskin	-	9.2(2)	13.0±1.1(5)	16.0±2.0(10)	18.6±1.2(6)	20.0±0.2(4)	20.6(2)
Pebbleloggitch	-	9.1(3)	15.2(1)	14.9±1.0(11)	16.1(2)	-	-

Table 2. Lengths (cm) at age for white perch and golden shiners; standard deviations and number of fish as described in Table 1. White perch from Wheaton Lake were collected in late September; those from Beaverskin in early September where golden shiners were collected from Mud Lake September 29, and from Park lakes in early September. (Numbers of fish are given in parentheses).

	White perch																
	(age) (yr)																
Lake	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16
Wheaton	-	-	12.1 ± 1.6(18)	14.4 ± 1.2(27)	18.6 ± 0.3(6)	19.3 ± 0.4(12)	19.7 ± 1.1(13)	19.7 ± 0.9(13)	20.3 ± 0.9(8)	21.5 ± 0.2(3)	22.0 ± 2.3(16)	22.8 - (2)	22.7 - (3)	23.0 - (4)	22.3 - (3)	22.1 - (1)	
Beaverskin	-	-	15.2 - (2)	21.2 ± 4.9(6)	23.5 ± 4.0(5)												
	Golden shiner																
Mud	-	-	11.1 ± 1.5(13)	13.6 ± 0.9(64)	14.6 ± 1.1(5)	17.4 - (1)											
Kejimkujik	-	-	12.5 ± 1.0(5)	13.3 - (1)													
Beaverskin	5.3 (3)																
Pebbleloggitch	-	-	12.7 - (1)														

Table 3. Length (cm) at age for yellow perch. (Numbers of fish are given in parentheses).

Lake	Yellow perch (age) (yr) 0	1	2	3	4	5	6	7	8	9	10	11	12
Mill (N.B.)	5.6 ± 1.1(33)	7.6 ± 1.0(33)	9.9 ± 1.2(52)	13.5 ± 2.9(26)	19.1 ± 2.8(10)	21.4 - (6)	21.8 ± 2.2(26)	22.8 ± 2.9(16)	26.2 ± 2.0(9)	29.8 ± 0.9(3)	30.0 - (1)		
Kejimkujik	-	8.7 - (1)	10.1 - (3)	11.4 - (1)									
Beaverskin	-	7.8 - (1)	9.3 ± 0.2(27)	10.2 ± 0.4(67)	12.0 ± 1.3(30)	15.2 ± 1.1(35)	17.0 ± 1.2(40)	20.4 ± 1.9(27)	24.0 ± 3.3(6)	24.5 - (1)			
Pebbleloggitch	-	8.7 ± 0.1(27)	9.5 ± 0.4(130)	11.5 ± 2.0(33)	14.5 ± 2.2(13)	14.3 ± 1.7(19)	17.8 - (3)	20.7 - (1)	-	23.4 - (1)			

The following abbreviations are used in the various figures depicting food habits of the various species:

Am.	: Amphipoda	Hir.	: Hirudinea
Ar.	: arachnids	Hyd.	: Hydracarina
Cha.	: Chaoborus	Is.	: Isopoda
Ch.	: Chironomidae	9-sp.	: ninespine stickleback
Cl.	: Cladocera	Od.	: Odonata
Col.	: Coleoptera	Os.	: Ostracoda
Cor.	: Corixidae	Pel.	: Pelecypoda
Cop.	: Copepoda	Plec.	: Plecoptera
Dip. L.	: Diptera larvae	Sal.	: salamander
Dip. P.	: Diptera pupae	Te. I.	: terrestrial insects
Dix.	: Dixidae	Tr.	: Trichoptera
Eph.	: Ephemeroptera	Turb.	: Turbellaria
F.	: fish		
Ac.	: Acarina		
Ga.	: Gastropoda		
Hel. L.	: Heleidae larvae		

