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Terry R. Maret
University of Nebraska-Lincoln

Edward J. Peters
University of Nebraska-Lincoln

FOOD HABITS OF THE WHITE CRAPPIE, *POMOXIS ANNULARIS* RAFINESQUE, IN BRANCHED OAK LAKE, NEBRASKA

TERRY R. MARET
EDWARD J. PETERS

Department of Forestry, Fisheries and Wildlife
University of Nebraska–Lincoln
Lincoln, Nebraska 68583

Food habits of adult white crappie, *Pomoxis annularis* Rafinesque, in Branched Oak Lake, Lancaster County, Nebraska, were studied by examination of stomach contents from 170 fish. Specimens ranging in size from 194–330 mm were collected by creel census and electrofishing between April 17 and May 5, 1977. Collections were confined to the area along the dam to determine whether crappie prey on newly-hatched walleye larvae.

Stomach contents were separated to the lowest feasible taxonomic category, counted, and weighed. Analyses showed that at least 17 taxa were eaten by the crappie. *Hexagenia* sp. was found to be the most important food item. It occurred in nearly 70 percent of all stomachs containing food and made up 48 percent of the total diet by weight. Fish were found in nearly 32 percent of all stomachs containing food and made up 31 percent of the total diet by weight. However, no larval fish were found. Other important food items consumed were Hirudinea, Chironomidae, Chaoboridae, and Amphipoda.

† † †

INTRODUCTION

White crappie, *Pomoxis annularis* Rafinesque, is an abundant and important sport fish in many reservoirs in southeastern Nebraska, including Branched Oak Lake, a 1,750-acre flood control reservoir located in Lancaster County. Walleye, *Stizostedion vitreum* (Mitchell), is also a prized game fish which attracts fishermen to Branched Oak Lake. Food habits of adult white crappie reveal that fish make up a major part of their diet (Mathur, 1972; Morgan, 1954; Green and Murphy, 1968; Ball and Kilambi, 1970). Because of this piscivorous diet, Nebraska Game and Parks personnel expressed concern when crappie were found to be abundant and actively feeding in the walleye spawning area at a time when walleye eggs should have been hatching. Due to the restricted walleye spawning habitat along the Branched Oak Lake dam, it was suspected that crappie predation may have a significant effect on walleye year class strength.

The objectives of this investigation were to describe quantitatively the composition of food eaten and to determine the impact of crappie predation on walleye larvae.

MATERIALS AND METHODS

A total of 170 crappie stomachs was collected between April 17 and May 5, 1977—105 by creel census and 65 by electrofishing. Collections were confined to the area along the dam where walleye eggs would be hatching. During the collecting period, water temperature ranged from 15.0° C to 18.0° C (Table I). Childers and Shoemaker (1953) found that the greatest feeding activity of white crappie occurs at dawn and dusk. Therefore, fish were taken either in the morning or evening hours to reduce digestion time.

The Nebraska Game and Parks Commission's creel survey (1977) determined that walleye spawning commenced around April 1 and ended abruptly on April 17, when water temperature rose approximately 4.0° C. Game and Parks Personnel first observed eggs among the rocks along the dam on April 10. At 57° F (14.0° C), walleye eggs hatch in about seven days (Niemuth, et al., 1966). Larvae average 7.5 mm at hatching and soon become pelagic (Houde and Forney, 1970). The time of collecting the crappie stomachs should have been optimum for determination of predation on larvae.

Stomachs were removed as soon as possible after fish were caught, placed in 10 percent formalin and later transferred to 40 percent isopropyl alcohol. Stomachs were cut open, the contents removed by scraping and washing with 40 percent isopropyl alcohol, and placed in a petri dish for examination under a dissecting microscope. Food items were identified to the lowest practicable taxonomic level and separated into vials for further analysis. All identifiable material except fish bone and scales (unless fish bodies were at least 50 percent intact) were enumerated. If, for example,

TABLE I

Collecting Dates Along with Time, Collecting Methods, and Water Temperatures for the Sample Periods

(Below this data is a summary of the sizes of fish collected.)

