SUPPLEMENT 1

BRUNSWICK STEAM ELECTRIC PLANT
CAPE FEAR STUDIES

1979 MONITORING PROGRAM

CAROLINA POWER & LIGHT COMPANY
ENVIRONMENTAL TECHNOLOGY SECTION

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Cape Fear Studies

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Environmental Technology Section
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1.0 Introduction

In September 1976 Carolina Power & Light Company (CP&L) initiated a two-year study aimed at characterizing the Cape Fear estuary (CFE) and determining the effects of the operation of the Brunswick Steam Electric Plant (BSEP) on the aquatic ecosystem. In developing this program, CP&L and its consultants utilized the pre-1976 data base, the hearing record from the June 1976 adjudicatory hea ing, and input from the North Carolina Division of Marine Fisheries and Division of Environmental Management. At three- to four-month intervals, each investigator presented a short progress report to members of a review committee consisting of representatives of the agencies participating in the June hearing. This committee had the opportunity to direct questions to each investigator and suggest changes in the overall program.

In September 1978, at the termination of the intensive two-year study, a long-term monitoring program was developed and initiated by CP&L. The studies were substantially reduced in scope from the two-year program as they were not intended to gather new information on biota transport or abundance in the Cape Fear River. Instead, they were designed for continual monitoring of both the plant's cropping rate (entrainment and impingement) and the trends in relative abundance of fish and shellfish in the lower estuary. The gear and methodology were kept as identical as possible to those used in previous programs so that direct comparisons could be made over time. Dr. Robert Monroe of NCSU assisted in the design to assure that the monitoring data were amenable to statistical comparison with previous data and for noting long-term trends. The long-term monitoring program consists of four separate studies--two dealing with larval fish and shellfish and two dealing with older life stages. This report on the long-term monitoring program is a supplement to the multivolume set of Cape Fear Studies that is summarized in the CFS Interpretive Report (IR). References are made in the text to these reports.

Section 2 examines the larval and postlarval populations of fish, shrimp, and crabs in the open portions of the CFE. Station locations ranged from the vicinity of Southport north to Buoy 43, which is several miles below Wilmington. The stations were primarily located in the ship channel or in tidal creeks. Replicate samples were collected every two weeks at surface and bottom depths during the day and at night. In this manner the species composition, size distribution, and relative abundance of larvae in the CFE could be estimated. This section of the report covers the period September 1978 through May 1979 but makes comparisons where possible to earlier data. Comparisons of these data with those collected over the past six years gave trends in abundance and strengthened the conclusions in the CFS that the plant is not having an adverse environmental impact on the CFE.

Section 3 examines the cropping rate of the plant through entrainment. Entrainment refers to the passage through the plant's condensers of those organisms too small to be retained by the plant's trash racks or traveling screens. To document the cropping of larval and postlarval fish, penaeid shrimp and portunid crabs, larval nets fitted with flowmeters were used to collect samples in the discharge sluiceway. The discharge sluiceway was used because after passage through the plant the organisms were well mixed and, therefore, evenly distributed in the water column. Eight samples with replicates were taken during a 24-hour sampling period once a week. The numbers of larvae and postlarvae entrained were determined by expanding net catch densities in relation to total cooling water flow. This section of the report covers the period September 1978 through May 1979 and also makes comparisons with earlier data as reported in the multivolume Cape Fear Studies.

Section 4 examines the nektonic populations of the lower CFE. A 41-foot trawl was used at the deeper stations, and a 21-foot trawl plus a 100-yard gill net were used at each of the shallow stations. Samples were collected every three weeks to determine the relative seasonal abundance, species composition, and size distribution of the juvenile and adult fish and shellfish. This section of the report covers the period January through

August 1979 and makes comparisons to nektonic studies of a similar design that had been conducted from 1973 through 1978, as reported in the multivolume Cape Fear Studies.

Section 5 of this report examines the cropping of juvenile and adult fish and shellfish by the plant impingement. Organisms that are drawn in with the cooling water but are too large (typically over one inch) to pass through the plant are collected by the plant's traveling screens. Every two to three hours the organisms are washed off the screens and transported back to the estuary by CP&L's nekton return boat, the Ms. SLUICE. One day a week (over a 24-hour period) the organisms are diverted to a collection basket and examined. The results of these examinations yield a good estimate of the plant's cropping rate by species and size group. Impingement studies have been conducted since the first intake pump was started in January 1974.

Also contained in Section 5 is a summary of a diversion device study conducted after a one-half inch screen mesh fence was installed near the mouth of the intake canal in an effort to prevent larger fish from entering the intake canal and being impinged. Installation of this experimental diversion device was completed in January 1979, and it was considered effective through mid-May 1979 when it began to break away. It has since been repaired.

Conclusions on the trends of abundance of larval and juvenile and adult finfish and shellfish, the effectiveness of the diversion device, and the impact of the plant's entrainment and impingement rates are presented in Section 6.

2.0 Larval Fish

2.1 Introduction

North Carolina State University (NCSU) conducted a comprehensive study of larvae and postlarvae in the Cape Fear estuary (CFE) from October 1976 through August 1978 (CFS, Vol. VII). In September 1978 Carolina Power & Light Company (CP&L) initiated a long-term larval monitoring program based on the intensive NCSU study, but reduced in size and scope.

There are two periods of peak abundance of larvae in the CFE (CFS, Vol. VII). One peak runs from about May to September (summer) of each year, consisting mainly of anchovies (Anchoa mitchilli and A. hepsetus), seatrout (Cynoscion nebulosus and C. regalis) and gobies (Gobiosoma spp. and Gobionellus spp.). The second peak starts about December and continues through early April of each year (winter), consisting of spot (Leiostomus xanthurus), croaker (Micropogonias undulatus), flounder (Paralichthys lethostigma, P. dentatus and P. albigutta), menhaden (Brevoortia tyrannus) and mullet (Mugil cephalus and M. curema). The three species of penaeid shrimp overlap these periods of abundance, with the brown shrimp (Penaeus aztecus) generally occurring in the late winter to early spring and the white (P. setiferus) and pink (P. duorarum) shrimp occurring during the summer.

The summer samples contain large numbers of organisms per sample and had not been analyzed at the time this report was prepared. They will be discussed in the next CFS supplement. This section covers only the data collected from September 1978 through May 1979 (Trips 1-19); therefore, only those species which enter the estuary during the winter period will be discussed. These data will be compared with data collected during the two-year NCSU studies' winter periods. Additional data collected by NCSU prior to the comprehensive two-year study will also be analyzed for localized long-term effects. These NCSU data are from September 1973 through September 1976 and include CP&L Stations 21, 24, and 25 (Hodson, Schneider, and Copeland 1977; Copeland and Hodson 1977).

2.2 Station Descriptions

Nine stations were chosen for the monitoring program, consisting of six mid-channel stations, two tidal creek stations, and one station in the intake canal near the plant (Fig. [illegible]). An additional station located on the west side of the ship channel 1.8 miles (2.9 km) south of the intake area in Price's Creek (Station 19) was sampled from January 30, 1979, (Trip 11) through April 25, 1979, (Trip 17). Eight of the monitoring stations chosen are the same stations used by NCSU in their two-year intensive larval fish program and retain the same station numbers used in that program (Copeland and Hodson 1977, Copeland, Hodson, and Moore 1979).

Station 11 is located in Dutchman Creek approximately 0.6 mile (1 km) upstream from its intersection with the Intracoastal Waterway. It is a shallow water station with a mean low water (mlw) depth of 3.3-6.6 feet (1-2 m). Because of the shallow depth, there is little or no difference observed between surface and bottom hydrography (temperature and salinity).

Station 18 is the only permanent station in the monitoring program that was not covered in the NCSU study. It is located in the ship channel, south of Buoy 15 where the river passes between Battery Island and Southport. This is the closest station to the ocean. Water depth is approximately 40 feet (12 m) at mlw.

Station 21 is in the intake canal approximately 650 feet (200 m) from the BSEP intake structures. Comparison can be made between catches at this station and entrainment data. This area is about 16 feet (5 m) deep at mlw.

Station 24 is located in Walden Creek immediately downstream from the old highway (River Road) bridge. This station is approximately 1.5 miles (2.3 km) upstream from the intersection of the canal and the creek. Water depth is 5-10 feet (1.5-3 m) at mlw.

Station 25 is located in the river channel north of Buoy 19, in the vicinity where the intake canal meets the river channel. Station 25 is approximately 3.3 miles (5 km) from the BSEP intake structure. Water depth is about 40 feet (12 m) at mlw.

Station 27 is located in the river channel north of Buoy 23, about 2.4 miles (3.6 km) upriver from Station 25. The southernmost channel to Sunny Point Military Terminal originates here. Water depth at mlw is about 40 feet (12 m).

Station 37 is located in the river channel south of Buoy 29, about 6.6 miles (9.9 km) upriver from Station 25. At this location the Intracoastal Waterway branches off the river channel to the northeast through Snows Cut. Water depth is about 40 feet (12 m) at mlw.

Station 34 is located in the river channel north of Buoy 37, about 10.8 miles (16.2 km) upriver from Station 25. The north channel from Snows Cut joins the river channel at this point. Water depth is about 40 feet (12 m) at mlw.

Station 41 is located in the river channel south of Buoy 43, in the vicinity of Campbell Island about 14 miles (22.2 km) upriver from Station 25. This is the uppermost station in the monitoring program. Until January 1979 this station was not sampled during heavy freshwater flow. Heavy freshwater flow was determined by the bottom salinity at Station 34 being less than 10 ppt. Since this only occurred twice, Station 41 was permanently added. Water depth is about 40 feet (12 m) at mlw.

For sampling purposes the estuary was divided into four sections by NCSU (CFS, Vol. VII). The sections were lettered A through D extending from the mouth of the estuary toward Wilmington. For the CP&L monitoring program, stations were likewise sectioned into groups using the same NCSU group designations: Stations 11, 18, and 19 were in Group A; Stations 21, 24, 25, and 27 were in Group B; Stations 34 and 37 were in Group C; and Station 41 was in Group D.