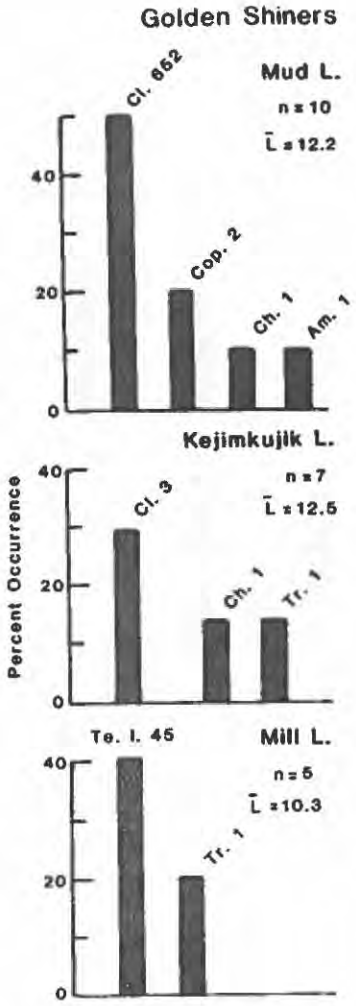

Fig. 1. Percentage of golden shiner stomachs containing various food items. Mud Lake shiners were collected in late September, Kejimkujik shiners in early September and Mill Lake shiners from Aug. 16 (2) and Sept. 26 (3). Ranges of fish lengths (cm): Kejimkujik (11.0-14.1), Mud (10.0-17.4), Mill (7.8-13.1).

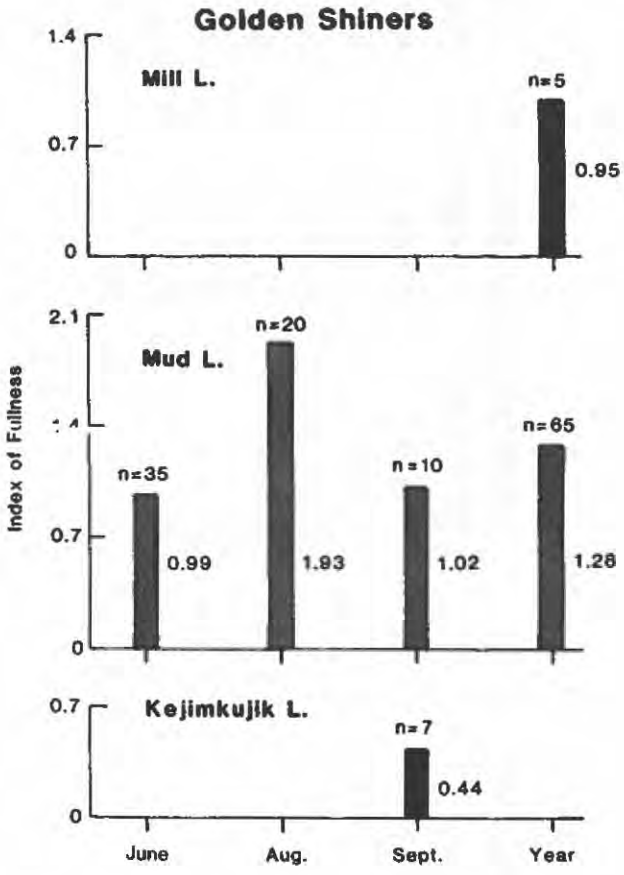

Fig. 2. Indices of fullness for golden shiner stomachs.