Date	Time	Number of Stomachs Obtained	Collecting Method	Water Temperature (°C)
April 17	0930		Creel	
	1130	16	Census	15.0
	1700			
	1930	28		
18	0600		Creel	
	0800	6	Census	15.0
	1800			
	2000	15		
19	0630		Creel	
	0715	8	Census	15.0
	1730			
	1930	3		
22	1830		Creel	
	2000	18	Census	17.0
26	0830		Creel	
	0900	1	Census	17.0
27	1800		Creel	
	2000	10	Census	17.0
May 5	0700		Electrofishing	
	0745	65		18.0

Total	170
Average length	267 mm
Range	194-330 mm
Average weight*	300 gm
Range	128-528 gm

*Based upon 65 fish collected on May 5, 1977.

a chironomid had been found in the stomach and the head was all that remained, only the head was counted. Identifiable major body parts were placed in the same vial along with the head. Unidentified material was retained for weighing. Weights of each taxonomic category along with unidentified material were determined to the nearest 0.1 milligram after air drying for 24 hours. Because unidentified material was often composed of numerous minute particles, it was suction filtered to quickly remove excess moisture. It must be noted that this determination is subject to some error because of possible atmospheric moisture differences over a 24-hour period. On some occasions, when small organisms were weighed with filter paper, the final weight was actually less than the original recorded weight of the filter paper. A trace value was given to the respective category when this occurred.

When an abundance of zooplankters was present, the numbers were estimated by counting a subsample and expanding this to obtain an estimate of total numbers.

Food habits were described by frequency of occurrence, percent numbers, and percent weight of prey items. Empty stomachs were excluded from these calculations. Frequency of occurrence was expressed as a percentage of the total number of stomachs examined containing each taxonomic category. The percent number of each species of food item is expressed as a percentage of the total number of food items eaten. Percent weight was determined by adding percent values for a taxonomic category from all stomachs and dividing by the total percent weight for all items from all stomachs containing food. This method gives all size fish equal weighting. The size of the stomach or its fullness are of the same importance. The real meaning of percent weight does not become so distorted by the occasional occurrence of a food item of exceptionally great weight, as when the total weight of each food category eaten is divided by the grand total weight of all food eaten.

Due to their small size and large numbers, only frequency of occurrence was calculated for bone remains and scales.

Sex and total length were recorded for all specimens. In addition, weights were taken for the 65 fish collected by electrofishing.

RESULTS AND DISCUSSION

Based on the observations of reproductive organs, all crappie collected were mature. These specimens ranged from 194-330 mm total length, with a mean of 268 mm. Weights ranged from 128-528 grams, with a mean of 300 grams (Table I).

Of the 170 stomachs examined, seven (4.1 percent) were empty. This suggests a high level of feeding activity for the population during collecting times. In addition, seven stomachs contained only unidentifiable material. Identifiable material made up 74.5 percent of the total food contents by weight.

Seventeen taxa were identified from crappie stomachs (Tables II and III). This wide variety of organisms in the diet suggests opportunistic feeding habits.

Figure 1 summarizes the importance of the five major taxonomic categories eaten by crappie. Insecta and fish are shown to be the major food items, together making up 67.8 percent by numbers and 85.5 percent by weight. Crustacea, Annelida, and Hydracarina were of lesser importance.

Aquatic insects were the predominant food item making up the diet. The most important contributor to this category was *Hexagenia* sp., a burrowing mayfly which occurred in 69.3 percent (113) of the stomachs, made up 16.7 percent of the diet by numbers, and 48.1 percent by weight (Table II). It is also apparent that *Hexagenia* is quite available. One stomach contained 38 individuals (Table III). Seifert (1968) found that *Hexagenia* was an important part of the diet of white crappie after they reached 150 mm in Lewis and Clark Lake, Nebraska. Stomachs examined from June through September, 1965, from fish in two size ranges (151-200 mm and 201-300 mm), showed an occurrence of 57 percent and 67 percent, respectively. He also concluded that growth of these fish after their first season of life appears related to the population density of *Hexagenia*.