2.3 Methods and Materials

Larvae and postlarvae in the CFE were sampled twice in a 24-hour period, every two weeks (Table 2.1). Stations were sampled once during the day and once at night. Sampling was usually begun at least an hour after sunrise and sunset. The time for a complete run depended upon the weather and the amount of detritus in the samples, but usually all nine stations were sampled within a 5-hour period.

Samples were collected with 505 micron mesh plankton nets mounted on rectangular or square frames. The surface nets were attached to 80-cm (31.5 inches) square frames which were fastened by a pivot to the deck of the boat. Two surface nets, one on each side of the boat, were simultaneously fished just below the surface of the water to provide replicate samples. Simultaneous replicate bottom samples were obtained using a sled on which a frame containing two 505 micron mesh plankton nets were mounted. The rectangular nets were attached side by side in 104 cm (41 inches) high by 51.4 cm (20.25 inches) wide openings. General Oceanics Model 2030 flowmeters were suspended in the mouth of each net. The sled was towed with 36.6 meters (120 feet) of rope attached to the runners of the sled. The runners kept the nets about 15 cm (6 inches) above the bottom. Salinity and temperature measurements were taken from the surface and bottom at each station using a Fisher immersion thermometer and an American Optical Model 10419 refractometer. Bottom water samples were collected with a Kemmerer water sampler.

Surface and bottom larval samples were collected simultaneously. Stations were resampled if there was more than a 2,000 revolution difference between the flow meters in replicate nets or if there were less than 3,000 revolutions recorded on any meter. Nets were washed using forced water from a water pump and hose. Each sample was preserved in 10% formalin in numbered plastic jars. Usually a total of 72 samples were collected during each sampling trip, although 80 samples were collected when Price's Creek was sampled (Table 2.1).

In the laboratory the preserved samples were washed to remove formalin, and all fish larvae and postlarvae, penaeid shrimp postlarvae, portunid crab megalops, and blue crabs were picked out using a 3X magnifying lamp. Juveniles and adults of these taxa were also processed although they were seldom collected. Organisms were identified to the lowest practical taxon (Table 2.2), measured (total length of up to 100 fish and shrimp), and counted. NCSU recorded length measurements in standard length (SL). To permit length comparisons, a conversion equation was utilized to compute standard length from total length (Table 2.3). All comparisons were done using these converted lengths. Organisms collected in this program after September 1, 1979, will be measured using standard length.

To assure accuracy in sample processing, a quality control check was performed on each set of samples. This consists of randomly selecting 12.5% of the samples which had been previously picked twice and having different people again pick through the residue. If a deviation of 5% or more of the total number of larvae recovered on the first sort was found in the second pick, the entire set was repicked. This process was used to check the accuracy and ensure consistency in identification, measuring, and counting organisms.

2.4 Results and Discussion

2.4.1 Hydrography

For comparison purposes, salinity and temperature measurements were combined by group (i.e., A, B, C, or D as detailed in Section 2.2). Salinity ranged from zero to near full strength ocean water (Figure 2.2). Overall, salinities were highest during the fall (19-33 ppt) and lowest in the spring (0-18 ppt). By group, salinities were highest downstream in Group A (9-33 ppt) and lowest upstream in Group D (0-21 ppt) with intermediate salinities recorded for Groups B and C.

Bottom salinities were higher than surface salinities. These observations are a result of a combination of the Cape Fear River freshwater flow and tidal influences and are consistent with observations recorded over the past ten years. Additional information on salinity gradients can be found in Section 4.3 (pp 4.18-4.20) of the Interpretive Report.

The water temperature recorded during this study ranged from a low of 6°C (42.8°F) during Trip 12 to a high of 27°C (80.6°F) during Trip 1 with practically no difference among the four groups (Figure 2.3). Typically lowest temperatures were recorded in February (Interpretive Report, Section 4.4).

2.4.2 Dominant Species

Ninety-six taxa of fish and shellfish were collected between September 1978 and May 1979 (Table 2.4). To facilitate analysis, eight major species or species groups were chosen because of their abundance and commercial/recreational importance for a more detailed examination (see Interpretive Report, Section 5.1.1). Six of these species or taxa represented over 65% of the total number of fish and shellfish collected during September through May 1979. Croaker represented 33.5%; spot, 19.4%; menhaden, 3.9%; shrimp, 4.5%, flounder, 2.8%; and mullet, 1.3%. Two other species groups, seatrout and anchovies, represented almost 10% of the total, but the majority of these species were not seen until later in the year, after the 1979 data cutoff in May.

2.4.3 Size Distribution

Spot were first collected at a mean length of around 10 mm (standard length) (Fig. 2.4). Their size increased to a mean length of around 22 mm during their peak abundance before decreasing in size near the end of recruitment. Croaker were first collected at around 7 mm and gradually increased to 12 mm (Fig. 2.5). They remained about the same size throughout recruitment before showing a rapid increase in size at the end of recruitment. Menhaden were first collected at around

19 mm and increased to 27 mm during the peak period of recruitment (Fig. 2.6). Shrimp collected during the fall (probably pinks and whites) were around 8-9 mm during their period of abundance (Fig. 2.7). The spring recruitment of shrimp (probably browns) started at a larger size (12-13 mm) and gradually decreased to around 10 mm near the end of recruitment. Flounder were first collected when around 9 mm in size (Fig. 2.8). They increased to around 13-17 mm in size by the end of recruitment. Mullet were collected when around 20-23 mm (Fig. 2.9).

Larvae in the upstream areas were significantly larger than those downstream. This agrees with NCSU data (CFS, Vol. VII). During the period of peak abundance, spot were 1-3 mm larger in Group D than those found in the other groups (Fig. 2.4). This characteristic was even more pronounced for croaker with as much as a 5-mm difference between Groups A and D (Fig. 2.5). This difference is even more appreciable when it is realized that these fish are only 13-20 mm in length. Shrimp and menhaden showed little size difference among the four groups. Flounder appeared to be slightly larger in Group D during recruitment but exhibited a large increase in size at the end of recruitment (Figures 2.7, 2.6, 2.8).

Mullet were caught in too few numbers to make any length comparisons. This is probably due to the low gear efficiency for mullet due to their behavior of swimming at the surface, while our surface nets sample just below the surface and their ability to avoid the net by high swimming speeds compared to spot (Rulifson and Huish 1975).

2.4.4 Temporal Distribution of Larvae

The arrival, period of peak recruitment, and the time of the cessation of recruitment for each species were essentially the same in the 1978-79 season as they had been in the two previous seasons. A comparison of Figures 2.10 through 2.15 in this report with Figures 7.2 through 7.7 in Volume VII of the Cape Fear Studies confirms this fact. Spot recruitment started in December and extended into the first part of April all three years. In 1978-79 spot larvae may have continued to enter the CFE an additional two weeks longer, perhaps as a result of colder temperatures.

Croaker were collected from September through May in all three years with the large densities collected in the upstream areas during the end of recruitment.

Menhaden exhibited a shorter recruitment period and were collected from February through May. In all three years, the highest catches were recorded near the end of March and during the first of April.

Brown shrimp recruitment started in March, peaked in April, and decreased to near zero in May before the summer recruitment of pink and white shrimp started.

Likewise, flounder recruitment occurred as expected, December to April, with the greatest densities found near the end of February and the first of March.

Mullet recruitment was initiated in December and extended through the first of May in 1976-77 and 1977-78 with a peak near the end of February or first of March. The 1978-79 data show the same peak, but the period of recruitment only lasted from December through March.

2.4.5 Spatial Distribution of Larvae

Subsequent to recruitment, certain behavioral mechanisms involving the net upstream tidal drift on the bottom of the ship's channel are used by the larvae to move to upstream nursery areas. Responses to light and depth enable the larvae to utilize tidal currents to reach the upstream areas (CFS, Vol. VII).

An examination of larval data collected by NCSU shows that croaker, shrimp, and flounder are much more abundant near the bottom than they are at the surface during the day. Mullet, on the other hand, have been consistently more abundant on the surface than the bottom.

Menhaden are usually more abundant on the surface, although these differences are not significant. Figure 2.16 illustrates that this behavioral characteristic of these species has not changed since 1973.

Another obvious phenomenon is the higher densities collected at night as compared to the daytime catches. All of the representative species, except menhaden, were caught in significantly higher densities at night. This characteristic has held true since 1973 (Fig. 2.17). Menhaden had in the past been collected more abundantly at night, but in 1978-79 the daytime densities were higher.

During the reported period (September through May), spot densities averaged just over 10/1000 m^3 during the day, while they averaged over 70/1000 m^3 at night. Croaker averaged 4/1000 m^3 during the day and 18/1000 m^3 at night; shrimp, 5/1000 m^3 during the day and 13/1000 m^3 at night; flounder, 2/1000 m^3 during the day and 16/1000 m^3 at night; mullet, 2/1000 m^3 during the day and 4-5/1000 m^3 at night; and menhaden, 6/1000 m^3 during the day and 5/1000 m^3 at night (Fig. 2.17).

The larger total number of larvae present in the estuary seen in nighttime densities is due to their vertical movement up in the water column. It is very probable that since our nets mounted on sleds do not sample the very bottom 15 cm (6 in) of the water column, the daytime bottom samples are not representative of the true abundance of larvae. Reduced catches, especially during daylight hours, could be the result of net avoidance by organisms. Although, as explained in Volume VII (Section 6.2.1), this is not the only reason.

The ANOVA tests show that the interaction of depth by day/night was highly significant (0.001 probability) which is consistent througnout the study period for all species except menhaden, which showed a lower significance (.1190 probability) for the depth by day/night interaction for 1979 (Table 2.5). Spot, flounder, and brown shrimp show mean surface and bottom densities at night to be very similar. This is due to their migrating to the surface at night The resulting interaction arises from the fact that bottom daytime and bottom nighttime densities are very similar, but surface daytime densities were extremely low, usually approaching zero even during periods of peak density.

Croaker showed a slight variation of this pattern because they did not migrate to the surface in large numbers even at night (Fig. 2.18). Croaker densities at the surface at night were seldom as high as daytime or nighttime densities at the bottom. They were, however, higher than surface daytime catches.

