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ABSTRACT

THE COLONIZATION AND SUBSEQUENT GROWTH OF DAPHNIA PULEX AND D. MAGNA POPULATIONS IN FOUR INTERCONNECTED LAKES

By

James Stephen Webber

Four newly constructed interconnected lakes were filled with water in autumn, 1973. A daily flow of treated sewage was never achieved during the sampling period and the lakes remained isolated from each other. Three lakes receiving several tons of introduced aquatic macrophytes in October were rapidly colonized by Daphnia pulex. Significant quantities of male D. pulex appeared in November, apparently in response to decreasing water temperatures. Population densities declined following spring maxima. Reductions in most instances were subsequent to reductions in pH or dissolved oxygen concentrations. D. magna appeared in Lakes 1 and 2 in July. Their increasing density and the coinciding density decrease of D. pulex might support the argument that D. magna are more efficient filter-feeders at higher temperatures.

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DAPHNIA PULEX AND D. MAGNA POPULATIONS
IN FOUR INTERCONNECTED LAKES

By

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INTRODUCTION

This investigation was designed to determine the response of selected freshwater filter-feeding planktonic microcrustacean species to nutrient levels in the water. These nutrients are first assimilated by phytoplankton or bacteria and these organisms thus become a food form utilizable by filter-feeding zooplankton.

Two major groups of freshwater planktonic microcrustaceans are filter-feeders: calanoid copepods and cladocerans. Calanoid copepods are generally found in the limnetic habitat of larger lakes. Consequently they were not expected to appear in abundance in the small lakes investigated. Cladocerans are common in both limnetic and littoral habitat. This investigator studied the ubiquitous limnetic cladoceran, Daphnia spp.

Zooplankton feeding has been reviewed extensively (Conover, 1964; Edmondson, 1957; Jorgensen, 1966). Many investigators have considered the role of cladocerans as herbivores, grazing primarily on phytoplankton. Saunders (1969) contended that thin-walled phytoflagellates are most digestible compared with heavy-walled algae and blue-green algae which may pass through the cladoceran intestine and remain viable. Ingestion, assimilation, survivorship, and

reproduction of D. pulex fed blue-green algae were lower than those fed green algae (Arnold, 1971). Furthermore, some blue-green algae exhibited toxicity or inhibition toward D. pulex.

Recent investigations have indicated that cladocerans are not dependent solely on algae for nutrition. Taub and Dollar (1968) found Chlorella sp. and Chlamydomonas sp. to be deficient in meeting the nutritional requirements of D. pulex. While detritus has normally been considered non-nutritious (Conover, 1964), Pennak (1955) contended that detritus must be the most important cladoceran food source in the Colorado lakes he studied. Artificially created detritus, labelled with carbon-14, comprised half of the organic matter assimilated by Daphnia spp. in Frains Lake, Michigan (Saunders, 1969). Bell (1970) estimated that contribution of detrital carbon to daily incorporation of Daphnia pulex was much less than contribution of phytoplankton but was significant. Incorporation of phytoplankton was more efficient than that of artificial detritus, as was also shown by Saunders (1969).

Bacteria have also been considered important in cladoceran diet (Manuilova, 1958; Rodina, 1958). Bacteria seemed to be limiting to zooplankton production in eutrophic lakes investigated by Hilbricht et al. (1966). Sorokin (1957) reported a correlation between the distribution of Daphnia spp. and chemosynthetic methane oxidizing bacteria in a reservoir. A general correlation between zooplankter size and bacterial

assimilation capacity was noted by Saunders (1969). Monakov and Sorokin (1961) contended that zooplankton are more efficient in assimilating algae than bacteria.

In any case, diet of cladocerans is complex. While phytoplankton may be the major component in the diet, detritus and bacteria, while more refractory to digestion, can be important supplementary components. They may even be dominant in eutrophic situations where there are high concentrations of bacteria and detritus.

This investigation was originally designed to correlate in situ feeding rates of cladocerans with their population densities and growth rates in each lake. Algal and bacterial species found in the lakes were to be carbon-14 labeled and used in a grazing chamber to detect feeding behavior differences between lakes. But continuous waterflow never occurred, the lakes remained isolated, and a nutrient gradient never developed. Hence the feeding experiment was not executed.

In mid-July, 1974, a leak was discovered in one of the artificial marshes adjacent to Lake 3. Lake 3 was drained and in early August Lakes 1 and 2 were also drained. The leak was repaired but the ponds were not completely filled again until early September. Cladoceran populations in the newly refilled lakes would likely have been influenced by variables not present in the lakes in July. Consequently sampling was terminated in late July.

STUDY AREA

The study area is located at the intersection of Jolly and College Roads on south campus of Michigan State University (Figure 1). Construction of four interconnected lakes was directed by the Institute of Water Research of Michigan State University.

The lakes were designed to receive two million gallons of secondarily treated sewage per day. Each lake is situated at an elevation lower than the preceding lake and gravity creates waterflow between lakes. Water flowing from Lake 2 can be passed directly through a water main to Lake 3 or be diverted into or through three artificial marsh areas west of Lake 3. Water from Lake 4 may be pumped to experimental spray irrigation sites. Water levels, flow rates, and avenues of flow are directed and determined in a control house on the east shore of Lake 4.

Surface areas of the four lakes vary from 8.1 to 12.3 acres. The lakes are shallow, with maximum depths of 2.1 to 2.4 meters limited to narrow channels draining into the outlets (Figures 2-5). The lake bottoms are sealed with clay to prevent seepage and consequent contamination of the adjacent ground waters.

Water was initially passed into Lake 2 in early October of 1973. Upon its filling, four aquatic plant species were

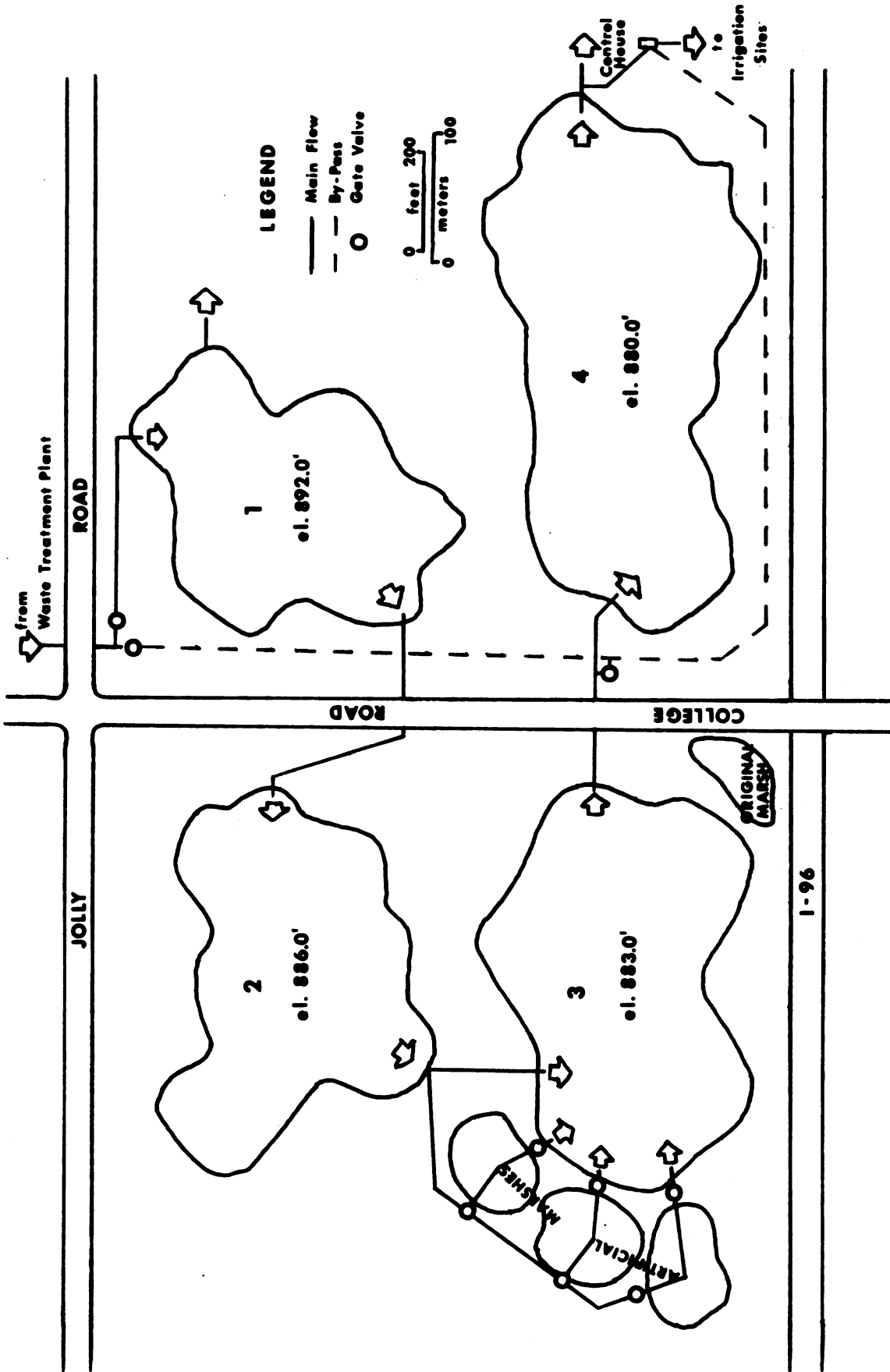


Figure 1. Water Quality Management Project. Arrows indicate direction of water flow.

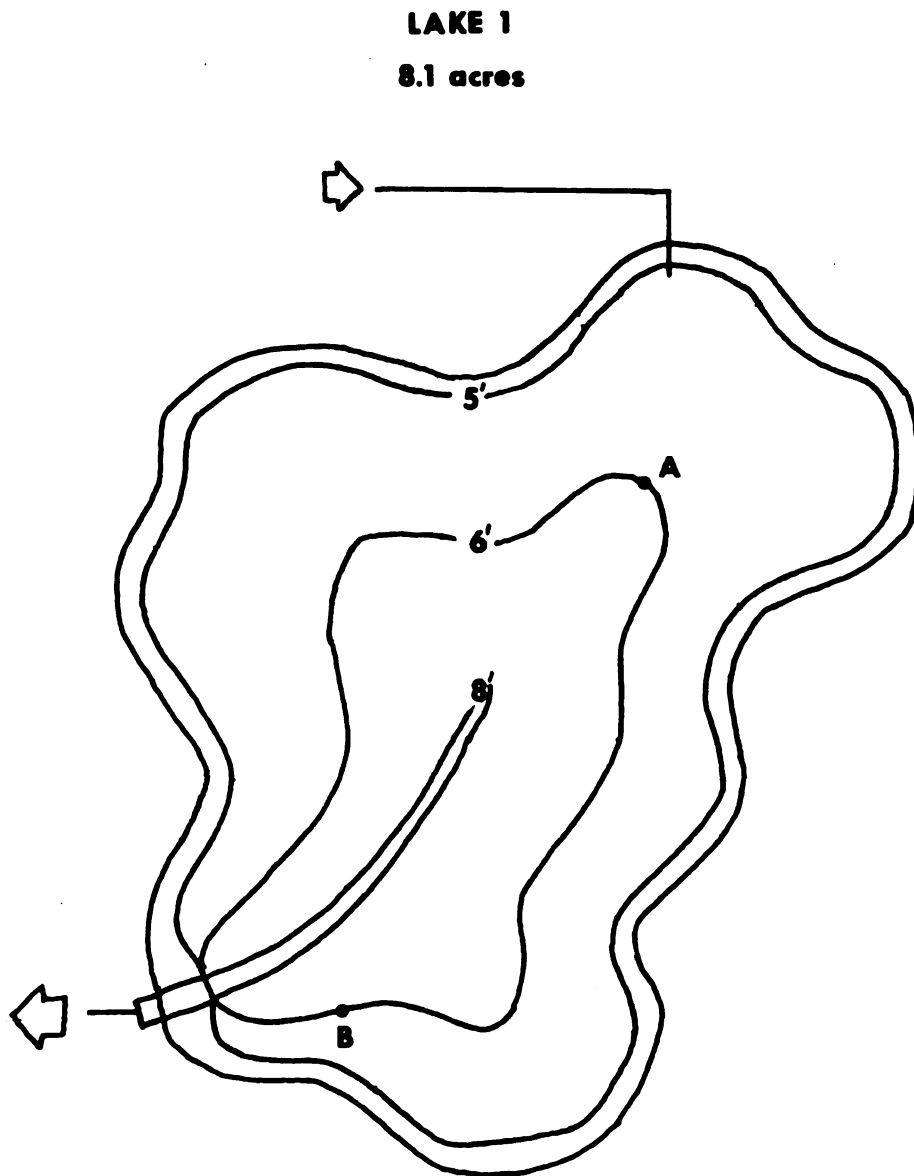


Figure 2. Lake 1: Sites A and B.

LAKE 2
8.2 acres

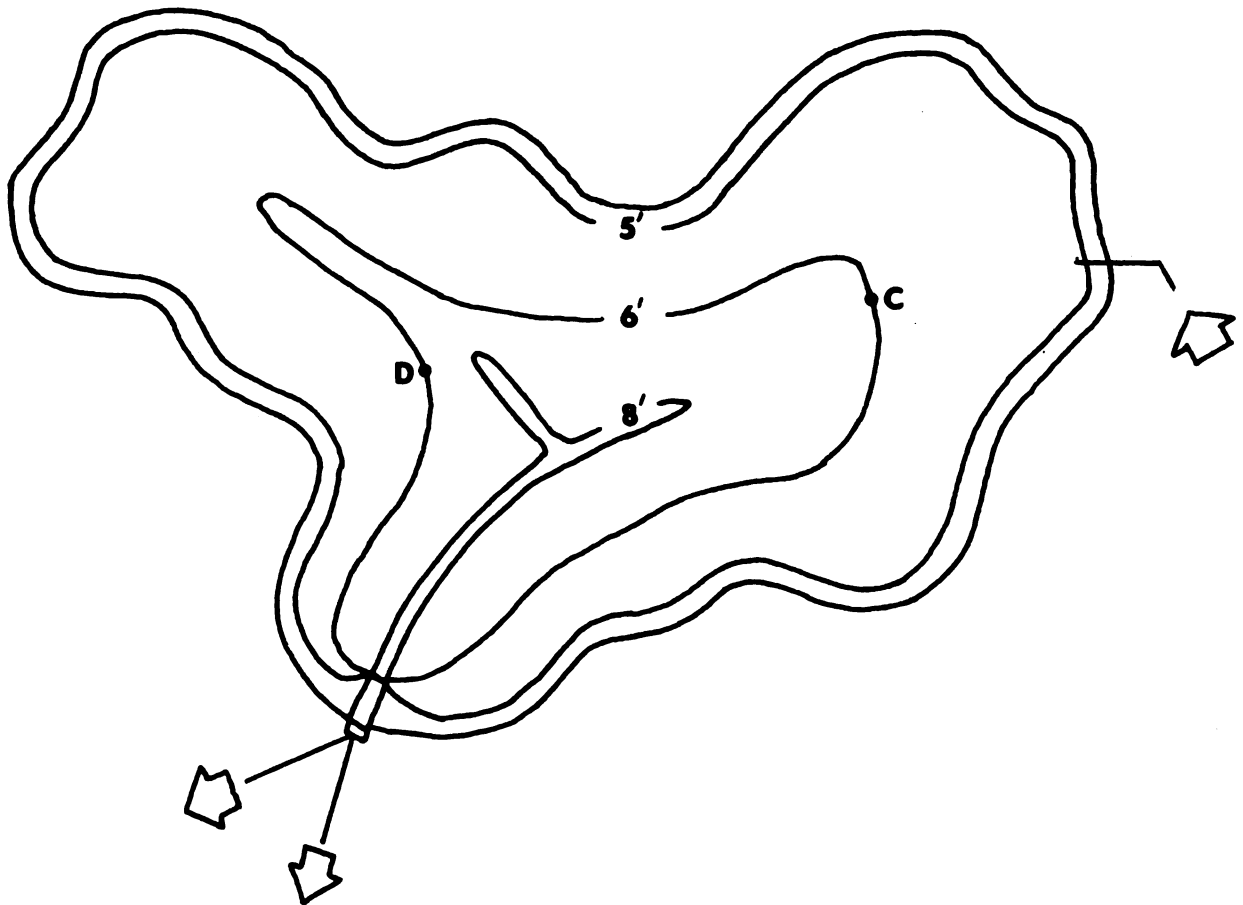


Figure 3. Lake 2: Sites C and D.