It is interesting to note that there were three pronounced size differences in *Hexagenia*, indicating possibly three overlapping generations. *Caenis* sp., a small mayfly, was considerably less important. It was found in 18.4 percent of the stomachs examined and made up a small part of the diet by numbers and weight.

Chironomid larvae and Chaoborid larvae made up the majority of Diptera eaten. Pupae of these families were less abundant. Adult Diptera were rarely utilized, suggesting that surface feeding was rare. Larvae were frequently present in the stomach contents but contributed little by weight. Percent numbers for Chironomidae and Chaoboridae were 8.3 and 26.7, respectively. These values are biased towards increased importance of these items due to their small size. One stomach contained 169 Chaoborid larvae. These organisms are apparently abundant, and crappie must be filter feeding to ingest this many small organisms. This also suggests that crappie are feeding to some extent during the night, when Chaoborid larvae would become available during migration to the lake surface. Ball and Kilambi (1970) found that *Chaoborus* sp. was an abundant food item of crappie in an Arkansas Reservoir. The continued plankton feeding phase of adult sizes of crappie is perhaps related to the long gill rakers of white crappie (Mathur, 1972).

TABLE II

Summary of Items Eaten by 163 Adult White Crappie
Collected from April 17 to May 5, 1977, at Branched Oak Lake, Nebraska

(Stomachs containing no food were excluded. Trace refers to values < 0.1 percent.)

Food Item	Percent Frequency of Occurrence	Percent of Total Numbers	Percent of Total Weight
INSECTA		64.8	54.5
Ephemeroptera			
Hexagenia	69.3	16.7	48.1
Caenis	18.4	1.4	0.5
Diptera			
Chironomidae			
larvae	48.5	8.3	1.0
pupae	28.2	3.9	1.0
adult	1.8	0.1	T
Chaoboridae			
larvae	35.6	26.7	1.4
pupae	16.0	5.6	1.6
adult	0.6	T	T
Ceratopogonidae			
larvae	12.3	0.9	0.1
unidentified pupae	1.2	0.1	T
unidentified adults	2.5	0.2	T
Odonata			
Zygoptera	9.2	0.5	0.6
Trichoptera			
Limnephilidae	3.1	0.2	0.1
Hydroptilidae	0.6	T	T
Coleoptera			
Dytiscidae	1.2	0.1	0.1
Hemiptera			
Corixidae	0.6	0.1	T
Hymenoptera	0.6	T	T
FISHES		2.3	31.0
Unidentified fish	30.6	1.5	28.9
Remains	19.6	-------	------
N. stramineus	1.2	0.1	1.6
P. promelas	0.6	T	0.5
Fish eggs	4.3	0.7	T
CRUSTACEA		31.7	0.6
Amphipoda	20.9	1.6	0.6
Copepoda	4.9	17.1	T
Cladocera	8.6	13.0	T
ANNELIDA			
Hirudinea	16.6	0.9	6.6
HYDRACARINA	5.5	0.3	T
UNIDENTIFIED MATERIAL ONLY	4.3	-------	7.3
		Σ 100.0	100.0

TABLE III

Summary of Contents of 163 Adult White Crappie Stomachs
Taken from April 17 to May 5, 1977, at Branched Oak Lake, Nebraska
Showing Total Numbers Eaten of Each Food Category
and the Greatest Number of Individuals in Any One Stomach

(Stomachs containing no food were excluded.)

Food Items	Total Number Eaten	Greatest Number in Any One Stomach
INSECTA		
Ephemeroptera		
Hexagenia	661	38
Caenis	55	6
Diptera		
Chironomidae		
larvae	327	28
pupae	155	19
adult	5	3
Chaoboridae		
larvae	1059	169
pupae	222	33
adult	1	1
Ceratopogonidae		
larvae	35	7
unidentified pupae	3	2
unidentified adult	7	3
Odonata		
Zygoptera	19	4
Trichoptera		
Limnephilidae	9	5
Hydroptilidae	1	1
Coleoptera		
Dytiscidae	2	1
Hemiptera		
Corixidae	2	1
Hymenoptera	1	1
FISHES		
Unidentified fish	60	2
Remains	--------	-------
Notropis stramineus	2	1
Pimephales promelas	1	1
Fish eggs	28	18
CRUSTACEA		
Amphipoda	63	8
Copepoda	677	519
Cladocera	516	144
ANNELIDA		
Hirudinea	37	5
HYDRACARINA	12	3
UNIDENTIFIED MATERIAL ONLY	--------	-------
Total	3960	