2.4.6 Larval Density Trend (1974-1979)

A trend analysis of larval densities in the Cape Fear River estuary for Stations 21, 24, and 25 which are in the vicinity nearest the intake (Fig. 2.1) for the years 1974-1979 is shown in Table 2.6. All species except brown shrimp show an upward trend in larval densities. The downward trend of brown shrimp can be clearly attributed to the cold winter of 1977 and the high freshwater flows in 1978 since this trend was observed in other North Carolina estuaries and in the Gulf of Mexico. As stated in the Current Fisheries Statistics, "The unusually cold winter of 1977 accounted for both the lower catch (shrimp) and a marked change in the species composition of the catch" (NMFS 1978). It occurred again in 1978 and the Current Fisheries Statistics stated "As in 1977, the unusually cold winter as well as heavy spring rains accounted for the lower catch of shrimp (in 1978)" (NMFS 1979). Thus, although the overall trend has been downward for shrimp, there was a substantial increase in 1979 densities, .cating that the brown shrimp is recovering from the disastrous years of 1977 and 1978 (Fig. 2.19) with almost a five-fold increase from 1978 to near the 1975 and 1976 levels.

The upward trend in larval densities ranged from 3.0% per year (menhaden) to 30.0% per year (spot) (Table 2.6). As stated in the Interpretive Report, Section 5.3.2.7, statistical analysis for each species suggests that some of these trends can be explained in terms of the year-to-year fluctuations in abundance or to the random sampling or both; but the weight of the combined evidence clearly suggests a healthy escuary with no increases in plant entrainment.

Trend lines including 95% confidence interval estimates of the true population densities are plotted in Figure 2.19. Differences among years were partitioned into a trend component proportional to the size of the linear increase (or decrease) and a deviation component proportional to the size of the year-to-year fluctuations around the trend line. The error component used to judge the significance of the first two was computed from the discrepancy between sampling periods within years. The percent change per year is calculated from the slope of the trend line, and the relative standard deviation is the square root of the error mean square expressed as percent of average density. The latter is included because it represents the intrinsic random error encountered with each species. The logarithm of the densities was analyzed throughout. (Interpretive Report, Section 5.3.2.7).

2.5 Conclusions

Spot, croaker, menhaden, brown shrimp, flounder, and mullet constitute the majority of larval and postlarval fish in the Cape Fear estuary during the period from September to May (Table 2.4). The arrival and departure time of particular larval species into the estuary has been consistent through the years 1974 to 1979. Spot occurred from December to April, croaker from September to May, menhaden from February to May, brown shrimp from March to May, flounder from December to April, and mullet from December to May. During this same five-year period, night densities were greater than day densities and bottom densities were greater than surface densities, with an increase of surface densities at night (Figs. 2.16, 2.17, and 2.18).

Another characteristic common to each year is the movement, concentration and growth of most species upstream from the intake canal area. A typical example is that of spot. After the initial recruitment of larvae from the ocean, there is a rapid dispersion of spot larvae throughout the estuary. During the latter part of the recruitment period when new waves of recruits seem to be entering the downriver sections, the mean size in the upriver sections is larger than the downriver sections indicating growth of those organisms upriver (Fig. 2.4). This is even more pronounced in croaker (Fig. 2.5).

Trend analysis performed on spot, croaker, menhaden, brown shrimp, flounder, and mullet to indicate long-term effects show increasing numbers of larvae over the years from 1974 through 1979 with the exception of brown shrimp which showed a downward trend (Fig. 2.19). This downward trend can be explained as a response to the colder temperatures experienced in 1977 [illegible]978 and the heavy freshwater flow during recruitment of 1978, especially since shrimp densities showed a large increase in 1979. Considering the overall increase in larval densities, it appears that the plant is having no adverse environmental impact.

2.6 References

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Table 2.1 Trip numbers, sampling dates, and number of larval samples collected in the Cape Fear River estuary. September 1978 - May 1979.

Trip	Date	# of Samples Collected
1	9/12-13/78	72
2	9/26-27/78	72
3	10/10-11/78	72
4	10/24-25/78	72
5	11/7-8/78	72
6	11/21-22/78	72
7	12/5-6/78	68*
8	12/18-19/78	64*
9	1/4-5/79	72
10	1/16-17/79	72
11	1/30-31/79	80**
12	2/13-14/79	80**
13	2/27-28/79	80**
14	3/12-13/79	80**
15	3/27-28/79	80**
16	4/10-11/79	80**
17	4/24-25/79	80**
18	5/8-9/79	72
19	5/22-23/79	72

*Station 41 not sampled because of heavy freshwater flow.

**Station 19 (Prices Creek) sampled.

Table 2.2 Larval fish identification guidelines.

Family	Identification Level
Clupeidae (herring)	Species
Engraulidae (anchovies)	12 mm TL and over - Species 11 mm TL and under - Genus
Atherinidae (silversides)	Family below 25 mm TL
Centrarchidae (sunfish)	Genus - except for *Micropterus salmoides*
Carangidae (jacks)	Genus - before ray development Species - after ray development
Gerreidae (mojarras)	Genus only
Uranoscopidae (stargazers)	Genus only
Blenniidae (blennies)	Family only
Gobiidae (gobies)	
1. Gobionellus	Genus - under 25 mm TL
2. Gobiosoma	Genus - under [illegible]
3. Microgobius	Genus only
Triglidae (sea robins)	Family - under 25 mm TL
Bothidae (flounder)	Genus - under 25 mm TL
Cynoglossidae (soles)	Genus - only prior to caudal ray development, then to species
Portunidae (swimming crabs)	
1. Megalops	Genus - only count
2. Juveniles	Species - count and measure

All other fish should be taken to species unless mutilated or rare.

TABLE 2.3 STANDARD LENGTH CONVERSION FROM TOTAL LENGTH

STANDARD = A + B (TOTAL)

SPECIES	A	B	R^2	# Fish
Spot	1.1026	0.7850	.98	50
Croaker	0.5592	0.7751	.92	125
Menhaden	0.3151	0.8699	.85	25
Flounder	0.7477	0.7643	.83	25
Mullet	-0.1232	0.8421	.95	25
Anchovy	1.3392	0.7972	.99	25
Weakfish	0.5928	0.7270	.99	25

TABLE 2.4 TOTAL DENSITY AND PERCENT TOTAL OF FISH AND PENAEID SHRIMP COLLECTED IN THE RIVER LARVAL FISH PROJECT, SEPTEMBER 1978 TO MAY 1979.

SPECIES SCIENTIFIC NAME	SPECIES COMMON NAME	DENSITY	PERCENT
MICROPOGONIAS UNDULATUS	ATLANTIC CROAKER	297910.32	33.48
LEIOSTOMUS XANTHURUS	SPOT	172471.23	19.38
GOBIOSOMA SPECIES	GOBIOSOMA SPECIES	88124.27	9.90
ATHERINIDAE	SILVERSIDES	62858.47	7.06
ANCHOA SPECIES	ANCHOVY SPECIES	51759.42	5.82
PENAEUS SPECIES	PENAEID SHRIMP	39632.38	4.45
BREVOORTIA TYRANNUS	ATLANTIC MENHADEN	34558.54	3.88
ANCHOA MITCHILLI	BAY ANCHOVY	22469.39	2.52
PARALICHTHYS SPECIES	FLOUNDER	21041.68	2.36
LAGODON RHOMBOIDES	PINFISH	18767.95	2.11
MUGIL CEPHALUS	STRIPED MULLET	11472.83	1.29
ANCHOA HEPSETUS	STRIPED ANCHOVY	8963.69	1.01
GOBIONELLUS SPECIES	GOBIONELLUS SPECIES	5920.14	0.67
BLENNIIDAE	COMBTOOTH BLENNIES	4454.42	0.50
PARALICHTHYS LETHOSTIGMA	SOUTHERN FLOUNDER	3437.78	0.39
CYNOSCION REGALIS	WEAKFISH	1342.26	0.15
MICROGOBIUS SPECIES	MICROGOBIUS SPECIES	1346.76	0.15
GOBIONELLUS BOLEOSOMA	DARTER GOBY	1119.64	0.13
ANGUILLA ROSTRATA	AMERICAN EEL	1119.42	0.13
BAIRDIELLA CHRYSURA	SILVER PERCH	1036.10	0.12
SYMPHURUS PLAGIUSA	BLACKCHEEK TONGUEFISH	991.56	0.11
MYROPHIS PUNCTATUS	SPECKLED WORM EEL	986.21	0.11
POGONIAS CROMIS	BLACK DRUM	778.36	0.08
GOBIESOX STRUMOSUS	SKILLETFISH	705.57	0.08
PARALICHTHYS ALBIGUTTA	GULF FLOUNDER	668.19	0.08
SYNGNATHUS FUSCUS	NORTHERN PIPEFISH	646.04	0.07
ELOPS LEPTOCEPHALUS	LADYFISH LARVAE	628.50	0.07
CITHARICHTHYS SPECIES	WHIFF	515.10	0.06
ORTHOPRISTIS CHRYSOPTERA	PIGFISH	376.04	0.04
CYPRINUS CARPIO	CARP	369.89	0.04
UNKNOWN TRIGLIDAE	SEAROBIN	342.20	0.04
SYNGNATHUS LOUISIANAE	CHAIN PIPEFISH	234.67	0.03
UNKNOWN FISH	UNKNOWN FISH	158.59	0.02
SYNODUS FOETENS	INSHORE LIZARDFISH	191.83	0.02
ALOSA SPECIES	HERRING	181.47	0.02
EUCINOSTOMUS SPECIES	MOJARRA	159.47	0.02
CYNOSCION NEBULOSUS	SPOTTED SEATROUT	144.15	0.02
DORMITATOR MACULATUS	FAT SLEEPER	141.58	0.02
PRIONOTUS TRIBULUS	BIGHEAD SEAROBIN	108.39	0.01
OPHICHTHUS GOMESI	SHRIMP EEL	107.51	0.01
GOBIOSOMA GINSBURGI	SEABOARD GOBY	99.40	0.01
SCIAENOPS OCELLATA	RED DRUM	89.65	0.01
PARALICHTHYS DENTATUS	SUMMER FLOUNDER	82.38	0.01
CARANX SPECIES	JACK	77.78	0.01
CHLOROSCOMBRUS CHRYSURUS	ATLANTIC BUMPER	77.04	0.01
LEPOMIS SPECIES	SUNFISH	72.26	0.01
GOBIONELLUS SHUFELDTI	FRESHWATER GOBY	72.04	0.01
MENTICIRRHUS SPECIES	KINGFISH	66.75	0.01
MONACANTHUS HISPIDUS	PLANEHEAD FILEFISH	56.96	0.01
CENTRARCHID SPECIES	UNIDENTIFIED SUNFISH	47.39	0.01
GOBIONELLUS HASTATUS	SHARPTAIL GOBY	46.56	0.01

TABLE 2.4 TOTAL DENSITY AND PERCENT TOTAL OF FISH AND PENAEID SHRIMP COLLECTED IN THE RIVER LARVAL FISH PROJECT, SEPTEMBER 1978 TO MAY 1979.

