



Ten Years of Data for Four Cyprinid Species in Lake 114, an Experimentally Acidified Lake in the Experimental Lakes Area, Northwestern Ontario

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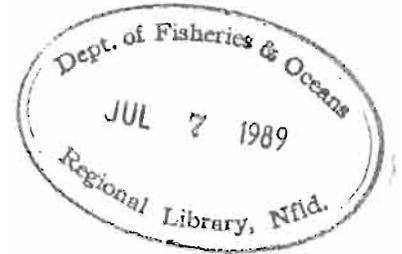
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TEN YEARS OF DATA FOR FOUR CYPRINID SPECIES IN
LAKE 114, AN EXPERIMENTALLY ACIDIFIED LAKE IN THE
EXPERIMENTAL LAKES AREA, NORTHWESTERN ONTARIO

by

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ABSTRACT

Chalanchuk, S.M., L.C. Mohr, and D.J. Allan. 1988. Ten years of data for four cyprinid species in Lake 114, an experimentally acidified lake in the experimental lakes area, northwestern Ontario. Can. Data Rep. Fish. Aquat. Sci. 733: iv + 23 p.

Length-frequency distributions and catch data are presented for four species of Cyprinidae in Lake 114, in the Experimental Lakes Area, northwestern Ontario: fathead minnow (Pimephales promelas), pearl dace (Semotilus margarita), northern redbelly dace (Phoxinus eos), and finescale dace (Phoxinus neogaeus). Lake 114 received monthly additions of sulphuric acid (H_2SO_4) from July 1979 until October 1986. Data presented in this report are from 1978 and 1980 to 1988. Maximum fork lengths attained by each species were 133 mm by pearl dace, 89 mm by fathead minnow, 85 mm by northern redbelly dace, and 97 mm by finescale dace. These lengths are compared to those of other North American populations.

Key words: Pearl dace; fathead minnow; finescale dace; northern redbelly dace; fork length; pH; acidification.

RÉSUMÉ

Chalanchuk, S.M., L.C. Mohr, and D.J. Allan. 1988. Ten years of data for four cyprinid species in Lake 114, an experimentally acidified lake in the experimental lakes area, northwestern Ontario. Can. Data Rep. Fish. Aquat. Sci. 733: iv + 23 p.

On présente les distributions de fréquence de longueurs et les données sur les prises pour quatre espèces de cyprinidés provenant du Lac 114 de la Région des Lacs Expérimentaux du nord-ouest de l'Ontario: le tête-de-boule (Pimephales promelas), le mulot perlé (Semolitus margarita), le ventre rouge du nord (Phoxinus eos) et le ventre citron (Phoxinus neogaeus). Le Lac 114 a fait l'objet d'additions mensuelles d'acide sulfurique (H_2SO_4) de juillet 1979 à octobre 1986. Dans le présent rapport on présente des données pour 1978 et pour 1980 à 1988. Les longueurs à la fourche maximales enregistrées pour chacune des espèces ont été les suivantes 133 mm pour le mulot perlé, 89 mm pour le tête-de-boule, 85 mm pour le ventre rouge du nord et 97 mm pour le ventre citron. Ces valeurs sont comparées à celles obtenues pour d'autres populations de l'Amérique du Nord.

Mots-clés : mulot perlé; tête-de-boule; ventre citron; ventre rouge du nord; longueur à la fourche; pH; acidification.

INTRODUCTION

The purpose of this report is to present data on the fish populations in Lake 114, the Experimental Lakes Area (ELA), northwestern Ontario. Fish species present in Lake 114 are fathead minnow (*Pimephales promelas*), pearl dace (*Semotilus margarita*), northern redbelly dace (*Phoxinus eos*), and finescale dace (*Phoxinus neogaeus*). (Scientific names of fishes in this report are based on American Fisheries Society, 1980). These four species are the most widespread and abundant species in the ELA (Beamish et al. 1976), and are distributed throughout a large part of North America (Scott and Crossman 1973). They are a significant food source for many larger fish (Scott and Crossman 1973), such as lake trout (*Salvelinus namaycush*), and thus constitute an important component of many aquatic ecosystems.

Recently, researchers have shown that many species of Cyprinidae are very sensitive to acidification (Rahel and Magnuson 1983; Mills and Schindler 1986; Pauwels and Haines 1986). Based on these studies, the pH values below which these species do not occur are 5.8 - fathead minnow, 5.3 - pearl dace, northern redbelly dace, and finescale dace. However, deleterious effects on these populations occur at higher pH values. For example, in a whole-lake acidification experiment in Lake 223, in the ELA, fathead minnows failed to reproduce at a pH of 5.9 (Mills 1984; Schindler et al. 1985; Mills et al. 1987).

In Lake 223, varying volumes of sulphuric acid were added to the lake as required to maintain pH at a constant target value each year (Cruikshank 1984). In Lake 114, fixed volumes of sulphuric acid were added to the lake at monthly intervals (Cruikshank 1984) and pH was not maintained at a constant value each year. The initiation of the Lake 114 acidification experiment in 1979 provided an opportunity for monitoring the population dynamics of the fish populations in response to acid "pulses" rather than to relatively constant acid inputs to the lake as had occurred in Lake 223. We hypothesized that the acidification of Lake 114 would have detrimental effects, such as reproductive impairment and population decline, on the acid-sensitive species of fish, especially fathead minnow, similar to those that occurred in Lake 223 (Mills et al. 1987).

In this report we present length-frequency data and catch data for the Cyprinidae in Lake 114 for 1978 and 1980 to 1988. Maximum lengths attained by each species in Lake 114 are compared to those for ELA lakes and other North American populations.

MATERIALS AND METHODS

Lake 114 is a small, shallow lake (area = 12.1 ha, maximum depth = 5.0 m, mean depth = 1.7 m) in the Experimental Lakes Area. Information on the background chemistry and morphometry are found in Armstrong and Schindler (1971);

Brunskill and Schindler (1971); and Cleugh and Hauser (1971).

Electrolyte grade sulphuric acid (36N H₂SO₄) was added to Lake 114 at monthly intervals during the open-water seasons from July 1979 until October 1986. Each month 33.6 L of acid were added to the surface of the lake using the "Prop-tube mix" method (Cruikshank 1984; 1986). This constant volume of acid was chosen to simulate monthly precipitation events at a pH one unit lower than the natural pH of rain on the lake (Schindler and Turner 1982). Mean surface pH decreased by 0.30 to 0.60 units after each acid addition, then gradually increased between additions. The time-weighted mean epilimnetic pH of Lake 114 varied from year-to-year throughout the acidification experiment, ranging from 5.65 to 6.26 (Cruikshank 1984; 1986). However, the mean pH has not substantially changed from background values. Mean epilimnetic pH of 6.11 in 1987 (D.R. Cruikshank, Freshwater Institute, Winnipeg, Manitoba, pers. comm.), the first year without acid additions, was similar to the pre-acidification value of 6.18 in 1978.

Fish were captured intermittently from May to October 1978 and April to October 1980 to 1988. Data for 1979 were presented by Tallman et al. (1984). Fish were primarily captured with modified versions of Beamish-style trap nets (Beamish 1972). These nets were equipped with pots having mesh sizes of 0.8, 1.6, or 3.2 mm. Trap nets were usually set for overnight periods. Standard wire-mesh minnow traps (mesh size 5 mm) were used in July 1982 to supplement trap net catches, and in April 1983 and April 1984 to sample fish under the ice. Catches of less than 1500 fish were sampled completely. However, catches of several thousand fish were common and these were subsampled.

Immediately after capture, fish were transported live to the field laboratory, anaesthetized with methane tricaine sulphonate (MS222), and measured for fork lengths (mm). Length-frequency distributions were constructed for monthly intervals each year for each species. Graphs were constructed if sample sizes were greater than nine fish.

Species catch composition was presented annually by calculating total catch for each species as a percentage of the entire annual catch of fish of all species. Catch-per-unit-effort (CPUE) was determined for each species based on total annual catches. One trap net set for one overnight period constituted one unit of effort.

ACKNOWLEDGMENTS

We would like to thank Ken Mills for his guidance and help throughout the study. Constructive criticisms by John Babaluk, Drew Rodaly and Everett Fee are appreciated.

REFERENCES

- AMERICAN FISHERIES SOCIETY. 1980. A list of common and scientific names of fishes from the United States and Canada. 4th ed. Am. Fish. Soc. Spec. Publ. 12. Bethesda, MD.
- ARMSTRONG, F.A.J., and D.W. SCHINDLER. 1971. Preliminary chemical characterization of waters in the Experimental Lakes Area, northwestern Ontario. J. Fish. Res. Board Can. 28: 171-187.
- BEAMISH, R.J. 1972. Design of a trap-net for sampling shallow-water habitats. Fish. Res. Board Can. Tech. Rep. 305: 14 p.
- BEAMISH, R.J., L.M. BLOUW, and G.A. McFARLANE. 1976. A fish and chemical study of 109 lakes in the Experimental Lakes Area (ELA), northwestern Ontario, with appended reports on lake whitefish ageing errors and the northwestern Ontario baitfish industry. Can. Fish. Mar. Serv. Tech. Rep. 607: 116 p.
- BRUNSKILL, G.J., and D.W. SCHINDLER. 1971. Geography and bathymetry of selected lake basins, Experimental Lakes Area, northwestern Ontario. J. Fish. Res. Board Can. 28: 139-155.
- CHADWICK, E.M.P. 1976. Ecological fish production in a small Precambrian Shield lake. Env. Biol. Fish. 1: 13-60.
- CLEUGH, T.R., and B.W. HAUSER. 1971. Results of the initial survey of the Experimental Lakes Area, northwestern Ontario. J. Fish. Res. Board Can. 28: 129-137.
- CRUIKSHANK, D.R. 1984. Whole lake chemical additions in the Experimental Lakes Area, 1969-1983. Can. Data Rep. Fish. Aquat. Sci. 449: iv + 23 p.
- CRUIKSHANK, D.R. 1986. Whole lake chemical additions in the Experimental Lakes Area, 1984-1985. Can. Data Rep. Fish. Aquat. Sci. 580: iv + 10 p.
- HELD, J.W., and J.J. PETERKA. 1974. Age, growth, and food habits of the fathead minnow, *Pimephales promelas*, in North Dakota saline lakes. Trans. Am. Fish. Soc. 103: 743-756.
- LALANCETTE, L.-M. 1977. Croissance, reproduction et regime alimentaire du mullet perle, *Semotilus margarita*, du lac Gamelin, Quebec. Naturaliste Can. 104: 493-500.
- MILLS, K.H. 1984. Fish population responses to experimental acidification of a small Ontario lake, p. 117-131. In G.R. Hendrey (ed.) Early biotic responses to advancing lake acidification. Butterworth Publishers, Woburn, MA.
- MILLS, K.H., S.M. CHALANCHUK, L.C. MOHR, and I.J. DAVIES. 1987. Responses of fish populations in Lake 223 to 8 years of experimental acidification. Can. J. Fish. Aquat. Sci. 44 (Suppl. 1): 114-125.
- MILLS, K.H., and D.W. SCHINDLER. 1986. Biological indicators of lake acidification. Water Air Soil Pollut. 30: 779-789.
- MOHR, L.C. 1986. Experimental enhancement of the commercial bait fish industry in northwestern Ontario, Northern Ontario Rural Development Agreement (NORDA) 1984-1986. 216 p.
- PAUWELS, S.J., and T.A. HAINES. 1986. Fish species distribution in relation to water chemistry in selected Maine lakes. Water Air Soil Pollut. 30: 477-488.
- RAHEL, F.J., and J.J. MAGNUSON. 1983. Low pH and the absence of fish species in naturally acidic Wisconsin lakes: inferences for cultural acidification. Can. J. Fish. Aquat. Sci. 40: 3-9.
- SCOTT, W.B., and E.J. CROSSMAN. 1973. Freshwater fishes of Canada. Bull. Fish. Res. Board Can. 184.
- SCHINDLER, D.W., and M.A. TURNER. 1982. Biological, chemical and physical responses of lakes to experimental acidification. Water Air Soil Pollut. 18: 259-271.
- SCHINDLER, D.W., K.H. MILLS, D.F. MALLEY, D.L. FINDLAY, J.A. SHEARER, I.J. DAVIES, M.A. TURNER, G.A. LINSEY, and D.R. CRUIKSHANK. 1985. Long-term ecosystem stress: the effects of years of experimental acidification on a small lake. Science (Wash., D.C.) 228: 1395-1401.
- STASIAK, R.H. 1978a. Food, age and growth of the pearl dace, *Semotilus margarita*, in Nebraska. Am. Midl. Nat. 100: 463-465.
- STASIAK, R.H. 1978b. Reproduction, age, and growth of the finescale dace, *Chrosomus neogaeus* in Minnesota. Trans. Am. Fish. Soc. 107: 720-723.
- TALLMAN, R.F., K.H. MILLS, and R.G. ROTTER. 1984. The comparative ecology of pearl dace (*Semotilus margarita*) and fathead minnow (*Pimephales promelas*) in Lake 114, the Experimental Lakes Area, northwestern Ontario, with an appended key to the cyprinids of the Experimental Lakes Area. Can. Manuscr. Rep. Fish. Aquat. Sci. 1756: iv + 27 p.

