The food and growth of splake. Report 59 1970

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THE FOOD AND GROWTH OF SPLAKE

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ABSTRACT

Splake (brook trout X lake trout), released as fall fingerlings and spring yearlings in Pallette Lake, Vilas County, Wisconsin, survived and grew at similar rates during 5 years of observation.

Cladocerans and copepods less than 1 mm long were not present in the stomach contents of splake 7 to 23 inches in total length. When the splake were 1 to 4 years of age, aquatic and terrestrial insects and planktonic crustaceans occurred most frequently in over 300 stomachs examined. Although fish began appearing in stomachs of splake which were 3 years old, not until the splake reached the age of 5 years and more and ranged in length from 15 to 23 inches were fish their most important food. In the stomachs of splake 5 years of age and older, fish constituted nearly 100 percent of the total food items.

Growth of the splake in length was highly variable, and the average coefficient of condition (R) was low after 4 years residence in Pallette Lake. The high average (R) of the splake when stocked was not regained until nearly 5 years in Pallette Lake. The largest splake recorded (25.5 inches in total length - 8.85 lbs.) from Pallette Lake was caught on hook and line in December, 1969.

The splake were readily caught on hook and line when collecting splake for growth and food studies before they were 4 years of age. By the time the splake reached age 4 and older, the stock level had declined through natural mortality and splake were no longer readily caught; less than 2 percent of the splake stocked were recorded in a permit-type creel census through 1969.

ACKNOWLEDGMENTS

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INTRODUCTION

To obtain a fast-growing salmonid that would adapt more readily to the developing sport fishery for "trophy" trout than had the slow-growing lake trout, Canada developed a hybrid called splake. Since this hybrid supposedly would have a faster rate of growth than lake trout, it would attain trophy size in a shorter period of time. The splake -- a cross between speckled (brook) trout, Salvelinus fontinalis (Mitchill) and lake trout, Salvelinus namaycush (Wolbaum) -- was stocked widely in Canadian lakes. Like the lake trout, it fed mainly on fish as it grew older and was nearly as easily caught by fishermen as brook trout. This hybrid, then, had promise as a predator on stunted fish in infertile, cold-water lakes in Wisconsin. Moreover, after splake had grown beyond the legal-size of 17 inches they would be a trophy catch for many trout fishermen.

To determine the adaptability of splake to an infertile cold-water lake with stunted fish, two groups of splake were released in Pallette Lake, Vilas County, where record of harvest would be complete under the permit-type creel census.

DESCRIPTION OF LAKE

Pallette Lake (Fig. 1), Vilas County lies in the Northern Highland Fishery Research Area. Surface area of Pallette Lake is 169 acres and maximum depth is approximately 60 feet, depending on time of the year. Origin of the water is seepage. Alkalinity is 12 ppm and pH, 6.8.

The resident fishes recorded to date are the following: black bullhead (Ictalurus melas), bluntnose minnow (Pimephales notatus), burbot (Lota lota), cisco (Coregonus artedii), common shiner (Nortropis cornutus), creek chub (Semotilus atromaculatus), golden shiner (Notemigonus crysoleucas), Iowa darter (Etheostoma exile), largemouth bass (Micropterus salmoides), logperch (Percina caprodes), mottled sculpin (Cottus bairdi), northern pike (Esox lucius), pumpkinseed (Lepomis gibbosus), rock bass (Ambloplites rupestris), smallmouth bass (Micropterus dolomieui), and yellow perch (Perca flavescens). Common shiners, smallmouth bass and yellow perch are abundant and slow growing. Northern pike and largemouth bass are scarce.

Two groups of splake from the same hatchery stock were released in Pallette Lake. The first group of 2,500 was released 18 October, 1963, as fingerlings, and the other group of 2,500 as yearlings 11 May, 1964.

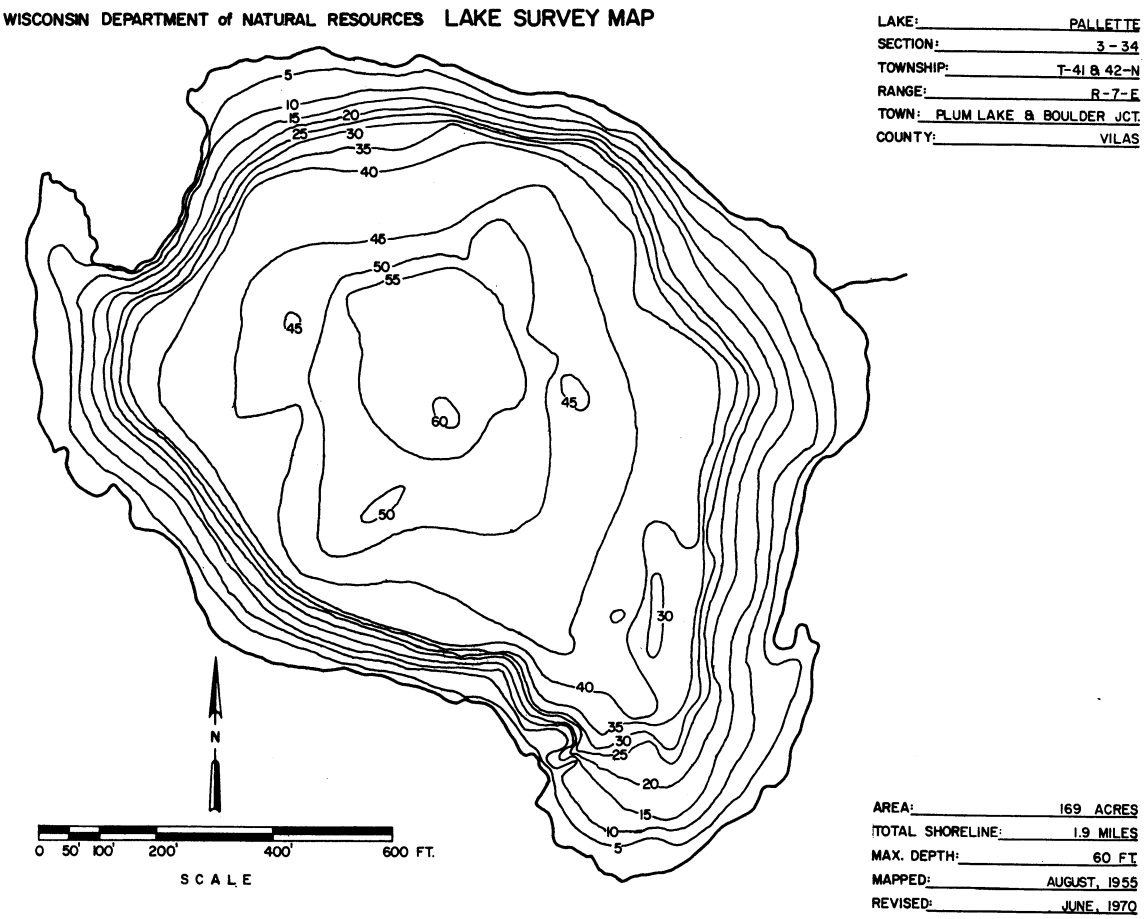

Figure 1. Contour map of Pallette Lake.

METHODS

Growth Determination

Periodic collections of the splake from Pallette Lake were made by employing seines and by using hook and line. Most of the splake captured were sacrificed; they were immediately measured in total length to the nearest one-tenth inch and weighed to the nearest gram. A 1-inch incision was made through the body wall and the splake were placed in 10 percent formalin solution with stomachs intact.

In addition to data recorded from these periodic collections, other data were obtained from the creel census on the lake. All splake captured by fishermen were registered at the checking station where fishing permits for splake were issued. Each splake was measured and weighed and had its stomach removed before the splake was returned to the angler. Identification and growth data for each splake was enclosed with its stomach in cheesecloth and placed in 10 percent formalin.

A sample of splake was captured in gill nets from Green Lake, Wisconsin, in order to compare their stomach contents and growth with those in Pallette Lake. Data from Green Lake splake were taken and recorded in the same manner as data from Pallette Lake splake.

Planktonic Crustacean Sampling

Samples of the planktonic crustaceans in Pallette Lake were collected periodically during 1960-66. Horizontal tows, at every 5-foot depth level from the surface down to 44 feet, were made with a Clarke-Bumpus plankton sampler with a number 2 net attached. The duration of each plankton tow was 3 minutes at a speed of approximately 3 miles per hour. Planktonic crustaceans were usually collected at the same time splake were collected for analysis of stomach content.

The crustaceans collected with the Clarke-Bumpus sampler were counted on a circular counting cell. Methods were similar to those employed by Priegel (1970). The full capacity of the counting cell was 3 ml. By counting the crustaceans contained in 3 counting cells, a total of 9 ml of the original sample from the lake was examined. Crustacean length, excluding spines and antennae, was measured with a micrometer inserted into the ocular of a binocular microscope.

Sandy Engel, of the University of Wisconsin Limnological Laboratory, collected and identified or varified the identification of the crustaceans according to The Systematics of North American Daphnia (Brooks, 1959). Species collected during the open water months of 1969 included: Bosmina longirostris (O.F. Müller), Chydorus sphaericus (O.F. Müller), Cyclops bicuspidatus thomasi Forbes, Daphnia galeata mendotae Birge, Daphnia longiremis Sars, Daphnia retrocurva Forbes, Diaphanosoma leuchtenbergianum Fischer, Diaptomus minutus Lilljeborg, Epischura lacustris Forbes, Eucyclops agilis (Knoch), Holopedium gibberum Zaddach, Leptodora kindtii (Focke), Mesocyclops edax (S.A. Forbes), Polyphemus pediculus (Linne) and Sida crystallina (O.F. Müller).