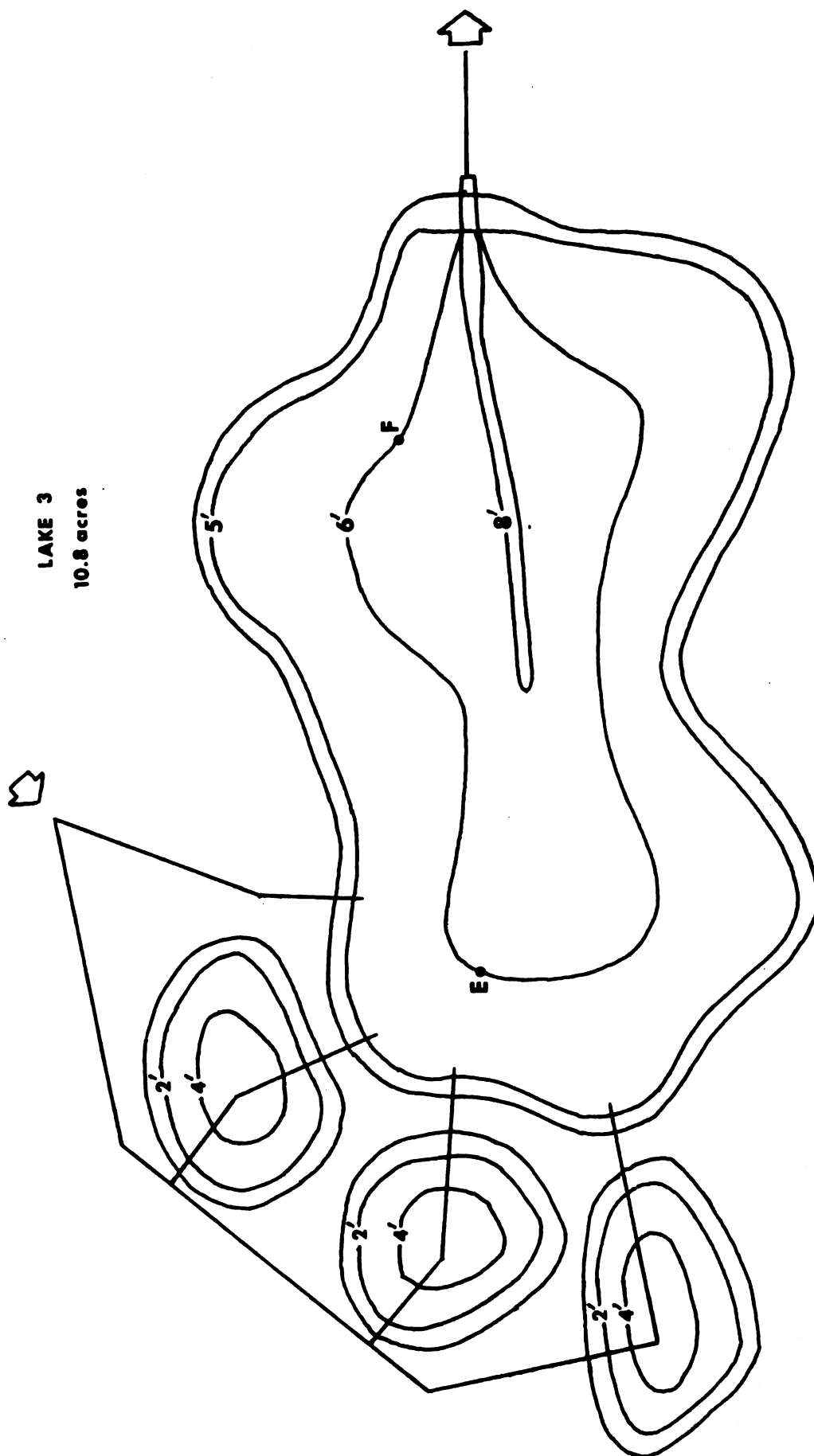


Figure 4. Lake 3: Sites E and F.

LAKE 4
12.3 acres

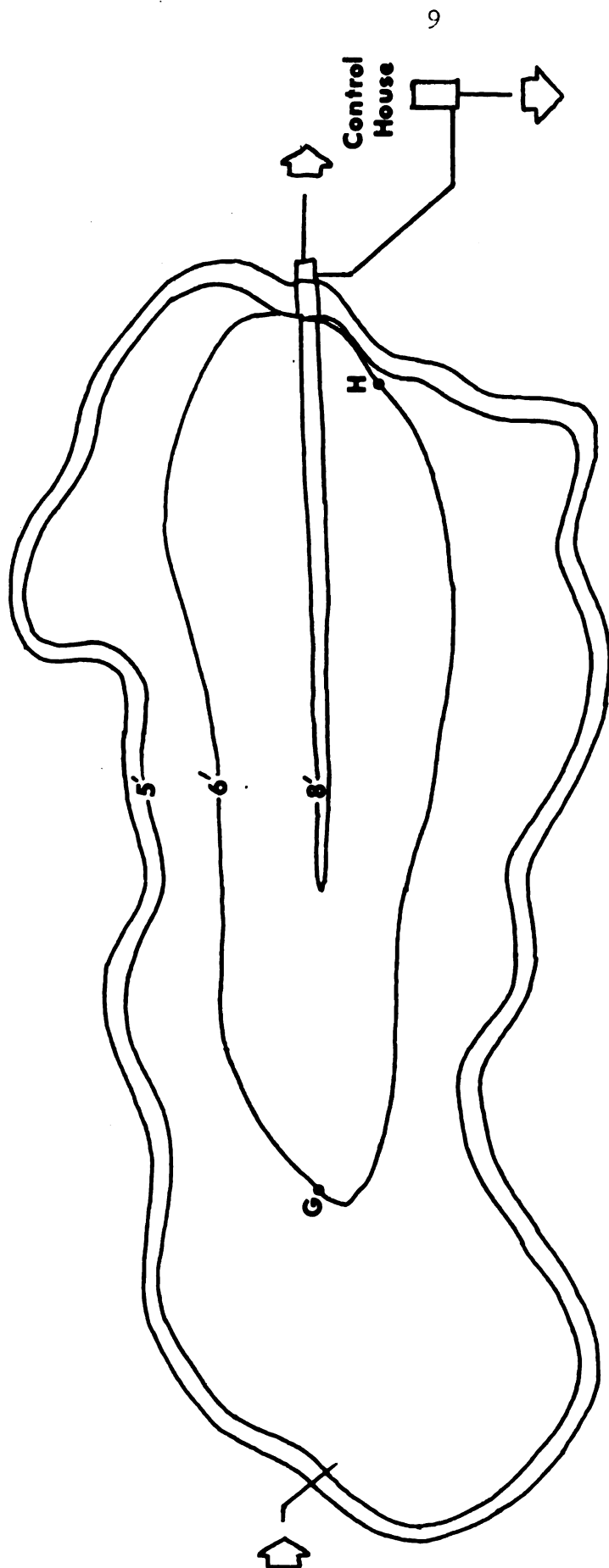


Figure 5. Lake 4: Sites G and H.

collected from four sites across Michigan and were introduced for management purposes. Lakes 3 and 4 were the next lakes to be filled with water and were also planted with macrophytes. Lake 1 was the last lake to receive water and no aquatic plants were introduced.

METHODS

PHYSICAL AND CHEMICAL MONITORING

Thirty-one different physical and chemical parameters were monitored monthly by the Water Quality Laboratory of Michigan State University. Determinations were made from water samples taken near the surface and bottom of each lake. Parameters given in graph form in this investigation are the mean values of the top and bottom measurements.

QUANTITATIVE SITE SAMPLING

Sampling sites were selected that appeared to be best in detecting responses to nutrient gradients within the lakes system. Each lake was assigned two sampling sites. Sites were chosen at a depth of 1.8 meters near the inlet and outlet of each lake (Figures 2-5). Duplicate samples, which should be the minimum allowable for population studies, were taken at each station from depths of 0, 0.6, 1.2 and 1.8 meters.

Zooplankton were trapped in a 2.1 liter horizontal transparent van Dorn water sampler. Utilization of a towed sampler, such as a Clarke-Bumpus plankton sampler, while superior in quantifying zooplankton densities, would have been impractical in the shallow lakes among the dense aquatic macrophytes.

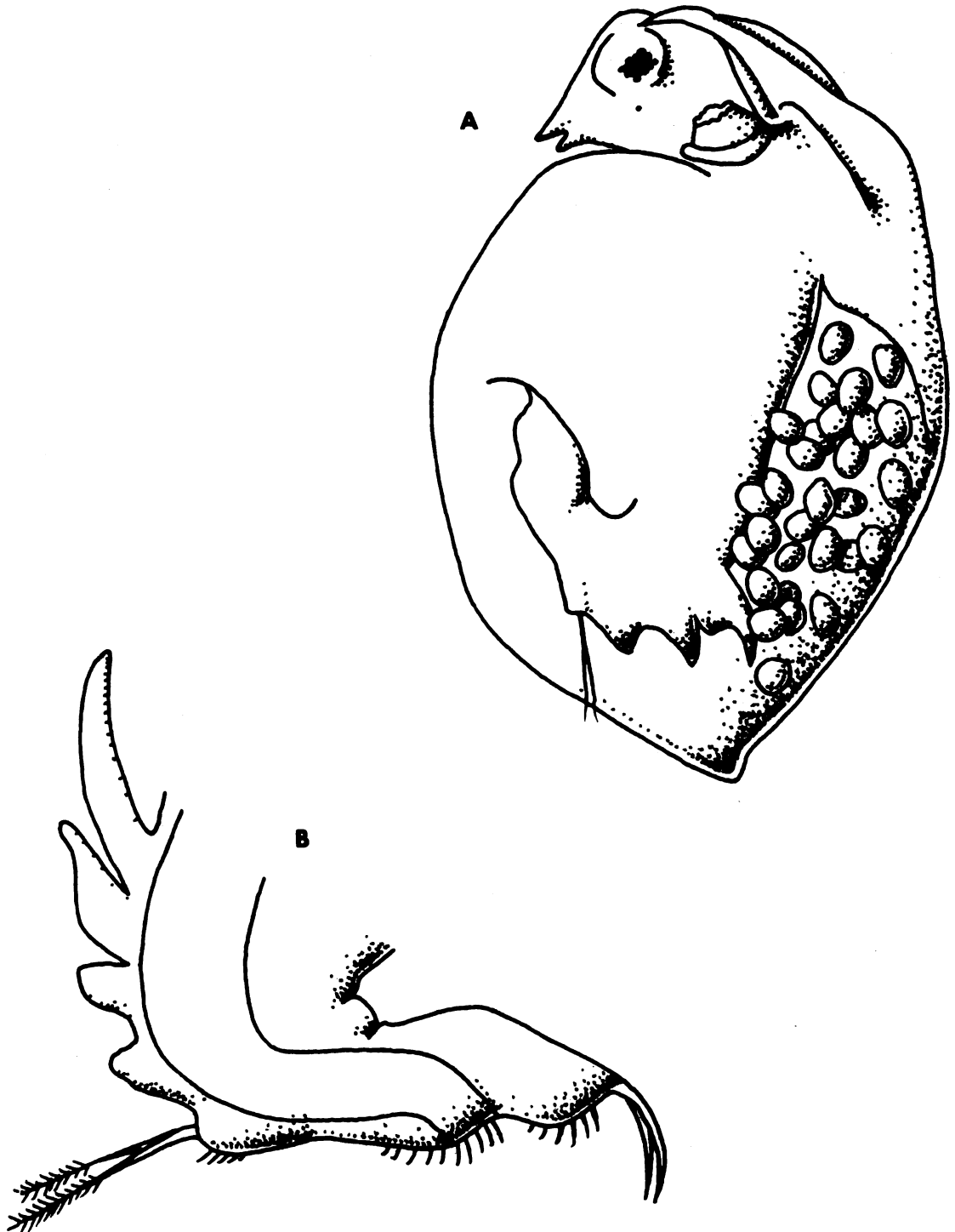
Samples were collected in a three hour period at midday. Since cladocerans tend to clump near bottom during daylight, the integrating process will tend to smooth out these aggregations (Hrabacek, 1966). Furthermore, vertical distribution of cladocerans was determined to be of no significance to this research. Hence, samples from the four depths were integrated into one sample.

In early May, larger, stronger-swimming cladocerans were observed swimming to the bottom of the sampler. By remaining below the spigot, they avoided inclusion in the sample. Subsequently, the bottom trap of the sampler was removed and its entire contents poured into a plankton tow net. The samples from the other three depths were likewise poured into the net and samples thus integrated in the field. Previously, samples from the four depths were poured into separate containers and integrated later in the laboratory. All samples were preserved in 95% ethyl alcohol for later quantification. Identifications were made according to Ward and Whipple (1959).

All Daphnia spp. in each integrated sample were counted. Then approximately 100 were measured for length and their eggs counted. Because D. pulex (Figure 6) and D. magna (Figure 7) are non-cyclomorphic cladocerans, length was measured from anterior-most point of helmet to base of caudal spine, and was determined to the nearest 0.1 mm. 97 percent of D. pulex with broods were 1.6 mm. or longer. Thus D. pulex less than 1.6 mm. in length were classified as juveniles. Broods were observed only in D. magna larger than 2.6 mm. Consequently, D. magna 2.5 mm. or less in length were classified as juveniles.

Figure 6. Daphnia pulex. A) Gravid female, lateral view, x38.
B) Male, lateral view, x64.
C) Postabdomen, female, x80.

Figure 7. Daphnia magna. A) Gravid female, lateral view, x28.
B) Postabdomen, female, x53.



Edmondson and Winberg (1971) have reported success in maintaining eggs and embryos within cladoceran brood pouches by dipping the living organisms in 95% ethyl alcohol. Because this method was not totally successful for this investigator, all eggs in the subsample were counted, whether they were inside or outside the maternal brood pouch. Fully developed D. pulex young larger than 0.5 mm. in length were observed in brood pouches. Consequently, all D. pulex smaller than 0.5 mm. in length were considered prematurely ejected embryos and were counted as eggs. Fully developed D. magna were not seen in brood pouches.

Reproductive rates were calculated using Edmondson's (1968) egg-ratio equation:

$$B = \frac{E}{D}$$

where:

B = average brood size

E = eggs/adult female

D = development time of eggs in days

Finite birth rate (b) can be calculated from B according to Hall (1964):

$$b = \ln(1+B)$$

Wet weights of Daphnia spp. were determined according to Burns' (1969) equation:

$$W = 0.0116 L_b^{2.67}$$

where:

W = wet weight in mg.

L_b = body length (excluding caudal spine) in mm.

