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FOOD HABITS OF YOUNG-OF-YEAR LARGEMOUTH BASS IN LAKE MEAD AND LAKE MOHAVE, ARIZONA-NEVADA

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ABSTRACT.—Young-of-year largemouth bass from lakes Mead and Mohave fed upon crustacean zooplankton, insects (primarily chironomids), and fish. Largemouth bass smaller than 32 mm TL fed extensively upon zooplankton. In Lake Mead, transition to an insect-dominated diet occurred at 32 mm TL; transition to an insect-fish–dominated diet did not occur in Lake Mohave until a length of 56 mm was reached. Largemouth bass from Lake Mohave consumed significantly more zooplankton than did those from Lake Mead, but largemouth bass from Lake Mead consumed significantly more insects. Fish were most common in the diet of young-of-year largemouth bass larger than 52 mm TL.

Lake Mead was formed in 1935 by impoundment of the Colorado River along the Arizona-Nevada border. Largemouth bass, *Micropterus salmoides*, were introduced into Lake Mead from 1935 to 1940, and the lake soon developed a nationally recognized largemouth bass fishery (Moffett 1943, Wallis 1951). From 1935 until 1977 largemouth bass was the primary sport fish in the lake (Moffett 1943, Wallis 1951, Hoffman and Jonez 1973, Allan and Roden 1978). Allan and Roden reported that largemouth bass received 30 to 40% of angler effort and contributed 24.5 to 79.5% of the sport-fish catch in Lake Mead during the 20-year period, 1958–1977. Striped bass, *Morone saxatilis*, has been the primary sport fish in Lake Mead since 1977, but largemouth bass is still an important component of the fishery.

Lake Mohave was impounded in 1951 and lies immediately downstream from Lake Mead. Largemouth bass occurred in the Colorado River below Lake Mead before impoundment of Lake Mohave (Moffett 1942) and has since become the second most popular sport fish in the lake. From 1962 to 1977 largemouth bass contributed between 8.8 and 39.8% of the sport-fish catch in Lake Mohave (Allan and Roden 1978).

Despite the importance of largemouth bass to the sport fisheries of lakes Mead and Mohave, little is known of its biology in these lakes. The purpose of this paper is to describe and compare diets of young-of-year (YOY) largemouth bass in lakes Mead and Mohave.

Methods

Young-of-year largemouth bass were collected from lakes Mead and Mohave by Nevada Department of Wildlife personnel during the spring (April–May) and summer (June–August) of 1976 to 1979. A total of 648 largemouth bass was collected from Lake Mead and 542 from Lake Mohave. Total lengths (TL) ranged from 6 to 150 mm.

For dietary analysis, stomachs were removed and each food item identified to the lowest possible taxon. Results for each year were expressed as mean number per occurrence and percent frequency of occurrence for each prey type. Empty stomachs were not included in the analyses. To study the association between diet and length (TL), we grouped fish less than 80 mm TL into 4-mm size classes; larger fish were included in an 80+ mm size class. We have pooled samples over the four-year study period and report herein unweighted means for mean number per occurrence and percent frequency of occurrence of major food items for each size class.

Results

Zooplankton were the most frequently consumed and most numerous prey of YOY largemouth bass in lakes Mead and Mohave (Table 1). Rotifers were found in the stomachs of 16 largemouth bass in 1976 (11.3% frequency of occurrence) but were not found again during

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TABLE 1. Mean number per occurrence and percent frequency of occurrence (in parentheses) of prey in the diet of young-of-year largemouth bass.

TL (mm)	Lake Mead			
	N	Zooplankton	Insects	Fish
8				
12	13	40.8 (100)	3.0 (20)	
16	41	91.6 (100)	1.8 (11)	
20	33	70.0 (100)	1.0 (18)	
24	8	151.9 (100)	2.0 (25)	
28	34	76.9 (100)	2.0 (9)	
32	5	110.0 (50)	20.8 (50)	
36	4	29.5 (67)	30.3 (50)	
40	14	90.4 (63)	28.9 (50)	
44	16	109.6 (67)	5.8 (74)	
48	15	82.5 (47)	11.4 (66)	
52	16	47.1 (53)	18.7 (92)	
56	17	54.7 (34)	18.8 (51)	3.0 (30)
60	29	20.7 (37)	24.6 (74)	2.1 (37)
64	21	14.3 (55)	33.4 (42)	1.0 (20)
68	31	43.4 (24)	11.3 (81)	1.0 (9)
72	30	34.0 (28)	25.7 (45)	1.0 (46)
76	16	25.1 (45)	24.6 (90)	1.0 (15)
80	19	30.3 (32)	13.6 (57)	1.0 (43)
80+	57	21.8 (12)	10.4 (56)	1.2 (52)

Table 1. Continued.

TL (mm)	Lake Mohave			
	N	Zooplankton	Insects	Fish
8	2	28.5 (100)		
12	72	21.8 (100)	2.0 (8)	
16	77	74.5 (100)	1.0 (7)	
20	5	51.0 (100)		
24	19	162.1 (100)	1.0 (11)	
28	22	175.3 (100)	1.0 (3)	
32	43	133.2 (100)	1.0 (6)	
36	22	82.6 (75)	2.9 (51)	1.0 (8)
40	4	105.3 (100)	3.0 (50)	
44	11	488.9 (44)	3.1 (58)	2.5 (14)
48	29	159.0 (61)	7.3 (73)	
52	31	126.5 (84)	6.9 (54)	1.5 (10)
56	37	147.1 (41)	18.7 (65)	1.0 (24)
60	21	57.2 (27)	12.0 (60)	2.7 (26)
64	19	53.9 (38)	7.1 (30)	1.3 (33)
68	8	294.0 (17)	7.4 (77)	1.0 (23)
72	3		38.0 (50)	1.0 (100)
76	8		12.3 (43)	1.0 (57)
80	2			1.0 (100)
80+	39		8.9 (48)	1.6 (69)

our study. Crustacean zooplankton comprised the majority (> 99%) of the zooplankton consumed. The most commonly preyed upon species were the copepods *Cyclops vernalis*, *Diacyclops bicuspidatus thomasi*, *Diaptomus clavipes*, *D. reighardi*, and *D. siciloides* and the cladocerans *Bosmina longirostris*, *Ceriodaphnia lacustris*, *Daphnia galeata mendotae*, *D. pulex*, and *Scapholeberis kingi*. With the exception of *S. kingi*, all are common elements of the limnetic zooplankton of lakes Mead and Mohave (Paulson et al. 1980, Wilde 1984).