Stomach Analysis

The stomach of each splake was examined for presence of large food items such as fish and the percentage of stomachs containing these items was recorded. After the examination, the contents of all stomachs were further analyzed for the presence of crustaceans, regardless of whether or not fish had been found in the preliminary stomach examinations.

The contents of the stomachs in a given group were placed in a common glass container and diluted with tap water to 1 liter. After thorough mixing, 3 sub-samples of 20 ml each were withdrawn and examined under a wide-field binocular microscope with an ocular micrometer to measure the size of the crustaceans present in the stomachs. Food items in each 20 ml sample were separated and counted. The combined food items in the three 20 ml samples were taken as the number of food items in 60 ml of the 1 liter container. Relative density of a food item in a given group of stomachs was calculated.

RESULTS

Splake

Food

The percentage of splake stomachs containing a food item and the percentage of that food item in relation to the total food items in the stomachs are presented in tables 1-13, App. A.

Cladocerans and copepods less than 1 mm long were not found in the stomach contents of splake 7 inches in total length and larger. The only items less than 1 mm in length found in the splake stomachs were larval water mites which were probably ingested along with their insect hosts to which they were parasitically attached during late spring (Tables 1, 5, 9, and 11, App. A). Adult free-swimming water mites were usually small, measuring 1 - 1.2 mm in length (Tables 2, 3, and 7, App. A), but when ingested during August (Tables 6 and 10, App. A), they were as large as 2 mm in length.

The splake in Pallette Lake apparently selected the large (up to 18 mm long) cladoceran, Leptodora kindtii, the density of this form being 0.1 per liter in the samples collected at 30 to 35 feet in depth where the splake were captured with hook and line in August, 1965-66. From 58 to 95 percent of the total food items in the splake stomachs examined during August, 1965 and 1966, were Leptodora (Tables 6 and 10, App. A). Density of Daphnia 1 mm and larger during August, 1965 and 1966, was 1.7 and 2.6 per liter, respectively at the depth where the splake were taken on hook and line. Although these densities are probably low for efficient grazing by fish, they are considerably higher than the 0.1 per liter density of Leptodora, and yet less than 8 percent of the total food items were Daphnia during August, 1965-66 (Tables 6 and 10, App. A).

Ivlev (1961) devised an index termed the "electivity index" which is derived as follows:

$$E = \frac{r_i - P_i}{r_i + P_i}$$

where r_i is the quantity of a food item in the stomach expressed as a percentage of the total food in the stomach, and P_i is the relative density of the same food item in the environment expressed as a percentage. E values range from -1 to +1; a negative value indicates negative selection of the food item and a positive value a positive selection.

There were only three positive values during the five periods of analysis (Table 14) and two of those were positive for selection of Leptodora when this cladoceran was present in small numbers (0.1 per liter) at the 30- to 35-foot depths where the splake were taken on hook and line in Pallette Lake during August, 1965-66. The other positive value was selection of Daphnia in October, 1964, when the lake was homothermous and density of Daphnia 1 mm and larger was approximately the same at depths of 10, 25 and 40 feet in Pallette Lake (Table 15 and Fig. 5, App. B).

TABLE 14

Electivity Values (E) Calculated from the Relationship Between Density of Various Planktonic Crustaceans and their Percentage Occurrence in Stomach Contents of Splake from Pallette Lake

Genus	Average Number Per Liter in Lake	Percentage 1 mm and Larger	Percentage of Total Crustacea in Stomachs	E
		19 - 20 October 1964		
Bosmina	0.0	--	0.0	--
Cyclops	2.2	0.8	0.0	-1.00
Daphnia	4.9	56.0	99.7	+0.47
Diaphonosoma	0.0	--	0.0	--
Diaptomus	6.4	0.0	0.3	-0.99
Holopedium	0.0	--	0.0	--
Leptodora	0.0	--	0.0	--

Table 14 - continued

Genus	Average Number Per Liter in Lake	Percentage 1 mm and Larger	Percentage of Total Crustacea in Stomachs	E
		25 - 26 May 1965		
Bosmina	0.2	0.0	0.0	-1.00
Cyclops	x	30.0	0.0	--
Daphnia	0.5	70.9	0.0	-1.00
Diaphonosoma	0.0	--	0.0	--
Diaptomus	1.0	37.1	0.0	-1.00
Holopedium	0.1	42.8	0.0	-1.00
Leptodora	0.0	--	0.0	--
		24 - 25 August 1965		
Bosmina	0.0	--	0.0	--
Cyclops	1.0	28.7	0.0	-1.00
Daphnia	4.6*	40.8	6.8	-0.79
Diaphonosoma	1.6**	11.6	0.0	-1.00
Diaptomus	0.6	9.5	0.5	-0.88
Holopedium	x	100.0	0.0	--
Leptodora	0.1	100.0	92.7	+0.97
		19 - 21 May 1966		
Bosmina	0.1	0.0	0.0	-1.00
Cyclops	0.3	17.1	0.0	-1.00
Daphnia	1.9	13.9	0.0	-1.00
Diaphonosoma	0.0	--	0.0	--
Diaptomus	0.1	0.0	0.0	-1.00
Holopedium	0.1	0.0	0.0	-1.00
Leptodora	0.0	--	0.0	--
		24 - 26 August 1966		
Bosmina	0.0	--	0.0	--
Cyclops	1.7	3.4	0.0	-1.00
Daphnia	8.6*	45.2	0.2	-0.99
Diaphonosoma	0.9	3.6	0.0	-1.00
Diaptomus	0.4	1.5	0.0	-1.00
Holopedium	x	50.0	0.0	-1.00
Leptodora	0.1	100.0	99.8	+0.98

* Only 1.7 and 2.6 Daphnia/liter 1 mm and larger at 33- to 35-foot depth near where splake were caught by hook and line in August, 1965 and 1966, respectively.

** None present at 35-foot depth.

x Indicates trace of organism.

TABLE 15

Density and Size of Daphnia in Pallette Lake in Number per Liter and Percentage 1 mm and Larger

Depth (in feet)	19 July 1961		22 Aug. 1963		20 Oct. 1964		26 May 1965		25 Aug. 1965		19 May 1966		24 Aug. 1966	
	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%	No.	%
1 - 4	0.2	79	0.1	80	2.8	62	0.8	97	--	--	0.2	5	0.1	67
5 - 7	2.0	85	0.4	89	--	--	--	--	1.0	63	--	--	--	--
8 - 10	4.4	92	1.5	87	--	--	--	--	--	--	--	--	--	--
11 - 13	4.4	91	--	--	5.7	66	0.5	85	--	--	2.0	7	1.8	70
15 - 18	4.5	88	1.4	85	--	--	--	--	2.9	82	--	--	--	--
20 - 23	--	--	1.4	80	--	--	0.1	50	--	--	2.5	6	2.2	68
25 - 28	--	--	2.1	83	5.6	71	--	--	5.6	62	--	--	--	--
30 - 33	20.9	44	2.1	87	--	--	0.7	43	--	--	2.1	2.0	15.2	17
35 - 38	--	--	2.3	89	--	--	--	--	8.9	19	--	--	--	--
39 - 41	36.1	49	3.0	75	5.5	53	--	--	--	--	--	--	--	--
43 - 45	--	--	10.1	12	--	--	--	--	--	--	2.9	22	23.9	60

Of 36 stomachs from yearling splake (7-9 inches in total length) captured in January, March and May, 1964, only 3 contained fish (Table 1, App. A). Aquatic and terrestrial insects and planktonic crustaceans, when available, were found in the stomachs most frequently. The larval water mites present in the splake stomachs in May, 1964, were apparently, as mentioned earlier, attached to their insect hosts when they were ingested by the splake. By February and May, 1965, when the splake were 2 years of age (8-13 inches in total length), 6 stomachs out of 68 examined contained fish (Tables 4 and 5, App. A). Stomach contents of the two-year-old splake were similar to the stomach contents of the yearlings during that period of the year when there were no thermal barriers to prevent the splake from foraging for minnows in the littoral zone. Not until November, 1965, did fish appear to be important prey of the splake (now nearly three years of age and ranging in total length from 9 to 14 inches) when 16 out of 41 (39 percent) stomachs contained fish; however, fish comprised less than 2 percent of the total food items ingested (Table 7, App. A). A year later in November, 1966, (when the creeled splake were nearly 4 years old and ranged in total length from 12 to 18 inches) fish were present in 33 percent of the stomachs examined but constituted less than 1 percent of the total food items in the stomachs (Table 10, App. A). No significant change in the number of stomachs containing fish or the amount of fish in those stomachs occurred during May and June, 1967, (Table 11, App. A) when the splake ranged from 13 to 18 inches in total length. It was not until the splake reached the age of 5 years and more, and ranged in total length from 15 to 23 inches that fish were their most important food. All stomachs examined November, 1967 through June, 1968, contained fish. Moreover, fish constituted nearly 100 percent of the total food items in the stomachs examined (Table 12, App. A).

Yellow perch, smallmouth bass, sculpins and minnows were preyed on by the splake. Yellow perch were present in the stomachs more often and in greater numbers than any other fish. Cisco, which are numerous enough in Pallette Lake to be fished by seining during their November spawning period were identified as being present in only one splake stomach and that was from a 25.5-inch, 8.85-pound fish that was caught through the ice in December, 1969 (See footnote, Table 16). None of the 2-year-old splake (11-16 inches in total length) from Green Lake (Table 13, App. A) had cisco in their stomachs. That the cisco are numerous enough to be prey to splake in Green Lake is supported by findings that 24 percent of the stomachs from lake trout 11 to 18 inches in total length contained cisco (Hacker, 1957).