Table 1. Maximum fork lengths of four species of Cyprinidae in Lake 114, ELA lakes; and other North American populations. Numbers in parentheses refer to number of populations.

Lake	Location	Pearl dace	Fathead minnow	Northern redbelly dace	Finescale dace	Reference
114	ELA	133	89	85	97	-
111	ELA	96	65	-	76	-
222	ELA	100	-	-	-	-
223	ELA	166	88	-	76	-
224	ELA	116	68	-	83	-
226	ELA	134	89	-	-	-
227	ELA	-	65	59	-	-
260	ELA	148	75	78	-	-
302N	ELA	125	91	93	104	-
302S	ELA	127	101	88	90	-
303	ELA	82	65	75	59	-
373	ELA	93	-	68	87	-
375	ELA	116	62	-	68	-
382	ELA	120	75	-	65	-
NB(1)	Nebraska	89 ^a	-	-	-	Stasiak 1978a
ND(9)	N. Dakota	-	79 ^b	-	-	Held and Peterka 1974
MN(1)	Minnesota	-	-	-	85 ^a	Stasiak 1978b
QU(1)	Quebec	120 ^b	-	-	-	Lalancette 1977
NA(3)	N. America	158 ^b	94 ^b	61 ^a	-	Scott and Crossman 1973
ON(11)	Ontario	160	83	91	98	Mohr 1986
ON(1)	Ontario	106 ^a	73 ^a	-	-	Chadwick 1976

^a Standard length

^b Total length

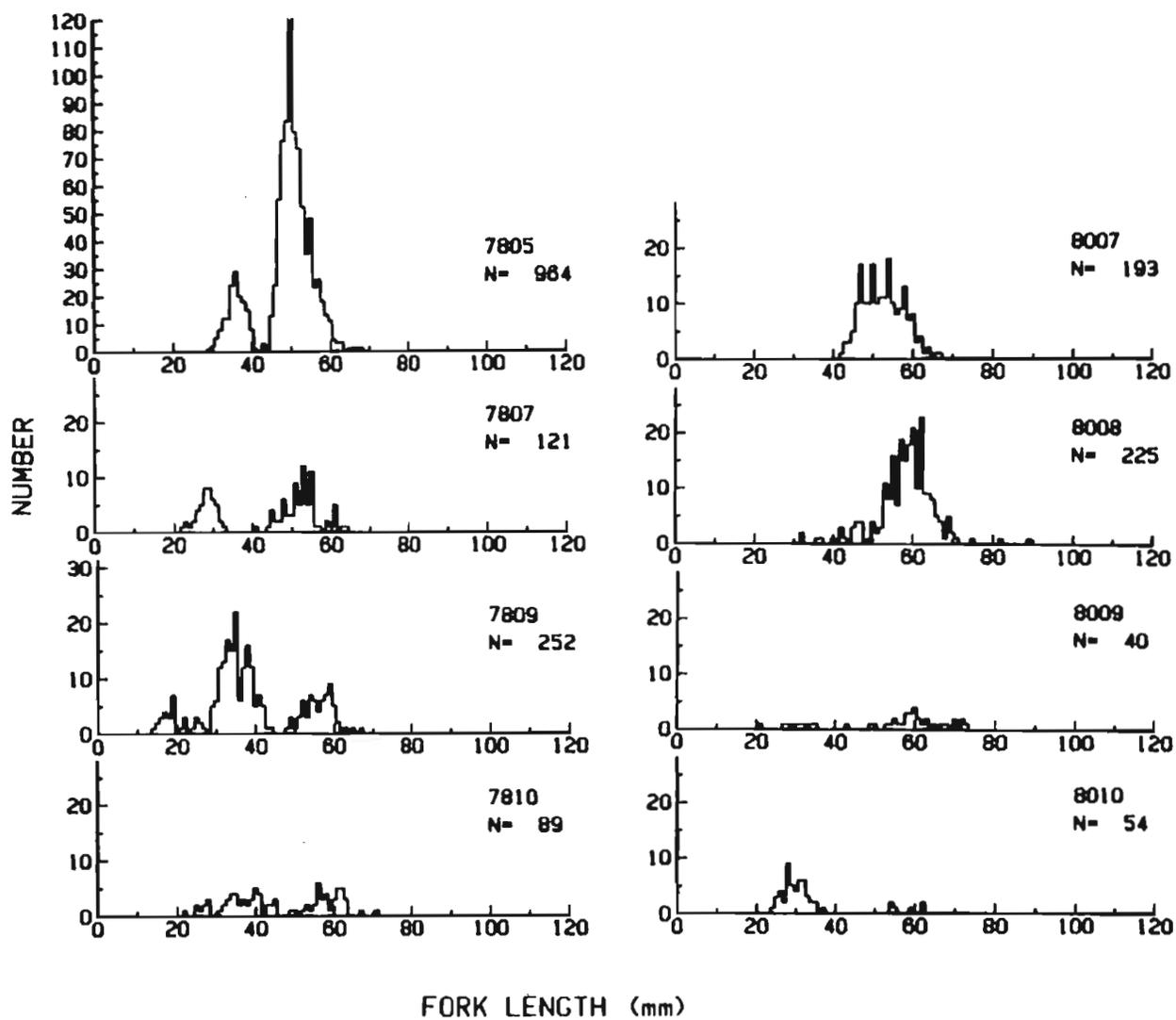


Figure 1a. Monthly length-frequency distributions for fathead minnow in Lake 114. All fish were caught by trap net. Note change in scale of y-axis for May 1978 (7805).

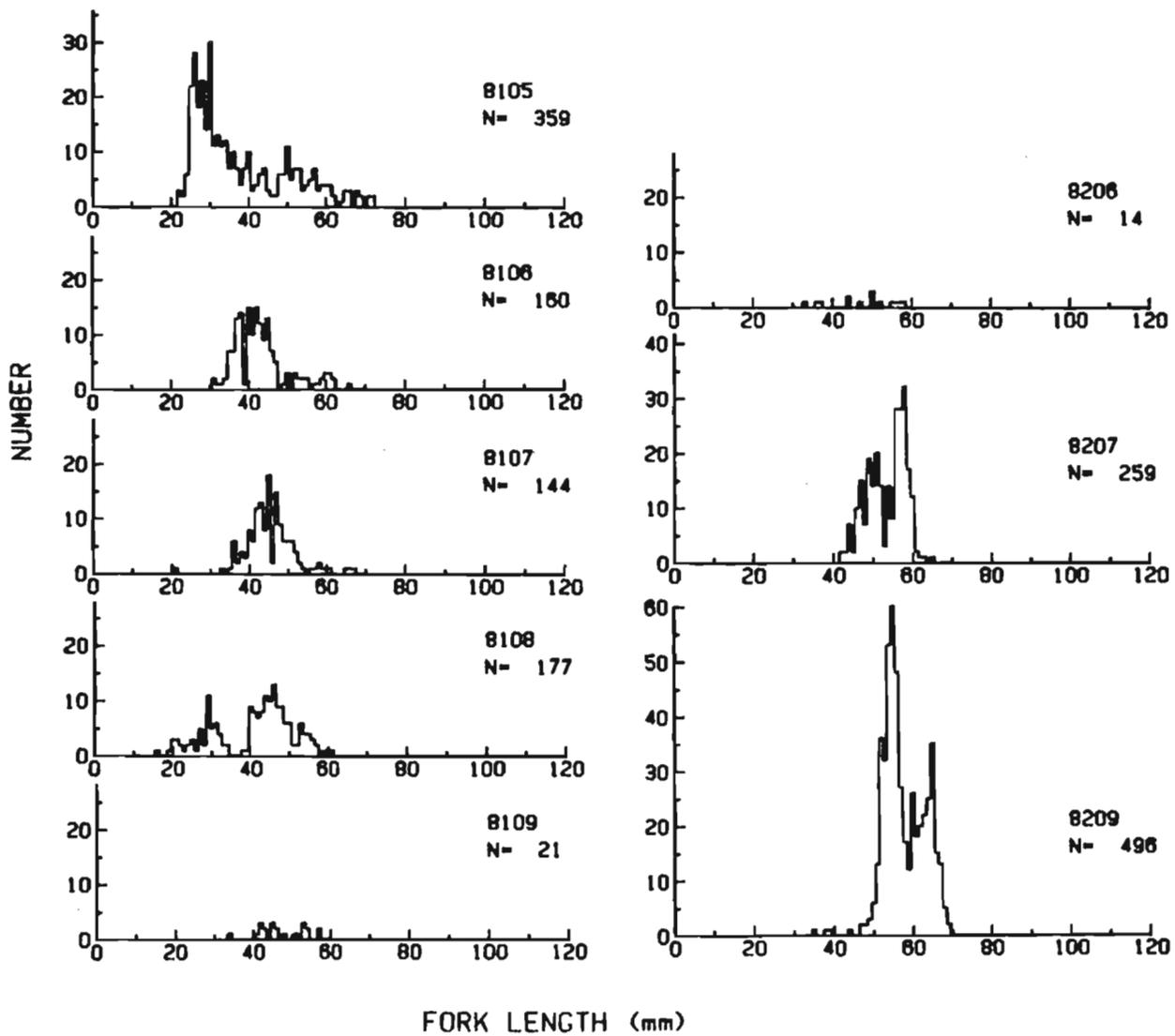


Figure 1b. Monthly length-frequency distributions for fathead minnow in Lake 114. All fish were caught by trap net.

