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s as possible predators and food . Investigations of Dolly Varden *malma)* at Chignik (Roos, 1959) that they are predators of juvenile lmon. Stomach analysis of coho collected during the summers of and 1959, has revealed that coho prey upon sockeye salmon fry. tion has previously been reported ıs Lake, British Columbia, by 41) for residual (200-400 milli-) coho salmon.

lakes of the Chignik system lie on Peninsula, some 200 miles west of ınd. Both lakes are small with sur-of 9 and 15 square miles and less feet above sea level. Black Lake) is shallow (less than 25 feet), ıignik Lake (lower lake) is deep depth, 190 feet). Fourteen species been found in the lakes. Sockeye he most abundant species of sal-oast-range sculpin *(Cottus aleuti-* pine stickleback *(Gasterosteus acu-* lly Varden, and coho salmon are lant species.

mon were collected with a beach the two lakes during May, June, One hundred and eighty-two pre-imens (10 percent formalin) were or standard length and the stomach m esophagus to pylorus identified. f sockeye salmon fry were re-individual food items other than ot counted nor were measurements or weight of food obtained. Re-xpressed as frequency of occur-ined by dividing the number of ing a specific food by the total fish inspected.

h examined, 97 percent had food machs at time of capture (Table st instances stomachs were dis-hty-seven percent of the stomachs ontained insects, of which Diptera the most prevalent. Thirty per-cohos fed on sockeye salmon fry, rage of 2.3 fry per stomach or an 0.7 sockeye salmon per stomach examined. This incidence is seven ımber of juvenile sockeye salmon Dolly Varden stomachs (Roos, maximum number of sockeye fry coho salmon stomach was seven. und in various stages of digestion

TABLE 1.—*Stomach content of coho salmon taken at Chignik, Alaska, in 1956, 1957, and 1959*

Item	Number of fish with food item				Percentage occurrence (all fish)
	1956	1957	1959	Total	
Sockeye salmon fry	2	4	48	54	29.7
Diptera larvae	22	19	100	141	77.5
Trichoptera	3	—	9	12	6.6
Plecoptera	—	—	1	1	0.5
Coleoptera	—	1	1	2	1.1
Unidentified insects	—	1	2	3	1.6
Amphipods	3	—	14	17	9.3
Oligochaeta	1	—	1	2	1.1
Araneae	—	—	1	1	0.5
Miscellaneous items	2	3	6	11	5.9
Number of empty stomachs	0	4	1	5	2.7
Number of fish feeding	25	22	130	177	97.3
Total examined	25	26	131	182	—

indicating that predation had taken place prior to the time of the seine haul.

The young coho salmon included two age groups, both of which fed on young sockeye salmon (Figure 1). It would therefore appear that each year class preys upon sockeye salmon for two seasons.

Inspection of stomachs of sockeye fingerlings (age-groups I and II) captured with the young coho revealed that they were feeding upon insects. It appears that young coho are also food competitors with sockeye salmon.

Sticklebacks were not found in the coho salmon collected at Chignik even though they composed 54 percent of fish in the seine hauls of which young sockeye made up 35

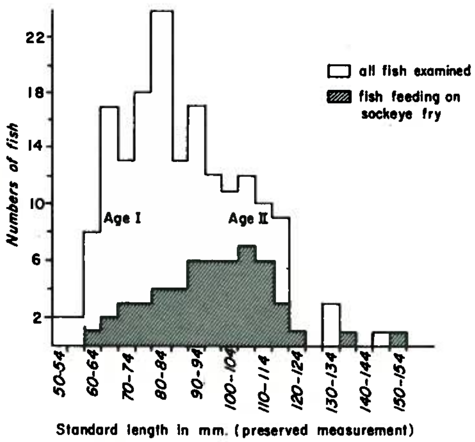

FIGURE 1.—Size-frequency distribution of young Chignik coho salmon examined for stomach contents and those which ate sockeye fry.

percent and young coho 11 percent. These data indicate that young coho in the Chignik system prefer young sockeye salmon over sticklebacks as a source of food. All evidence gathered to date at Chignik suggests that coho salmon are more detrimental than beneficial to sockeye salmon.

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Age and Growth of Four Species of Warm-Water Game Fish from Three Montana Ponds[1]

A considerable number of ponds, lakes, and streams in Montana have been stocked with various species of warm-water game fish. In most instances low water temperatures and short growing seasons have precluded satisfactory growth of these fishes but not their ability to reproduce and compete with cold-water species. Many largemouth bass *(Micropterus salmoides)*, bluegills *(Lepomis macrochirus)*, black crappie *(Pomoxis nigromaculatus)*, and yellow perch *(Perca flavescens)* became available for an age-and-growth study when three gravel-pit ponds near Three Forks, Montana, were poisoned for the removal of these species (July 17-18, 1957).