Cisco eggs, however, were present in splake stomachs collected in November (Tables 3, 7, and 10, App. A), January (Table 1, App. A) and March (Table 8, App. A). In November, 1964 and 1966, cisco eggs occurred in more stomachs and in greater numbers than any other food item (Tables 3 and 10, App. A). Sucker eggs occurred in 2 of the 13 splake stomachs collected May 15, 1967, (Table 11, App. A) when suckers were spawning in the shallows of Pallette Lake. The two splake with sucker eggs were 13.8 and 14.9 inches in total length and were 4 years of age. Martin (1960) and Hacker (1962) observed that splake and lake trout (approximately 13 inches in length) had ingested splake and lake trout eggs, respectively.

Plant remains were common in the splake stomachs, and were probably ingested incidentally while splake were foraging for aquatic invertebrates. Plant remains were present in a high percentage of stomachs of yearling and two-year-old rainbow trout stocked in lakes (Brynildson, 1958). Pebbles (2-3 mm) and sand were present in some splake stomachs collected during January and March, 1964, (Table 1, App. A) and pebbles (3-6 mm) were present in some splake stomachs collected during June, 1967, (Table 11, App. A) and during the winter and spring of 1967-68 (Table 12, App. A).

There was little difference in the stomach contents of splake stocked during fall and spring (Tables 2-9, App. A). The splake stocked in spring had 8 less food items in their stomachs in October, 1964, (Table 2, App. A) than did the splake stocked in the fall, however, this may indicate that the sample of stomachs was too small to be indicative of the splake diet during that period. Similarity of the contents of stomachs from larger samples of the two stocks collected during November, 1964, indicates that their foraging habits were basically similar.

Growth

Growth characteristics of splake from Pallette Lake are presented in table 16 and figure 2. Average growth by the two stocks of splake was slow compared to growth of brown and rainbow trout in some Wisconsin lakes (Brynildson and Christenson, 1961; Brynildson, 1968). However,

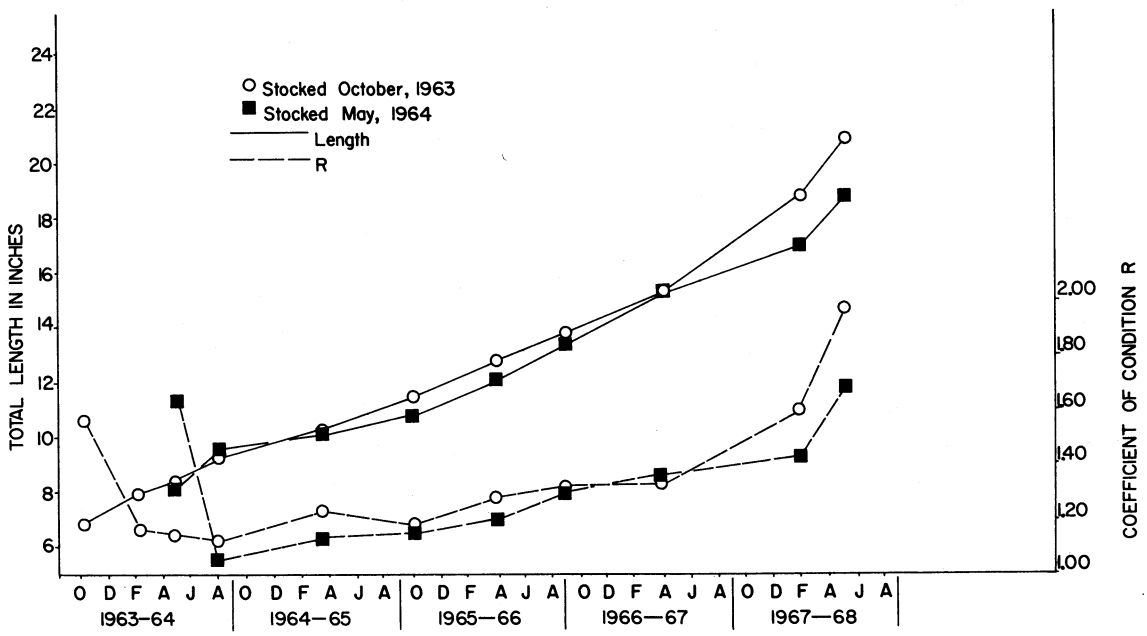

Figure 2. Growth and coefficient of condition of splake after their release into Pallette Lake, October, 1963 and May, 1964.

TABLE 16

Growth Characteristics of Splake in Pallette Lake, 1964-68

Date	Number Measured	Total Length (in Inches) Range	Total Length (in Inches) Average	Average Weight (in grams)	Ave. R
Fall-stocked Splake					
18 Oct 63 (stocked)	150	6.0 - 7.8	6.8	51	1.56
22 Jan--11 Mar 64	23	7.0 - 8.6	7.9	59	1.17
11 May 64	16	7.7 - 9.0	8.4	67	1.14
11 Jun--19 Nov 64	54	7.8 - 10.7	9.3	94	1.12
17 Feb--25 May 65	19	9.2 - 11.8	10.3	138	1.23
24 Aug--10 Nov 65	56	9.6 - 14.6	11.5	181	1.18
3 Mar--21 May 66	12	11.2 - 18.2	12.8	308	1.28
13 Jul--16 Nov 66	15	11.2 - 15.2	13.8	346	1.32
15 May--24 Dec 67	33	13.4 - 16.6	15.3	481	1.33
20 Jan--24 Mar 68	11	17.2 - 20.2	18.7	1054	1.60
1 Apr--27 Jun 68	11	18.3 - 23.3	20.9	1854	1.97
Spring-stocked Splake*					
11 May 64 (stocked)	150	6.0 - 11.1	8.2	94	1.63
11 Jun--19 Nov 64	57	8.0 - 11.1	9.6	96	1.05
17 Feb--25 May 65	54	7.7 - 12.7	10.1	120	1.13
24 Aug--10 Nov 65	44	9.3 - 12.6	10.8	146	1.15
3 Mar--21 May 66	19	10.3 - 14.0	12.1	217	1.20
13 Jul--16 Nov 66	11	12.5 - 14.6	13.4	320	1.30
15 May--24 Dec 67	21	13.8 - 17.7	15.3	488	1.36
20 Jan--24 Mar 68	9	15.0 - 18.0	17.0	676	1.43
1 Apr--27 Jun 68	8	18.0 - 19.7	18.8	1134	1.68

* A spring-stocked splake, 25.5 inches in total length and weighing 8.85 pounds, was caught on hook and line in early December, 1969.

growth of splake from time of stocking in October, 1963, and May, 1964, was better than growth of similar stocks of rainbow trout in Pallette Lake during 1959-60 (Brynildson, 1961). The average coefficient of condition (R) of the splake, however, was lower than the (R) of the rainbow trout after several months in Pallette Lake. The two-year-old splake from Green Lake averaged three inches longer, weighed twice as much and had a higher average coefficient of condition than their

counterparts in Pallette Lake in October, 1965, (Brynildson, 1966). The high average (R) of the splake when stocked was not regained until after nearly five years in Pallette Lake (Table 16 and Fig. 2) when the splake stomachs examined contained a high percentage of fish (Table 12, App. A). The largest splake recorded from Pallette Lake had a coefficient of condition (R) of 2.24 (See footnote, Table 16).

The growth rate of splake was variable in Pallette Lake. The length range of the fall-stocked splake was as much as seven inches in May, 1966, after two-and-a-half years in the lake. Splake, stocked as yearlings in South Bay of Lake Huron, ranged in length from 11.5 to 17.0 inches a year later and averaged nearly four inches longer than wild lake trout of the same age (Budd, 1957). Martin and Baldwin (1960) did not report any great variability in growth of individual splake but stated that splake grew more rapidly than brook or lake trout in Ontario lakes investigated.

Survival

A total of 250 fall-stocked and 223 spring-stocked splake were captured by hook and line or by seine during the period, 1964-68. No population estimate of the splake were made, but assuming equal vulnerability of the two stocks to capture by hook and line and by seine, survival of the splake stocked as fingerlings in October was as good as survival of the yearlings stocked in May, even though the average length of the yearlings was 1.4 inches greater than the fingerlings when stocked. Pycha and King (1967) reported that the average returns by netting of lake trout released in Lake Superior as fall fingerlings and spring yearlings, ranged from approximately 4 to 1 and 7 to 1 in favor of the spring-stocked yearlings.

Although the two stocks survived at the same rate, both of them apparently did not survive well. Low numbers of splake caught 4 and 5 years after stocking and poor seining success during these same years seem to indicate that the splake stock in Pallette Lake had declined drastically after four years.

Harvest

The statewide minimum size-limit of 17 inches was removed on splake in Pallette Lake when most of the splake had not attained that length after three years in the lake. The statewide bag of two splake was retained. The fishing season on splake in Pallette Lake opened with the regular trout fishing season in early May, 1967.

The splake were relatively easy to catch with hook and line during 1964-66 when they were collected for growth and food studies. During spring and fall (when there were no thermal barriers) splake were caught on small minnows, spinning lures and dry flies in the bays. During midsummer the splake were caught on minnows at the 30- to 35-foot depths in the thermocline only, where the water temperatures were 50 to 55 F. (See Fig. 9 for limnological characteristics). By 1967, due apparently to a low surviving stock, splake could not be caught in the

bays with consistency during the cold water months, nor in the thermocline during midsummer. Only 67 splake were recorded in the permit-type creel census during 1967-68, and only one splake has been caught since then (See footnote, Table 16). Martin and Baldwin (1960) reported that, with one exception, anglers recovered less than two percent of the splake stocked in several Ontario lakes.