RESULTS

PHYSICAL AND CHEMICAL MONITORING (Figures 8-11)

Temperatures rose slowly in all four lakes from January to March. Upon the disappearance of ice cover, temperatures increased sharply until June at which time they began to level off at approximately 20°C.

Dissolved oxygen concentrations in Lakes 3 and 4 declined gradually from peak values under ice until May and June when decline became more pronounced. Lake 1 and 2 were characterized by more dynamic fluctuations in dissolved oxygen concentrations.

In Lakes 1, 3, and 4, pH increased slowly to greater than 9.0 but dropped sharply to as low as 7.4 in Lake 4 in April and in Lakes 1 and 3 in May. Lake 2 was characterized by a sharp pH increase in January following a slow decline, but pH dropped suddenly in April and continued declining.

Soluble phosphorous concentrations in Lakes 1, 2, and 3 rose under the ice cover until January when concentrations began a steady decline. Lowest concentrations occurred in May; after which concentrations began to increase. Lake 4 was characterized by a very gradual decline throughout sampling period, although a minimum of 0.13 mg/l-P did occur in May.

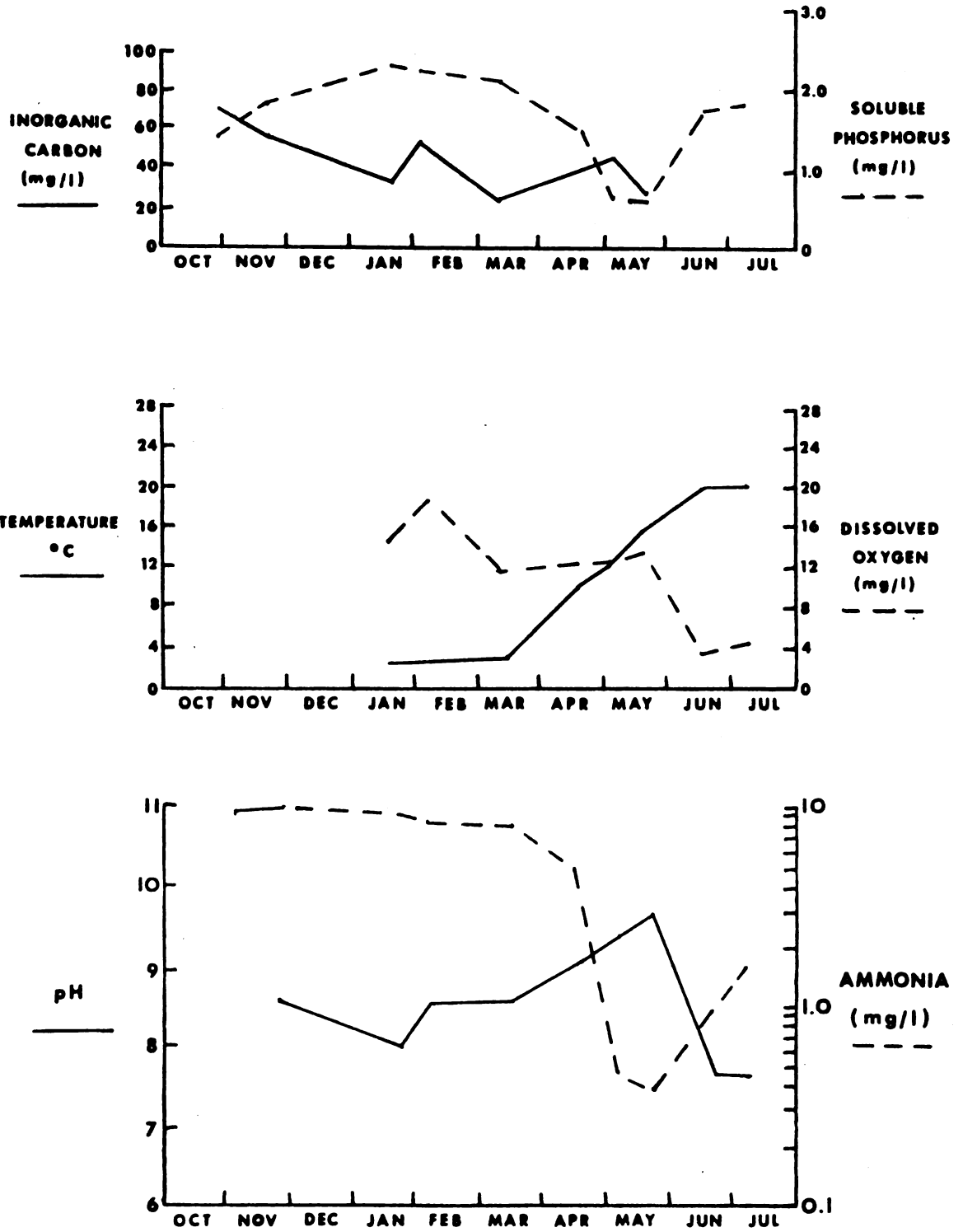


Figure 8. Physical and chemical parameters: Lake 1.

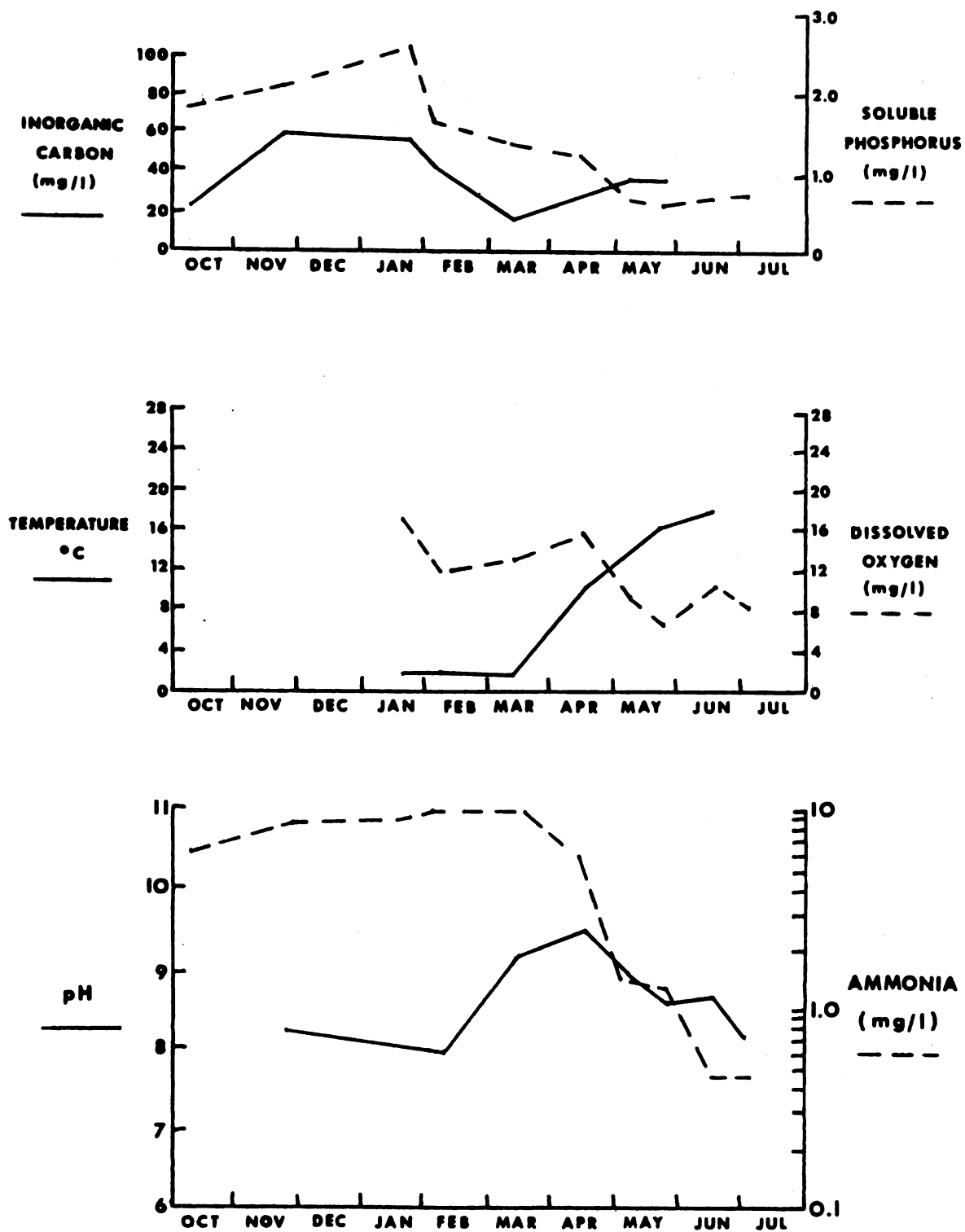


Figure 9. Physical and chemical parameters: Lake 2.

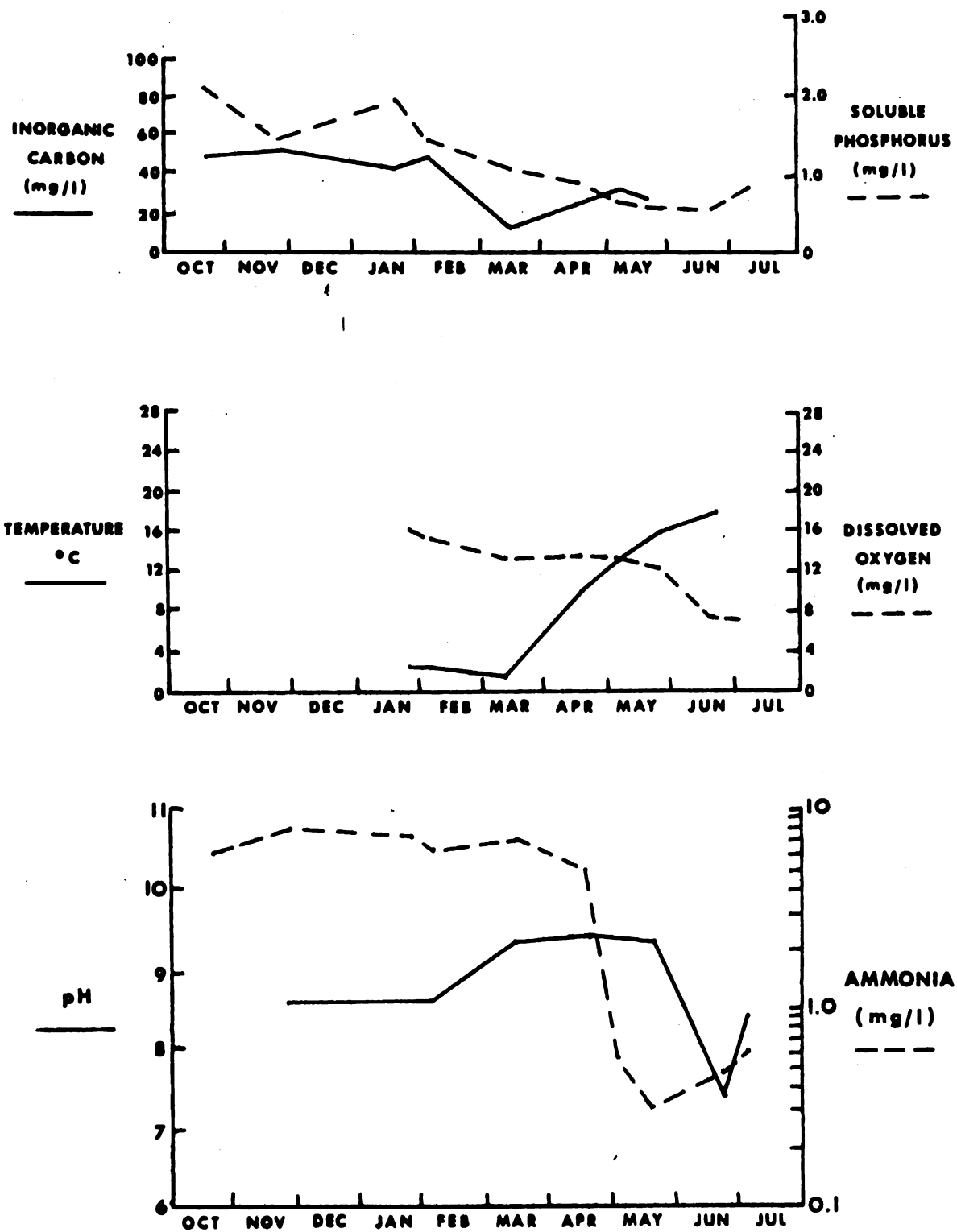


Figure 10. Physical and chemical parameters: Lake 3.

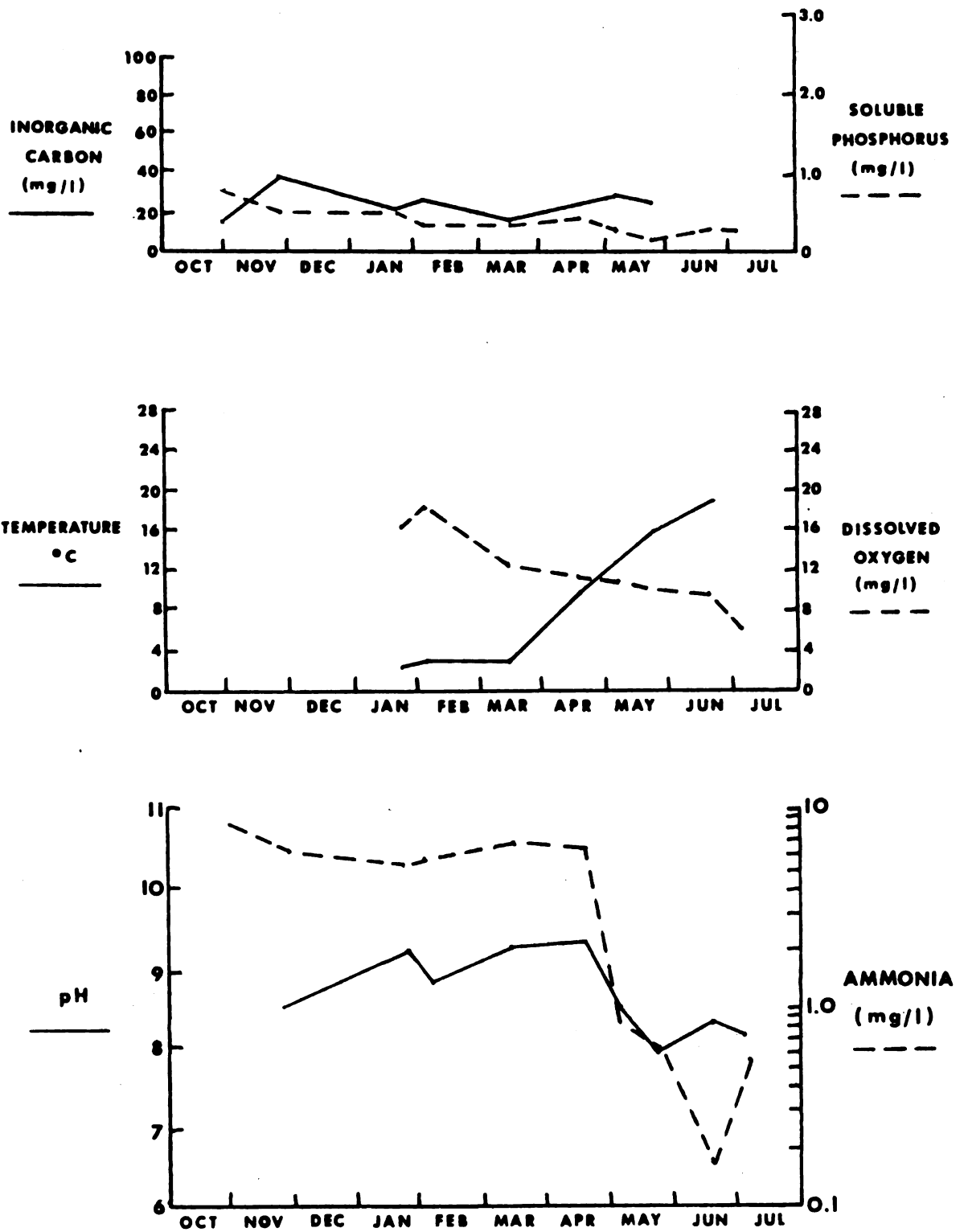


Figure 11. Physical and chemical parameters: Lake 4.