Wollitz[2] has given a complete description of these ponds and the effects of toxicants on their fish and fish-food organisms. These ponds lie adjacent to one another, are without inlets or outlets, and depend upon seepage for their water supply. Daytime maximum summer (mid-July to mid-August) water temperatures at the surface varied between 65° and 75° F. Surface water usually cooled considerably at night and sub-surface temperatures were usually 2°—6° F. cooler than those at the surface during the day. There was no marked thermal stratification and frequent wind-induced circulation of water occurred throughout the ice-free period. The period of ice-cover is ordinarily from early November to the early part of April.

The East Pond is over 30 years old, the Middle Pond over 25 years, and the West Pond, while dredging began about 20 years ago, is still in use for gravel dredging at the present time. The areas, maximum depths, and fish present at the time of poisoning are shown in Table 1.

TABLE 1.—*Size, depth, and fish species for the Three Forks Ponds*

Item	East Pond	Middle Pond	West Pond
Area (acres)	12.9	23.3	12.8
Maximum depth (feet)	12	18	19
Fishes[1]	Yellow perch Bluegill Largemouth bass Black crappie Carp Longnose sucker Common sucker Golden shiner	Bluegill Yellow perch Black bullhead Black crappie Largemouth bass Carp White sucker	Yellow perch Bluegill Largemouth bass

[1]Fishes listed in decreasing order of abundance.

The fish used in the age-and-growth study were randomly selected for size from several thousand specimens picked up after the ponds were treated with toxicants. Total length measurements were made to the nearest 0.1 inch and weights to the nearest 0.01 pound. Sex was determined on mature fish but age-and-growth data are not separated by sex since they showed no important differences. Scales were taken from the area between the dorsal fin and lateral line. Scale impressions were made on plastic, and annuli were determined and increments measured along the anterior radius after the scales were projected. A constant ratio of scale radius to body length was assumed in the calculations

[1]Contribution from Montana State College Agricultural Experiment Station, Project No. MS844, Paper No. 490 Journal Series.

[2]Wollitz, Robert E. (1958) The effects of certain commercial toxicants on the limnology of three cold water ponds near Three Forks, Montana. Thesis, Montana St. Coll., 63 pp.

LARGEMOUTH BASS

he average calculated length at each an- s shows very slow growth in all three ıds (Figure 1, Table 2). This species grew ıtly faster in the West Pond. A useful (10 inches) was not reached until the year, and a weight of 1 pound was not eved until the sixth or seventh year. The . number of largemouth bass recovered, nches or over in total length, was as fol- : East Pond, 15; Middle Pond, 15; West ı, 12. The longest fish was 16.2 inches in length and weighed 2.6 pounds. The iest fish was a female, 16.1 inches long weighing 3.3 pounds.

·evious work on the age and growth of rarchidae in Montana is limited to the y of a few specimens from three ponds in ·rn Montana (Brown and Thoreson, .). Twenty-two largemouth bass from ₃ ponds showed an average calculated length of 2.1 inches at the first annulus. is slightly better than the Three Forks ls which had an average of 1.9 inches. vth was much faster in Baugh Pond ·wn and Thoreson, 1951) where large- ıh attained a length of 7.4 inches at the time of second annulus and 10.3 inches at the third.

We found no record where largemouth bass grew as slowly as determined for Three Forks ponds. Weyer (1940) reported this species to reach 10.5 inches at the third annulus. This same length was reached at the third annulus in Wisconsin (Bennett, 1937). In Minnesota[3] it attained 9.3 inches at the third annulus and in Oklahoma (Jenkins and Hall, 1953) an average length of 9.7 inches was achieved at the second annulus. Stroud (1948) reported 12.2 inches at the second annulus for Tennessee.

BLUEGILL

Bluegills, like largemouth bass, showed slow growth. They did not reach a total length of 5 inches until their fifth year (Figure 1, Table 2). Bluegills from the Middle Pond were larger than the others at annuli I and II but those from the West Pond were larger at annuli III and IV. The largest bluegill recovered was a male 7.3 inches long from the Middle Pond which weighed 0.3 pound. Brown and Thoreson (1951) reported on 43 bluegills taken from six eastern Montana farm ponds. Their average growth was somewhat higher than that of fish from the Three Forks Ponds with an average total length of 5.3 inches at the third annulus.