Planktonic Crustacean Density and Size

The density of the planktonic crustaceans collected in the number 2 net at different periods during ice-free months are presented in Table 2. The density and size of *Daphnia* at various depths in Pallette Lake during those periods are presented in table 14 and figures 3-8, App. B.

Daphnia were the most consistent crustaceans in the Clarke-Bumpus sampler and in the splake stomachs examined. *Daphnia* were absent, or nearly so, in the stomachs of splake during periods when *Daphnia* were generally unavailable to the splake. During the summer, for example, thermal barriers above the thermocline and lack of adequate dissolved oxygen below 45 feet (Fig. 9) to sustain splake, but adequate for *Daphnia*, restricted the feeding zone of the splake mainly within the thermocline. In May, 1965 and 1966, the *Daphnia* were low in density (Tables 14 and 15) or were mostly less than 1 mm in length

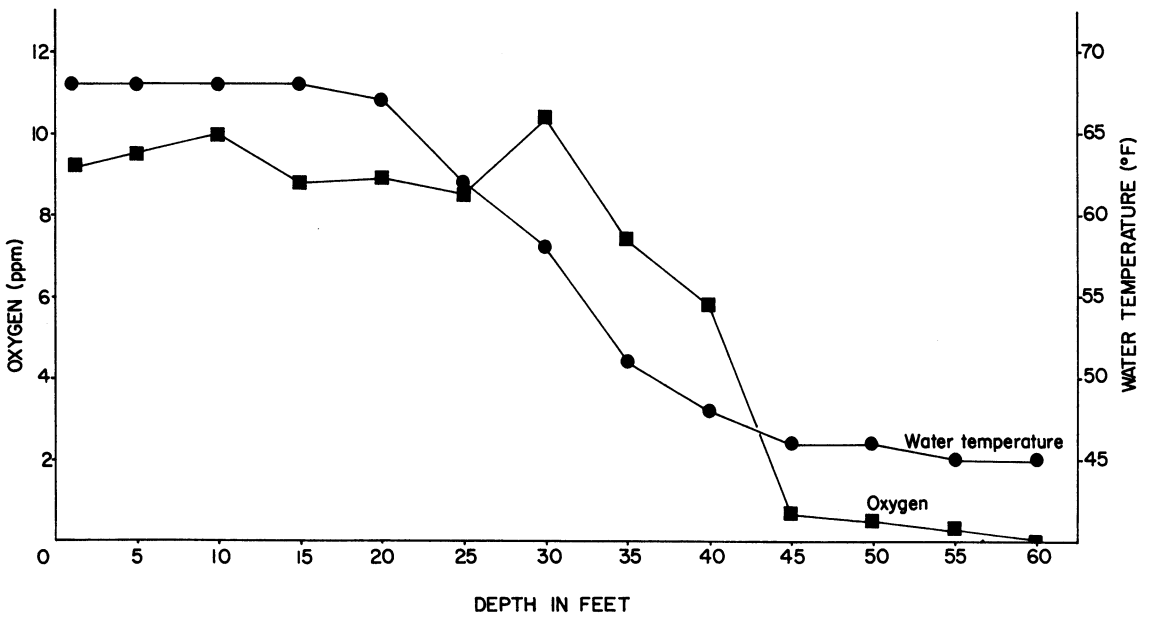

Figure 9. Average water temperatures and dissolved oxygen at different depths in Pallette Lake during mid-August, 1964-68.

(Table 15 and Fig. 7, App. B) in the shallow bay area where the splake were caught on hook and line. In August, 1965, there was also a scarcity of Daphnia 1 mm and larger in the 35-foot depth level (Table 15 and Fig. 6, App. B) where the splake were caught on hook and line. Although the highest density of Daphnia (8.9 per liter) was at the 35-foot depth level, in August 1965, only 1.7 per liter were 1 mm and larger. At the 25-foot depth level there were 3.5 Daphnia per liter 1 mm and larger, but at that depth and above, the water temperature was 68 F and was a thermal barrier to foraging splake.

DISCUSSION

Splake

Food

Lindström (1955) and Nilsson (1955) observed that large char Salvelinus alpinus, selected larger food items (including planktonic crustaceans) than did the small char. Nilsson (1965) reported that char up to 400 mm (15.7 inches) in length from Lake Torraure included Eurycercus (a large cladoceran of 3 mm) in their diet, but char over 400 mm did not feed on Eurycercus. Other investigators found strong evidence that rainbow trout 7 to 17 inches in total length (Brynildson, 1958, 1960 and 1961; Galbraith, 1967), yellow perch 3 to 10 inches in total length (Galbraith, 1967), alewife (Brooks and Dodson, 1965) and other planktivorous fish (Brooks, 1965) prey mainly on crustaceans 1 mm and larger. The general conclusion was that these planktivores select the larger crustaceans.

Young walleyes positively selected a large copepod, Epischura (Houde, 1967) and young saugers positively selected Leptodora (Priegel, 1969) even though Leptodora was present in lower densities than any other planktonic crustaceans in Lake Winnebago. Evidence that rainbow trout over 7 inches in total length also select larger forms such as Leptodora, even when it is sparse, was that Leptodora kindtii was present in stomachs of rainbow trout taken from Turk Lake (Chippewa County, Wisconsin), although Leptodora were never present in the bimonthly zooplankton collections from Turk Lake during 4 years of sampling (Brynildson, 1958). In Moose Lake (Waukesha County, Wisconsin), when the density of Daphnia was low at the beginning of the spring Daphnia pulse in early May, 24 percent of the 124 yearling rainbow trout (7 to 10 inches in total length) stomachs examined contained Daphnia, all 1 to 1.5 mm in length. By early June, when the spring pulse was at its

peak and the density of Daphnia of all sizes was high, 93 percent of the 91 trout stomachs examined contained Daphnia, all 1.5 to 2 mm in length. The trout apparently were selecting the largest Daphnia when they were available (Brynildson, 1969).

The electivity index provides a method to determine if feeding by fish is selective whenever the prey is equally available in the living zone of the fish. Because planktonic crustaceans of suitable size and density were only periodically available to splake in Pallette Lake (due to thermal barriers and overgrazing by splake themselves and other planktivores), the electivity index (E) could not be applied consistently to determine relative selection of various crustaceans as food by splake.

Stunted cisco were expected to become a major food item for splake because both fish inhabited the cool depths during summer. Only one splake stomach contained cisco; one possible reason that more cisco were not found was that most of the stomachs examined were from splake 1-3 years of age. The sample of stomachs from splake 4 and 5 years of age was small (Table 12, App. A) and may not be large enough to indicate the total fish in their year-round diet.

Availability of different food items in a lake is probably the principal factor which determines food habits of trout within a length group. Of the total food items in the stomachs of the two-year-old splake from Green Lake during October - November, 97 percent was composed of crustaceans, of which Daphnia comprised 92 percent. No fish were found in these stomachs (Table 13, App. A). Of the total food items in the stomachs of their counterparts in Pallette Lake during the same period, 44 to 66 percent was Daphnia (Table 7, App. A). Unlike the splake from Green Lake, 16 of the 41 splake from Pallette Lake contained fish. Availability of crustaceans (especially Daphnia) in Green Lake throughout the year may have conditioned the younger splake to use this source of food. Daphnia were not available to splake in Pallette Lake throughout the year because the foraging areas of the splake were restricted by high water temperatures or lack of dissolved oxygen.

The major food of lake trout less then approximately 16 inches in total length in Green Lake was Mysis relicta (Hacker, 1957 and 1962; Daly et al., 1962). The yearling and two-year-old splake captured in the shoal areas of Green Lake during October-November, 1965, ranged in length from 9 to 16 inches in total length. Of the 24 stomachs examined from these splake 8 contained Mysis relicta and 15 contained Daphnia (Table 13, App. A). Probably because these splake were not restricted by thermal barriers in the fall and were foraging in the shoals, they had access to relatively high densities of Daphnia as compared to densities of Mysis and therefore consumed more Daphnia.

Growth

Stomachs from lake trout 16 to 18 inches in total length contained (when not empty) 88 to 94 percent fish (Hacker, 1957; Dryer et al., 1965).

Splake in Pallette Lake did not feed extensively on fish until they were 15 to 23 inches in total length. Probably if the splake had begun feeding on fish earlier in life more would have grown to a larger size at an earlier age.

Differential growth in length was reported by Martin (1952, 1954 and 1966), Hacker (1962), Nilsson and Svardson (1968), and DeRoche (1969) for lake trout and Budd (1957) for splake. Moreover, Martin (1966) found a significant correlation between zooplankton feeding and growth of lake trout. The plankton-feeders grew slower and their maximum length was 30 inches, whereas the fish-feeders grew faster and reached a length of 36 inches and more. Brynildson (1958) reported that stomachs of fast-growing yearling rainbow trout in Cather Lake (Chippewa County, Wisconsin) contained a high percentage of largemouth bass fingerlings and crayfish but no terrestrial insects and only a trace of planktonic crustaceans. In this same study, stomachs of slow-growing yearling rainbows were found to contain a relatively high percentage of terrestrial insects and planktonic crustaceans, but only a trace of bass fingerlings and no crayfish.