SPECIES SCIENTIFIC NAME	SPECIES COMMON NAME	DENSITY	PERCENT
TRINECTES MACULATUS	HOGCHOKER	43.99	0.00
PERCA FLAVESCENS	YELLOW PERCH	43.96	0.00
UNKNOWN SCIAENIDAE	DRUM	43.90	0.00
MENIDIA MENIDIA	ATLANTIC SILVERSIDE	41.69	0.00
CITHARICHTHYS SPILOPTERUS	BAY WHIFF	30.44	0.00
GOBIOSOMA BOSCI	NAKED GOBY	28.77	0.00
NOTEMIGONUS CRYSOLEUCAS	GOLDEN SHINER	28.20	0.00
SCOPHTHALMUS AQUOSUS	WINDOWPANE	26.65	0.00
SYMPHURUS CIVITATUS	OFFSHORE TONGUEFISH	25.74	0.00
ARCHOSARGUS PROBATOCEPHALUS	SHEEPSHEAD	24.81	0.00
UNKNOWN CLUPEIDAE	HERRING	23.10	0.00
MYCTEROPERCA SPECIES	GROUPER	21.92	0.00
ALOSA PSEUDOHARENGUS	ALEWIFE	21.89	0.00
STELLIFER LANCEOLATUS	STAR DRUM	17.72	0.00
PRIONOTUS SCITULUS	LEOPARD SEAROBIN	17.17	0.00
EPINEPHELUS SPECIES	GROUPER	16.32	0.00
ETROPUS CROSSOTUS	FRINGED FLOUNDER	15.29	0.00
ASTROSCOPUS Y-GRAECUM	SOUTHERN STARGAZER	13.98	0.00
UNKNOWN CYPRINODONTIDAE	KILLIFISH	13.18	0.00
MEGALOPS ATLANTICA	TARPON	12.64	0.00
GERREIDAE	MOJARRAS	12.01	0.00
STRONGYLURA MARINA	ATLANTIC NEEDLEFISH	11.77	0.00
LUTJANUS GRISEUS	GRAY SNAPPER	11.66	0.00
MUGIL CUREMA	WHITE MULLET	11.65	0.00
TRACHINOTUS FALCATUS	PERMIT	11.59	0.00
SYNGNATHUS SPECIES	PIPEFISH SPECIES	10.89	0.00
TRACHYPENAEUS CONSTRICTUS	BANDIT SHRIMP	10.89	0.00
FUNDULUS HETEROCLITUS	MUMMICHOG	7.97	0.00
MORONE SAXATILIS	STRIPED BASS	7.90	0.00
ETHEOSTOMA SPP	DARTER	7.58	0.00
UNKNOWN PERCIDAE	PERCH	7.58	0.00
TAUTOGA ONITIS	TAUTOG	7.39	0.00
UNKNOWN CYPRINIDAE	UNKNOWN MINNOW	7.38	0.00
MORONE SPECIES	MORONE SPECIES	7.12	0.00
HYPORHAMPHUS UNIFASCIATUS	HALFBEAK	7.03	0.00
OPSANUS TAU	OYSTER TOADFISH	7.00	0.00
ELEOTRIS PISONIS	SPINYCHEEK SLEEPER	6.98	0.00
UNKNOWN LUTJANIDAE	SNAPPER	6.21	0.00
EUCINOSTOMUS LEFROYI	MOTTLED MOJARRA	5.94	0.00
CONGER OCEANICUS	CONGER EEL	5.89	0.00
UNKNOWN URANOSCOPIDAE	STARGAZER	5.50	0.00
SYMPHURUS SPECIES	TONGUEFISH	5.40	0.00
UROPHYCIS REGIUS	SPOTTED HAKE	4.87	0.00
SPHOEROIDES MACULATUS	NORTHERN PUFFER	4.56	0.00
CHILOMYCTERUS SCHOEPFI	STRIPED BURRFISH	4.26	0.00
	TOTAL	889920.61	96.60

Table 2.5 Results of analysis of variance for river larval fish study, September 1978 - May 1979

Source	DENSITY Spot	Croaker	Menhaden	Flounder	Mullet	Brown Shrimp
Year	***	***	**	***	***	***
	9 8 7 5 4 6	8 9 5 7 6 4	9 7 5 4 8 6	9 8 7 5 6 4	9 8 7 6 5 4	5 6 9 7 8
Time Period	***	***	****	***	***	***
Year*Temp.	***	***	***	***	***	***
Station	**	***	**	***	***	***
	24 25 21	25 21 24	24 25 21	25 24 21	24 21 25	24 21 25
Depth	***	***	*	***	***	***
	B>S	B>S	S>B	B>S	S>B	B>S
Station*Depth	***	***	**	**	***	ns
Year*Station	*	***	ns	ns	***	**
Year*Depth	***	***	ns	***	**	*
Temp.*Station	**	***	**	*	ns	***
Temp.*Depth	***	***	ns	***	*	[illegible]
Day/Night	***	***	***	***	***	***
	N>D	N>D	D>N	N>D	N>D	N>D
Year*Day/Night	**	***	***	***	**	***
Temp.*Day/Night	***	***	***	***	***	ns
Station*Day/Night	***	*	ns	***	**	***
Depth*Day/Night	***	***	ns	***	***	***
$\bar{X}$	1.259	0.850	0.661	0.527	0.197	0.694
s^2	.374	.358	.355	.232	.142	.325
r^2	.670	.640	.477	.555	.432	.623
Time Periods	9-17	1-18	11-17	9-15	11-15	13-18
Season	Dec-Apr	Sept-May	Feb-May	Dec-Apr	Dec-Mar	Mar-May

*significant at the .05 α - level
**significant at the .01 α - level
***significant at the .001 α - level

Table 2.6 River larval-fish trend analysis, Stations 21, 24, and 25, September 1974 - May 1979

SPECIES	MEAN SQUARES			% CHANGE/YEAR
	TREND	DEVIATION	ERROR	
Spot	.23253**	.06149**	.00869	+30
Croaker	.05442**	.01347	.00669	+14
Menhaden	.00294	.00664	.01617	+ 3
Flounder	.13910**	.00770	.00823	+23
Mullet	.10968**	.00420	.00636	+20
Brown shrimp*	.15238	.10750	.04510	-25

*No data available for 1973
**Significance level = 0.01

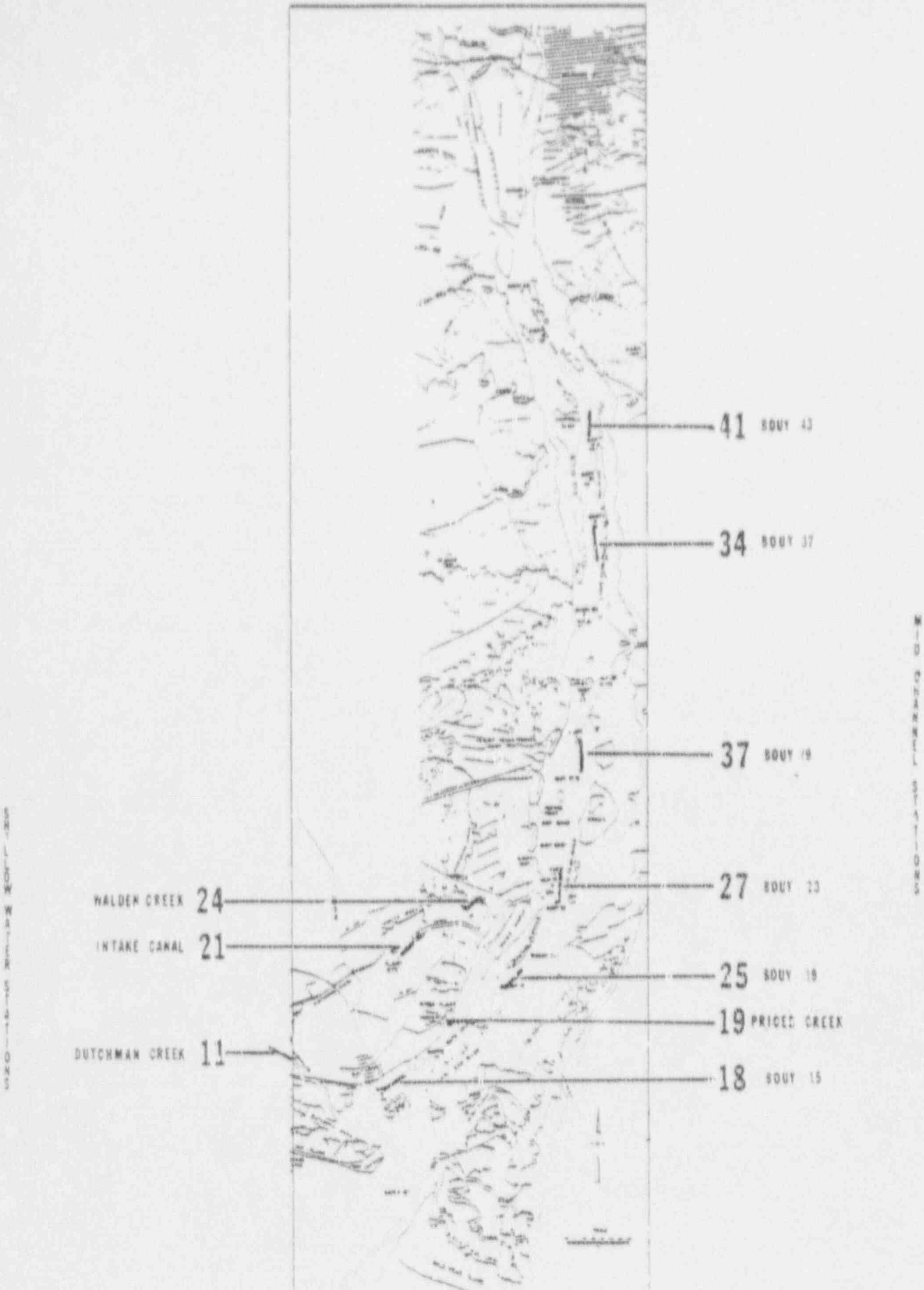


Figure 2.1 CP&L MONITORING STATIONS — LARVAL FISH PROGRAM

FIGURE 2.2 MEAN SALINITY BY GROUP FOR RIVER LARVAL FISH PROJECT.
(September 1978 - May 1979)