Bluegills from Ohio showed even poorer growth than those from the Three Forks ponds (Evans, I. M., cited by Carlander, 1953). They did not reach 5 inches in total length until the fifth annulus. Some fish from Missouri averaged 2.6 inches at their third annulus, but no older specimens were reported (Weyer, 1940). In contrast, a size of more than 5 inches in total length at the second annulus has been reported (I. M. Evans, cited by Carlander, 1953; Upper Mississippi River Conservation Committee[4]; Roach[5]).

[3]Moyle, John B., and Charles R. Burrows. (1954) Manual of instructions for lake survey. Minn. Dept. Cons., Fish. Res. Unit, Spec. Publ. No. 1, 70 pp.

₃ 2.—*Calculated total lengths in inches at the end of each year of life of largemouth bass, bluegills, ck crappie, and yellow perch from three ponds in southwestern Montana*

[Number of specimens in parentheses]

Species	Ponds	Year of life									
		I	II	III	IV	V	VI	VII	VIII	IX	X
nouth bass	East	2.0 (52)	3.7 (40)	5.6 (34)	7.7 (28)	9.3 (20)	10.9 (17)	12.3 (15)	13.2 (12)	14.0 (6)	13.8 (3)
	Middle	1.8 (61)	3.7 (54)	5.5 (51)	7.4 (47)	10.0 (28)	11.7 (23)	13.4 (15)	14.3 (10)	15.2 (5)	—
	West	2.0 (45)	4.2 (31)	6.2 (27)	8.5 (20)	10.4 (17)	12.0 (12)	13.3 (8)	14.3 (6)	15.8 (1)	—
	Average	1.9 (158)	3.8 (125)	5.7 (112)	7.7 (95)	9.9 (65)	11.5 (52)	12.9 (38)	13.8 (28)	14.7 (12)	13.8 (3)
ll	East	1.7 (67)	2.9 (39)	4.0 (35)	4.7 (29)	5.2 (14)	5.6 (2)	6.6 (1)	—	—	—
	Middle	0.8 (25)	1.8 (25)	2.8 (22)	3.8 (21)	4.7 (14)	5.3 (10)	6.0 (4)	6.9 (1)	—	—
	West	0.8 (27)	2.2 (20)	4.8 (5)	5.7 (2)	—	—	—	—	—	—
	Average	1.3 (119)	2.4 (84)	3.6 (62)	4.4 (52)	5.0 (28)	5.4 (12)	6.1 (5)	6.9 (1)	—	—
crappie	East	1.0 (29)	2.2 (29)	3.3 (28)	4.3 (25)	5.4 (13)	6.8 (6)	6.9 (1)	—	—	—
	Middle	1.3 (26)	2.6 (22)	4.3 (21)	5.5 (19)	6.1 (12)	6.5 (7)	7.1 (2)	—	—	—
	Average	1.1 (55)	2.4 (51)	3.7 (49)	4.8 (44)	5.7 (25)	6.6 (13)	7.0 (3)	—	—	—
perch	East	1.9 (18)	3.5 (14)	4.6 (13)	4.9 (8)	5.5 (1)	—	—	—	—	—
	Middle	2.0 (22)	3.3 (15)	4.1 (14)	4.8 (7)	5.7 (4)	—	—	—	—	—
	West	2.4 (43)	4.8 (31)	7.0 (27)	8.5 (23)	9.7 (17)	10.7 (3)	—	—	—	—
	Average	2.2 (83)	4.1 (60)	5.7 (54)	7.1 (38)	8.8 (22)	10.7 (3)	—	—	—	—

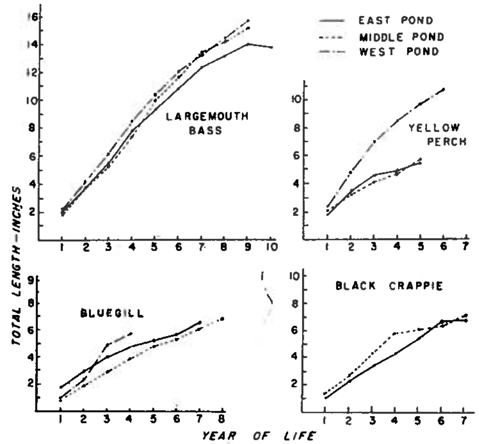

FIGURE 1.—Average calculated total length in inches at each annulus for largemouth bass, bluegills, black crappie, and yellow perch for each of the Three Forks Ponds.

BLACK CRAPPIE

Calculated total lengths of crappie (Figure 1, Table 2) show that it reached a useful size of 6 inches during the fifth summer. There was little difference between the growth rate in the East and Middle ponds, and the species was absent from the West Pond. The la specimen taken was 8.2 inches and we 0.27 pound and the oldest specimens (t had seven annuli and averaged 7.0 inch total length.