Planktonic Crustacean Density and Size

Overgrazing of the zooplankton by planktivores is probably a common occurrence in Pallette Lake. During the spring, when thermal barriers are absent, heavy grazing apparently reduced the Daphnia 1 mm and larger to a low level above the 30-foot depth level (Fig. 7, App. B). When cisco, large yellow perch and splake were concentrated at 30 to 35-foot depths during late summer, overgrazing could have depleted the population of larger sized species of Daphnia such as D. galeata mendotae and D. retrocurva, (Fig. 6, App. B), and the smaller (mostly less than 1 mm in length) form, Daphnia longiremis, could have become dominant in density at the lower depths of Pallette Lake. This dominance by D. longiremis was observed during the summer of 1969 by Sandy Engel (Personal Communication).

When dissolved oxygen is inadequate for planktivorous fishes but adequate for Daphnia, as in Pallette Lake below 40 feet (Fig. 9), Daphnia cannot readily be grazed upon by these fishes and their high density may be more easily maintained (Fig. 7, App. B). At the 26- to 30-foot depth in Riley Lake (Chippewa County, Wisconsin), the majority of Daphnia pulex were 1 to 2 mm in length, and were at a density of 6 per liter of lake water in August. At this level dissolved oxygen was only 1 ppm, and between the 26- and 20-foot depth dissolved oxygen was less than 1 ppm, forming a barrier between fish and Daphnia. Above the 20-foot depth the dissolved oxygen was adequate for fish, and density of Daphnia varied from 2 to 4 per liter but less than 1 per liter were 1 mm and larger (Brynildson, 1958). Heavy grazing by planktivorous fishes could have reduced the population of Daphnia over 1 mm in length in this upper zone. Of 35 stomachs from yearling rainbow trout taken from Riley Lake during that August, 34 contained Daphnia which comprised 97 percent of the total food items in the stomachs (Brynildson, 1958).

SUMMARY AND MANAGEMENT IMPLICATIONS

1. Stomachs from splake over 7 inches in total length did not contain crustaceans less than 1 mm in length. Several studies on the diet of rainbow trout in lakes revealed that crustaceans less than 1 mm in length were absent from their stomachs. Therefore, splake and rainbow trout should not be stocked in lakes that contain low numbers of Daphnia (the "bread and butter" crustacean to planktivorous fish) less than 1 mm in length. Low numbers of Daphnia which are mainly less than 1 mm in length indicates overgrazing by resident planktivorous fish. Low numbers of Daphnia of any size indicates adverse limnological characteristics unfavorable to Daphnia.

2. Not until the splake in Pallette Lake were nearly 3 years of age did fish appear to be an important food item in their diet, when nearly 40 percent of the splake stomachs examined contained fish. When the splake were 5 years of age and older, fish were present in all stomachs examined. Stock level was low by the time angling for the 4 year-old splake was permitted. The splake, therefore, did not provide Pallette Lake with an effective predator of the stunted panfish nor did they provide the angler with trophy trout.

3. Survival of the splake stocked in October as fingerlings was as good as the survival of their counterparts stocked in May as yearlings. The similar survival rates of the October and May stocks can be attributed mainly to their large average total length of 6.8 and 8.2 inches, respectively, when released into Pallette Lake.

TABLE 1

Contents of Stomachs from Fall-stocked Splake
Collected at Pallette Lake in January, March and May, 1964

Food Items	22 January 12 Stomachs - 367 Food Items		11 March 12 Stomachs - 87 Food Items		11 May 12 Stomachs-2,932 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Snails	0.0	--	0.0	--	6.2	0.6
Oligochaetes	0.0	--	0.0	--	43.8	0.2
Daphnia	50.0	22.6	25.0	19.5	0.0	--
Cyclops	0.0	--	50.0	19.5	0.0	--
Diaptomus	8.3	4.6	0.0	--	0.0	--
Hyalella	0.0	--	0.0	--	0.0	--
Chironomidae	0.0	--	0.0	--	100.0	56.3
Aquatic beetles*	0.0	--	8.3	19.5	18.8	0.1
Aquatic bugs*	0.0	--	0.0	--	6.2	0.1
Terrestrial insects	0.0	--	0.0	--	100.0	24.4
Water mites	0.0	--	8.3	38.0	93.8	15.9
Spiders	0.0	--	0.0	--	50.0	2.3
Fish	0.0	--	25.0	3.5	0.0	--
Cisco eggs	50.0	72.8	0.0	--	0.0	--
Plant remains	50.0	x	33.3	x	100.0	x
Pebbles and Sand	50.0	x	41.7	x	0.0	--

* The aquatic beetles were adults of Haliplidae and Hydrophilidae, and the aquatic bugs were Corixidae, Gerridae and Notonecta undulata.

x Indicates trace of food item in stomachs.

TABLE 2

Contents of Stomachs from Splake Collected
at Pallette Lake 19 October 1964

Food Items	Fall-stocked Splake 12 Stomachs-4,849 Food Items		Spring-stocked Splake 10 Stomachs-3,468 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Snails	8.3	x	10.0	0.5
Oligochaetes	8.3	x	0.0	--
Daphnia	75.0	73.5	40.0	78.8
Alona*	25.0	x	0.0	--
Eurycercus*	33.3	x	0.0	--
Diaptomus	16.7	0.4	0.0	--
Hyalella	25.0	x	10.0	0.5
Chironomidae	50.0	16.1	80.0	14.9
Chaoborus*	50.0	1.0	10.0	x
Simulidae (adults)	16.7	1.0	0.0	--
Aquatic beetles*	16.7	x	0.0	--
Aquatic bugs*	91.7	1.1	60.0	3.4
Damselfly nymphs	8.3	x	0.0	--
Dragonfly nymphs	8.3	x	10.0	x
Terrestrial insects	100.0	6.9	60.0	1.4
Water mites	8.3	x	30.0	0.5
Spiders	16.7	x	0.0	--
Plant remains	100.0	x	100.0	x

* The cladocerans were Alona guttata and Eurycercus lamellatus, the aquatic beetles were adults of Dytiscidae and Hydrophilidae, the aquatic bugs were Corixidae and Notonecta undulata and the remaining insect was Chaoborus punctipennis.

x Indicates trace of food item in stomach

TABLE 3

Contents of Stomachs from Splake Collected at Pallette Lake 16-19 November, 1964

Food Items	Fall-stocked Splake 37 Stomachs-16,079 Food Items		Spring-stocked Splake 42 Stomachs-8,674 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Snails	13.5	0.1	7.1	0.4
Daphnia	40.5	3.2	19.5	1.7
Latonopsis*	0.0	--	4,8	x
Hyalella	16.2	x	9.5	0.6
Chironomidae	16.2	0.1	9.5	0.4
Ceratopogonidae*	2.7	x	0.0	--
Aquatic beetles*	2.7	x	9.5	0.6
Aquatic bugs*	27.0	0.2	26.6	0.6
Dobsonfly nymphs	0.0	--	2.4	x
Caddis larvae*	21.6	0.1	16.7	x
Terrestrial insects	16.2	0.6	16.7	0.7
Water mites	5.4	x	7.1	0.2
Fish	29.7	0.1	16.7	0.1
Cisco eggs	97.3	95.6	90.5	94.1
Plant remains	97.3	x	90.5	x

* Latonopsis occidentalis was the cladoceran, the Ceratopogonidae larvae were Dasyhelea sp., the aquatic beetles were adults of Dytiscidae and Hydrophilidae, the aquatic bugs were Corixidae, the dobsonfly nymphs were Chauliodes sp., and most of the caddis larvae were Helicopsyche borealis.

x Indicates trace of food item in stomachs.

TABLE 4

Contents of Stomachs from Splake Collected at Pallette Lake 17 February 1965

Food Items	Fall-stocked Splake 4 Stomachs - 9 Food Items		Spring-stocked Splake 16 Stomachs - 55 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Snails	0.0	--	6.2	1.8
Clams	25.0	11.1	0.0	--
Daphnia	0.0	--	12.5	30.9
Chironomidae	0.0	--	6.2	30.9
Aquatic bugs*	25.0	11.1	0.0	--
Dragonfly nymphs	25.0	11.1	0.0	--
Mayfly larvae*	0.0	--	18.8	30.9
Caddis larvae	75.0	55.6	6.2	1.8
Fish	25.0	11.1	6.2	3.7
Plant remains	25.0	x	6.2	x

* The aquatic bugs were Corixidae and the Mayfly larvae were Hexagenia sp.

x Indicates trace of food item in stomachs.

TABLE 5

Contents of Stomachs from Splake Collected at Pallette Lake 25 May 1965

Food Items	Fall-stocked Splake 14 Stomachs-2,961 Food Items		Spring-stocked Splake 34 Stomachs-4,319 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Snails*	21.4	2.8	23.5	0.8
Oligochaetes	7.1	x	2.9	x
Eurycercus	0.0	--	2.9	x
Chironomidae	100.0	9.0	79.4	7.3
Ceratopogonidae (larvae)	0.0	--	2.9	x
Simulidae (adults)	100.0	16.3	85.0	23.2
Aquatic beetles*	21.4	x	8.8	x
Aquatic bugs*	50.0	x	38.2	0.8
Damselfly nymphs	0.0	--	2.9	x
Dragonfly nymphs	7.1	x	0.0	--
Terrestrial insects	100.0	50.7	94.1	55.6
Water mites	100.0	20.0	73.5	10.8
Spiders	57.1	1.1	38.2	1.5
Fish	14.3	0.1	5.9	x
Plant remains	100.0	x	94.1	x

* The snails were Amnicola sp., the aquatic beetles were adults of Gyrinidae and Hydrophilidae, and the aquatic bugs were Gerridae and Notonecta undulata.

x Indicates trace of food item in stomachs.