Total inorganic carbon concentrations in all four lakes fluctuated throughout the sampling period but minima for each lake occurred in March.

Ammonia concentrations decreased in all four lakes during the sampling period. The decrease was gradual except for a sharp decline which occurred in all four lakes in April.

QUANTITATIVE SITE SAMPLING

Mean lengths and variances of the duplicate samples were compared to determine any significant differences between the duplicate samples. Employing student's t-test with a .01 level of significance, determination was made that there was insufficient evidence to indicate a difference in 85 percent of the duplicate samples.

Daphnia spp. were not detected in Lake 1 at either site in autumn, 1973 (Figures 12 & 13). Dense populations ($10^6/\text{m}^3$) of rotifers in the genera Asplanchna, Brachionus, and Platytias in April were succeeded by a rapid population growth of Daphnia pulex by the first week of May. From this peak, the cladoceran populations slowly declined. In the second week of June, all D. pulex from Lake 1 were pink. D. magna first appeared in samples in the first week of July, comprising eight percent of cladoceran population. By the last week in July, D. magna comprised 96 percent of Daphnia population.

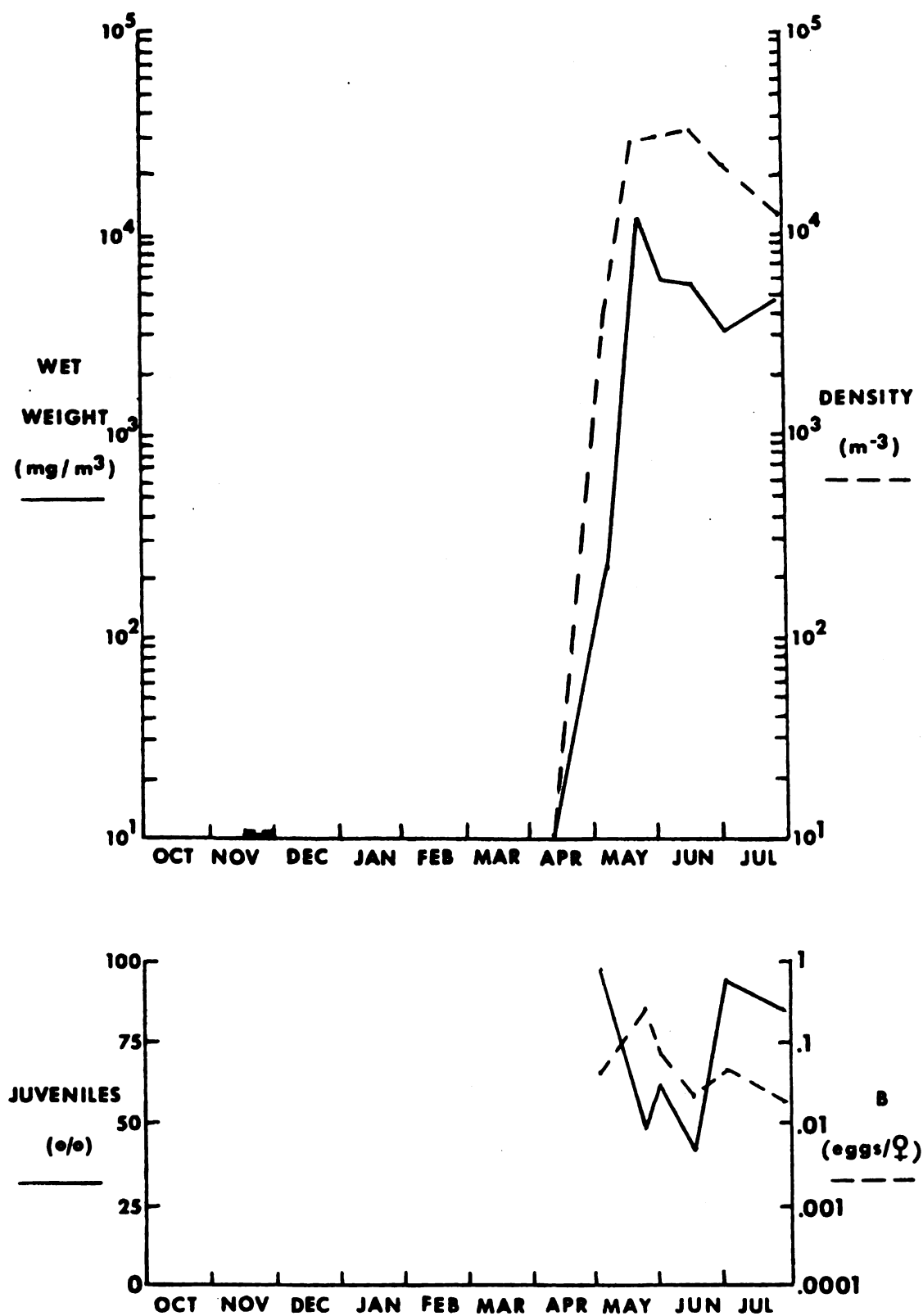


Figure 12. Daphnia spp. population parameters: Site A.

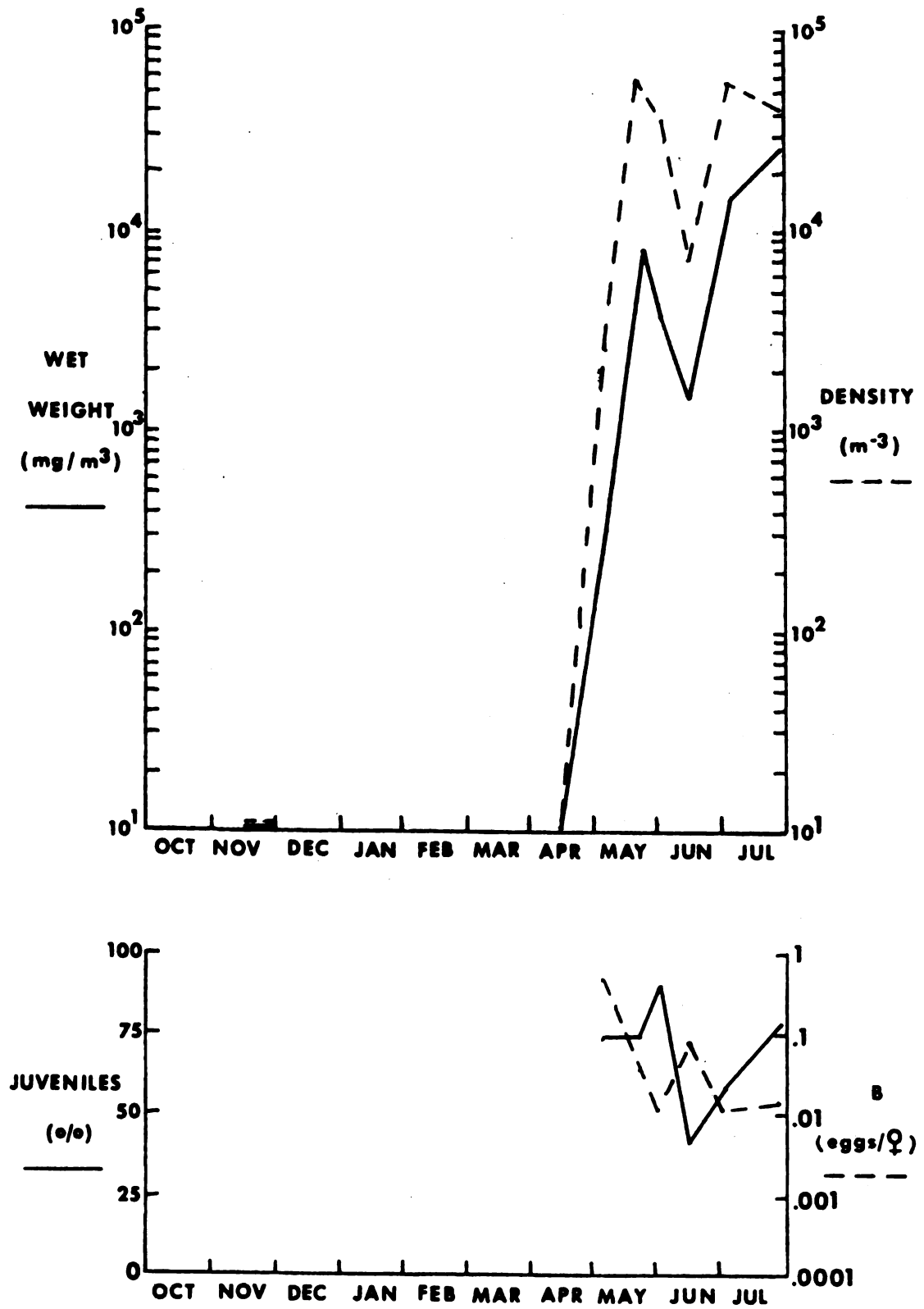


Figure 13. Daphnia spp. population parameters: Site B.

Fluctuations in B values generally preceeded corresponding fluctuations in population densities. Percentage of juveniles in populations were generally inversely proportional to B values. Only one male D. pulex was observed in Lake 1 during sampling period and no male D. magna were seen.

D. pulex population densities measured at sites C and D in Lake 2 increased into the second week in November and subsequently declined (Figures 14 & 15). Densities increased in spring and a maximum was reached in the first week of May. Following a decline, a second peak of same magnitude occurred in the first week of July. D. magna appeared by the last week of July and comprised one percent of Daphnia population.

Spring and summer values of B at site C generally declined and had little correlation with population densities. Fluctuations of spring and summer B values at site D approximated fluctuations of population density.

Male D. pulex comprised from 8.3 to 25 percent of the population in autumn but were not detected the following spring or summer. No D. magna males were observed. Percentage of juveniles in the population was generally inversely proportional to B values.

D. pulex populations in Lake 3 at sites E and F reached peaks in the second week of November (Figures 16 & 17). Population at site E achieved two density maxima in May and June. Population at site F reached a single peak, of $140,000/m^3$, highest density for any site, in the third week of June. D. magna were not observed in Lake 3.

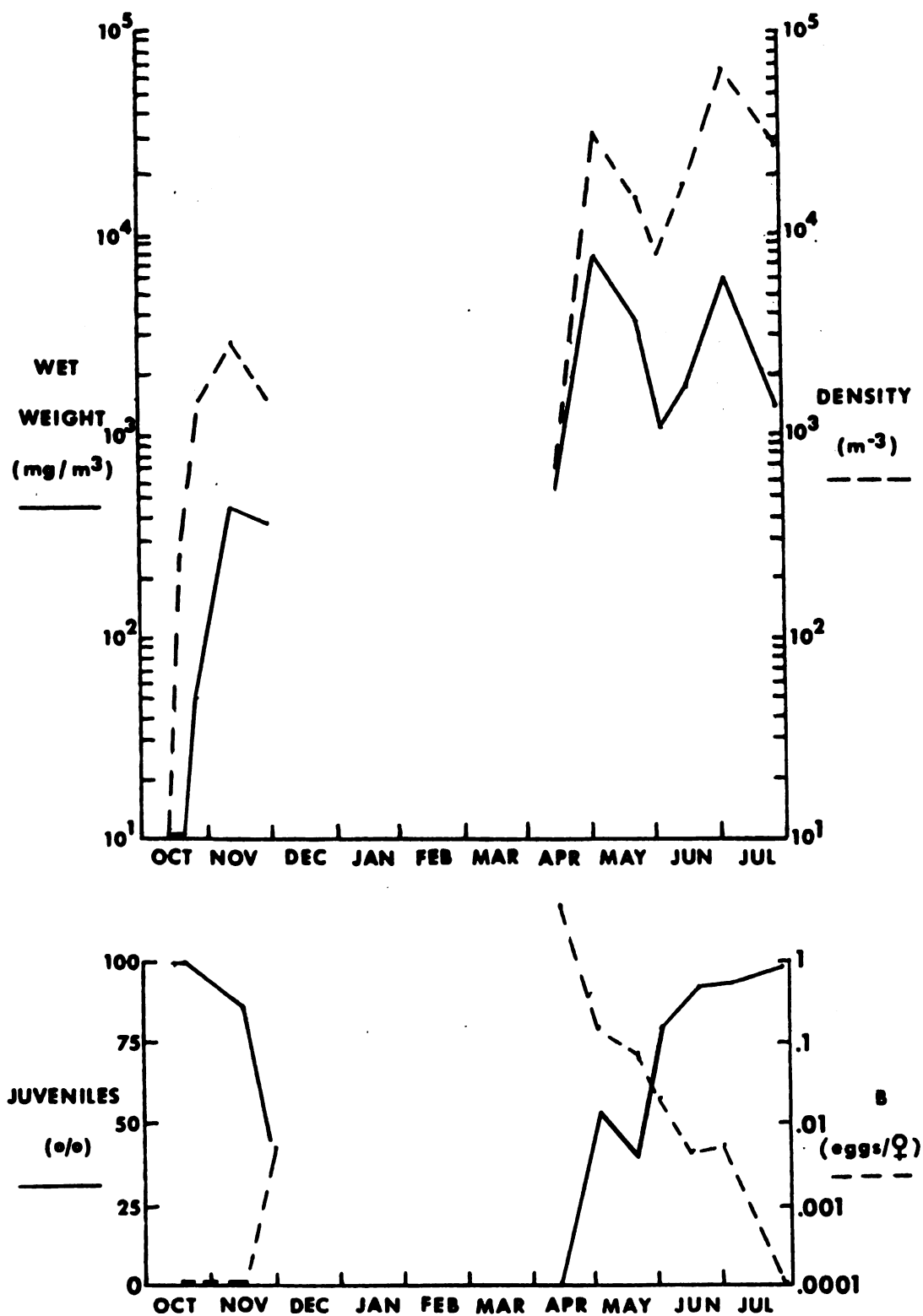


Figure 14. Daphnia spp. population parameters: Site C.