Black crappies from Raymond Reserv eastern Montana (Brown and Thor 1951) grew much faster and reached 6 in in total length late in their third year. In tain other states the average calculated length at the third annulus is as foll Minnesota[6], 6.8 inches; Ohio (Roach, 19 9.2 inches; and Tennessee (Stroud, 19 11.8 inches.

YELLOW PERCH

The average calculated total length perch at the third annulus was 5.7 in (Figure 1, Table 2). Growth was much r rapid in the West Pond where 7.0 inches attained at this annulus. The largest speci taken was a female 11.2 inches long weighing 0.75 pound, and the oldest sp mens had six annuli and averaged 10.7 in in total length. All of the larger fish from the West Pond. In several thou perch recovered from the East and Mi ponds, all were less than 6 inches long.

Yellow perch from Raymond Reser (Brown and Thoreson, 1951) in eastern M tana reached 6.6 inches at their third annu Those from Lower Thompson Lake (F 1955) in western Montana averaged only inches at the third annulus.

In other states the calculated total len at the third annulus were: Ohio (Ro 1948b), 5.5 inches; Minnesota[7], 6.0 inc Connecticut (Webster, 1942), 7.7 inc Lake Erie, Ohio (Jobes, 1952), 8.5 inc Iowa (Lewis, 1950), 10.3 inches.

The relatively better growth of yel perch, bluegills, and largemouth bass in West Pond is attributed to the smaller p lation there. It is surmised that dredging erations have interfered with reprodu and that this pond has not attained its mate numerical capacity.

[4]Upper Mississippi River Conservation Committee. (1946) Second progress report of the Technical Committee for Fisheries. 27 pp. Mimeo.

[5]Roach, Lee S. (1949) Lake management reports for Meander Lake. Ohio Div. Conserv., 37 pp. Mimeo.

[6]Kuehn, Jerome H. (1949) Statewide average length in inches at each year. Minn. Fish. Res. Suppl. to Invest. Rept. No. 51 (2nd revision).

[7]See footnote 6.

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REVIEWS

FRESH-WATER BIOLOGY. *By Henry B. Ward and George C. Whipple. Second edition edited by W. T. Edmondson. John Wiley & Sons, Inc., New York. 1959. 1248 pp. $34.50.*

This fine book, dedicated to Dr. G. Evelyn Hutchinson, brings this fresh-water "bible" up to date for those concerned with aquatic organisms. First published in 1918 by John Wiley and Sons, the 27 collaborators to the old volume are replaced by 51 contributors to this new and greatly expanded edition. Two of the original contributors to the 1918 edition, Dr. W. R. Coe (nemerteans) and Dr. J. Percy Moore (hirudineans) revised their sections for the new edition.

As stated on page 1 of the Introduction, the book "consists of a series of illustrated keys to the fresh-water flora and fauna of North America north of the Rio Grande, each preceded by a statement of information necessary to its correct use."

The old edition contained 1111 pages while the new totals 1248 pages with materials expanded to include much new knowledge of aquatic plants and animals accumulated since the original publication. For instance, present sections on fungi, bryophytes, tardigrades, and polychaetes were omitted in the first edition. Aquatic vertebrates and internal parasites are rightly omitted because of space limitations and the fact that the last named are not truly aquatic. Free-swimming cercaria larvae (trematoda) and spiders associated with water are also omitted. The sections on bacteria, algae, protozoa, gastrotrics, branchiopods, ostracods, copepods, malacostracans, mites, aquatic insects, and vascular plants have been greatly expanded. Adult terrestrial forms with immature under-water stages have been omitted, probably because of space limitations and the fact that excellent monographs are available with which to identify them.

The section on water mites is based on a careful survey of the literature and contains an exceptional number of unsupported opinions that show considerable insight and may well prove to be true. As an alternative to his laborious enzymatic method of preparing specimens, Newell recommends a poor procedure and neglects a much superior method that has been used by every mite specialist since Köenike. The fact that the number of genera increased by some 25 percent (none of it due to splitting) while the key was in manuscript form, is a measure of its obsolescence. Unfortunately, many extensive additions to the known fauna came in the period between preparation and publication of the manuscript, making omissions unavoidable.

Seeing again many of the figures that appeared in the first edition was like meeting old friends which like the latter, showed some signs of wear. Even so, most of the chapters contain many new and generally excellent illustrations. In an apparent effort to keep the index small, numerous terms used in the text are omitted—such items as whirligig beetle, ligula, compound eye, birotulate, and trichocyst.

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THE BIOLOGY OF POLLUTED WATE[illegible]
Hynes. University Press of Li[illegible]
England. 1960. 202 pp. 25s.

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