TABLE 6

Contents of Stomachs from Splake Collected
at Pallette Lake 24-25 August 1965

Food Items	Fall-stocked Splake 32 Stomachs-2,168 Food Items		Spring-stocked Splake 23 Stomachs-2,288 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Snails	0.0	--	4.3	x
Oligochaetes	6.2	x	4.3	x
Daphnia	12.5	3.1	26.1	7.3
Leptodora*	81.2	58.5	73.9	84.6
Diaptomus	6.2	x	26.1	0.7
Hyalella	9.4	0.8	0.0	--
Chironomidae	65.6	3.8	43.5	3.6
Aquatic bug*	0.0	--	8.7	0.7
Terrestrial insects	0.0	--	8.7	x
Water mites	28.1	33.8	34.8	2.9
Fish	3.1	x	17.4	0.2
Plant remains	18.8	x	26.1	x

* Leptodora kindtii was the large (up to 18 mm) predacious cladoceran and the aquatic bugs were Corixidae.

x Indicates trace of food item in stomachs.

TABLE 7

Contents of Stomachs from Splake Collected
at Pallette Lake 1-10 November 1965

Food Items	Fall-stocked Splake 21 Stomachs-2,094 Food Items		Spring-stocked Splake 20 Stomachs-922 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Snails*	14.3	5.6	25.0	10.8
Oligochaetes	4.8	x	0.0	--
Daphnia	28.6	66.1	30.0	45.2
Latonopsis*	0.0	--	14.2	25.3
Leptodora*	0.0	--	5.0	0.1
Diaptomus	0.0	--	5.0	0.1
Hyalella	4.8	0.8	30.0	0.1
Chironomidae	47.6	6.4	40.0	5.4
Simulidae (adults)	19.0	x	5.0	0.1
Aquatic beetles*	14.3	0.1	10.0	0.1
Aquatic bugs*	4.8	0.8	40.0	1.9
Damselfly nymphs	9.5	x	5.0	0.1
Caddis larvae*	33.3	3.2	30.0	2.0
Terrestrial insects	47.6	8.7	50.0	10.8
Water mites	14.3	0.8	15.0	1.9
Spiders	19.0	x	5.0	0.1
Fish	28.6	0.3	50.0	1.2
Cisco eggs	33.3	7.2	25.0	1.8
Plant remains	76.2	x	80.0	10.8

* The snails were Amnicola sp. and Gyrulus sp.; the cladocerans were Latonopsis occidentalis and Leptodora kindtii; the aquatic beetles were adults of Dytiscidae, Gyrinidae and Haliplidae; the aquatic bugs were Corixidae and Notonecta undulata; and most of the caddis larvae were Helicopsyche borealis.

x Indicates trace of food item in stomachs.

TABLE 8

Contents of Stomachs from Splake Collected
at Pallette Lake 3 March 1966

Food Items	Fall-stocked Splake 3 Stomachs - 35 Food Items		Spring-stocked Splake 5 Stomachs - 88 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Daphnia	0.0	--	40.0	37.5
Chironomidae	0.0	--	20.0	1.1
Aquatic bugs*	33.3	22.9	20.0	9.1
Dragonfly nymphs	0.0	--	20.0	19.3
Caddis larvae	100.0	71.4	60.0	28.5
Fish	66.6	5.7	40.0	3.4
Cisco eggs	0.0	--	20.0	1.1
Plant remains	66.6	x	40.0	x

* The aquatic bugs were Corixidae.

x Indicates trace of food item in stomachs.

TABLE 9

Contents of Stomachs from Splake Collected
at Pallette Lake 19-21 May 1966

Food Items	Fall-stocked Splake 9 Stomachs-1,340 Food Items		Spring-stocked Splake 14 Stomachs-1,659 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Snails*	0.0	--	21.4	0.1
Hyalella	11.1	0.1	0.0	--
Chironomidae	77.8	24.8	92.8	60.2
Aquatic beetles*	22.2	1.3	35.7	0.2
Aquatic bugs*	67.7	2.4	71.4	1.9
Dragonfly nymphs	11.1	1.3	7.1	0.1
Caddis larvae	11.1	0.1	28.6	0.1
Terrestrial insects	66.7	13.7	42.8	0.1
Water mites	66.7	56.0	78.6	37.2
Spiders	22.2	0.1	0.0	--
Fish	33.3	0.2	14.3	0.1
Plant remains	0.0	--	64.3	x

* The snails were Amnicola sp.; the aquatic beetles were adults of Dytiscidae, Gyrinidae and Hydrophilidae; and the aquatic bugs were Corixidae.

x Indicates trace of food item in stomachs.

TABLE 10

Contents of Stomachs from Fall- and Spring-stocked Splake Collected at Pallette Lake August and November, 1966

Food Items	25-26 August 4 Stomachs - 466 Food Items		4-16 November 12 Stomachs-13,280 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Snails*	0.0	--	8.3	x
Daphnia	25.0	0.2	0.0	--
Leptodora*	50.0	94.6	0.0	--
Eurycercus*	0.0	--	16.7	0.1
Chironomidae	50.0	0.8	33.3	0.1
Chaoborus	25.0	3.6	0.0	--
Aquatic bugs*	0.0	--	8.3	x
Caddis larvae*	0.0	--	83.3	0.2
Water mites	50.0	0.2	0.0	--
Fish	50.0	0.6	33.3	0.1
Cisco eggs	0.0	--	87.5	99.5
Plant remains	0.0	--	41.7	x

* The snails were Amnicola sp., the large cladocerans were Leptodora kindtii and Eurycercus lamellatus, the aquatic bugs were Corixidae, and the caddis larvae were mainly Helicopsyche borealis.

x Indicates trace of food item in stomachs.

TABLE 11

Contents of Stomachs from Fall- and Spring-stocked Splake Collected at Pallette Lake May and June, 1967

Food Items	15 May 13 Stomachs-1,052 Food Items		1-20 June 35 Stomachs-2,383 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Snails	30.8	14.2	20.0	5.6
Oligochaetes	0.0	--	8.6	0.1
Daphnia	0.0	--	5.7	x
Hyalella	7.7	0.1	0.0	--
Chironomidae*	100.0	39.6	57.1	11.2
Ceratopogonidae	0.0	--	11.4	0.7
Aquatic beetles*	7.7	0.1	5.7	0.7
Aquatic bugs*	23.1	0.2	11.4	0.7
Damselfly nymphs	0.0	--	8.6	0.7
Dragonfly nymphs	7.7	0.1	0.0	--
Terrestrial insects*	15.4	1.6	82.8	56.1
Water mites	84.6	14.2	65.7	22.4
Spiders	0.0	--	14.3	1.4
Fish	30.8	1.0	31.4	0.4
Sucker eggs	15.4	0.2	0.0	--
Plant remains	46.2	x	48.6	x
Pebbles	0.0	--	22.8	x

* Pupae comprised 94 percent of the combined number of chironomid larvae and pupae in the stomachs examined, the aquatic beetles were Gyrinidae and Hydrophilidae, and the terrestrial insects were mostly June beetles.

x Indicates trace of food item in stomachs.

TABLE 12

Contents of Stomachs From Fall- and Spring-stocked Splake Collected at Pallette Lake during the Winter of 1967-68, Spring of 1968 and June 1968

	Dec., 1967-Feb., 1968 10 Stomachs - 54 Food Items		Mar.-April, 1968 10 Stomachs - 56 Food Items		June, 1968 3 Stomachs - 9 Food Items	
Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Chironomidae	0.0	--	10.0	10.7	0.0	--
Caddis larval	10.0	1.9	0.0	--	0.0	--
Fish	100.0	98.1	100.0	89.3	100.0	100.0
Plant remains	10.0	x	0.0	--	0.0	--
Pebbles	10.0	x	20.0	x	0.0	--

x Indicates trace of food item in stomachs.

TABLE 13

Contents of Stomachs from Spring-stocked Splake
Collected at Big Green Lake
October and November, 1965

Food Items	Yearling Splake 4 Stomachs - 300 Food Items		Two-year-old Splake 20 Stomachs-5,550 Food Items	
	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items	Percentage of Stomachs Containing Food Item	Percentage of Total Food Items
Daphnia*	50.0	16.7	65.0	92.5
Leptodora*	0.0	--	35.0	3.0
Copepods	0.0	--	5.0	x
Mysis*	25.0	16.7	35.0	1.2
Hyallela*	100.0	x	15.0	x
Pontoporeia*	75.0	x	5.0	x
Chironomidae*	75.0	66.6	35.0	0.9
Damselfly nymphs	0.0	--	5.0	x
Terrestrial insects	0.0	--	25.0	2.4
Water mites	25.0	x	10.0	x
Spiders	0.0	--	5.0	x

* The species of Daphnia in this lake was D. pulex; the cladoceran was Leptodora kindtii; the larger crustaceans were Mysis oculata var. relecta, Hyallela azteca and Pontoporeia affinis; and the chironomids were both larvae and pupae.

x Indicates trace of food item in stomachs.