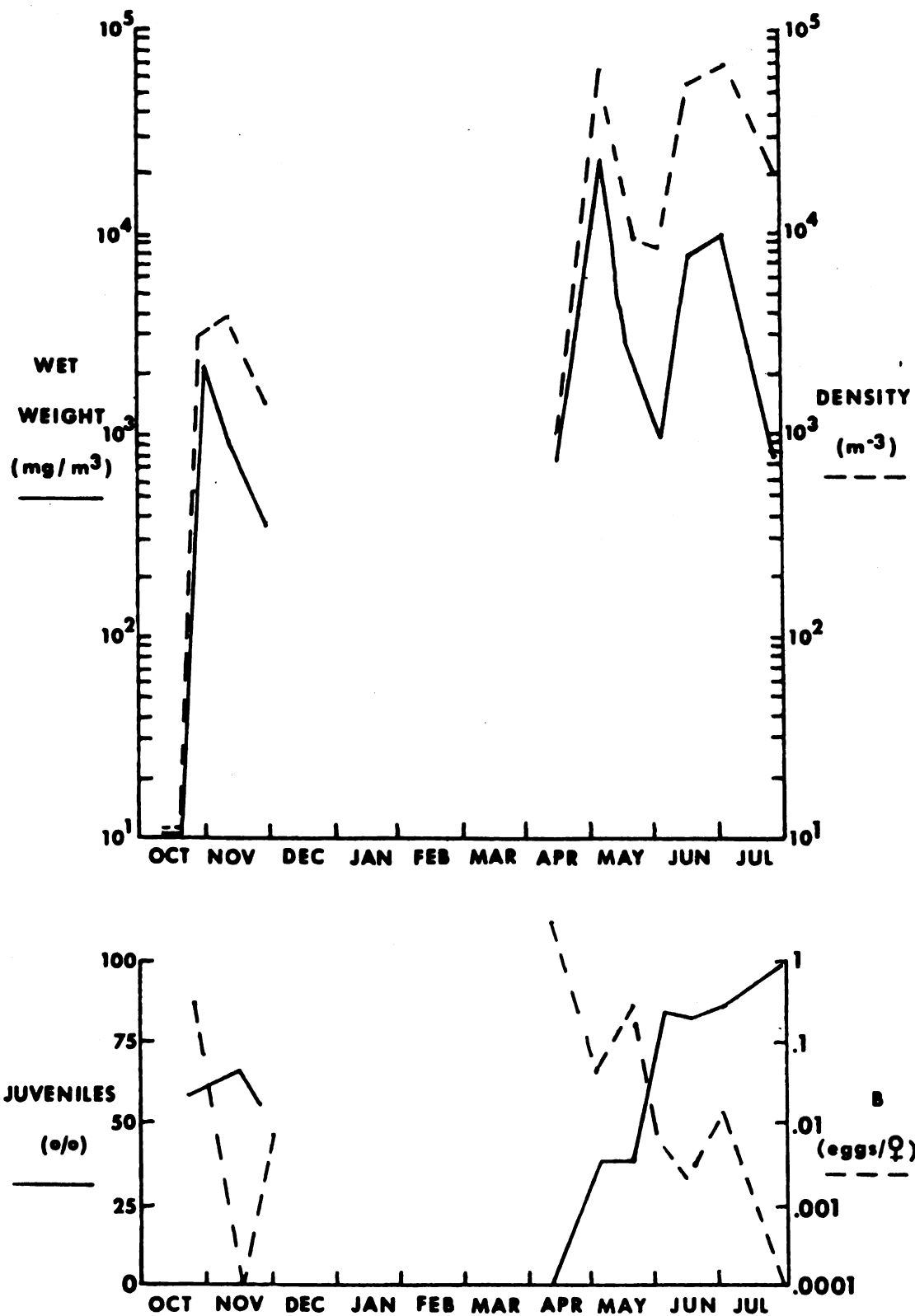


Figure 15. Daphnia spp. population parameters: Site D.

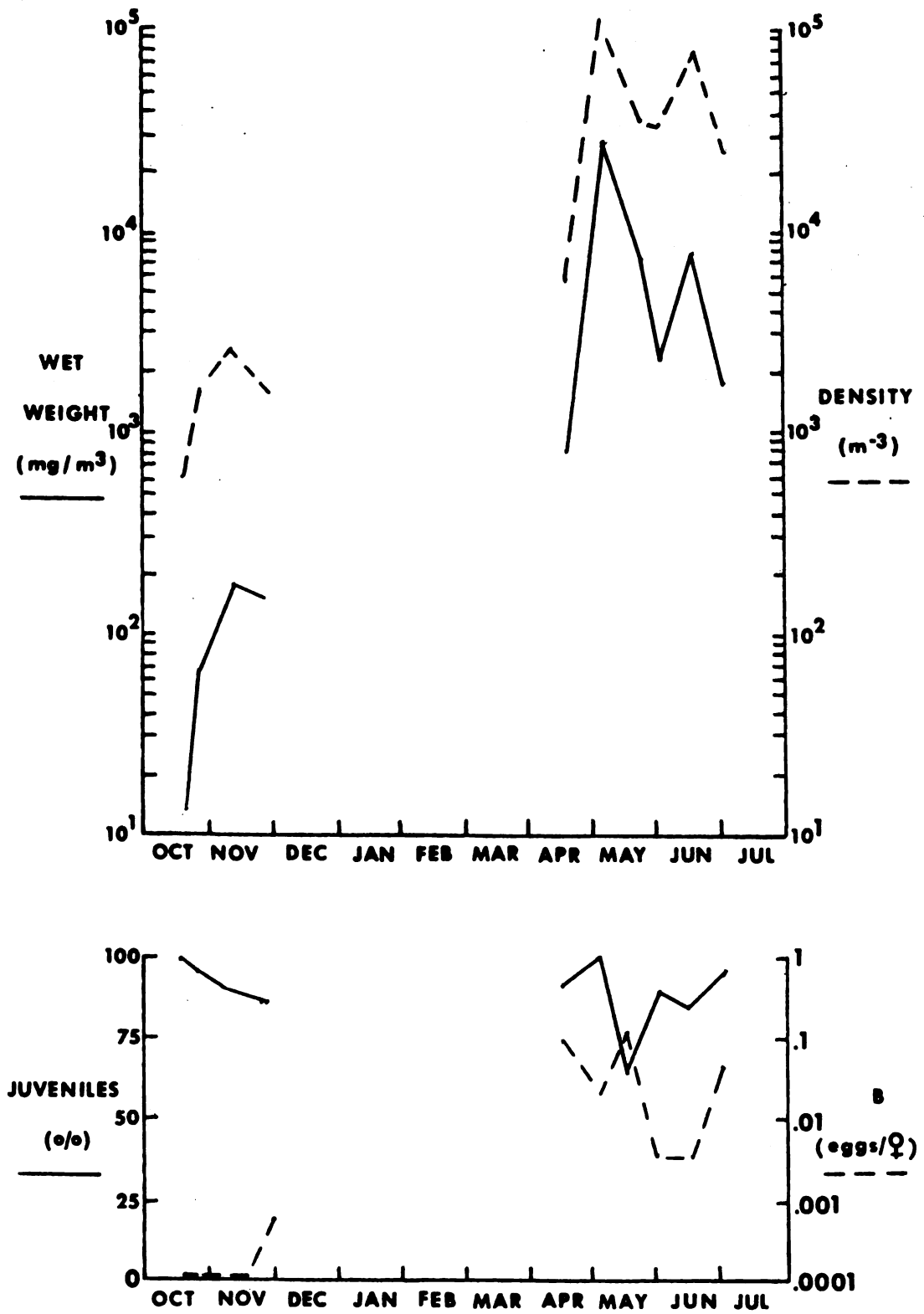


Figure 16. Daphnia spp. population parameters: Site E.

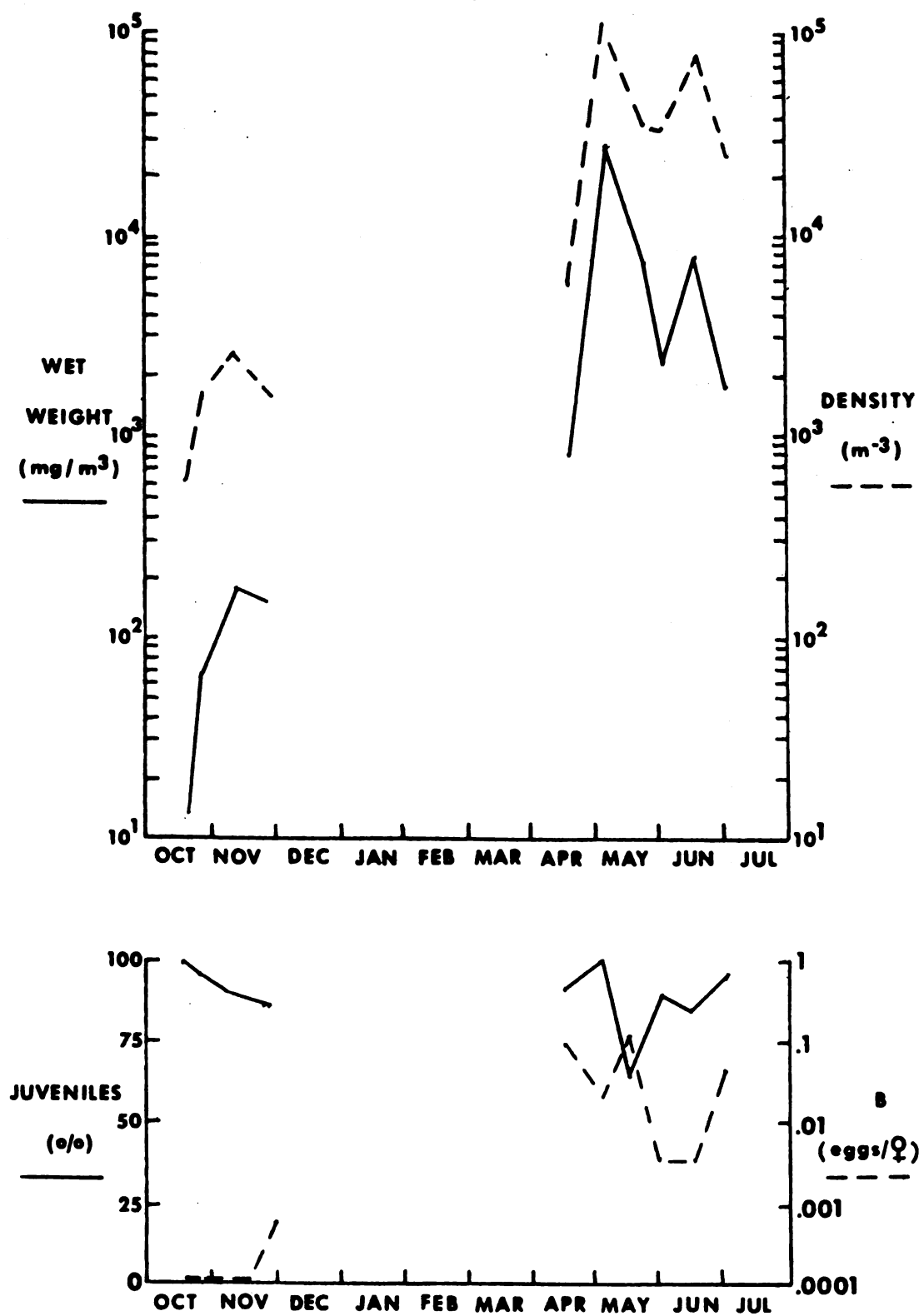


Figure 16. Daphnia spp. population parameters: Site E.

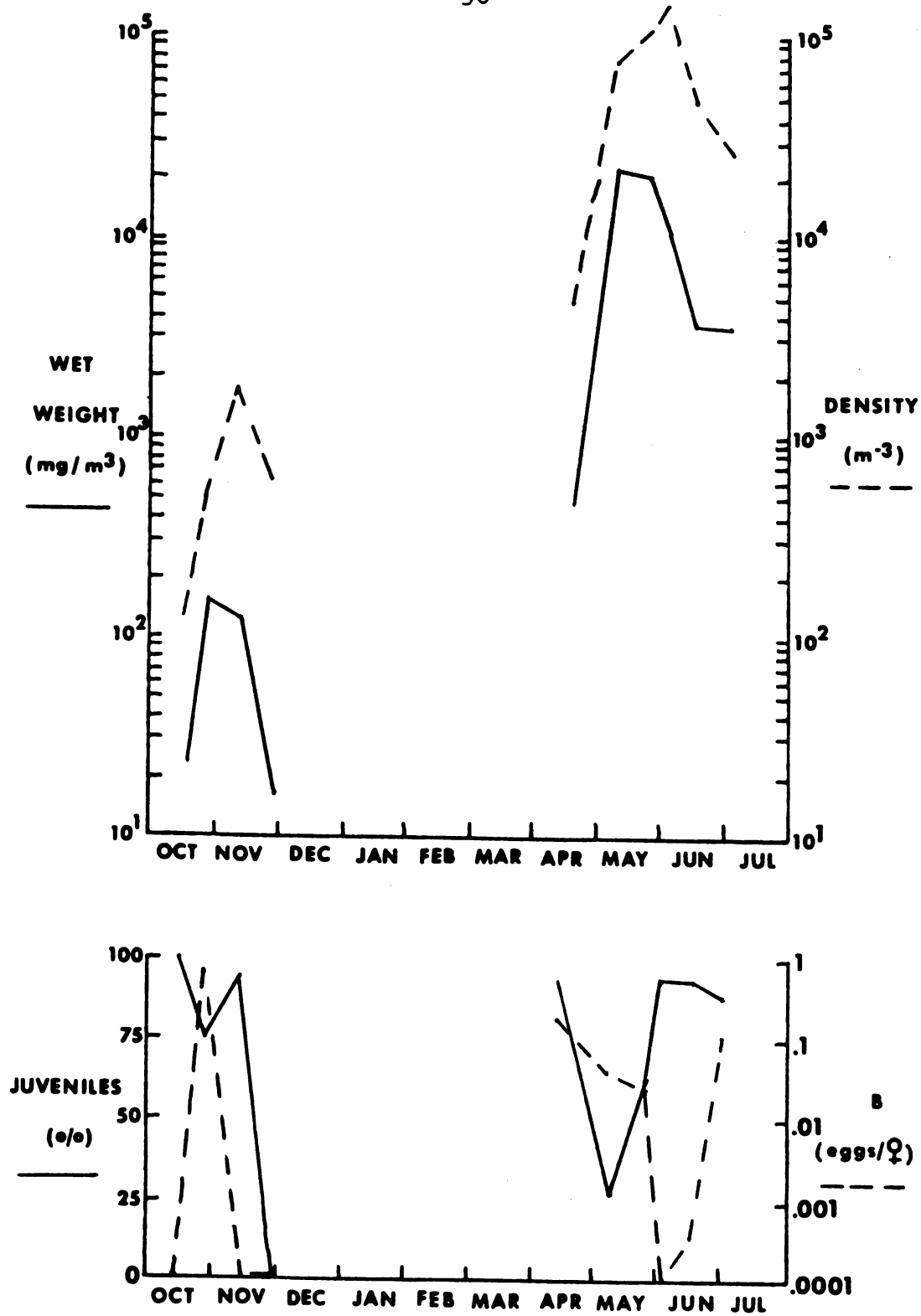


Figure 17. Daphnia spp. population parameters: Site F.

At both sites B values varied generally inversely to densities. Fluctuations of juvenile percentage at site E preceded fluctuations in densities. Fluctuations of juvenile percentage at F did not correlate with fluctuations of population parameters at the site.

D. pulex males were present in fall populations in Lake 3, comprising 10.5 to 16.7 percent of the population, but only one male was detected the following spring and summer.

D. pulex populations in Lake 4 at sites G and H increased in densities during the third week of November (Figures 18 & 19). Densities increased again in April and subsequently declined sharply during the first week of May. Densities fluctuated to two more maxima at site G and rose sharply to one maximum at site H. D. magna were not detected at either site.

At site G, B values and juvenile percentage fluctuated concurrently but did not correlate with density. B values and juvenile percentage at site H were not so closely correlated and neither one correlated closely to fluctuations in density.

D. pulex males comprised up to 33 percent of the population at site H in November and were present at both sites early next spring but had disappeared by the third week of May.