Zooplankton occurred in 100% of largemouth bass smaller than 32 mm TL in both lakes. At 32 mm TL, largemouth bass

TABLE 2. Spearman correlations (r_s) between total length (TL) and composition of the diet of young-of-year largemouth bass. Fish greater than 80 mm TL were not included in the analyses.

	Lake Mead	Lake Mohave
Mean number of zooplankton per stomach	−0.600**	−0.158
Frequency of occurrence of zooplankton	−0.884***	−0.936***
Mean number of insects per stomach	0.574*	0.904***
Frequency of occurrence of insects	0.676**	0.497*

* p < .05
** p < .01
*** p < .001

switched to an insect-dominated diet in Lake Mead; a similar transition did not occur in Lake Mohave until a length of 56 mm was reached. Frequency of occurrence of zooplankton in the diet of largemouth bass was negatively related to TL in both lakes (Table 2). Mean number of zooplankton was negatively related to TL in Lake Mead but not in Lake Mohave, reflecting the greater utilization of zooplankton in that lake. Overall, largemouth bass from Lake Mohave consumed significantly more zooplankton than did those from Lake Mead (Mann-Whitney U-test, $p < .05$).

Chironomid midges (larvae, pupae, and adults) were the most frequently consumed insects in lakes Mead and Mohave and represented 90% of the insects consumed by largemouth bass in both lakes. Other insect prey were, in order of importance, corixids, odonatids (primarily damselflies), coleopterans, miscellaneous dipterans, and ephemeropteran nymphs. Hydracarinids were infrequently consumed and are included in Table 1 as insects. In both lakes mean number and frequency of occurrence of insects in the diet were positively related to TL. Mean number of insects consumed was significantly greater in Lake Mead than in Lake Mohave ($p < .05$).

Fish were preyed upon by largemouth bass as small as 36 mm TL but were most common in the diets of individuals greater than 52 mm TL. Fishes consumed included largemouth bass, green sunfish (*Lepomis cyanellus*), and threadfin shad (*Dorosoma petenense*). Bluegill, *L. macrochirus*, although a common prey of largemouth bass in lakes Mead and Mohave (Moffett 1943, Allan and Roden 1978), were not found in any of the fish we examined.

DISCUSSION

The progression from zooplankton to insect- and fish-dominated diets observed in lakes Mead and Mohave is commonly reported for YOY largemouth bass (Kramer and Smith 1960, Applegate and Mullan 1967, Miller and Kramer 1971, Clady 1974, Timmons et al. 1981). In Lake Mead, largemouth bass switched to an insect-dominated diet at a smaller size (32 versus 56 mm TL) and consumed significantly more insects than in Lake Mohave. McCammon et al. (1964) suggested that composition of the diet of YOY largemouth bass reflects prey availability. Greater utilization of insects in Lake Mead may indicate a greater abundance of insects, especially chironomids, in that lake. Largemouth bass consumed significantly more zooplankton in Lake Mohave than in Lake Mead; this may result from greater density of zooplankton in Lake Mohave (Paulson et al. 1980), but it is more likely a consequence of lower insect abundance. Water level fluctuations expose a greater proportion of the littoral zone in Lake Mohave than in Lake Mead; these fluctuations can reduce the abundance of benthic invertebrates and, hence, their availability to game fishes (Hale and Bayne 1980).

Growth rate of YOY largemouth bass is positively related to size of prey consumed (Kramer and Smith 1960, Miller and Kramer 1971). First-year growth of largemouth bass in Lake Mead (201 mm TL) is approximately 10% greater than in Lake Mohave (178 mm TL, Allan and Roden 1978) and may result from the earlier and more extensive consumption of larger prey (insects) in Lake Mead. Applegate and Mullan (1967) found similar differences in diet and growth of YOY largemouth bass in Beaver and Bull Shoals reservoirs; first-year growth was greater in Beaver Reservoir where insects were available to "bridge the gap" between zooplankton- and fish-dominated diets.

Allan and Romero (1975) suggested that early survival of largemouth bass in Lake

Mead was limited by low availability of zooplankton. Since that study, nutrient loading into Lake Mead, especially via the Las Vegas Wash, has been greatly reduced. This has resulted in reduced phytoplankton abundance (Paulson and Baker, in press) and zooplankton density (Wilde 1984) in much of the lake. The Colorado River via discharge from Hoover Dam (Lake Mead) is the sole source of nutrient loading into Lake Mohave; phytoplankton abundance has decreased in Lake Mohave since the late 1970s (Paulson et al. 1980, Paulson unpublished data), and a reduction in zooplankton density seems likely given the generally strong relationship between phytoplankton and zooplankton abundance (McCauley and Kalff 1981). Our results show that crustacean zooplankton comprise the majority of the early diets of YOY largemouth bass in Lake Mead and Lake Mohave. Reductions in zooplankton density will likely have an adverse affect upon early growth and survival (Aggus and Elliot 1975) of largemouth bass in both lakes.

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