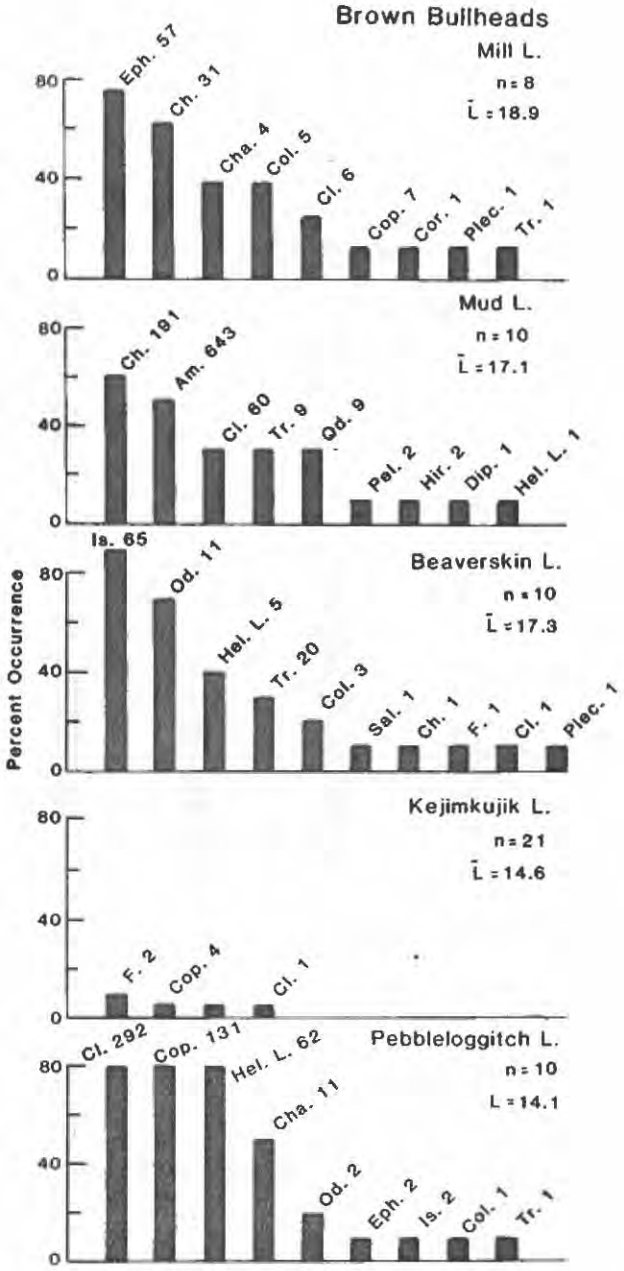

Fig. 3. Percentage of brown bullhead stomachs containing various food items; the brown bullheads were collected from Mill Lake on Aug. 16 (4) and Sept. 26 (4), from Mud Lake on Aug. 10 and from the Park lakes in early September. Ranges of bullhead length (cm): Mill (16.4-20.9), Mud (11.4-24.6), Beaverskin (9.1-20.4), Kejimkujik (9.2-19.5), Pebbleloggitch (9.7-16.5).

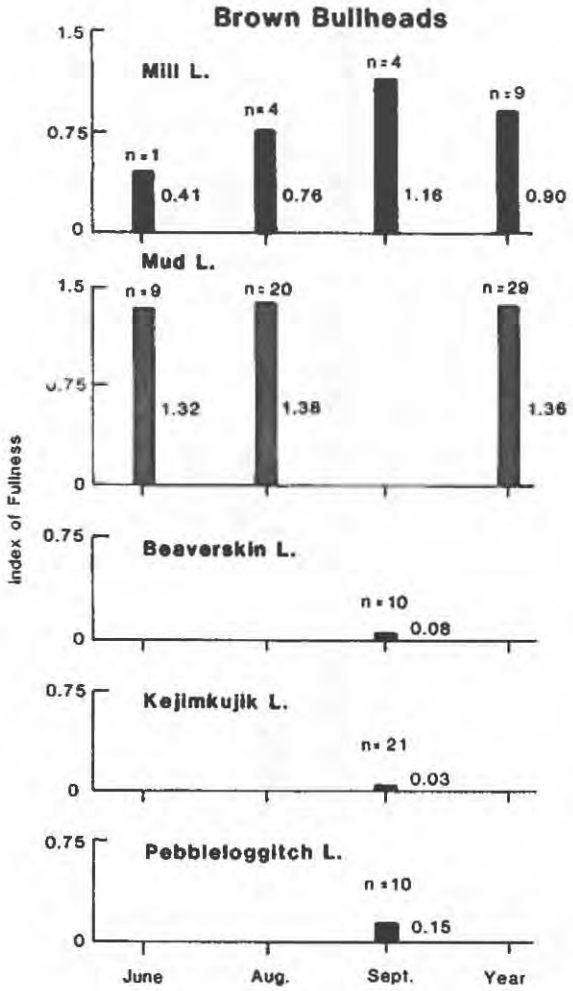

Fig. 4. Indices of fullness for brown bullhead stomachs.