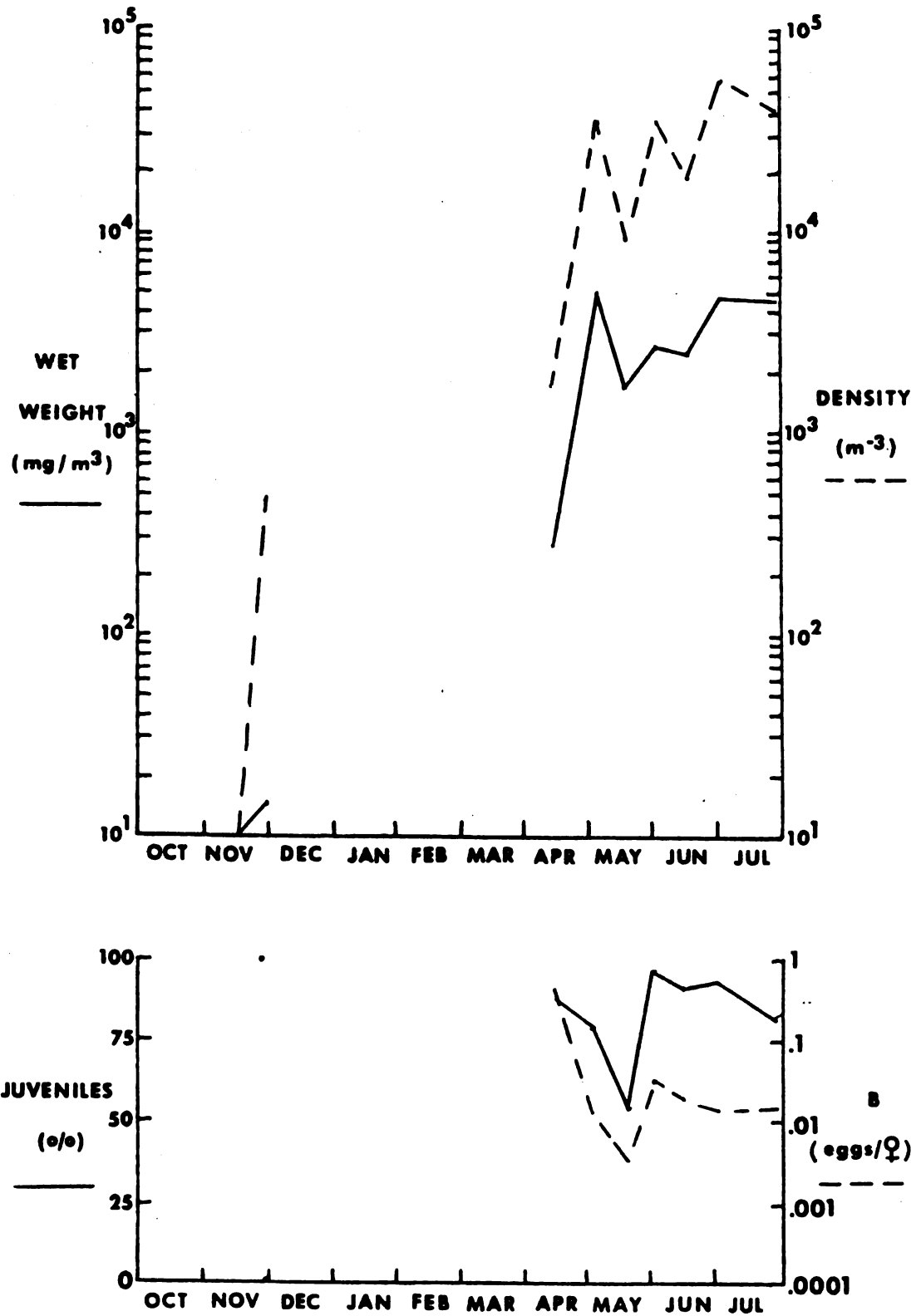


Figure 18. Daphnia spp. population parameters: Site G.

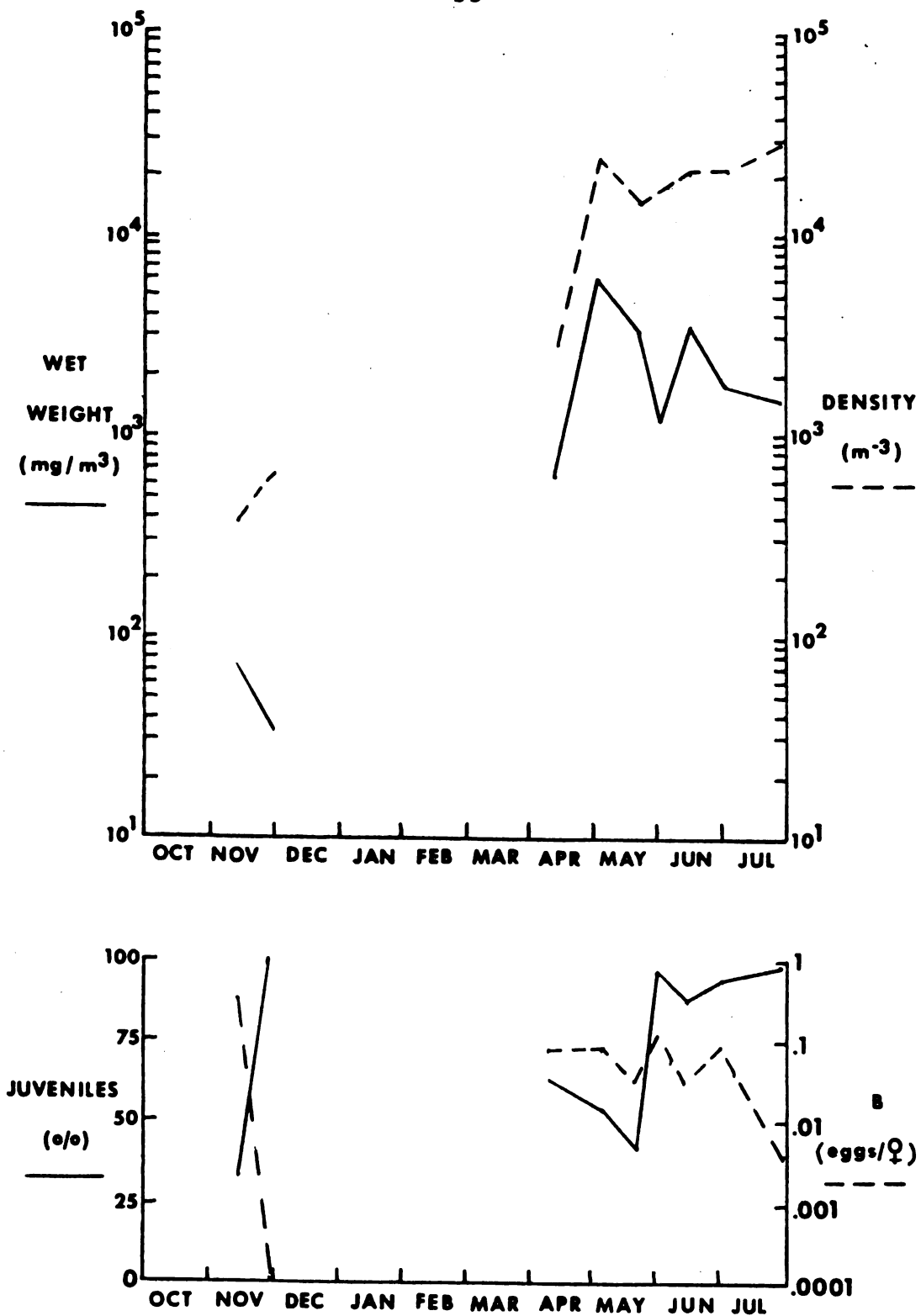


Figure 19. Daphnia spp. population parameters: Site H.

DISCUSSION

Sudden reduction in ammonia and subsequent declines in pH seen in all four lakes in spring could be associated with primary productivity. Peak primary productivity in early spring, characteristic of most freshwater bodies, creates a high pH. High pH will convert much of the inorganic nitrogen to ammonia, much of which is subsequently lost to the atmosphere as a gas. As a result of this large inorganic nitrogen loss in the four lakes, primary productivity may have become nitrogen-limited. Decreased photosynthesis results in decreased pH while oxygen production is drastically reduced.

Soluble phosphorous and inorganic carbon concentrations never fell below .13 mg/l-P and 15 mg/l-C and probably neither were limiting to photosynthesis.

Dissolved oxygen concentrations less than 8.0 mg/l cannot be ascribed to lowered solubility due to increased temperatures in these lakes. In temperature ranges encountered, dissolved oxygen saturation values exceed 8.0 mg/l at an elevation of 900 feet (Table 1). Oxygen is being depleted by some type of demand, probably respiratory.

In Lake 1, the lowest dissolved oxygen concentration for any of the four lakes, 3.8 mg/l, is recorded in the third

Table 1. Dissolved oxygen saturation in water at 900 ft.
elevation.

Table 1.

TEMPERATURE (°C)	100% SATURATION mg/l - D.O.
15	9.5
16	9.3
17	9.1
18	8.9
19	8.8
20	8.6
21	8.5
22	8.3

week of June. The concentration may have fallen even lower between May and June monitoring dates. In this case, appearance of pink-colored D. pulex at sites A and B in the first week of June coincides with low dissolved oxygen concentration. Some pond cladocerans produce increased amounts of erythrocrucorin when dissolved oxygen concentrations are low (Fennak, 1953) , giving the organisms a pinkish color. Apparently low dissolved oxygen concentration in Lake 1 initiated such a response in D. pulex.

Oxygen reduction may have caused the concurrent D. pulex population crash at site B. A similar crash occurred at site A but not until a month later. Two factors may have contributed to the difference in time between the two sites. Site A, situated in a more open area of Lake 1, may have experienced more mixing by wind and subsequently slower decline in oxygen. Site B is adjacent to the outlet channel



of Lake 1. The lake bottom slopes toward this relatively deep channel and gravity may have caused particulate organics to aggregate in the bottom of the channel. Site B, then, could have experienced greater oxygen loss due to increased biological oxygen demand in the nearby channel.

None of the other lakes experienced so severe an oxygen depletion nor the appearance of pink D. pulex.

At five other sites (C, D, F, G, and H), declines in D. pulex densities are preceded by lowering pH. Decreases in pH may be indicative of reduction in primary productivity and consequent decline in algal populations. Assuming algae to be a major component in the diet of D. pulex in these lakes, D. pulex densities would decline as their food disappeared. Such may be the case at these five sites. Likewise in Lake 1 this phytoplankton reduction may have interacted with low dissolved oxygen concentrations to cause the crashes in the D. pulex populations. Declination of population density at site E preceded pH declination.

Predation probably was not an important factor in reduction of cladoceran densities. Cyclopoid copepods, ubiquitous predators on rotifers and planktonic microcrustaceans, were never abundant in samples taken from the lakes. Larval Chaoborus spp., predators common in limnetic habitat, were detected in only a few samples. Failure to detect these two invertebrate predators in quantity, however, may have been due in part to sampling techniques. The horizontal sampler employed in this investigation creates

turbulence as it is lowered through water and cyclopoid copepods and larval Chaoborus spp., being faster swimmers than Daphnia spp., may have escaped capture.

Fish, particularly small ones, are important planktivores. Some fish species were probably introduced with the introduction of macrophytes in October, 1973. Mosquitofish, Gambusia affinis, were extremely abundant in the small original marsh 100 feet south of Lake 3 and could easily have been carried from the marsh to any one of the lakes on the feet and feathers of waterfowl. However, offspring of a few pioneer fish would not have been able to fill the lakes with significant populations in less than a year. Hence the impact of fish on the cladoceran populations is considered to be slight.

Fungal and/or other diseases may have contributed to high density losses observed in populations, but cladocerans were not examined for diseases.

Juvenile percentage B, and population density should have been more closely correlated within sites. According to Wright (1965) increased brood sizes would have predicated increased densities, a correlation detected clearly only at sites A and B. Hall (1964) reported that a high relatively constant proportion of juveniles is reflective of a population growing under relatively stable conditions. Such a high relatively constant proportion of juveniles was present at sites C, D, and E but in these cases population densities were fluctuating.

Colonization of the lakes by D. pulex was rapid. One possible source of this species was the original marsh. Plankton samples were taken from the marsh in June, 1973, when construction of the lakes was in its initial stages. The only planktonic microcrustacean was a single copepod nauplius. Abundance of planktivorous mosquitofish in the marsh undoubtedly kept water depleted of most large zooplankton. Mud samples from the marsh were cultured in laboratory and D. pulex were hatched, probably from ephippia observed earlier in mud samples.

A more probable source of large numbers of D. pulex was the several tons of aquatic plants introduced to the lakes in October. Subsamples of the plants were cultured in laboratory and D. pulex were produced in subsamples from three of the sites. The potentially large number of D. pulex included in several tons of wet macrophytes could easily account for the rapid colonization of Lakes 2, 3, and 4 in the autumn. Lake 1 was not planted with macrophytes and D. pulex did not appear there until the next spring.

Appearance of D. magna in Lakes 1 and 2 in July is interesting from the view point of their filtering rates. Burns (1969) determined that adult D. pulex filtering rate was slightly higher at 20°C than at either 15 or 25°C. In contrast, filtering rate of D. magna increased with increasing temperature and at 25°C was more than twice its rate at 15°C. This increased filtering capacity of D. magna at

higher temperatures would increase its capability of displacing D. pulex in summer.

In Ward and Whipple (1959) the appearance of males in normally parthenogenetic female populations is reported to be initiated by a shortage of food. In Pennak (1953) production of males is attributed to other factors:

1) crowding of females and a subsequent accumulation of waste products, and 2) decreasing water temperature.

D. pulex populations in the lakes had reached only low densities in autumn when significant numbers of males appeared. Consequently there could have been little metabolic waste product accumulation in the lakes. Food was probably plentiful to the sparse populations, especially in the form of suspended organic detritus which would have abounded in the newly-filled lakes. Falling water temperature, then, would best explain male production.

SUMMARY AND CONCLUSIONS

While the scope of this investigation was less extensive than originally planned due to complications beyond the control of this investigator, there were some results of interest: 1) Colonization of three of the lakes by D. pulex was rapid. The apparent sources of D. pulex were the introduced macrophytes. 2) D. pulex began to disappear as D. magna populations grew during the summer. 3) Predation was apparently not important in reducing cladoceran populations during the sampling period. 4) Appearance of D. pulex males in autumn was apparently initiated by falling water temperatures. 6) None of the four lakes were identical in fluctuations of physical and biological parameters.

This investigation proposed to correlate fluctuations in some population parameters of Daphnia spp. with changes in physical and chemical parameters. The lack of well-defined correlations between these parameters indicates the implausibility of correlating zooplankton response directly to physical and chemical variations. An investigator cannot concentrate on a single parameter or a narrow set of parameters to the exclusion of others. All parameters of both biological and physical nature must be considered in natural population studies.

The four lakes were similar in many respects. They shared the same geographical location, they were constructed at the same time, they were similar morphologically, and three were filled in the same month with the same type of water and were planted with aquatic macrophytes. In spite of these similarities, the lakes varied greatly in both physical and biological characteristics. This variation would reinforce the argument that results of limnological research in one situation should be extrapolated only with greatest caution to other situations.

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APPENDICES

APPENDIX A
CHEMICAL PARAMETERS

Table A1. Chemical parameters: Lake 1 - Top.