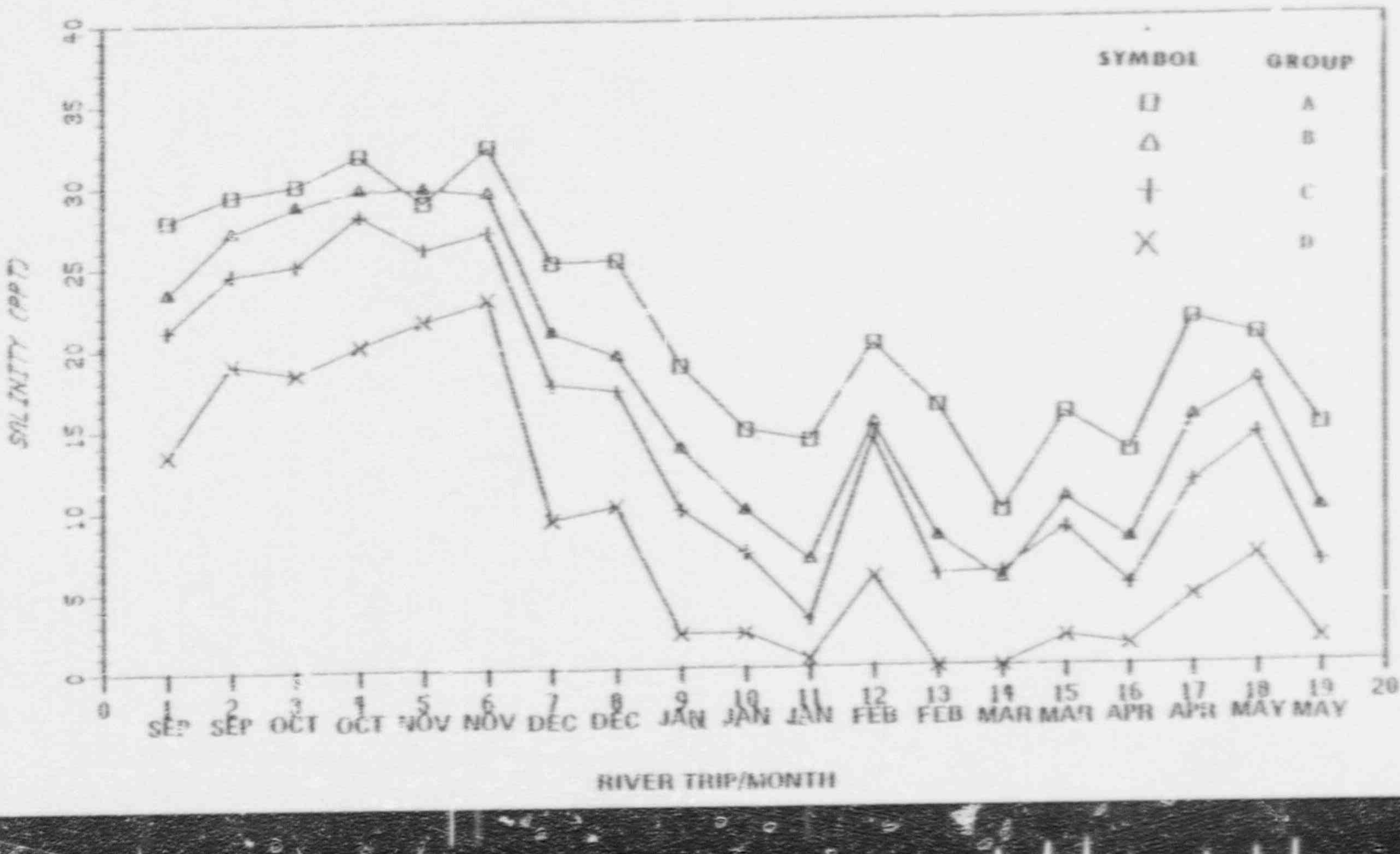


FIGURE 2.3 MEAN TEMPERATURE BY GROUP FOR RIVER LARVAL FISH PROJECT.
(September 1978 - May 1979)

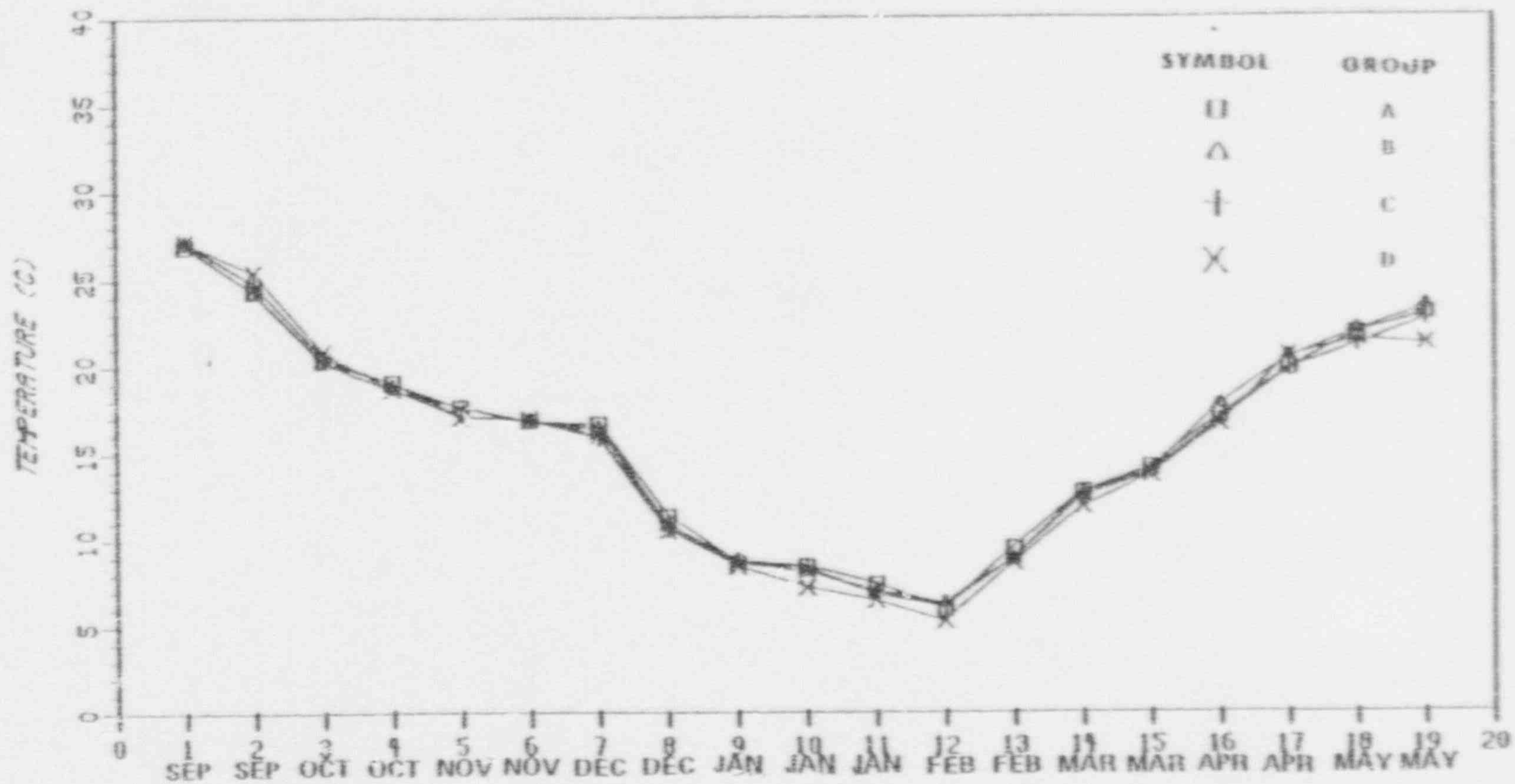


FIGURE 2.4 MEAN LENGTH OF RIVER LARVAE BY GROUP, SEPTEMBER 1978 - MAY 1979.