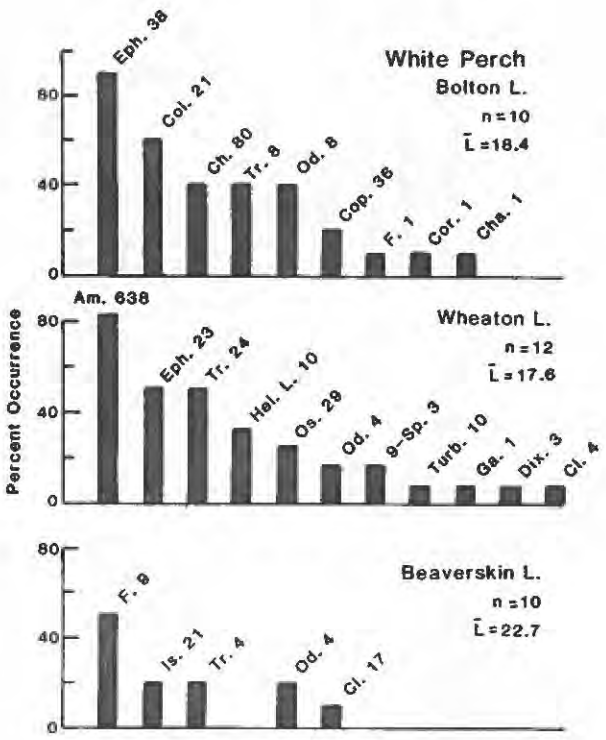

Fig. 5. Percentage of white perch stomachs containing various food items; all white perch were collected in September. Ranges of white perch lengths (cm): Bolton (14.2-26.2), Wheaton (12.8-24.2), Beaverskin (16.3-28.1).

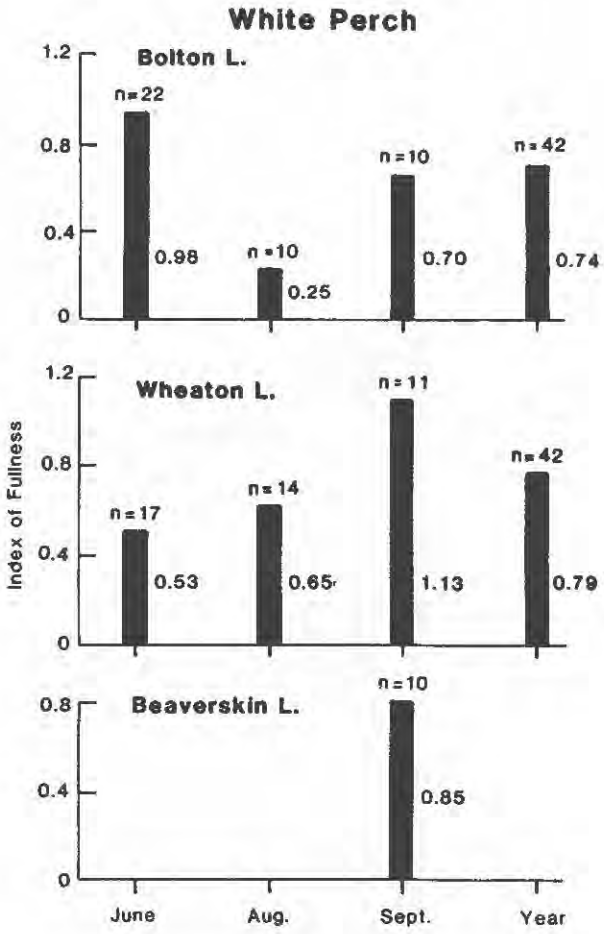

Fig. 6. Indices of fullness for white perch stomachs.