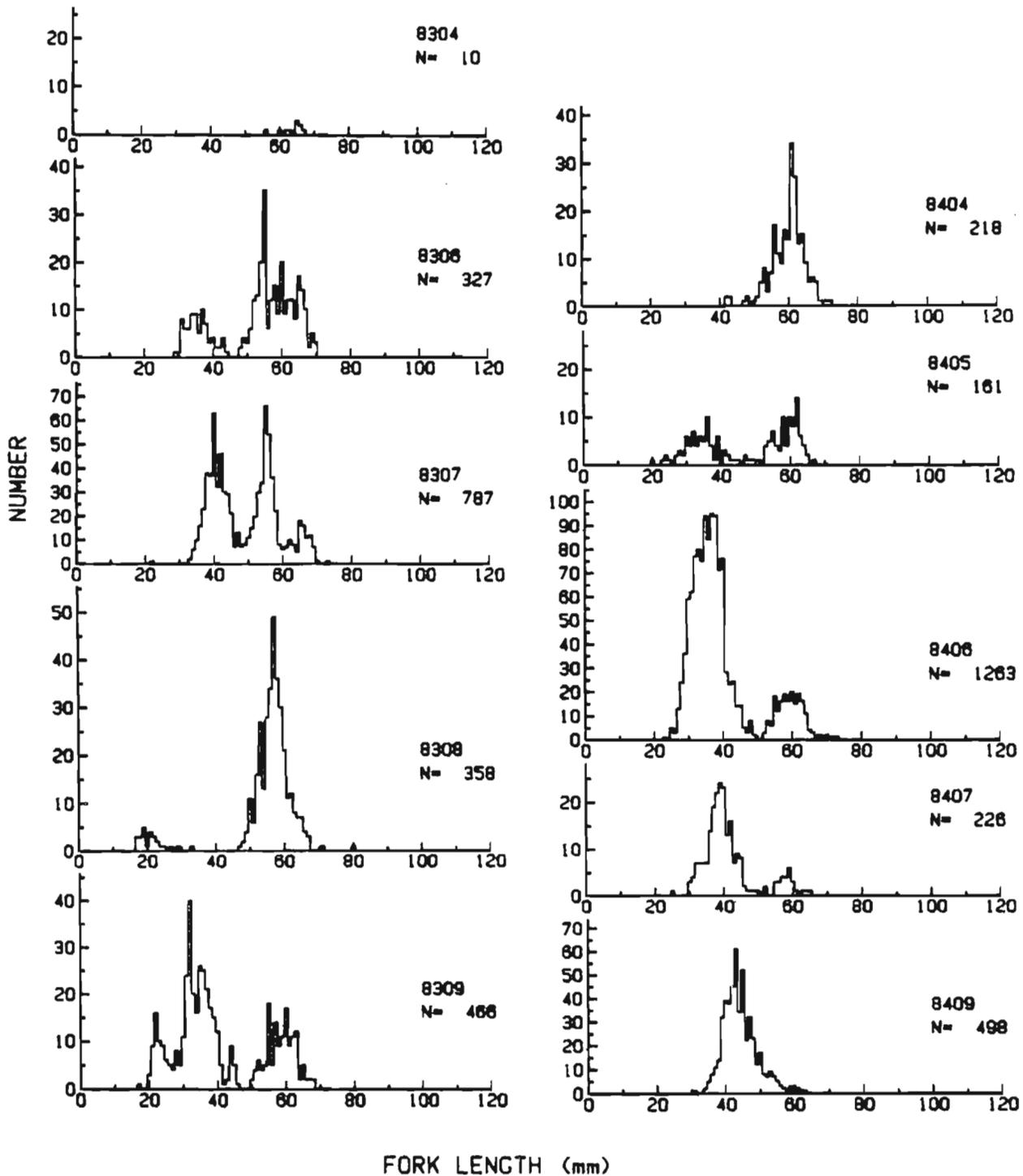


Figure 1c. Monthly length-frequency distributions for fathead minnow in Lake 114. Fish captured during April 1983 (8304) and April 1984 (8404) were caught by minnow trap. All other fish were caught by trap net. Note change in scale of y-axis for July 1983 (8307), June 1984 (8406), and September 1984 (8409).

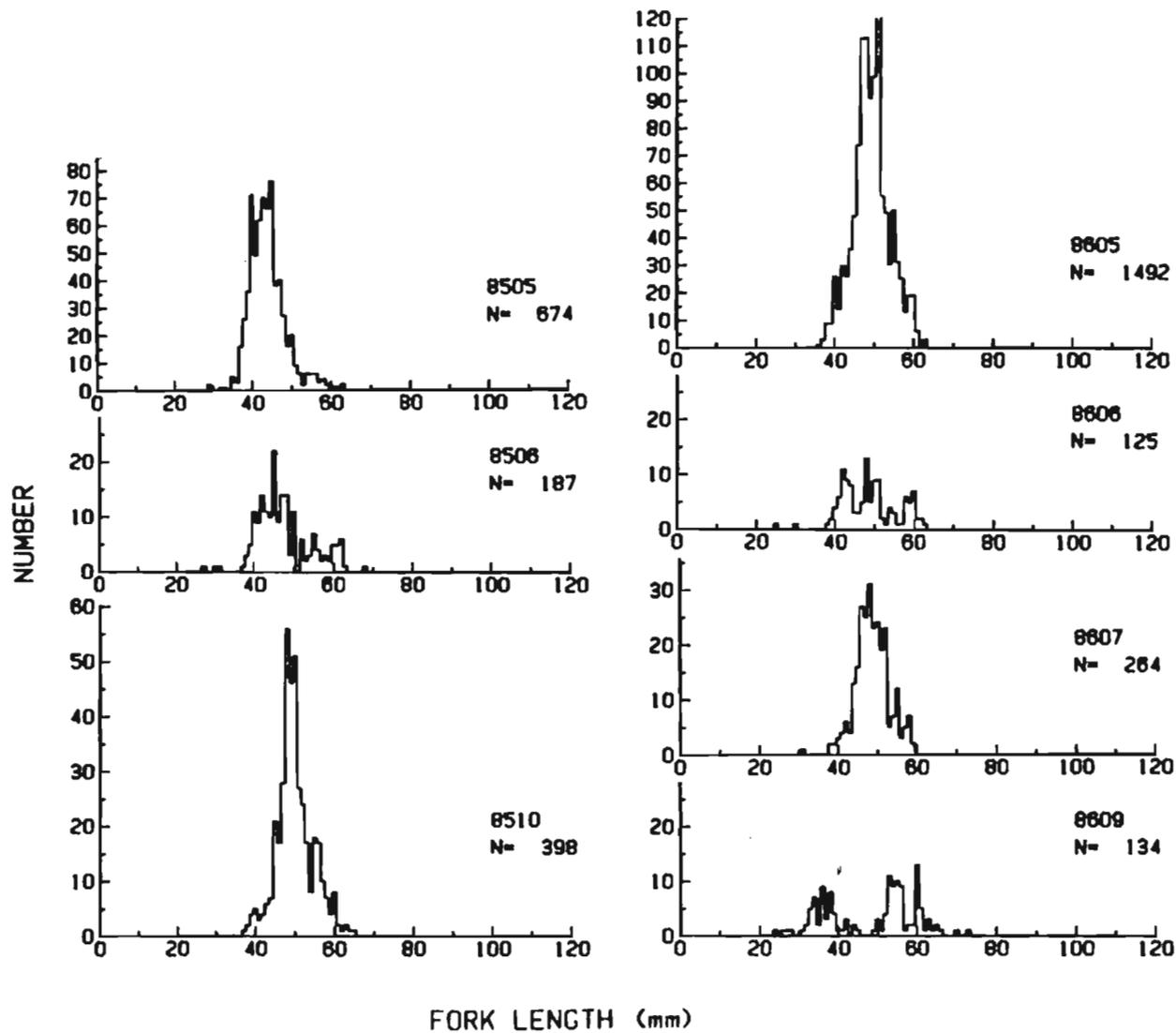


Figure 1d. Monthly length-frequency distributions for fathead minnow in Lake 114. All fish were caught by trap net. Note change in scale of y-axis for May 1985 (8505) and May 1986 (8605).

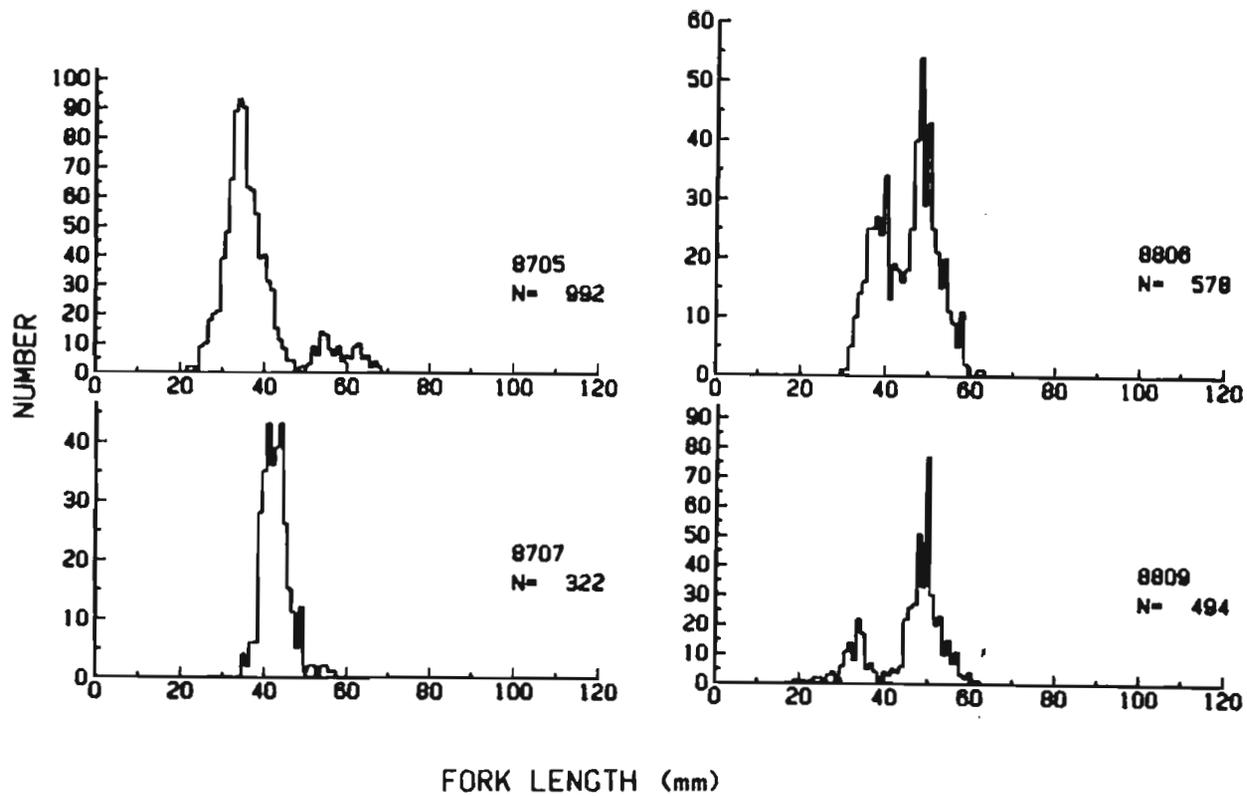


Figure 1e. Monthly length-frequency distributions for fathead minnow in Lake 114. All fish were caught by trap net. Note change in scale of y-axis for May 1987 (8705) and September 1988 (8809).