SPECIES=SPOT

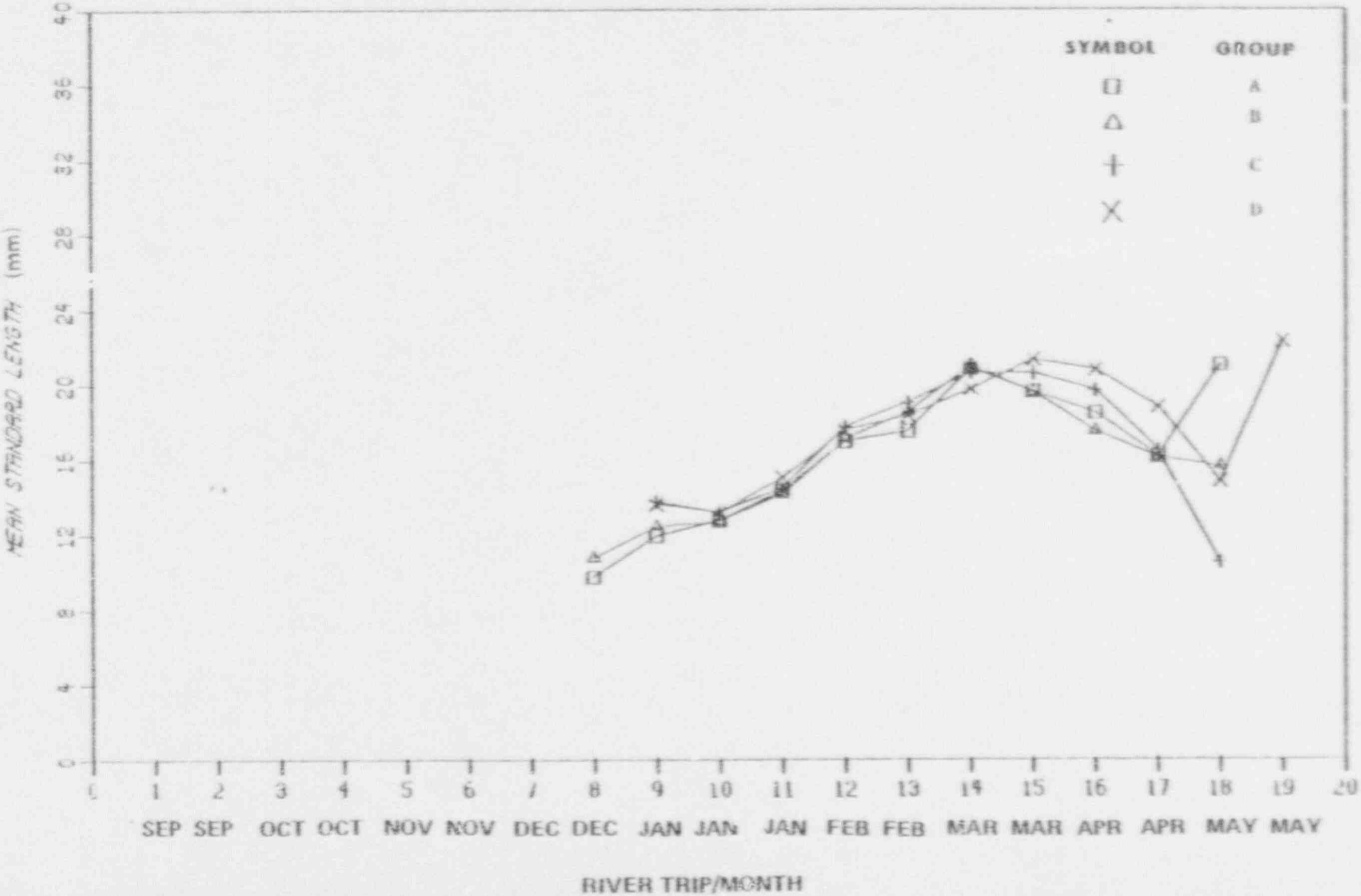


FIGURE 2.5 MEAN LENGTH OF RIVER LARVAE BY GROUP, SEPTEMBER 1978 - MAY 1979.

SPECIES-CROAKER

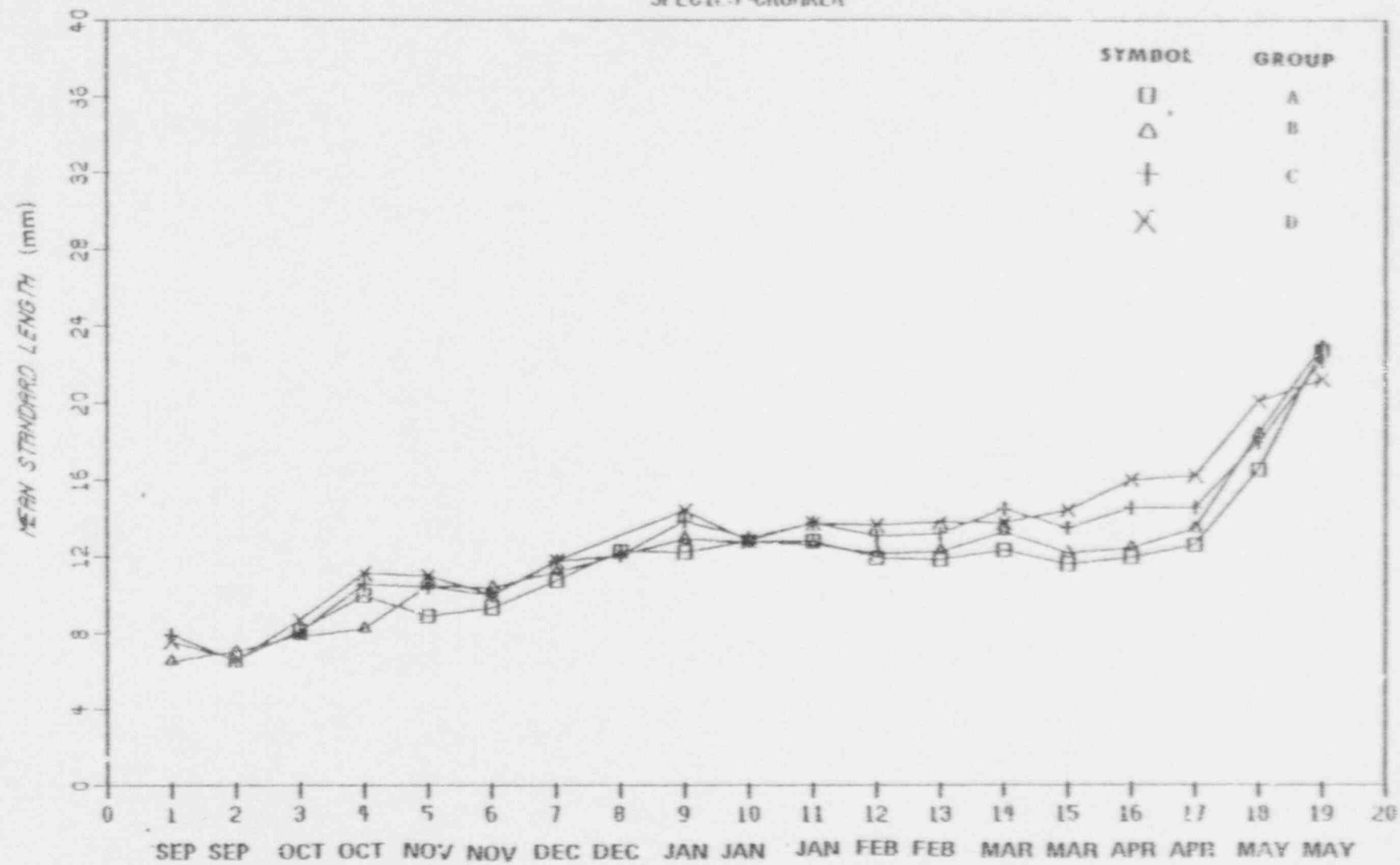


FIGURE 2.6 MEAN LENGTH OF RIVER LARVAE BY GROUP, SEPTEMBER 1978 - MAY 1979.

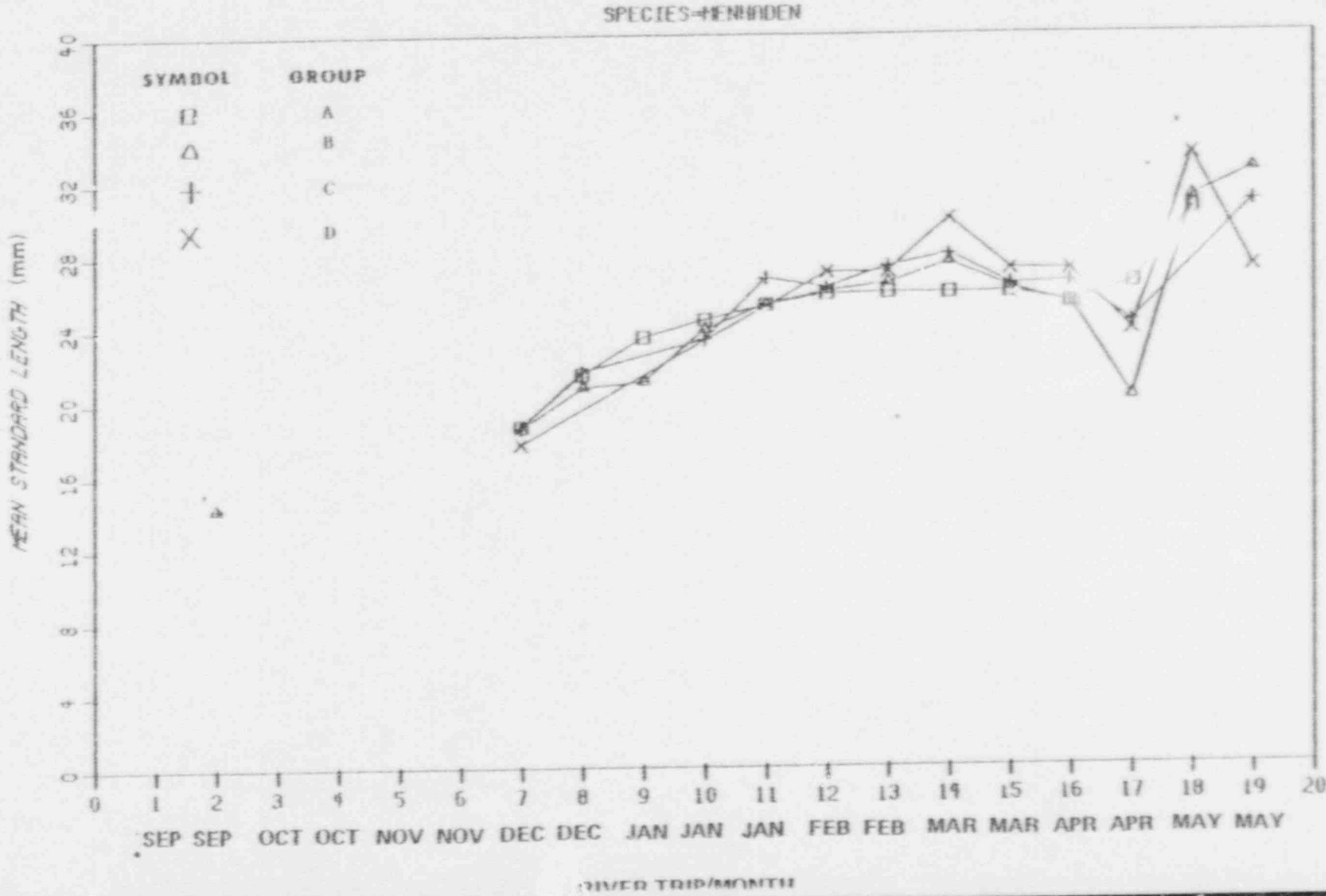


FIGURE 2.7 MEAN LENGTH OF RIVER LARVAE BY GROUP, SEPTEMBER 1978 - MAY 1979.