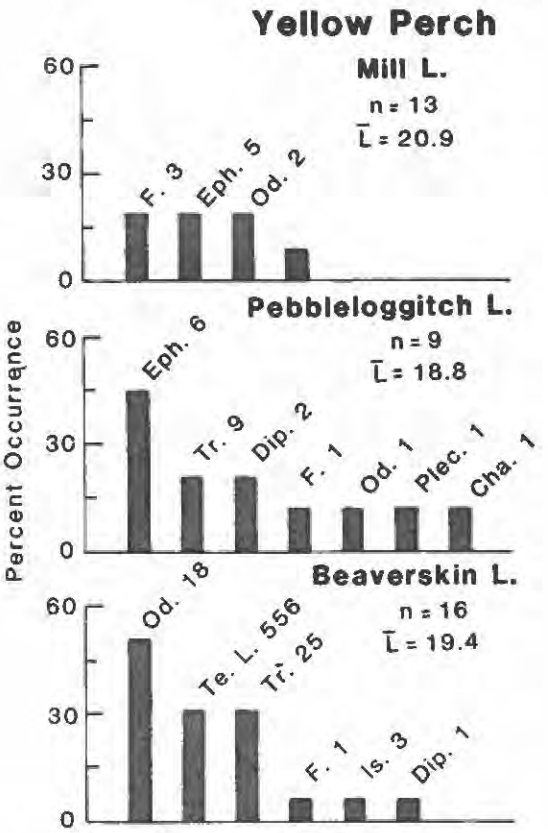

Fig. 7. Percentage of yellow perch stomachs containing various food items for fish >15 cm long; the yellow perch were collected from Mill Lake on Aug. 16 (6) and Sept. 26 (7), and from the Park lakes in early September. Ranges of lengths (cm): Mill (16.0-24.8 cm), Pebbleloggitch (16.0-23.4), Beaverskin (15.5-30.2).

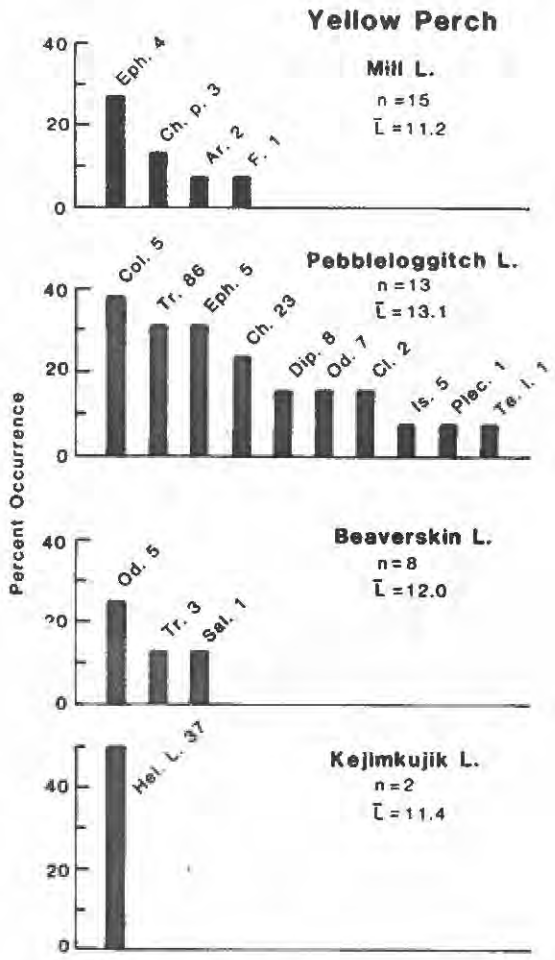

Fig. 8. Percentage of yellow perch stomachs containing various food items for fish >10-15 cm long. Ranges of lengths (cm): Mill Lake (10.1-13.7), Pebbleloggitch (10.2-14.5), Beaverskin (11.1-15.0), Kejimkujik (11.3-11.4).