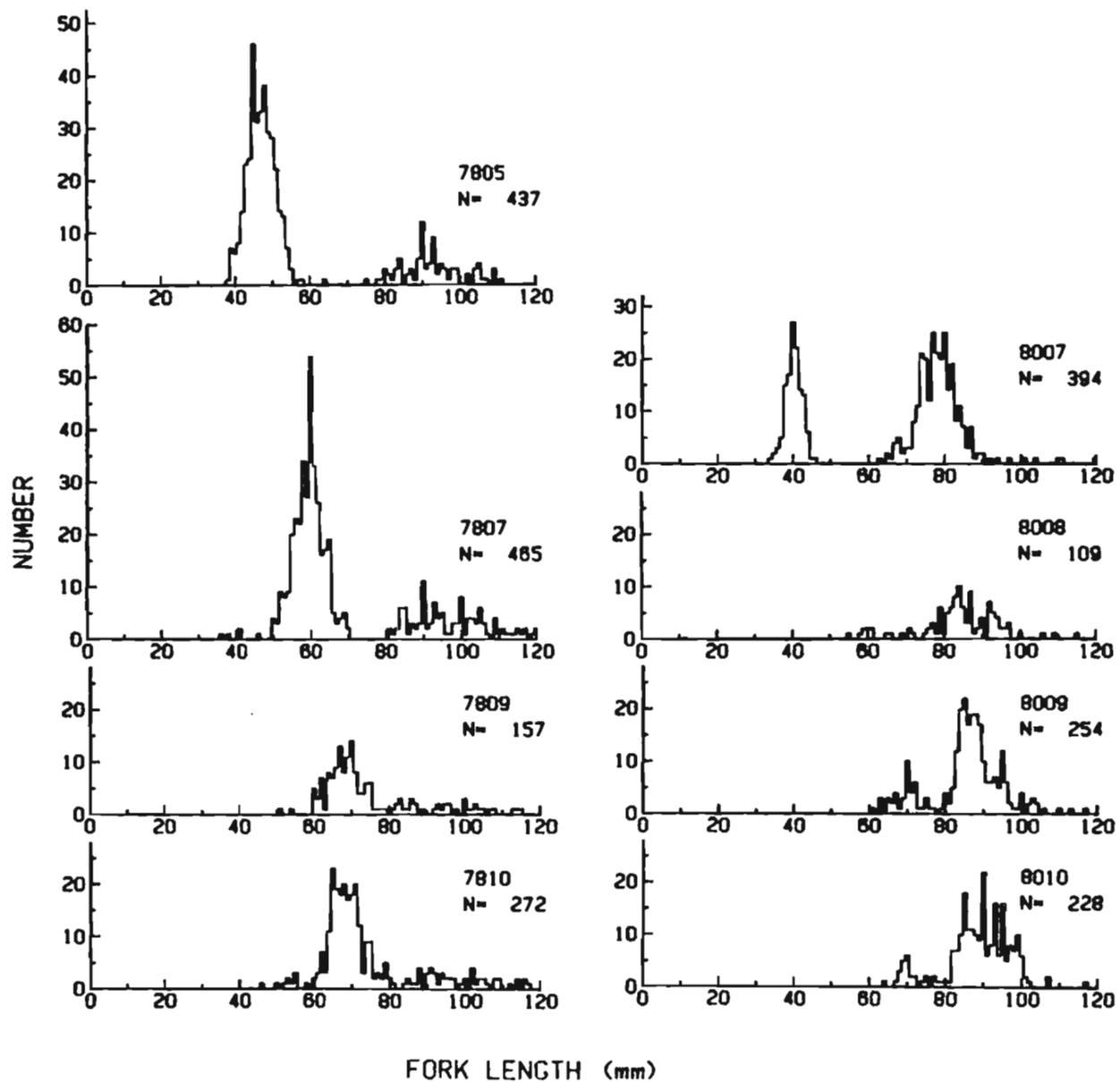


Figure 2a. Monthly length-frequency distributions for pearl dace in Lake 114. All fish were captured by trap net.

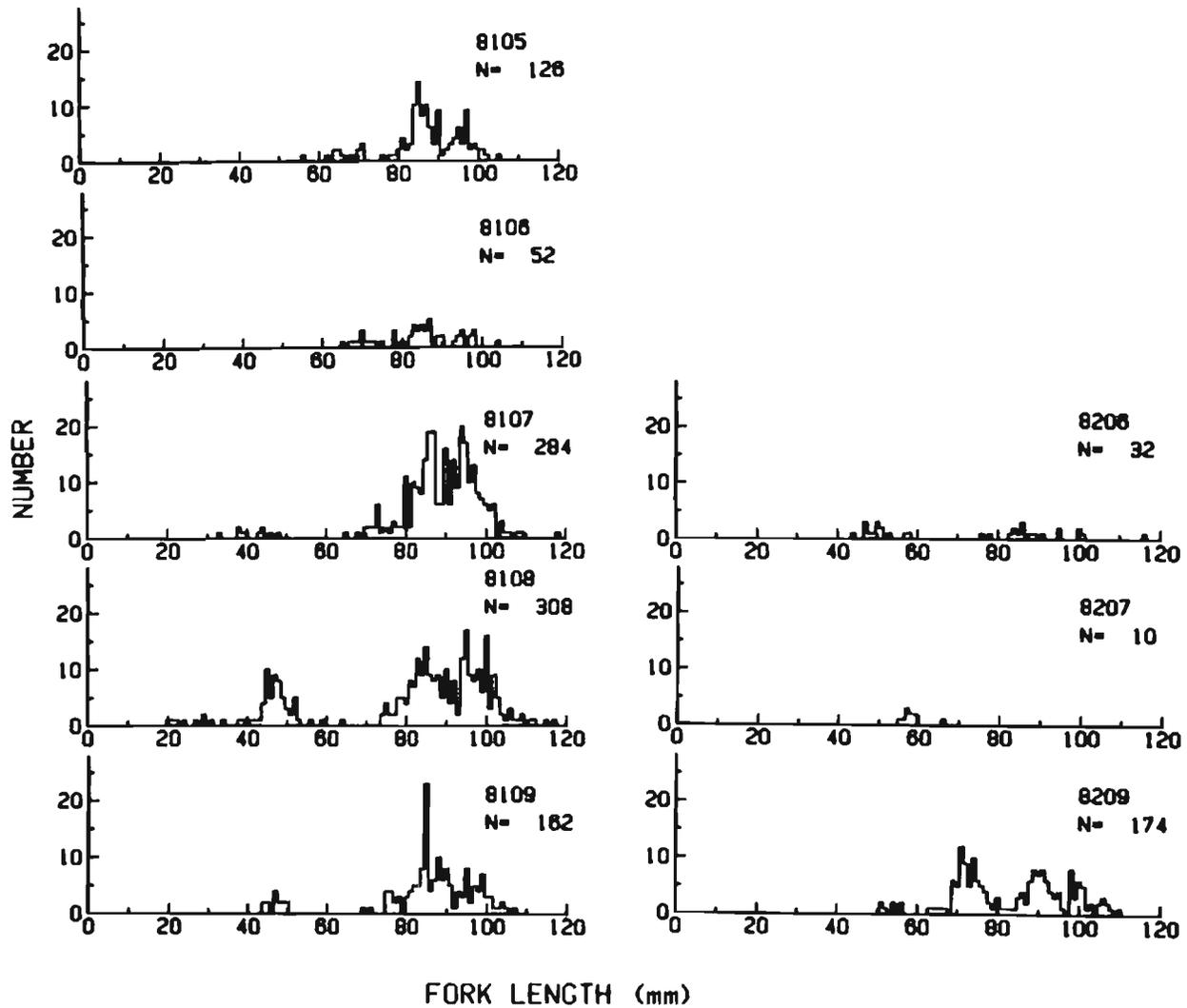


Figure 2b. Monthly length-frequency distributions for pearl dace in Lake 114. Fish captured during July 1982 (8207) were caught by minnow trap. All other fish were caught by trap net.