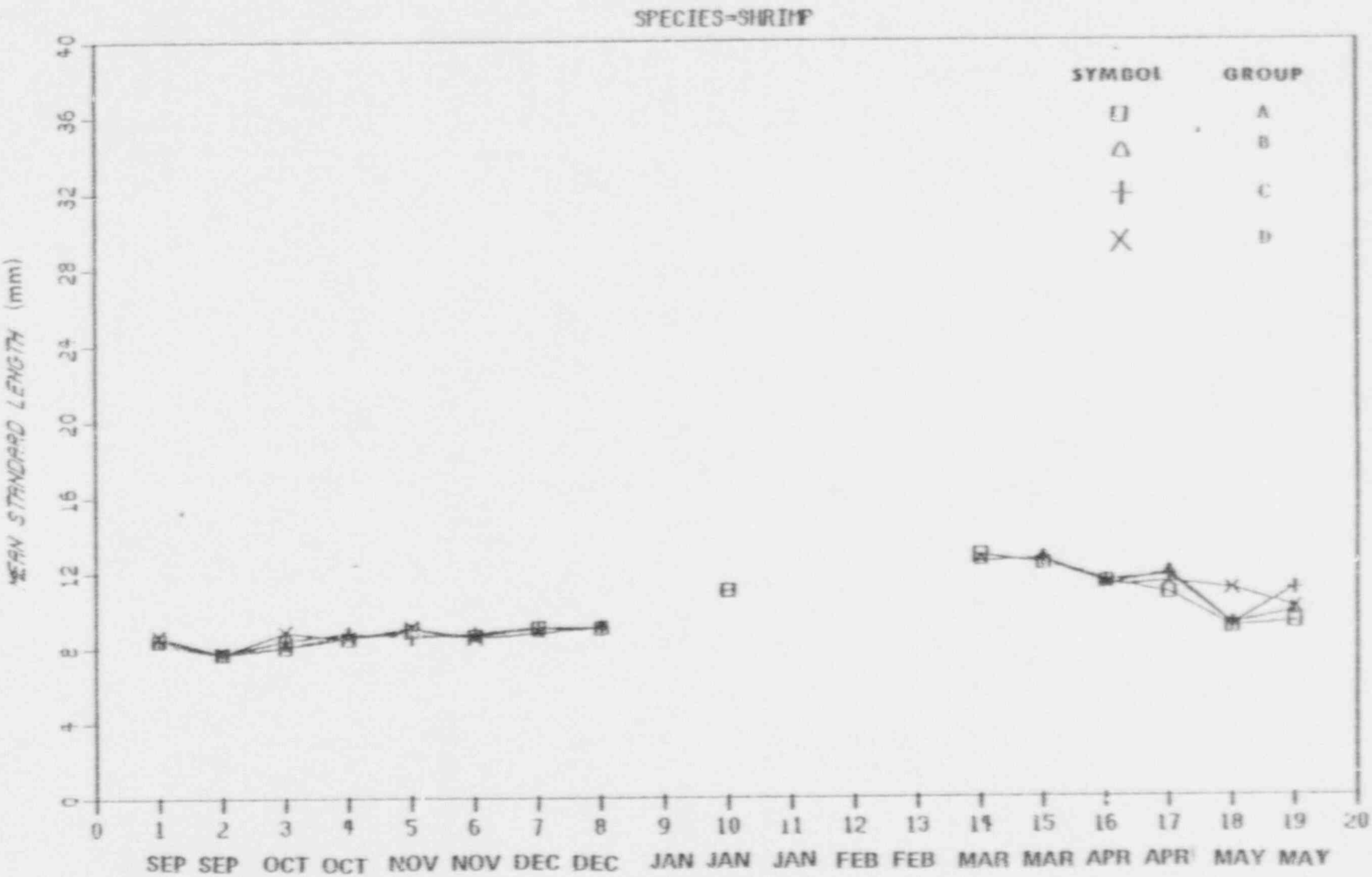


FIGURE 2.8 MEAN LENGTH OF RIVER LARVAE BY GROUP, SEPTEMBER 1978 - MAY 1979.

SPECIES=FLOUNDER

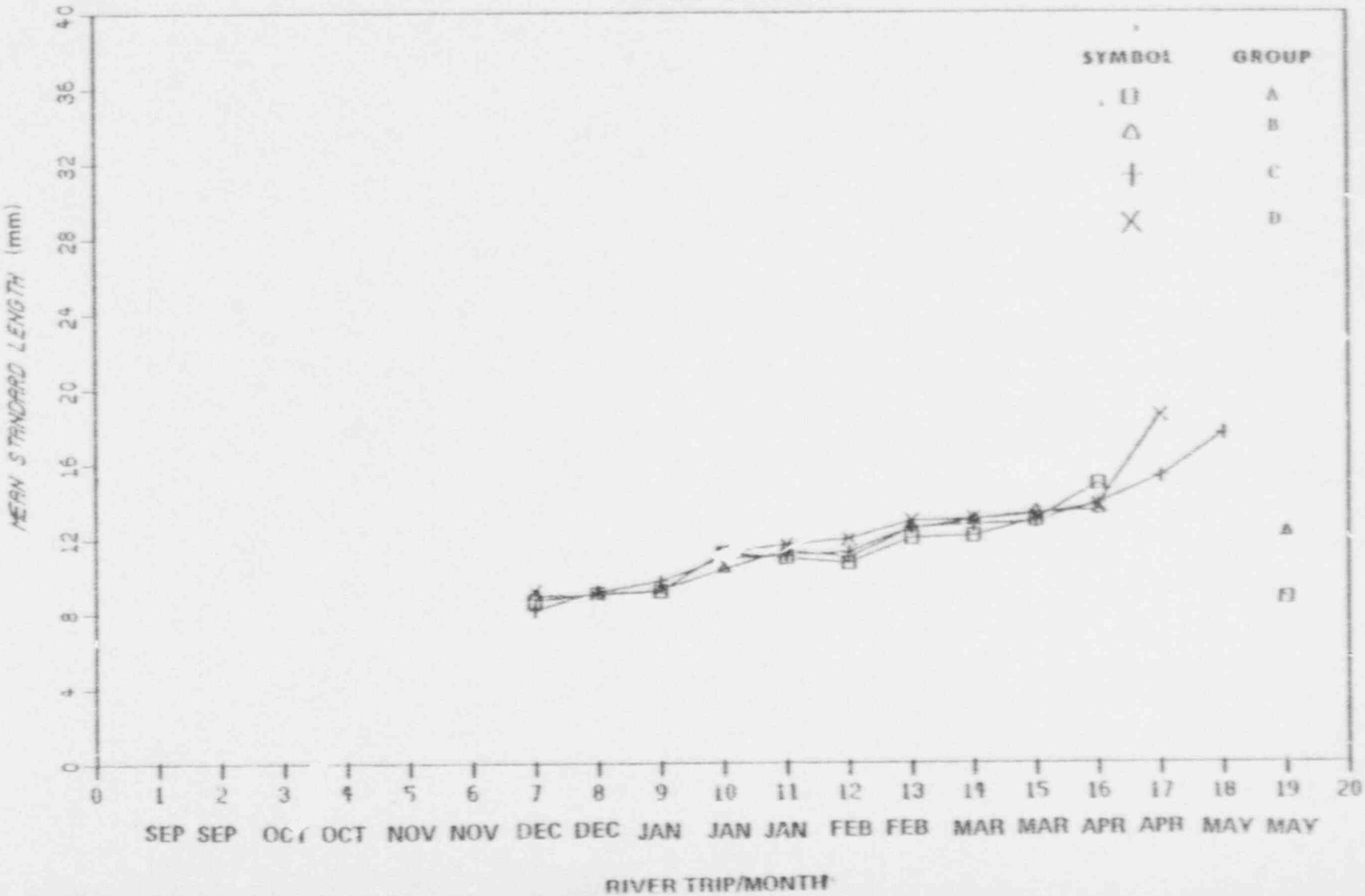


FIGURE 2.3 MEAN LENGTH OF RIVER LARVAE BY GROUP, SEPTEMBER 1978 - MAY 1979.