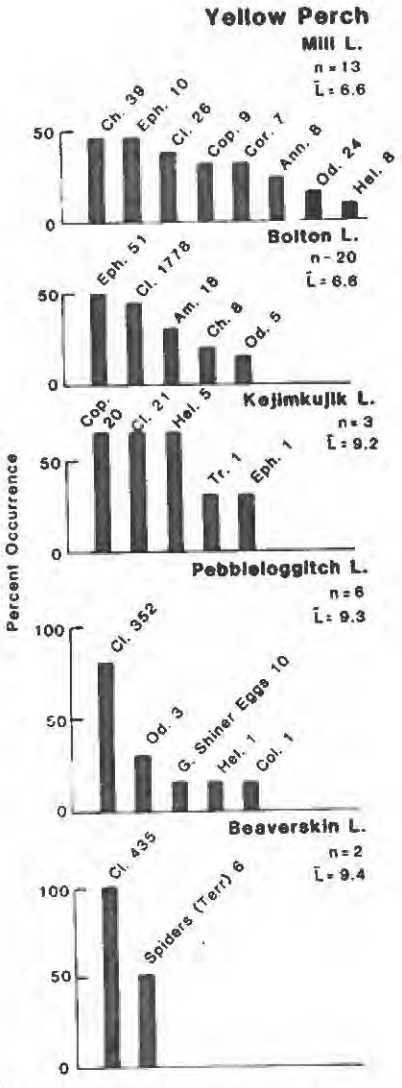

Fig. 9. Percentage of yellow perch stomachs containing various food items for fish ≤10 cm long. Ranges of lengths (cm): Mill (4.3-9.8), Bolton (4.5-8.6), Pebbleloggitch (8.4-10.0), Beaverskin (9.0-9.8), Kejimkujik (8.7-9.7).

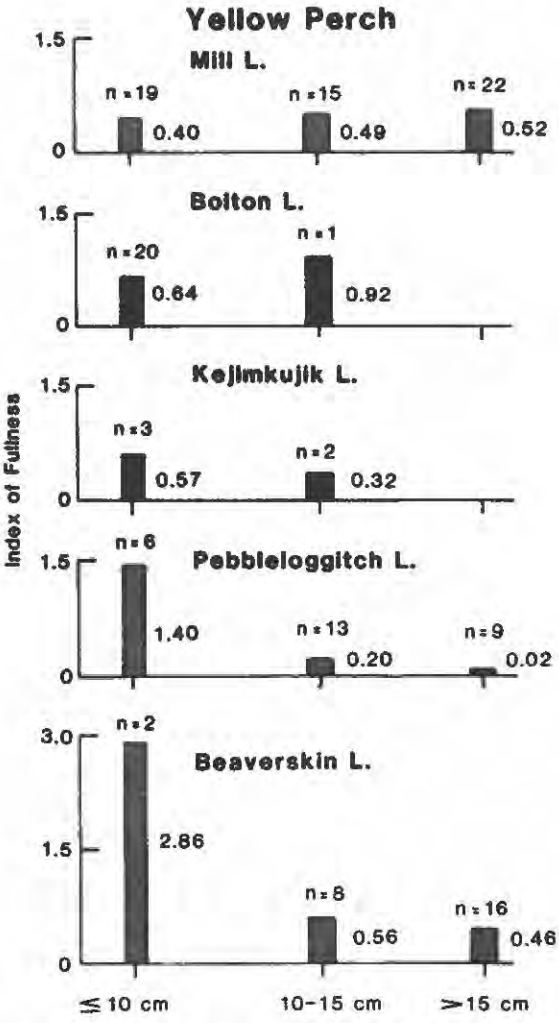

Fig. 10. Indices of fullness for yellow perch stomachs.