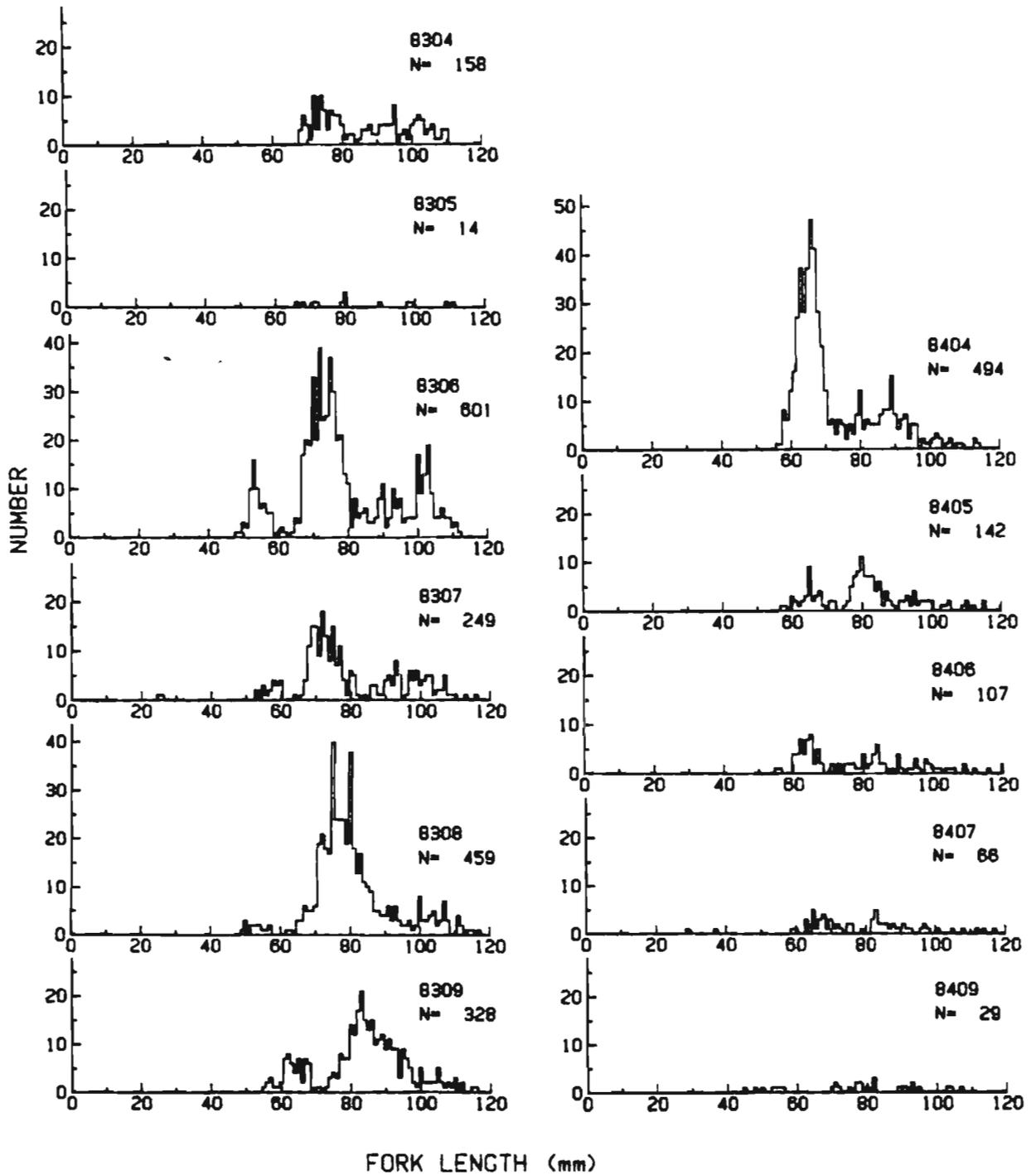


Figure 2c. Monthly length-frequency distributions for pearl dace in Lake 114. Fish captured during April 1983 (8304) and April 1984 (8404) were caught by minnow trap. All other fish were caught by trap net.

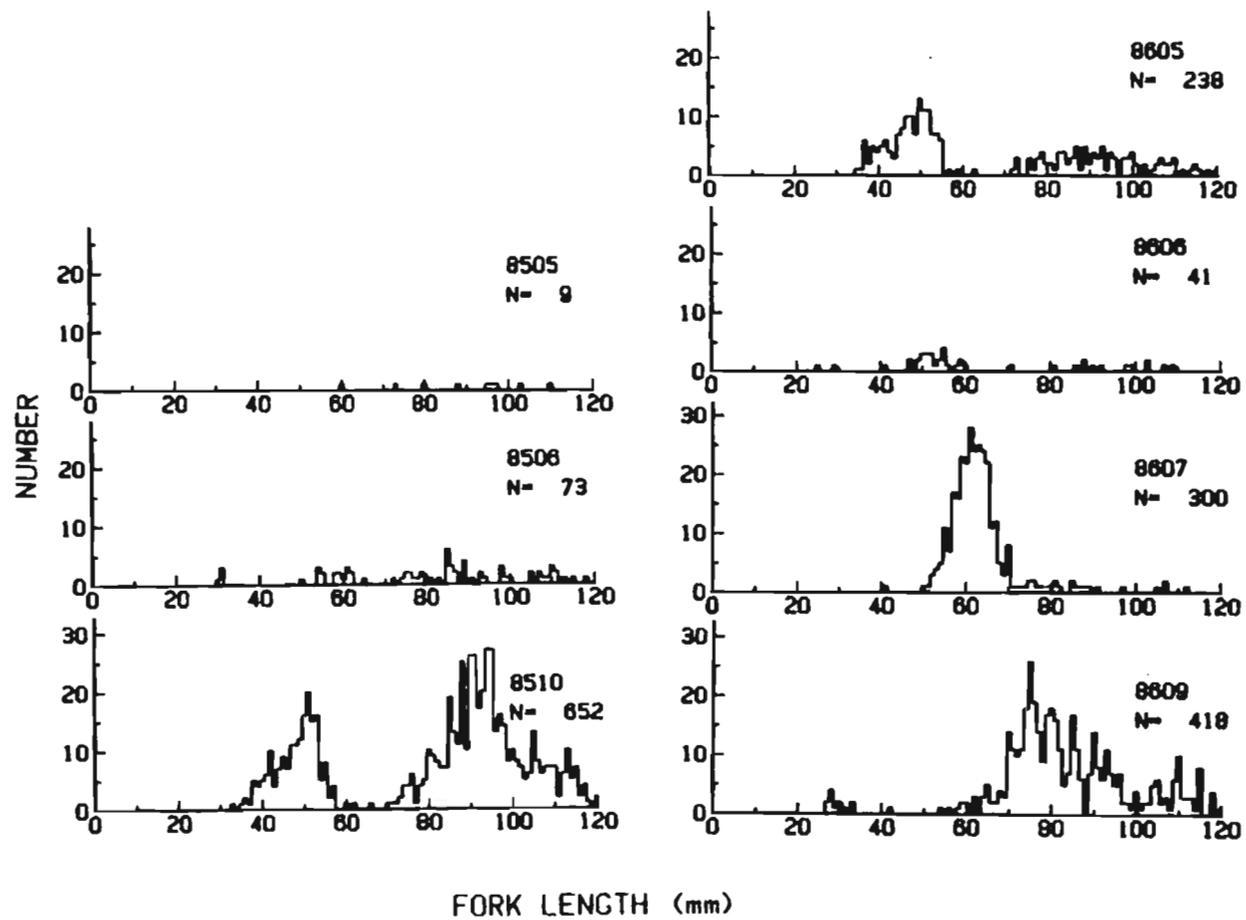


Figure 2d. Monthly length-frequency distributions for pearl dace in Lake 114. All fish were captured by trap net.

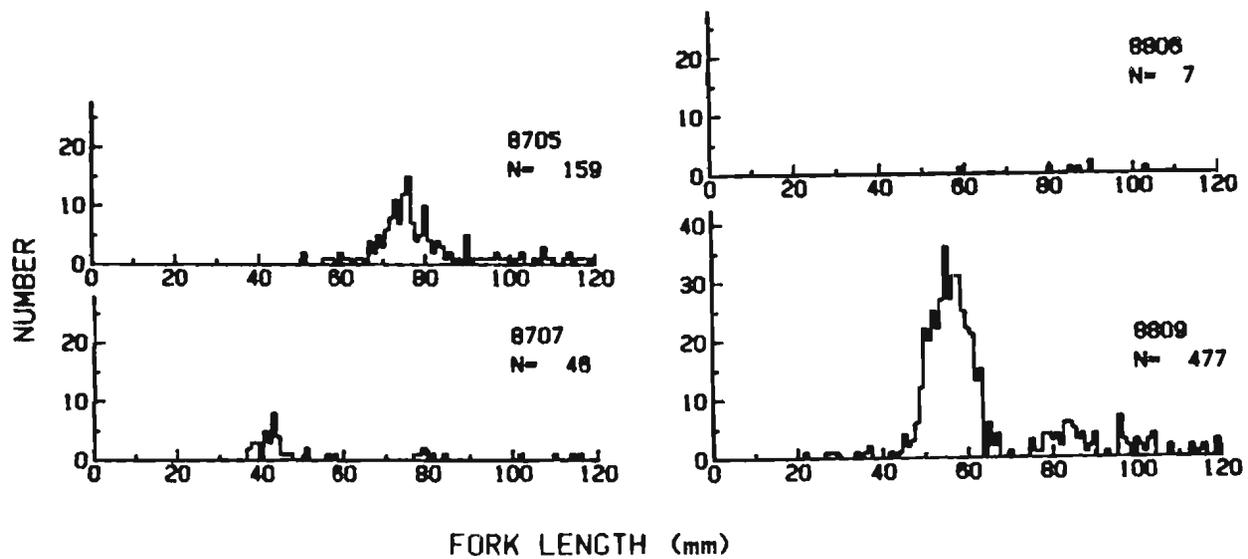


Figure 2e. Monthly length-frequency distributions for pearl dace in Lake 114. All fish were captured by trap net.

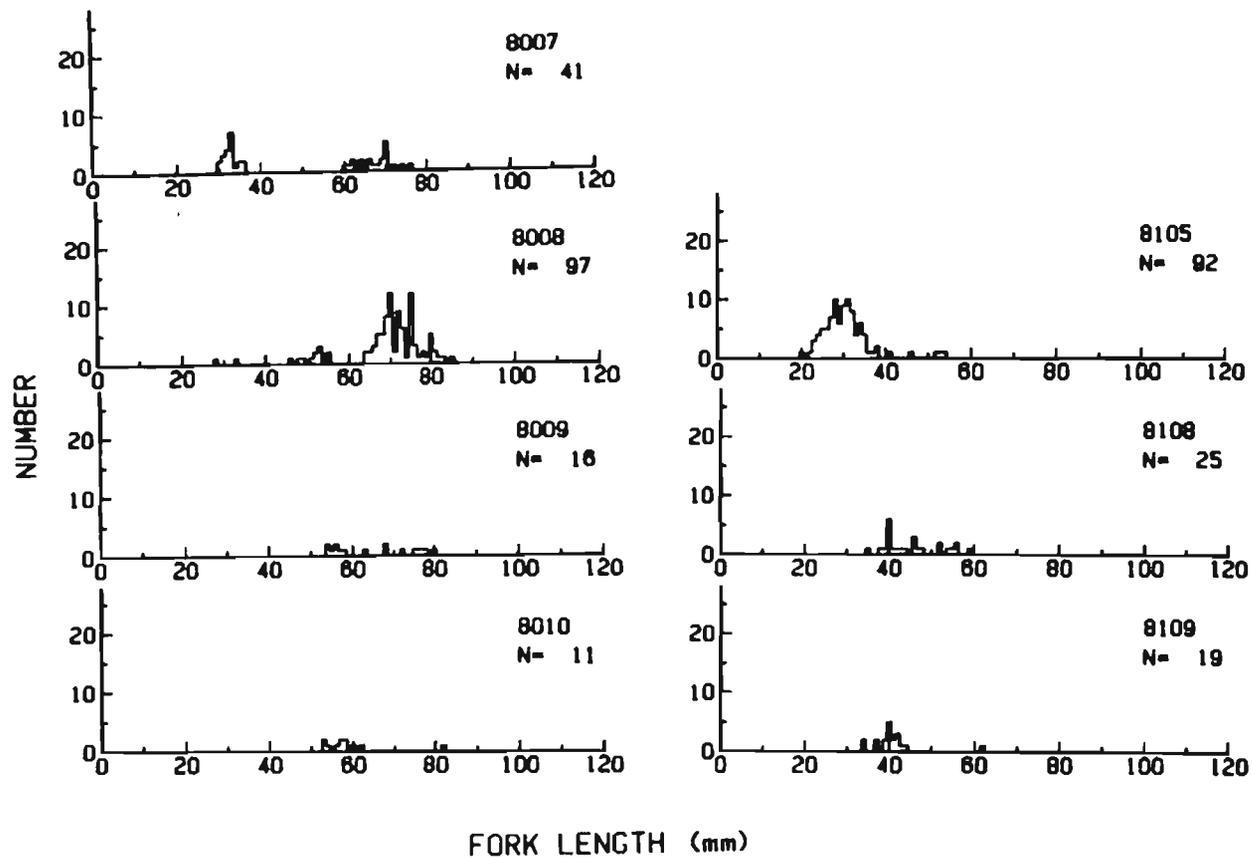


Figure 3a. Monthly length-frequency distributions for northern redbelly dace in Lake 114. All fish were captured by trap net.