PARAMETER - UNITS

DATE COLLECTED

	1973					1974				
	23 Jan	6 Feb	12 Mar	18 Apr	6 May	20 May	17 Jun	8 Jul		
Alkalinity - mg/l CaCO ₃										
Calcium - mg/l Ca	144	174	97	116	122	150	172	187		
Carbon-Total - mg/l	80	63	43	42	43	43				
Carbon-Dissolved Organic - mg/l C	6	64	27		52	35				
Carbon-Total Organic - mg/l C	13	7	25		45	28				
Chloride - mg/l Cl		10	6		9	18				
Cadmium - mg/l Cd		105	107	105	105	100	106	111		
Chromium - mg/l Cr		<0.01	0.04	0.03	0.04	0.03				
Conductance - ohms/cm		<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2		
Copper - mg/l Cu		850	950	870	850	750	850	920		
Dissolved Oxygen - mg/l D.O.			0.20	0.20		0.25				
Fluoride - mg/l F			12.2	12.2	13.0	13.8	3.8	4.4		
Hardness - mg/l CaCO ₃			0.98	0.90	0.90	0.79	0.92	0.92		
Iron - mg/l Fe		214	214	213	216	208	272	236		
Lead - mg/l Pb		0.5	0.5	0.7	0.5	0.4	0.6	0.6		
Magnesium - mg/l Mg		<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3		
Manganese - mg/l Mn		2.3	2.1	1.9	1.8	1.7	1.9	2.0		
Nickel - mg/l Ni		0.05	<0.05	0.05	<0.05	0.05	0.06	0.05		
Nitrogen-Ammonia - mg/l N		<0.01	<0.01			<0.01	<0.02	<0.02		
Nitrogen-Nitrate - mg/l N	9.1	9.7	8.1	5.8	0.52	0.36	0.93	1.42		
Nitrogen-Nitrite - mg/l N	0.20	1.09	1.01	1.25		0.07	0.97	0.42		
Nitrogen-Total Kjeldahl - mg/l N	0.030	0.142	0.118	0.074		0.006	0.208	0.094		
pH	21.3	16.0	10.6	7.37	5.05	1.16				
Phosphorus-Total - mg/l P		8.50	8.75	9.0	9.30	9.70	7.80	7.65		
Phosphorus-Soluble - mg/l P	2.02	2.16	2.35	1.73	1.01	0.89	1.70	1.78		
Potassium - mg/l K	1.36	1.77	1.74	1.45	0.68	0.58	1.68	1.64		
Sodium - mg/l Na		12	6	7	8	8	7.1	7.4		
Sulfate - mg/l SO ₄		96	68	79	80	82	79	82		
Temperature - °C		50	54	75	76	81	77	78		
			1.0	3.0	13.5	16.5	2.0			

Table A2. Chemical parameters: Lake 1 - Bottom.

PARAMETER - UNITS

DATE COLLECTED

	1973					1974					
	23 Jan	6 Feb	12 Mar	18 Apr	6 May	20 May	17 Jun	8 Jul			
Alkalinity - mg/l CaCO ₃	192	216	111	118	123	150	173	195			
Calcium - mg/l Ca	71	73	43	43	42	39					
Carbon-Total - mg/l	72	76	45		56	51					
Carbon-Dissolved Organic - mg/l C											
Carbon-Total Organic - mg/l C											
Chloride - mg/l Cl	10	10	16		10	13					
Cadmium - mg/l Cd	140	147	114	106	106	99	107	128			
Chromium - mg/l Cr	<0.01	<0.01	0.04	<0.03	0.03	<0.03					
Conductance - ohms/cm	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2			
Copper - mg/l Cu	1320	1100	980	870	840	760	850	940			
Dissolved Oxygen - mg/l D.O.		0.46	0.20	0.20		0.25					
Fluoride - mg/l F	12.0	17.0	11.2	12.1	12.8	13.0					
Hardness - mg/l CaCO ₃	1.20	1.16	0.84	0.92	0.88	0.82	0.92	1.08			
Iron - mg/l Fe	313	296	220	216	208	208	286	227			
Lead - mg/l Pb	0.8	0.7	0.6	0.6	0.6	0.4	0.8	0.7			
Magnesium - mg/l Mg	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3			
Manganese - mg/l Mn	30	32	20	19	18	17	19	19			
Nickel - mg/l Ni	0.10	0.10	<0.05	0.05	0.05	0.05	0.05	0.06			
Nitrogen-Ammonia - mg/l N	<0.1	<0.1	<0.1								
Nitrogen-Nitrate - mg/l N	9.3	8.9	8.4	5.2	0.54	0.41	0.96	1.73			
Nitrogen-Nitrite - mg/l N	1.01	1.23	1.16	1.21		0.06	0.97	0.44			
Nitrogen-Total Kjeldahl - mg/l N	0.280	0.310	0.334	0.074		0.006	0.208	0.096			
pH	13.1	12.7	11.0	7.54	6.24	2.30					
Phosphorus-Total - mg/l P	7.40	8.30	8.70	9.10	9.30	9.70	7.60	7.65			
Phosphorus-Soluble - mg/l P	3.00	3.23	2.42	1.47	0.97	0.86	1.76	1.84			
Potassium - mg/l K	2.33	2.66	1.90	1.38	0.63	0.55	1.73	1.72			
Sodium - mg/l Na	10	11	14	8	8	8	7.0	7.5			
Sulfate - mg/l SO ₄	111	76	86	80	79	78	81	81			
Temperature - °C	100	105	76	74	75	79	73	70			
	4.0	4.0	3.0	10	13	16		2.0			

Table A3. Chemical parameters: Lake 2 - Top.

PARAMETER - UNITS

DATE COLLECTED

	1973					1974								
						23 Jan	6 Feb	12 Mar	18 Apr	6 May	20 May	17 Jun	8 Jul	
Alkalinity - mg/l CaCO ₃		168.		95.	232.	94.	94.	111.	140.	175.	186.			
Calcium - mg/l Ca		69.		70.	30.	37.	39.	40.	43.					
Carbon-Total - mg/l	32.	69.		63.	35.	26.								
Carbon-Dissolved Organic - mg/l C	8.	7.			0									
Carbon-Total Organic - mg/l C	9.	11.		8.	4.	9.			10.					
Chloride - mg/l Cl		96.		129.	59.	98.	84.	87.	95.	100.				
Cadmium - mg/l Cd		<0.01		<0.01	<0.01	0.03	<0.03	<0.03	<0.03					
Chromium - mg/l Cr		<0.1		<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2		
Conductance - ohms/cm		730.		1260.	550.	860.	910.	870.	790.	790.	890.			
Copper - mg/l Cu					0.12	0.20	0.20	0.20	0.20					
Dissolved Oxygen - mg/l D.O.				17.2	13.5	13.3	16.0	10.3	7.4	10.6	8.5			
Fluoride - mg/l F				1.16	0.36	0.80	0.86	0.82	0.83	0.79	0.92			
Hardness - mg/l CaCO ₃		307.		300.	123.	195.	209.	202.	193.	273.	234.			
Iron - mg/l Fe		0.6		0.3	0.4	0.6	1.2	0.8	0.9	1.0	1.1			
Lead - mg/l Pb		<0.3		<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3			
Magnesium - mg/l Mg		34.		13.	32.	18.	17.	15.	17.	18.				
Manganese - mg/l Mn		0.07		0.05	0.03	<0.05	<0.05	0.05	0.05	0.05	<0.05			
Nickel - mg/l Ni		<0.1		<0.1	<0.1	<0.1								
Nitrogen-Ammonia - mg/l N	6.0	8.6		8.7	9.2	9.7	5.7	1.48	1.16	0.26	0.31			
Nitrogen-Nitrate - mg/l N	0.06	1.03		0.61	5.82	1.16	1.15		0.09	0.32	0.32			
Nitrogen-Nitrite - mg/l N	0.32	112.		124	126	0.66	0.70		0.34	0.90	0.680			
Nitrogen-Total Kjeldahl - mg/l N	12.0	15.0		12.3	14.3	8.45	5.13	7.83	3.30					
pH		8.20			7.95	9.30	9.50	8.90	8.60	8.75	8.20			
Phosphorus-Total - mg/l P	2.19	2.31		2.60	1.45	1.77	1.37	0.78	0.69	0.72	0.70			
Phosphorus-Soluble - mg/l P	1.76	2.04		2.49	1.02	1.45	1.26	0.66	0.60	0.60	0.69			
Potassium - mg/l K		10.		9.	5.	6.	7.	7.	7.	5.9	6.4			
Sodium - mg/l Na		93.		105.	49.	77.	75.	73.	68.	79.	76.			
Sulfate - mg/l SO ₄		62.		94.	38.	75.	75.	74.	72.	76.	74.			
Temperature - °C					0.0	1.5	11.	13.5	16.5	18.				

Table A4. Chemical parameters: Lake 2 - Bottom.

PARAMETER - UNITS

DATE COLLECTED

	1973					1974					
	23 Jan	6 Feb	12 Mar	18 Apr	6 May	20 May	17 Jun	8 Jul			
Alkalinity - mg/l CaCO ₃	158.	236.	92.	110.	113.	140.	175.	186.			
Calcium - mg/l Ca	68.	60.	36.	40.	38.	39.					
Carbon-Total - mg/l	65.	64.	24.		45.	52.					
Carbon-Dissolved Organic - mg/l C											
Carbon-Total Organic - mg/l C											
Chloride - mg/l Cl	7.	7.	9.		9.	11.					
Cadmium - mg/l Cd		123.	108.	84.	83.	87.	95.	78.			
Chromium - mg/l Cr	<0.01	<0.01	0.04	<0.03	0.03	<0.03					
Conductance - ohms/cm	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2			
Copper - mg/l Cu	1260.	1100.	895.	915.	865.	780.	785.	890.			
Dissolved Oxygen - mg/l D.O.		0.13	0.20	0.20		0.20					
Fluoride - mg/l F	17.2	10.5	12.9	15.4	8.9	6.0					
Hardness - mg/l CaCO ₃	1.16	1.16	0.78	0.88	0.80	0.63	0.74	1.01			
Iron - mg/l Fe	300.	247.	196.	210.	197.	183.	272.	227.			
Lead - mg/l Pb	1.0	1.5	0.6	1.6	0.9	2.3	1.0	1.2			
Magnesium - mg/l Mg	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3			
Manganese - mg/l Mn	13.	33.	18.	17.	17.	15.	18.	18.			
Nickel - mg/l Ni	0.09	0.09	<0.05	<0.05	0.05	0.05	<0.05	0.05			
Nitrogen-Ammonia - mg/l N	<0.1	<0.1	<0.1			<0.1	<0.2	<0.2			
Nitrogen-Nitrate - mg/l N	8.7	10.6	9.4	5.3	1.36	1.03	0.62	0.67			
Nitrogen-Nitrite - mg/l N	0.61	10.9	1.28	1.19		0.08	0.39	0.39			
Nitrogen-Total Kjeldahl - mg/l N	.124	.182	.064	.060		.035	.104	.084			
pH	12.3	15.4	7.88	6.04		5.20					
Phosphorus-Total - mg/l P		7.95	9.00	9.40	7.90	8.65	8.65	8.10			
Phosphorus-Soluble - mg/l P	3.15	2.55	1.63	1.34	0.77	0.93	0.84	0.72			
Potassium - mg/l K	2.62	2.19	1.28	1.17	0.66	0.57	0.72	0.66			
Sodium - mg/l Na	10.	9.	17.	6.	6.	7.	6.0	6.4			
Sulfate - mg/l SO ₄	108.	95.	81.	78.	74.	68.	79.	75.			
Temperature - °C	104.	79.	70.	75.	73.	74.	74.	93.			
		4.0	2.0	10.0	13.0	16.0					

Table A5. Chemical parameters: Lake 3 - Top.

PARAMETER - UNITS

DATE COLLECTED

	1973				1974							
	23 Jan	6 Feb	12 Mar	18 Apr	6 May	20 May	17 Jun	8 Jul				
Alkalinity - mg/l CaCO ₃	97.	108.	85.	104.	110.	117.	142.	154.				
Calcium - mg/l Ca	68.	37.	36.	39.	35.	34.						
Carbon-Total - mg/l	60.	37.	24.		40.	39.						
Carbon-Dissolved Organic - mg/l C	7.											
Carbon-Total Organic - mg/l C	11.	6.	12.		10.	12.						
Chloride - mg/l Cl	95.	79.	99.	82.	80.	87.	94.	101.				
Cadmium - mg/l Cd	<0.01	<0.01	<0.03	<0.03	<0.03	<0.03						
Chromium - mg/l Cr	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2				
Conductance - ohms/cm	690.	710.	820.	840.	730.	705.	765.	840.				
Copper - mg/l Cu		0.11	0.15	0.15		0.15						
Dissolved Oxygen - mg/l D.O.		17.1	13.6	13.6	13.2	12.4	7.5	7.1				
Fluoride - mg/l F		1.12	0.56	0.76	0.79	0.74	0.71	0.86				
Hardness - mg/l CaCO ₃	256.	200.	184.	207.	198.	182.	241.	205.				
Iron - mg/l Fe	0.3	0.4	0.7	1.7	0.7	1.8	1.3	1.3				
Lead - mg/l Pb	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3				
Magnesium - mg/l Mg	32.	24.	18.	16.	15.	14.	16	16				
Manganese - mg/l Mn	<0.03	<0.03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05				
Nickel - mg/l Ni	<0.1	<0.1	<0.1									
Nitrogen-Ammonia - mg/l N	6.0	6.7	6.8	4.9	0.58	0.27	0.44	0.67				
Nitrogen-Nitrate - mg/l N	0.10	0.72	1.37	1.03		0.78	1.37	0.77				
Nitrogen-Nitrite - mg/l N	0.020	0.108	0.76	0.76								
Nitrogen-Total Kjeldahl - mg/l N	14.8	10.1	4.90	6.61	8.63	4.50	114	0.36				
pH	8.6		9.30	9.40	9.40	9.30						
Phosphorus-Total - mg/l P	2.48	1.72	1.37	1.01	0.82	0.66	0.55	1.18				
Phosphorus-Soluble - mg/l P	2.10	1.47	1.20	0.86	0.64	0.51	0.52	0.80				
Potassium - mg/l K		9.	8.	5.	6.	7.	5.8	6.2				
Sodium - mg/l Na	102.	108.	77.	78.	73.	63.	79.	65.				
Sulfate - mg/l SO ₄	65.	61.	73.	74.	75.	78.	70.	70.				
Temperature - °C		1.0	1.0	10.	13.	16.	18.					

Table A6. Chemical parameters: Lake 3 - Bottom.