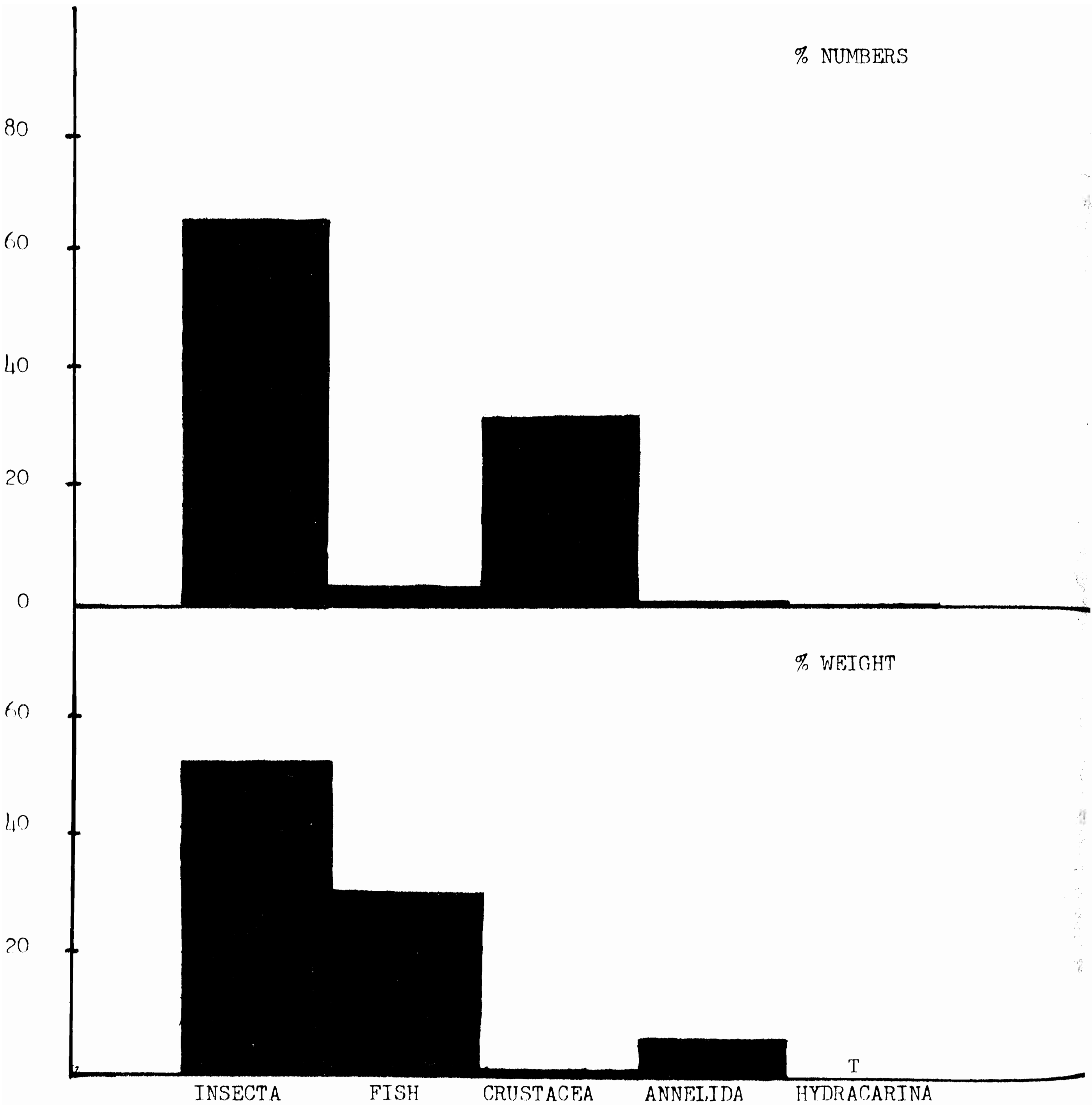

Figure 1. Summary of the food habits of the white crappie showing the five major food categories eaten expressed as percent total numbers and weight.