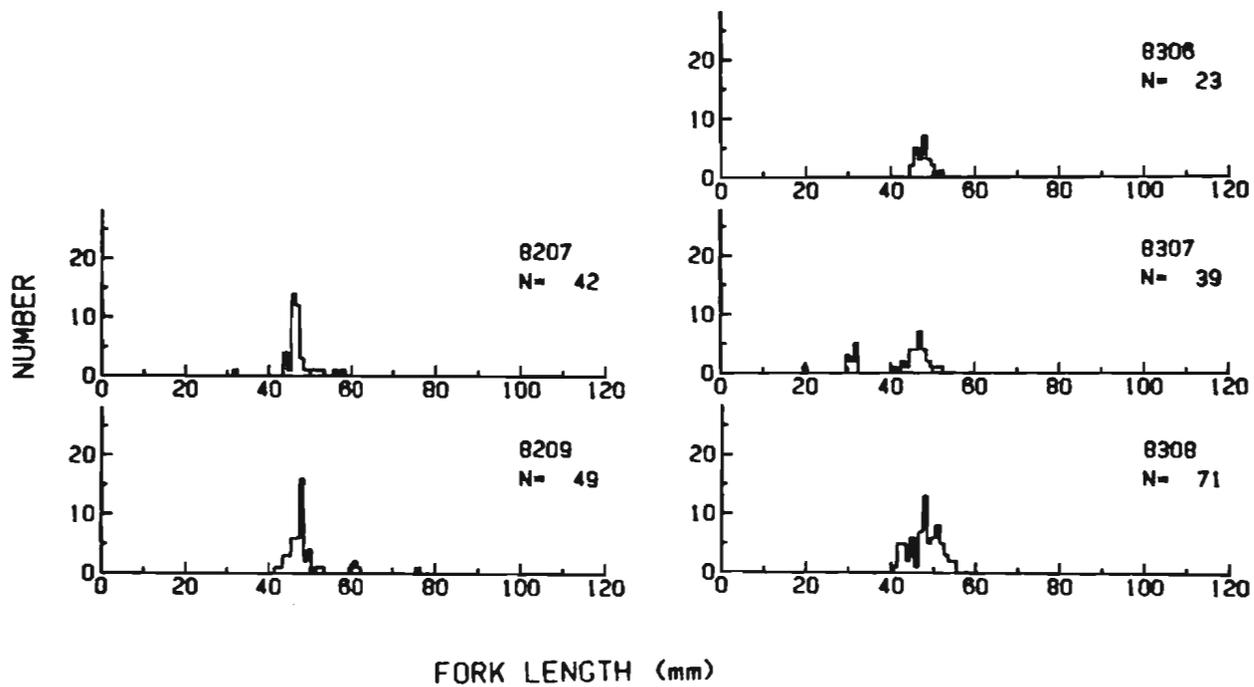


Figure 3b. Monthly length-frequency distributions for northern redbelly dace in Lake 114. All fish were captured by trap net.

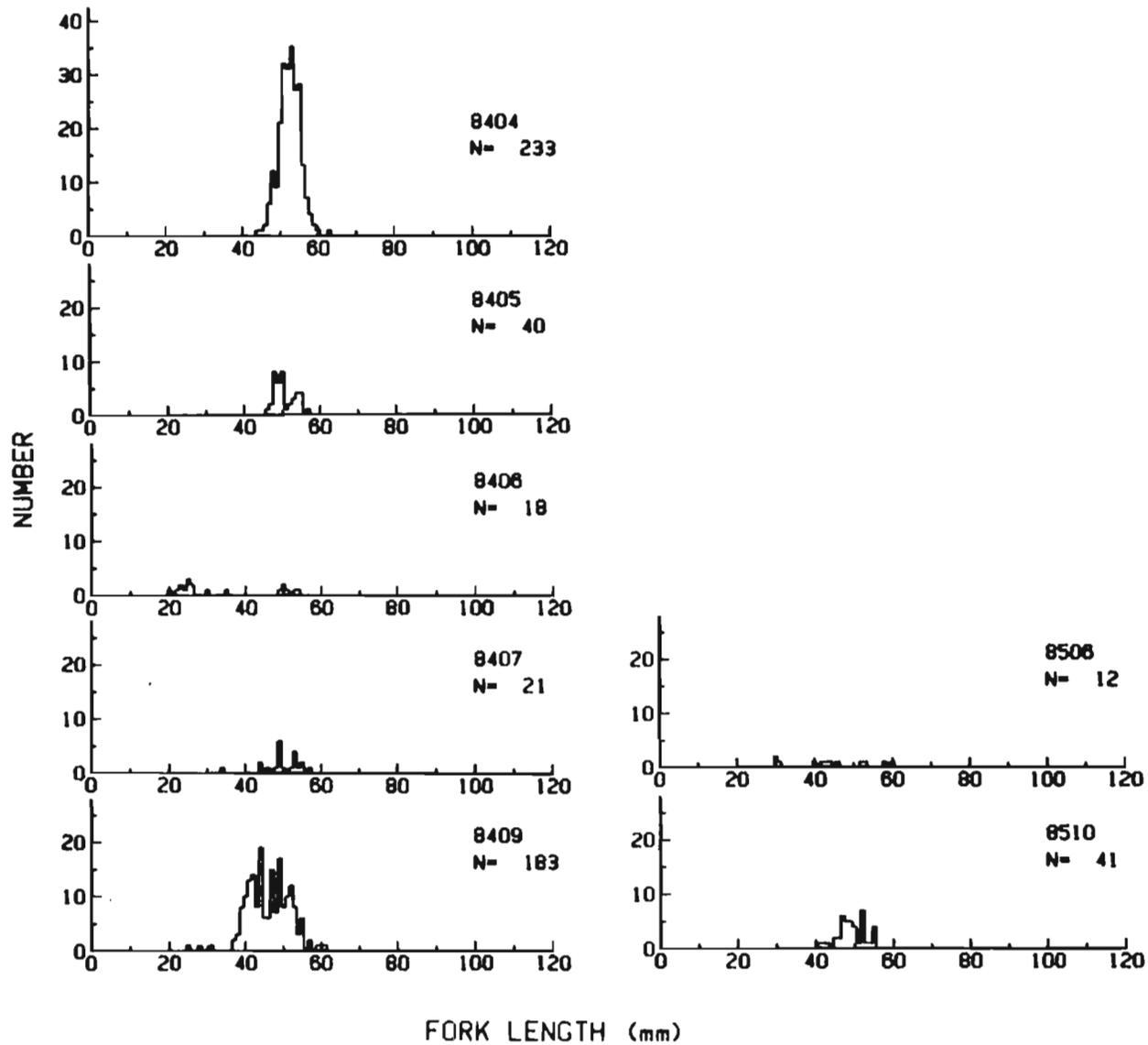


Figure 3c. Monthly length-frequency distributions for northern redbelly dace in Lake 114. Fish captured during April 1984 (8404) were caught by minnow trap. All other fish were caught by trap net.

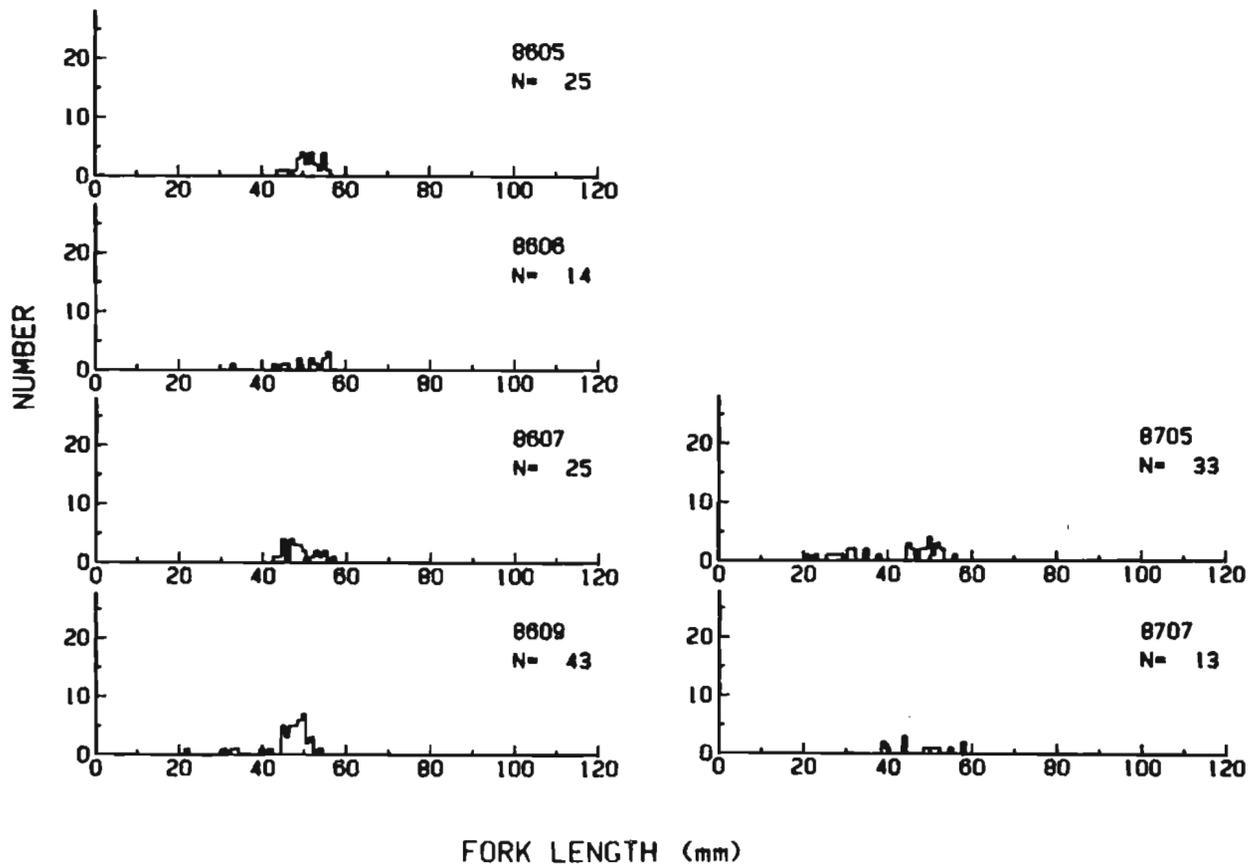


Figure 3d. Monthly length-frequency distributions for northern redbelly dace in Lake 114. All fish were caught by trap net.