APPENDIX B (FIGURES 3-8)

WATER TEMPERATURES AND DAPHNIA DENSITIES IN PALLETTE LAKE

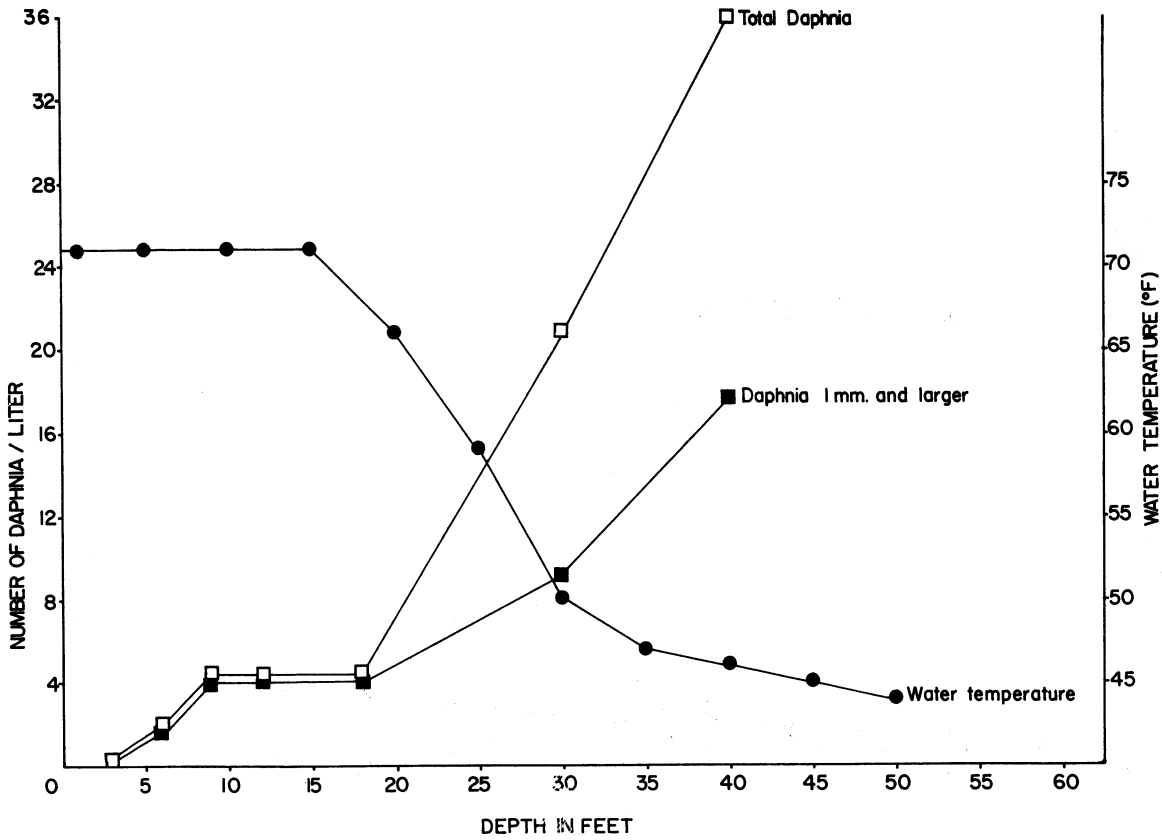

Figure 3. Water temperatures and the density of Daphnia at different depths in Pallette Lake 19 July 1961.

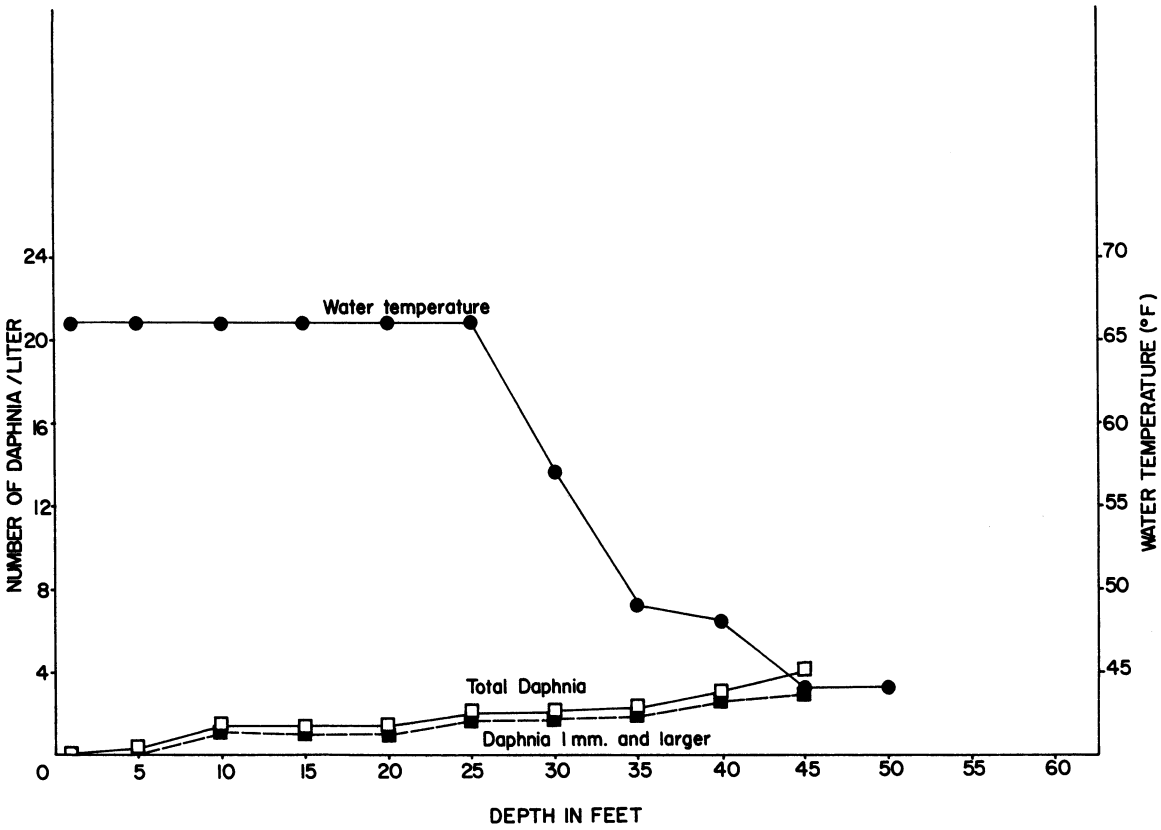

Figure 4. Water temperatures and the density of Daphnia at different depths in Pallette Lake 22 August 1963.

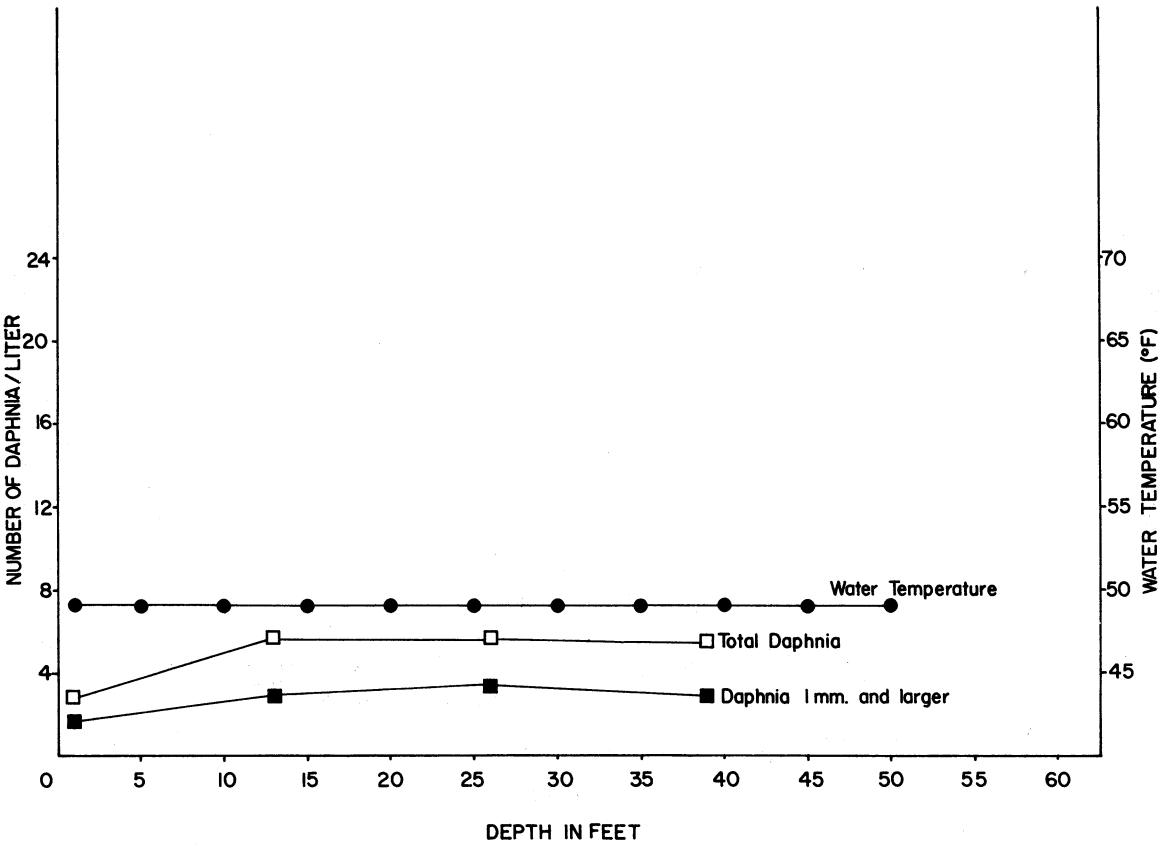

Figure 5. Water temperatures and the density of Daphnia at different depths in Pallette Lake 20 October 1964.