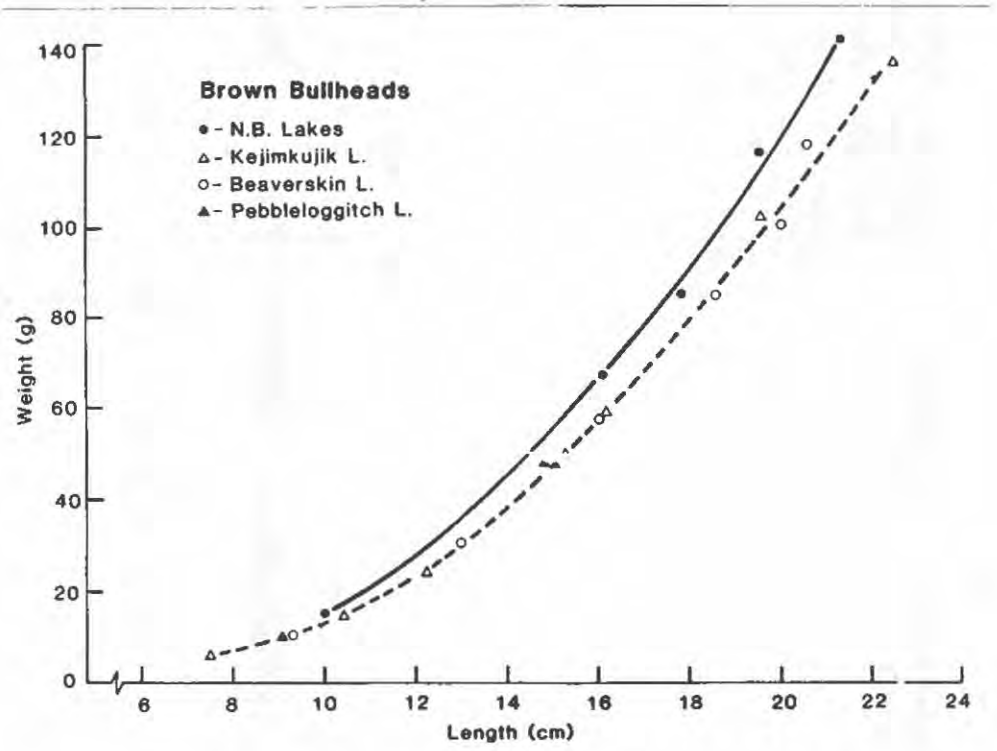

Fig. 11. Weights of brown bullheads at various lengths; numbers of fish representing each point are given in Table 1; lines estimated by eye.

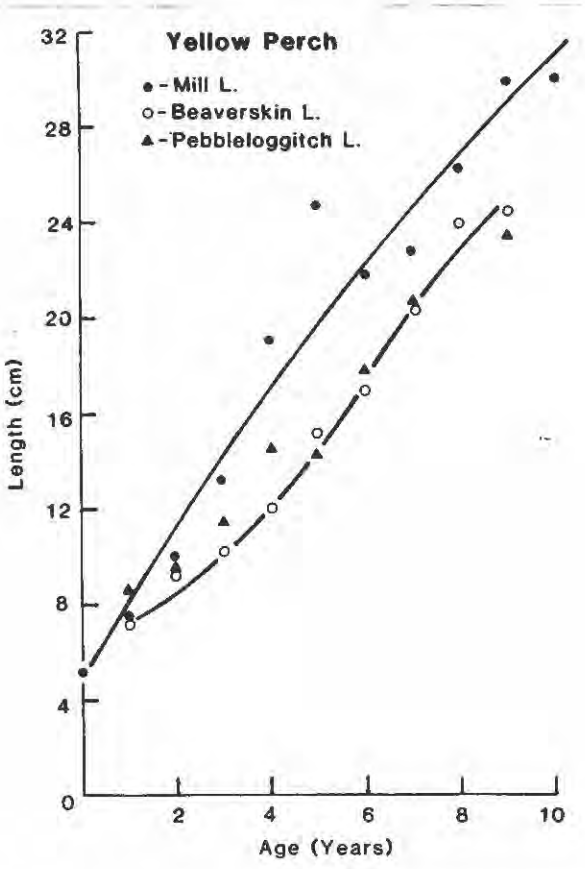

Fig. 12. Growth curves for yellow perch from three lakes; numbers of fish representing each point are given in Table 3; lines estimated by eye.