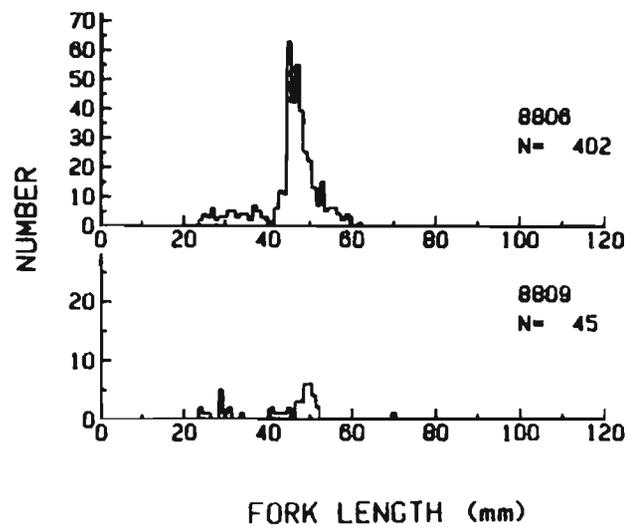


Figure 3e. Monthly length-frequency distributions for northern redbelly dace in Lake 114. All fish were caught by trap net.

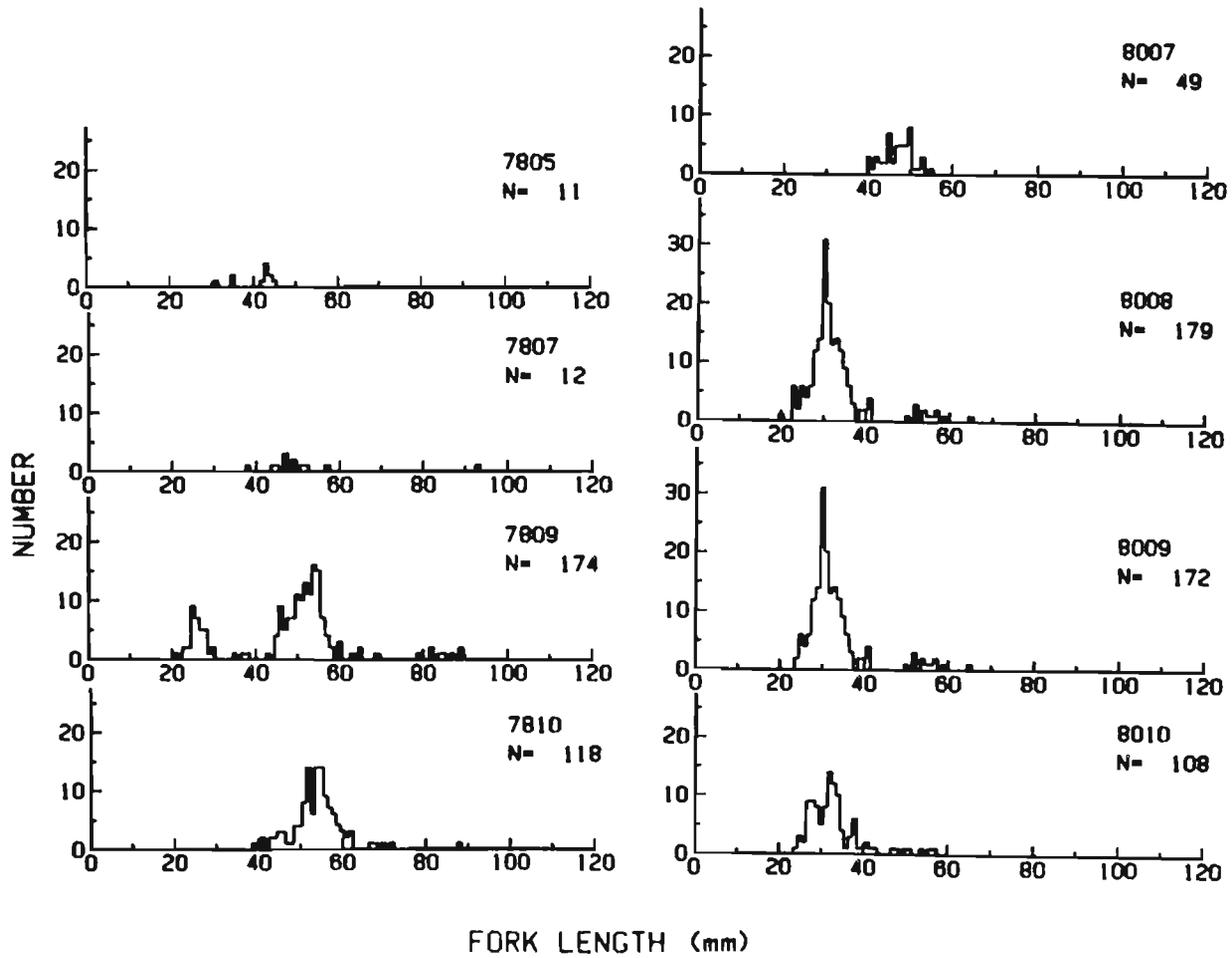


Figure 4a. Monthly length-frequency distributions for finescale dace in Lake 114. All fish were caught by trap net.

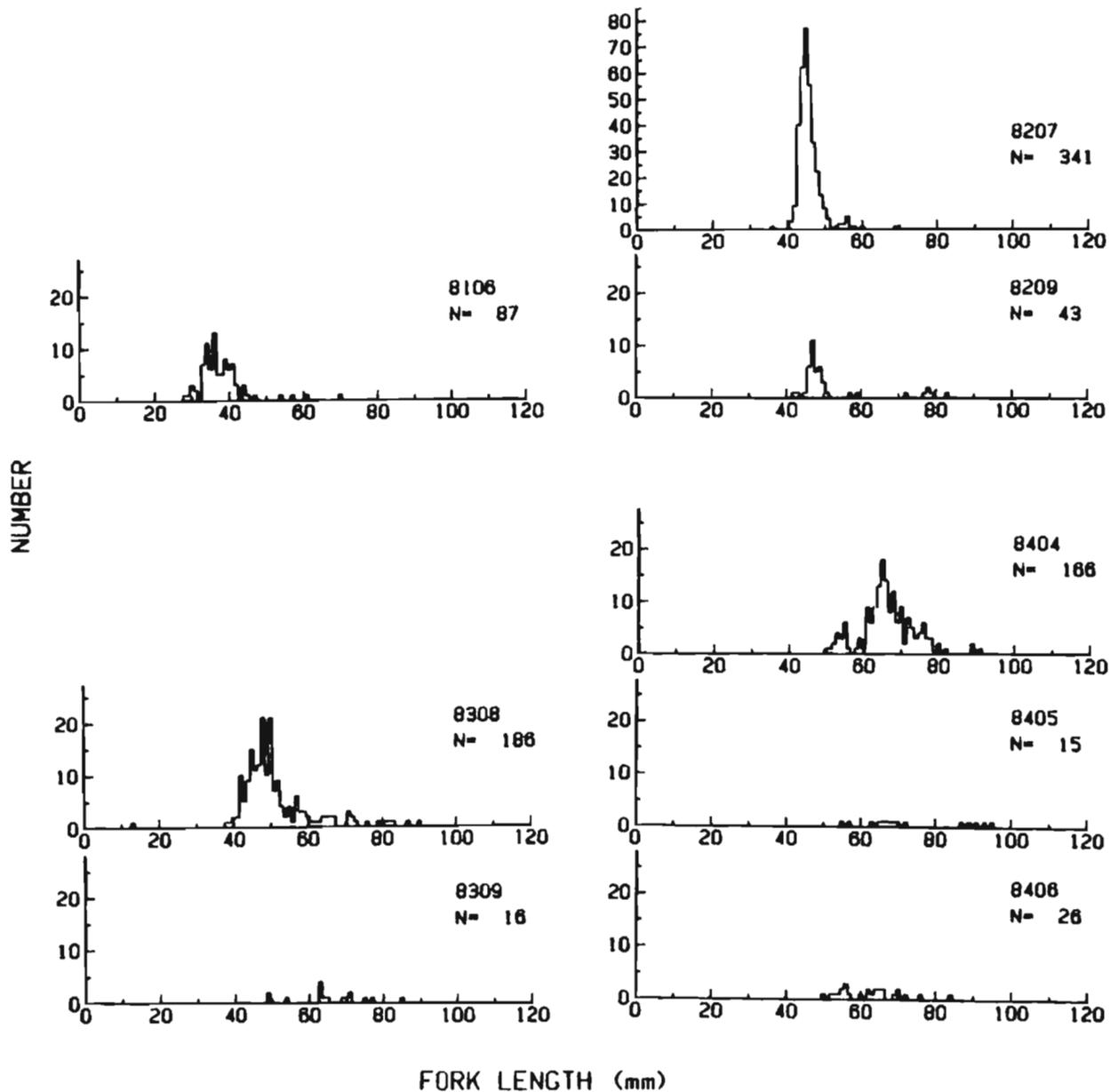


Figure 4b. Monthly length-frequency distributions for finescale dace in Lake 114. Fish captured during April 1984 (8404) were caught by minnow trap. All other fish were caught by trap net. Note change in scale of y-axis for July 1982 (8207).