PARAMETER - UNITS	DATE COLLECTED											
	1973						1974					
	23 Jan	6 Feb	12 Mar	18 Apr	6 May	20 May	17 Jun	8 Jul				
Alkalinity - mg/1 CaCO ₃	164.	221.	88.	106.	110.	117.	142.	157.				
Calcium - mg/1 Ca	66.	58.	35.	39.	37.	37.						
Carbon-Total - mg/1	63.	56.	25.		42.	40.						
Carbon-Dissolved Organic - mg/1 C												
Carbon-Total Organic - mg/1 C	8.	7.	10.		8.	13.						
Chloride - mg/1 Cl	150.	123.	95.	82.	79.	87.	94.	103.				
Cadmium - mg/1 Cd	<0.01	<0.01	<0.03	<0.03	<0.03	<0.03						
Chromium - mg/1 Cr	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2				
Conductance - ohms/cm	1220.	1040.	810.	830.	735.	700.	770.	840.				
Copper - mg/1 Cu		0.39	0.10	0.15		0.15						
Dissolved Oxygen - mg/1 D.O.	16.3	11.5	13.6	13.6	13.6	12.4						
Fluoride - mg/1 F	1.18	0.89	0.76	0.80	0.72	0.73	0.70	0.92				
Hardness - mg/1 CaCO ₃	274.	238.	183.	207.	199.	186.	239.	198.				
Iron - mg/1 Fe	0.3	0.8	1.0	1.7	0.7	1.8	1.2	1.4				
Lead - mg/1 Pb	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3				
Magnesium - mg/1 Mg	27.	31.	19.	16.	15.	14.	16.	16.				
Manganese - mg/1 Mn	0.03	<0.03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05				
Nickel - mg/1 Ni	<0.1	<0.1	<0.1									
Nitrogen-Ammonia - mg/1 N	7.9	6.3	7.3	5.0	0.64	0.36	0.43	0.34				
Nitrogen-Nitrate - mg/1 N	0.50	1.72	1.41	1.07		0.82	1.37	0.72				
Nitrogen-Nitrite - mg/1 N	122.	102.	0.92	0.80								
Nitrogen-Total Kjeldahl - mg/1 N	11.2	11.0	5.45	5.21	9.32	4.27						
pH		8.80	9.30	9.40	9.30	9.25	7.35	8.35				
Phosphorus-Total - mg/1 P	2.25	3.35	1.47	0.87	0.78	0.73	0.55	0.82				
Phosphorus-Soluble - mg/1 P	1.70	2.32	1.02	0.86	0.63	0.53	0.51	0.77				
Potassium - mg/1 K	9.	8.	6.	6.	6.	6.	5.9	6.2				
Sodium - mg/1 Na	107.	91.	73.	78.	73.	64.	79.	66.				
Sulfate - mg/1 SO ₄	99.	87.	77.	75.	74.	77.	76.	92.				
Temperature - °C		4.0	2.0	10.0	13.5	11.0						

Table A7. Chemical parameters: Lake 4 - Top.

PARAMETER - UNITS	DATE COLLECTED									
	1973					1974				
	23 Jan	6 Feb	12 Mar	18 Apr	6 May	20 May	17 Jun	8 Jul		
Alkalinity - mg/l CaCO ₃	94.	40.	77.	101.	105.	101.	118.	135.		
Calcium - mg/l Ca	35.	22.	34.	35.	35.	35.				
Carbon-Total - mg/l	35.	18.	17.		33.	32.				
Carbon-Dissolved Organic - mg/l C	6.									
Carbon-Total Organic - mg/l C	20.	3.	5.		7.	8.				
Chloride - mg/l Cl	69.	48.	83.	79.	78.	76.	84.	91.		
Cadmium - mg/l Cd	<0.01	<0.01	<0.03	<0.03	<0.03	<0.03				
Chromium - mg/l Cr	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2		
Conductance - ohms/cm	630	400	685	710	660	610	680	750		
Copper - mg/l Cu		0.75	0.10	0.10	0.10	0.10				
Dissolved Oxygen - mg/l D.O.		20.0	12.9	11.9	10.9	10.4	9.5	6.1		
Fluoride - mg/l F		0.36	0.60	0.72	0.62	0.65	0.60	0.74		
Hardness - mg/l CaCO ₃	155.	99.	162.	205.	183.	167.	232.	182.		
Iron - mg/l Fe	0.3	0.4	0.8	1.5	0.6	1.4	1.0	0.9		
Lead - mg/l Pb	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3		
Magnesium - mg/l Mg	13.	4.	16.	14.	12.	12.	13.	15.		
Manganese - mg/l Mn	<0.03	<0.03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		
Nickel - mg/l Ni	<0.1	<0.1	<0.1	<0.1			<0.2	<0.2		
Nitrogen-Ammonia - mg/l N	8.3	6.4	6.8	5.3	0.83	0.63	0.10	0.18		
Nitrogen-Nitrate - mg/l N	0.10	0.89	0.94	0.90		0.93	1.25	0.46		
Nitrogen-Nitrite - mg/l N	0.020	0.42	0.62	0.62				0.32		
Nitrogen-Total Kjeldahl - mg/l N	11.7	14.2	9.10	4.54	8.60	7.85	8.3	8.2		
pH		8.5	9.10	9.30	8.07	7.00				
Phosphorus-Total - mg/l P	1.00	0.90	0.84	0.44	0.29	0.22	0.58	0.33		
Phosphorus-Soluble - mg/l P	0.77	0.49	0.34	0.37	0.25	0.14	0.34	0.26		
Potassium - mg/l K		6.	3.	4.	4.	5.	4.5	5.8		
Sodium - mg/l Na	70.	16.	61.	63.	60.	54	65.	62.		
Sulfate - mg/l SO ₄	47.	25.	72.	72.	72.	73.	68.	79.		
Temperature - °C		1.5	3.0	10.	13.5	16.	19.			

Table A8. Chemical parameters: Lake 4 - Bottom.

PARAMETER - UNITS

DATE COLLECTED

	1973					1974				
	23 Jan	6 Feb	12 Mar	18 Apr	6 May	20 May	17 Jun	8 Jul		
Alkalinity - mg/l CaCO ₃	154.	156.	94.	99.	105.	100.	121.	131.		
Calcium - mg/l Ca	28.	51.	38.	36.	36.	35.				
Carbon-Total - mg/l	43.	44.	23.		38.	33.				
Carbon-Dissolved Organic - mg/l C										
Carbon-Total Organic - mg/l C	8.	7.	6.		8.	8.				
Chloride - mg/l Cl	122.	109.	92.	79.	77.	76.	83.	89.		
Cadmium - mg/l Cd	<0.01	<0.01	<0.01	<0.03	<0.03	<0.03				
Chromium - mg/l Cr	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.2	<0.2		
Conductance - ohms/cm	980.	860.	720.	715.	640.	610.	860.	750.		
Copper - mg/l Cu		0.90	0.10	0.10		0.10				
Dissolved Oxygen - mg/l D.O.	17.5	17.0	12.3	11.2	11.0	10.2				
Fluoride - mg/l F		0.78	0.60	0.70	0.60	0.64	0.60	0.71		
Hardness - mg/l CaCO ₃	231.	211.	163.	206.	187.	170.	231.	189.		
Iron - mg/l Fe	0.3	0.4	0.9	1.6	0.5	1.3	1.1	1.2		
Lead - mg/l Pb	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3	<0.3		
Magnesium - mg/l Mg	20.	15.	17.	14.	13.	12.	13.	15.		
Manganese - mg/l Mn	<0.03	<0.03	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05		
Nickel - mg/l Ni	<0.1	<0.1	<0.1			<0.1	<0.2	<0.2		
Nitrogen-Ammonia - mg/l N	4.7.	5.4	6.7	5.5	0.84	0.57	0.22	0.67		
Nitrogen-Nitrate - mg/l N	0.50	0.80	0.86	0.89		0.83	1.25	0.39		
Nitrogen-Nitrite - mg/l N	.084	.054	.092	.060		.070	.066	.036		
Nitrogen-Total Kjeldahl - mg/l N	7.6	6.3	4.54	4.04	4.03	2.50				
pH	8.60	8.95	9.40	9.30	8.40	8.05	8.30	8.10		
Phosphorus-Total - mg/l P	1.27	0.73	0.67	0.49	0.29	0.25	0.23	0.31		
Phosphorus-Soluble - mg/l P	0.80	0.41	0.30	0.39	0.27	0.12	0.21	0.28		
Potassium - mg/l K	7.	6.	11.	5.	5.	5.	4.5	5.7		
Sodium - mg/l Na	60.	79.	61.	64.	62.	57.	65.	62.		
Sulfate - mg/l SO ₄	76.	80.	72.	73.	73.	73.	66.	81.		
Temperature - °C	3.5	4.0	3.0	9.5	13.0	16.0				

APPENDIX B

DAPHNIA SPP.

POPULATION PARAMETERS

Table B1. Daphnia spp. population parameters: Site A

	#/m ³	Wet Wt. (mg/m ³)	Mean Length	Standard Deviation	Males (%)	B	Juveniles (%)
11 Oct 73	-----						
18 Oct 73	-----						
25 Oct 73	-----						
15 Nov 73*	(Lake filled) 0						
30 Nov 73*	0						
11 Apr 74*	0						
04 May 74*	4,000*	221.75	0.83	0.32	0	.032	97
21 May 74*	29,438*	10,228.35	1.66	0.68	0	.262	48.5
01 Jun 74*	31,375*	6,097.40	1.30	0.57	0	.086	63
14 Jun 74*	32,563*	5,940.00	1.54	0.22	0.04	.019	40
02 Jul 74**	22,063**	3,247.26	1.30	0.36	0	.039	91
27 Jul 74***	12,188***	4,566.52	1.68	0.68	0	.017	83.5

*100% D. pulex**91% D. pulex, 9% D. magna***4% D. pulex, 96% D. magna

Table B2. Daphnia spp. population parameters: Site B

	#/m ³	Wet Wt. (mg/m ³)	Mean Length	Standard Deviation	Males (%)	B	Juveniles (%)
11 Oct 73	-----						
18 Oct 73	-----						
25 Oct 73	-----						
15 Nov 73	0						
30 Nov 73	0						
11 Apr 74	0						
04 May 74	2,500*	323.75	1.18	.46	0	.142	75
21 May 74	58,458*	8,310.48	1.16	.48	0	.033	76.5
01 Jun 74	38,938*	3,894.84	1.06	.42	0	.011	90
14 Jun 74	7,188*	1,584.25	1.58	.23	0	.091	40.5
02 Jul 74	55,750**	14,183.76	1.57	.43	0	.011	61.5
27 Jul 74	41,125***	26,135.90	2.22	.44	0	.015	78

* 100% D. pulex** 93% D. pulex, 7% D. magna*** 4% D. pulex, 96% D. magna

Table B3. Daphnia spp. population parameters: Site C.

	#/m ³	Wet Wt. (mg/m ³)	Mean Length	Standard Deviation	Males (%)	B	Juveniles (%)
11 Oct 73	0	0	0	0	0	0	0
18 Oct 73	250*	2.50	0.55	.05	0	0	100
25 Oct 73	1,375*	51.25	0.73	.26	18	0	100
15 Nov 73	2,875*	453.75	1.19	.55	21.7	0	83
30 Nov 73	1,500*	390.00	1.49	.60	25	.006	42
11 Apr 74	625*	562.50	2.52	.40	0	1.550	0
04 May 74	30,625*	7,330.00	1.44	.59	0	.131	59
21 May 74	15,438*	3,996.55	1.58	.43	0	.090	39
01 Jun 74	7,938*	1,038.50	1.23	.38	0	.025	79
14 Jun 74	18,500*	1,842.62	1.06	.31	0	.004	88.5
02 Jul 74	66,000*	5,959.83	1.12	.32	0	.005	91.5
27 Jul 74 (Lake drained)	26,875**	1,354.05	0.93	.24	0	0	98

* 100% D. pulex** 98% D. pulex, 2% D. magna

Table B4. Daphnia spp. population parameters: Site D.

	#/m ³	Wet Wt. (mg/m ³)	Mean Length	Standard Deviation	Males (%)	B	Juveniles (%)
11 Oct 73	0	0	0	0	0	0	0
18 Oct 73	0	0	0	0	0	0	0
25 Oct 73	3,000	2,176.25	1.70	1.16	8.3	.266	58
15 Nov 73	4,000	926.25	1.35	.60	15.6	0	69
30 Nov 73	1,375	341.25	1.45	.65	36.4	.007	55
11 Apr 74	875	670.00	2.36	.51	0	1.268	0
04 May 74	65,625	23,520.00	1.74	.55	0	.037	36
21 May 74	9,563	2,836.25	1.64	.53	0	.236	37
01 Jun 74	8,375	989.38	1.23	.30	0	.008	81
14 Jun 74	58,188	7,420.13	1.17	.38	0	.002	80
02 Jul 74	71,500	9,381.71	1.22	.38	0	.013	85.5
27 Jul 74 (Lake drained)	20,250	762.07	.85	.18	0	0	99

Table B5. Daphnia pulex population parameters: Site E.

	#/m ³	Wet Wt. (mg/m ³)	Mean Length	Standard Deviation	Males (%)	B	Juveniles (%)
11 Oct 73	-----						
(Lake filled)							
18 Oct 73	625	13.75	.68	.18	0	0	100
25 Oct 73	1,500	68.75	.83	.31	16.7	0	92
15 Nov 73	2,375	191.25	1.02	.37	10.5	0	89
30 Nov 73	1,500	140.00	.99	.47	16.7	.006	83
11 Apr 74	6,625	746.25	.98	.53	0	.091	89
04 May 74	101,000	28,593.54	1.68	.38	0	.018	100
21 May 74	38,375	7,213.46	1.28	.58	.05	.104	65.5
01 Jun 74	35,063	2,271.61	1.01	.32	0	.003	89.5
14 Jun 74	77,625	7,404.38	1.07	.40	0	.003	85
02 Jul 74	24,188	1,742.40	.94	.36	0	.043	93.5
(Lake drained)							
27 Jul 74	-----						

Table B6. Daphnia pulex population parameters: Site F.

	#/m ³	Wet Wt. (mg/m ³)	Mean Length	Standard Deviation	Males (%)	B	Juveniles (%)
11 Oct 73	-----						
(Lake filled)							
18 Oct 73	125	22.50	1.50	---	0	0	100
25 Oct 73	500	148.75	1.18	1.18	0	.711	75
15 Nov 73	1,875	112.50	.95	.32	13.3	0	93
30 Nov 73	625	15.00	.74	.11	0	0	0
11 Apr 74	4,625	498.75	.92	.54	0	.150	92
04 May 74	76,375	22,958.02	1.69	.38	0	.036	27
21 May 74	108,063	21,526.30	1.37	.53	0	.022	67.5
01 Jun 74	140,438	10,352.91	1.02	.33	0	0	93.5
14 Jun 74	48,813	3,572.06	1.04	.36	0	.003	91.5
02 Jul 74	27,500	3,265.11	1.10	.48	0	.105	86.5
(Lake drained)							
27 Jul 74	-----						

Table B7. Daphnia pulex population parameters: Site G.

	#/m ³	Wet Wt. (mg/m ³)	Mean Length	Standard Deviation	Males (%)	B	Juveniles (%)
11 Oct 73	----						
18 Oct 73	----						
25 Oct 73	----						
15 Nov 73	0	0	0	0	0	0	0
30 Nov 73	500	13.75	.78	.18	0	0	100
11 Apr 74	1,875	300.00	1.12	.66	6.7	.334	87
04 May 74	38,500	5,074.23	1.19	.46	0	.014	78
21 May 74	9,250	1,796.50	1.46	.35	0	.004	53
01 Jun 74	38,813	2,495.78	.85	.32	0	.042	96.5
14 Jun 74	19,438	2,312.78	1.18	.45	0	.020	90
02 Jul 74	54,125	4,733.72	1.04	.36	0	.015	92
27 Jul 74	40,813	4,642.71	1.09	.46	0	.016	81.5

Table B8. Daphnia pulex population parameters: Site H.

	#/m ³	Wet Wt. (mg/m ³)	Mean Length	Standard Deviation	Males (%)	B	Juveniles (%)
11 Oct 73	-----						
18 Oct 73	-----						
25 Oct 73	-----						
15 Nov 73	375	72.50	1.50	.36	33	.352	33.3
30 Nov 73	625	31.25	.84	.38	20	0	100
11 Apr 74	2,750	615.00	1.24	.74	9.1	.071	68
04 May 74	25,875	6,000.00	1.45	.56	1.9	.073	54
21 May 74	14,188	3,182.56	1.56	.34	0	.031	39.5
01 Jun 74	18,938	1,156.88	.87	.39	0	.111	94.5
14 Jun 74	21,125	3,146.18	1.23	.47	0	.033	86
02 Jul 74	22,188	1,794.10	1.04	.34	0	.095	93
27 Jul 74	28,625	1,368.55	.91	.22	0	.004	98

(Lake filled)

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