Other major aquatic insect taxa contributing a small part of the diet were Odonata, Trichoptera, Hemiptera, and Coleoptera. Hymenoptera was the only terrestrial taxon eaten. Green and Murphy (1968) found that from March to May, insect larvae contributed up to 45 percent of the volume of food of white crappie in a Texas Reservoir. Their findings were similar to the results of this study.

Fish were not the most important food item consumed—as one might expect, considering the large sizes of crappie. Fish were second to insects in importance. Intact fish occurred in 32.4 percent of all stomachs examined, with fish remains (bone and scales) occurring in 19.6 percent of all stomachs examined. Fish made up 2.3 percent of the numbers and 31.0 percent of total weight. Fish eggs were included in this category. Whether the eggs found were from walleye is unknown. When crappie ingested fish, it was a substantial portion of the diet by weight. The greatest number of fish found in any one stomach was two. The explanation for this is that crappie were consuming fish of large size. All fish found were much larger than larval or fry stage.

The majority of the fish were unidentifiable. However, one fathead minnow, *Pimephales promelas,* and two sand shiners, *Notropis stramineus,* were identified. It must be kept in mind while appraising these results that many of the fish collected were from a creel census, and ingestion of bait fishes likely occurred. There were no apparent differences between the collecting method and fish found.

Crustaceans were not an important food item. In terms of percent numbers, which are biased towards small organisms, they made up 31.7 percent of the total. They contributed only 0.6 percent of the total weight of food eaten. Amphipods were found to be the major crustacean found in the stomachs. They occurred in 20.9 percent of the stomachs. Whenever crustaceans were observed in the stomachs, they were usually present in prodigious numbers. One stomach contained 519 copepods, and another contained 144 cladocerans, suggesting again the filter feeding habits of the crappie (Table III). Copepods and cladocerans contributed little to the diet by weight. These results are in agreement with the findings of Mathur (1972). Crustaceans are utilized throughout the life of white crappie in most waters, but insects and forage fish are usually the major food of larger crappie.

Hirudinea contributed more than expected to the diet. They were present in 16.6 percent of all stomachs examined. In terms of percent numbers, they contributed very little to the diet. However, due to the large size of these organisms, they made up a significant portion of the diet by weight (6.6 percent). The consumption of leeches, to our knowledge, has not been reported in any other food-habits study of this species.

Hydracarina were not an important part of the diet, being found in only 5.5 percent of all stomachs examined. Parasitic nematodes were often encountered but not enumerated.

Crappie were actively feeding, as indicated by angling success and the small percentage of empty stomachs. Their abundance throughout the walleye spawning habitat immediately following egg deposition would lead one to believe that perhaps significant predation on larvae could take place. Contrary to this, our findings report no larvae were ingested. There is the strong possibility that hatching success was low, making larvae unavailable to crappie. Wide fluctuation in size of walleye year classes is common (Smith and Krefting, 1954). Perhaps sampling time was not optimum, or the majority of larvae dispersed before sampling took place. This seems unlikely when considering the creel census information and time of collections following the spawn. Perhaps the sample size was not large enough to adequately describe this phenomenon.

Sampling larval fish densities would have been very complementary to this study. One needs to know if the eggs are hatching and if larvae are available for the crappie.

Although the availability of organisms was not studied in this investigation, it is important to realize that the difference in food habits is related to the nature of the food supply and its availability. One cannot make conclusions on selectivity of food items without knowing its availability. Since this study is biased due to a single-season sampling, it must be kept in mind that the diet of this species may vary considerably from the reported results, depending on time of year.

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