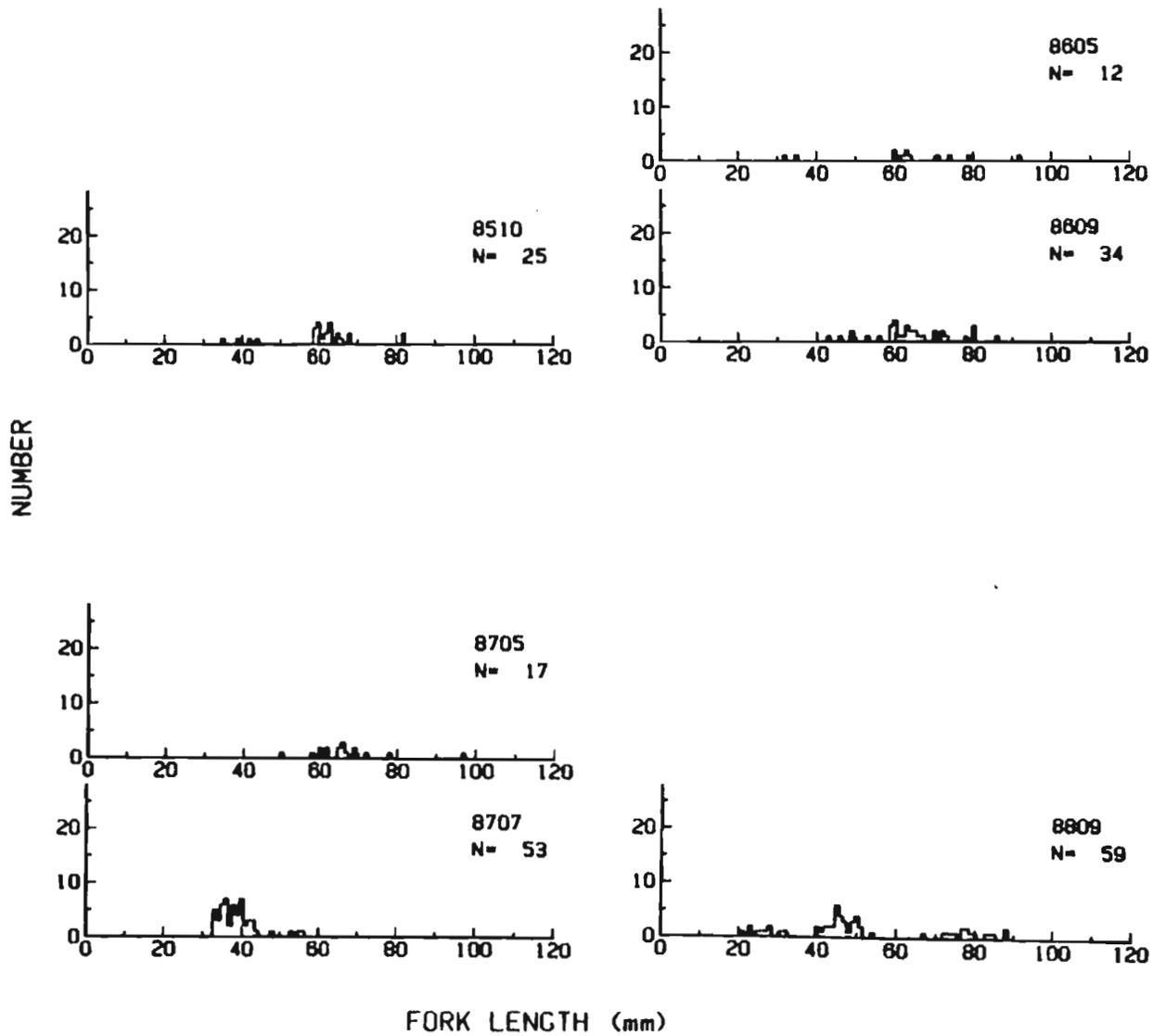


Figure 4c. Monthly length-frequency distributions for finescale dace in Lake 114. All fish were caught by trap net.

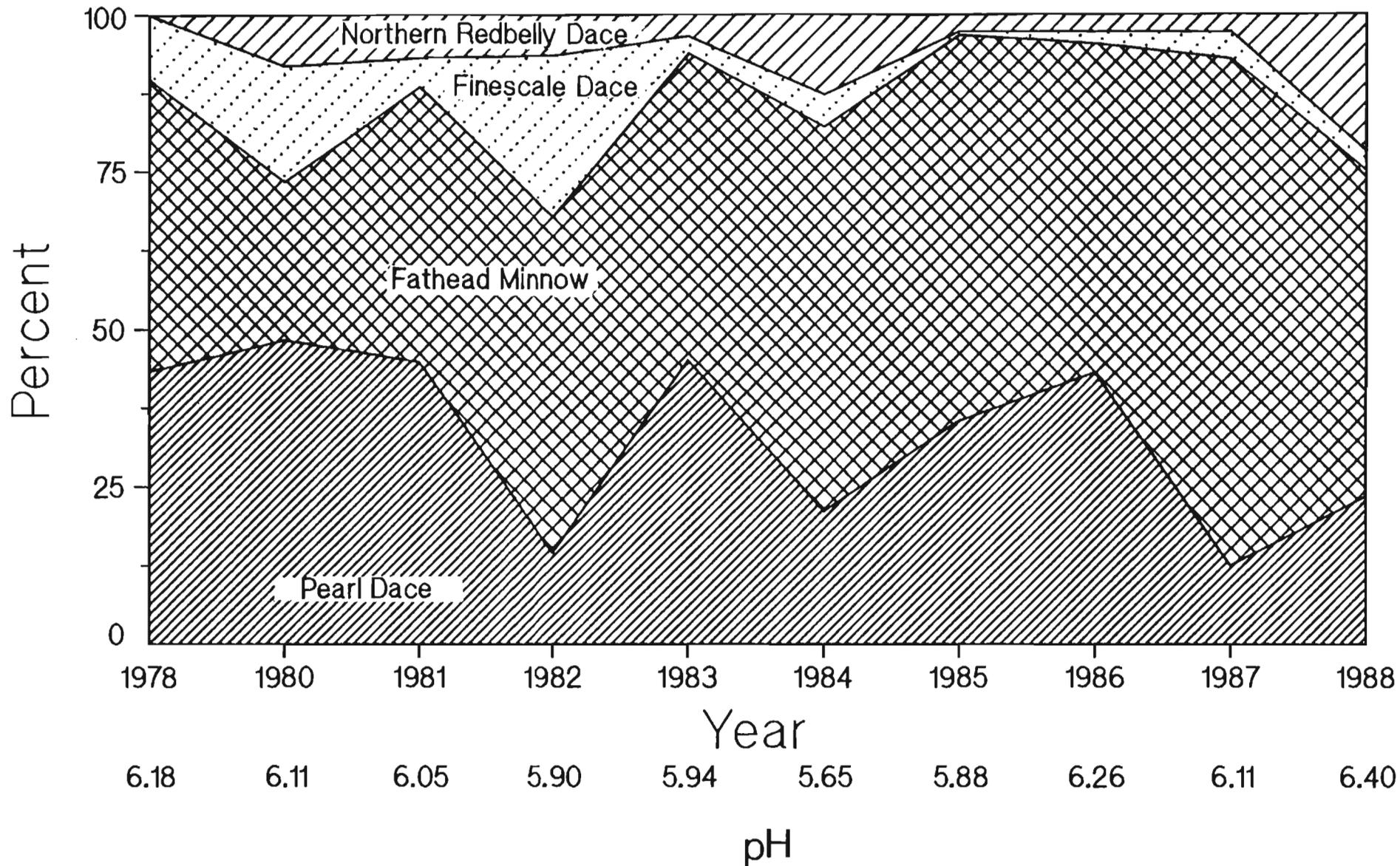


Figure 5. Annual catch composition (percentage) of Lake 114 fish. Note that data from 1979 are not on the graph.

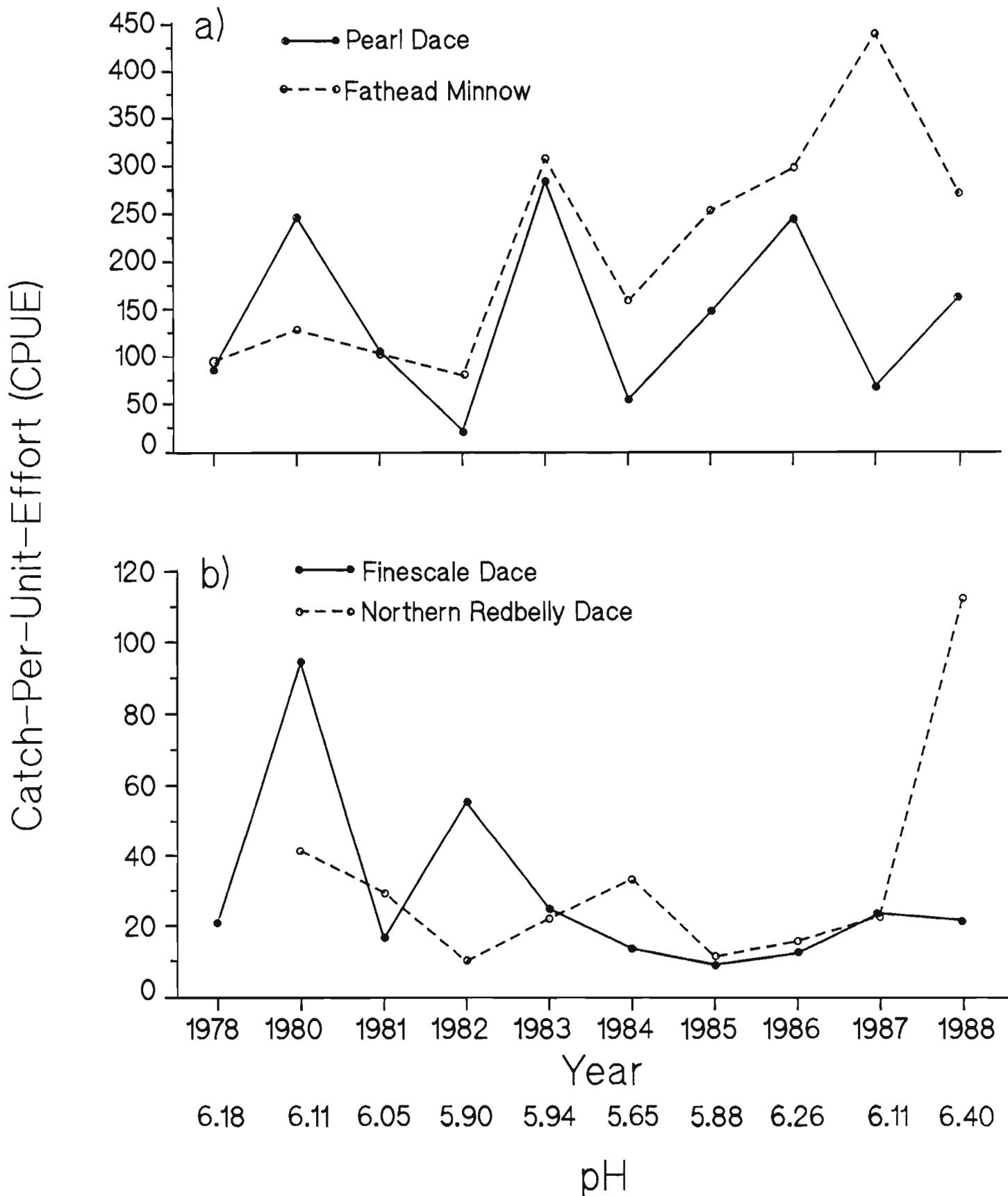


Figure 6. Catch-per-unit-effort for a) pearl dace and fathead minnow, and b) finescale dace and northern redbelly dace. Note that data for 1979 are not on the graph.