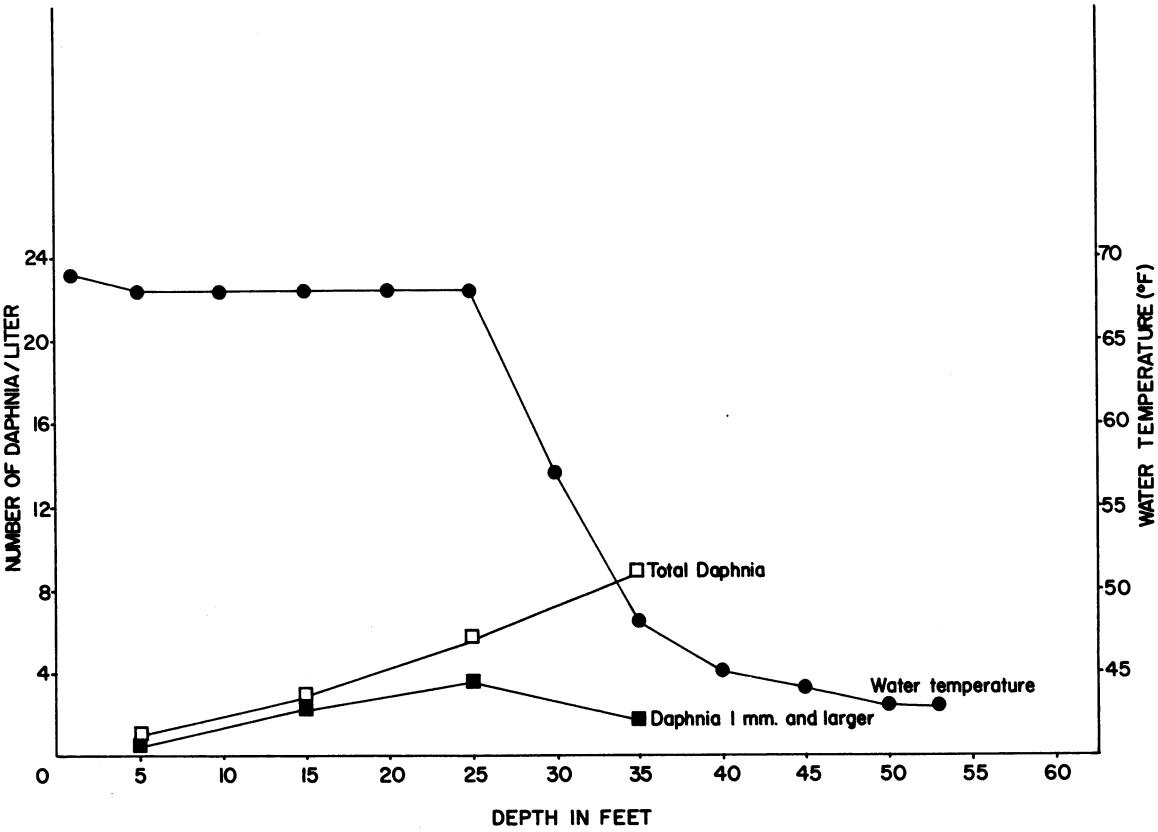

Figure 6. Water temperatures and the density of Daphnia at different depths in Pallette Lake 25 August 1965.

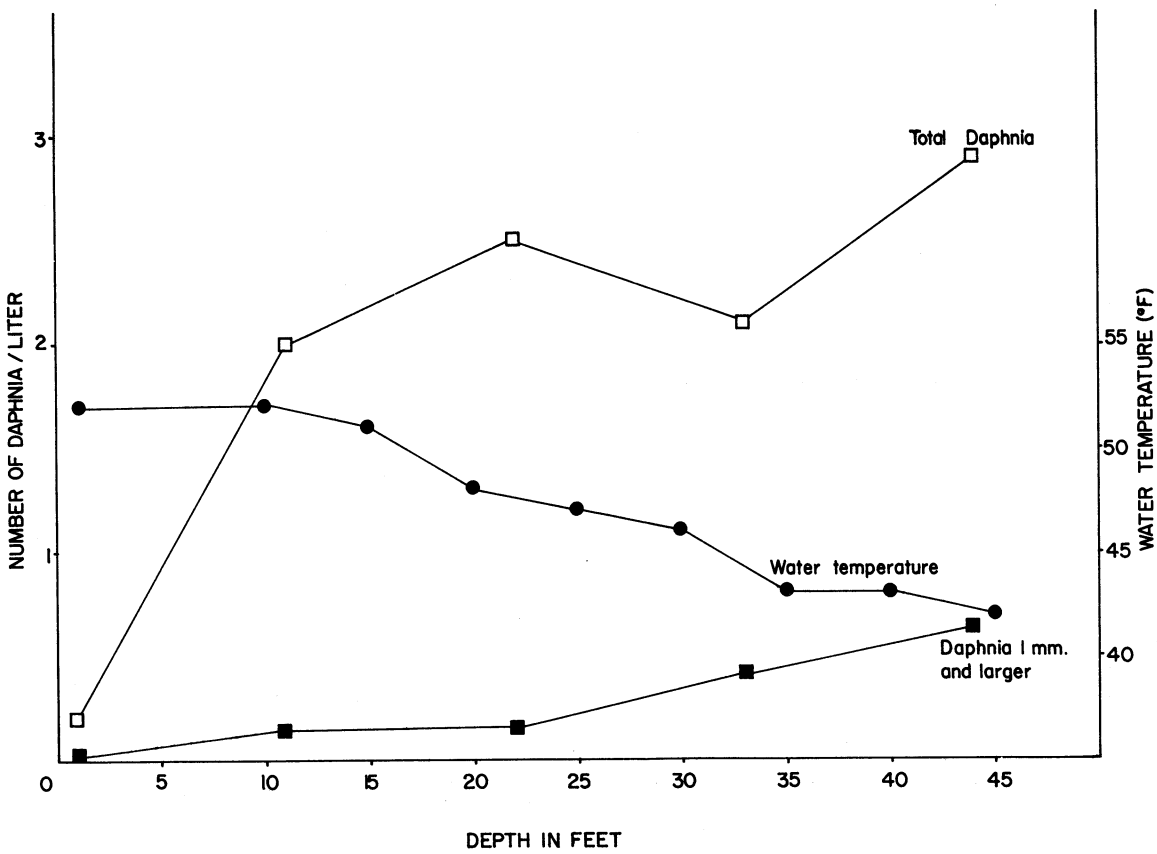

Figure 7. Density of Daphnia at different depths in Pallette Lake 19 May 1966 and average mid-May water temperatures at different depths in Pallette Lake.

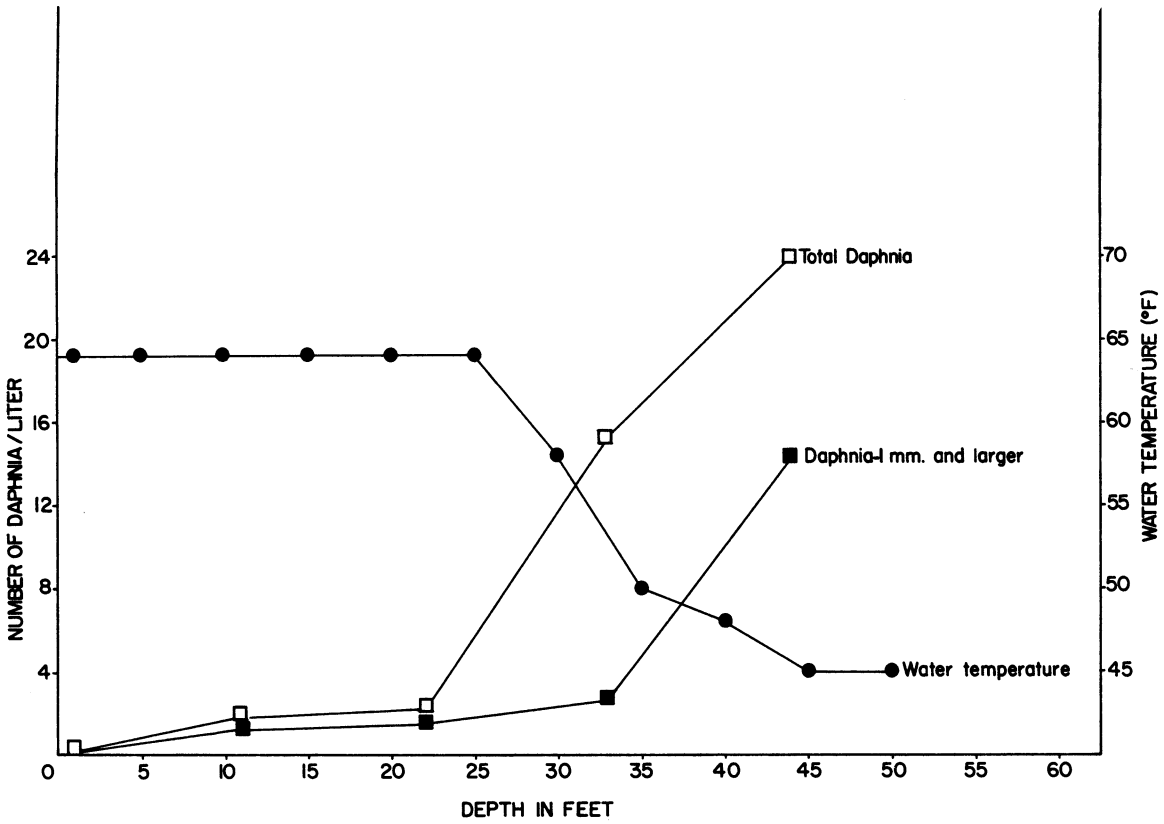

Figure 8. Water temperatures and the density of Daphnia at different depths in Pallette Lake 24 August 1966.

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