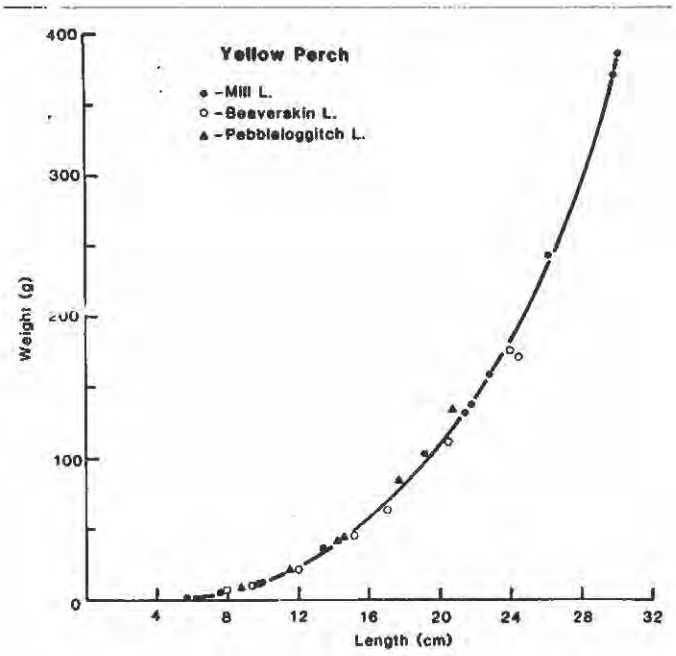

Fig. 13. Weights of yellow perch at various lengths; numbers of fish representing each point are given in Table 3; lines estimated by eye.

APPENDIX 1. Distribution of fishes in three lakes in Kejimkujik National Park in 1972 (data from Kerekes (1975)).

Species	Lake		
	Beaverskin	Kejimkujik	Pebbleloggitch
Lake whitefish		+	
Brown trout		+	
Brook trout	+	+	
Golden shiner	+	+	[a]
Creek chub		+	
White sucker		+	
Brown bullhead	+	+	+
American eel	+	+	+
Banded killifish	+	+	
Ninespine stickleback		+	
White perch	+	+	
Yellow perch	+	+	+
Number of species	7	12	3

[a]This study, one specimen only, probably a stray from the Shelburne River system.

APPENDIX 2. Geographic, physical, and chemical parameters of lakes from which fish were sampled for analyses given in this report.

Lake	Lat. & Long.	Major ions (μeq/L) pH	K	Ca	Mg	Na	Cl	HCO_3^-	$SO_4^{=a}$	Conductance μS cm^{-1} @ 25°C
Beaverskin	44°18'N 65°20'W	5.3	8	20	32	126	124	0.6	58	25
Kejimkujik	44°23'N 65°15'W	5.0	6	38	39	135	121	0	81	30
Pebbleloggitch	44°18'N 65°21'W	4.5	6	18	30	126	111	0	95	34
Mud	45°50'N 67°32'W	7.6	23	571	45	61	38	508	110	58
Bolton	45°42'N 67°35'W	7.0	9	127	34	48	28	104	74	24
Mill	45°11'N 66°46'W	7.1	11	149	48	109	98	102	84	33
Wheaton	45°11'N 66°16'W	7.1	9	197	58	193	209	150	80	57

[a]Obtained by the methyl-thymolblue method, subject to color interference.