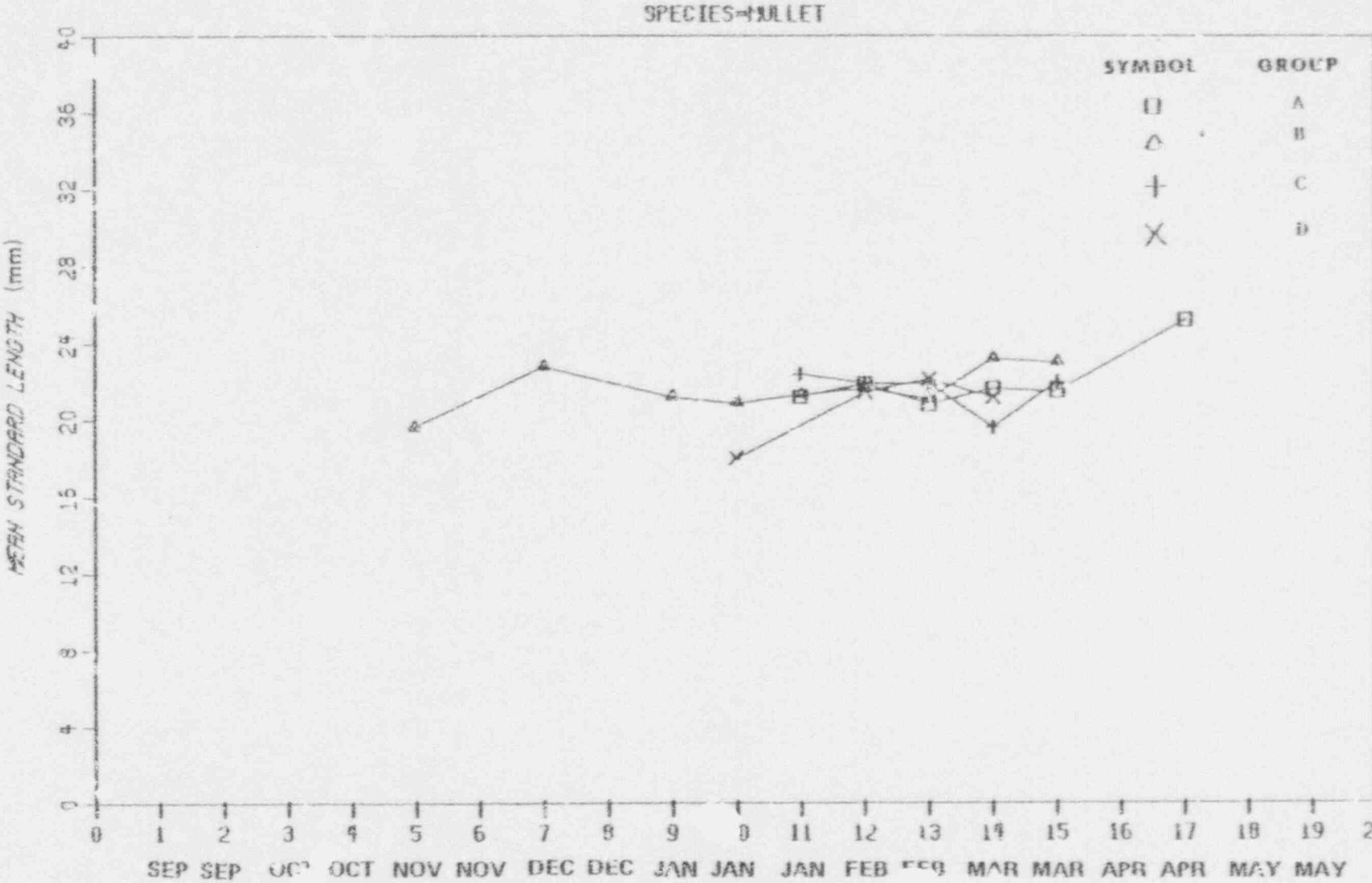


FIGURE 2.10 LOG 10 MEAN DENSITY BY GROUP FOR RIVER LARVAL FISH PROJECT.
(September 1978 - May 1979)

SPECIES=SPOT

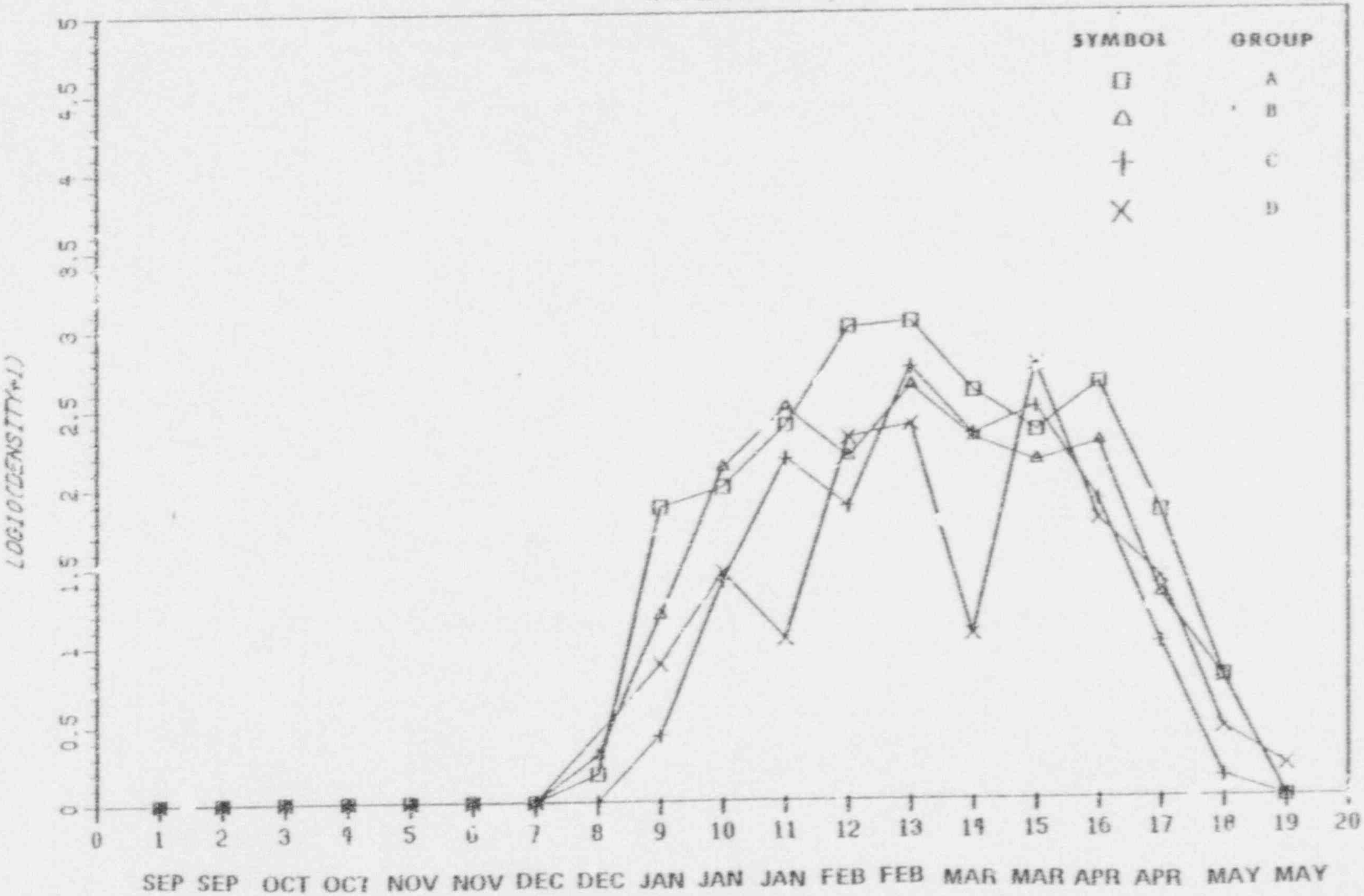


FIGURE 2.17 LOG 10 MEAN DENSITY BY GROUP FOR RIVER LARVAL FISH PROJECT.
(September 1978 - May 1979)

SPECIES=CROAKER

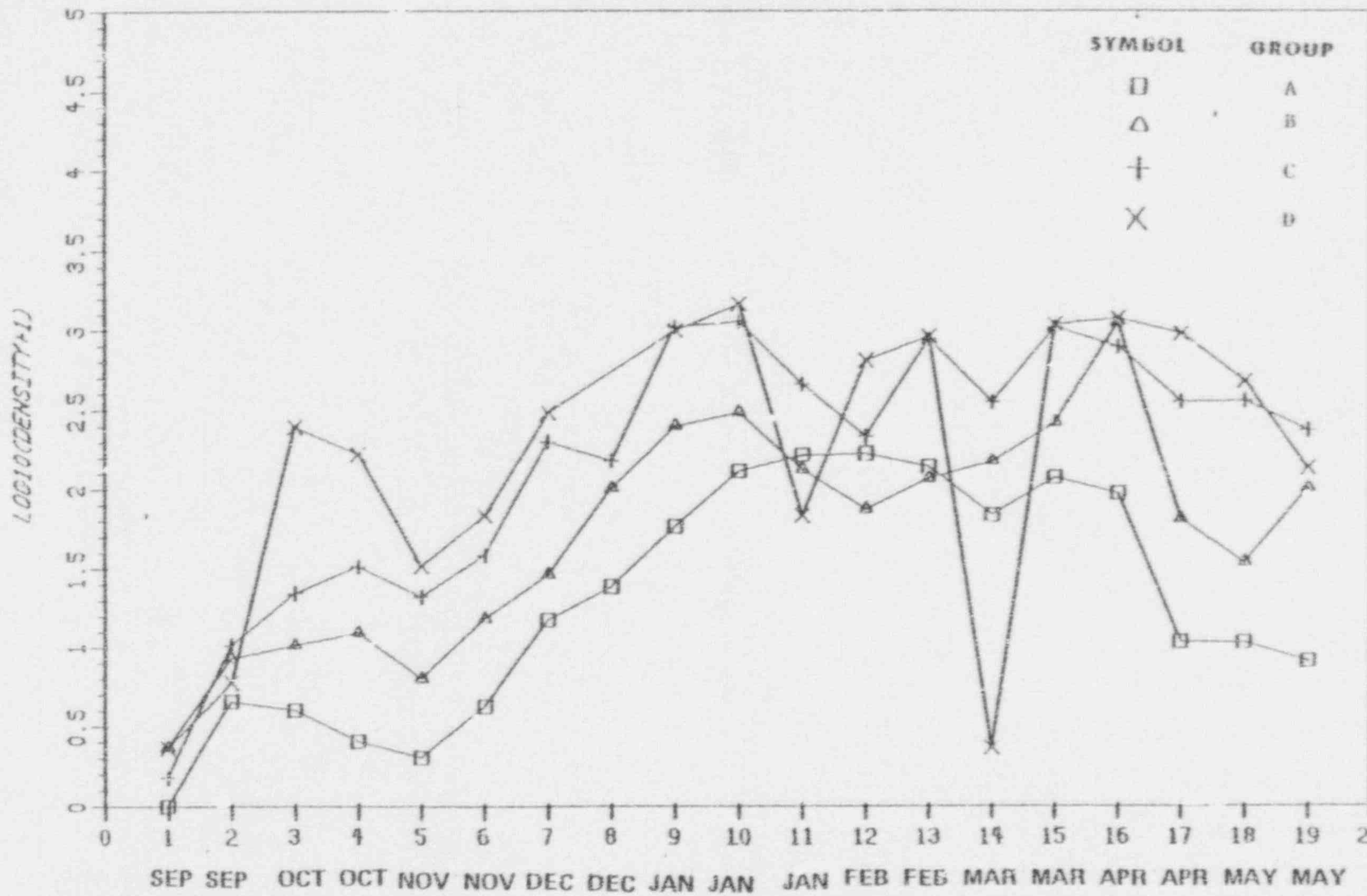


FIGURE 2.12 LOG 10 MEAN DENSITY BY GROUP FOR RIVER LARVAL FISH PROJECT.
(September 1978 - May 1979)

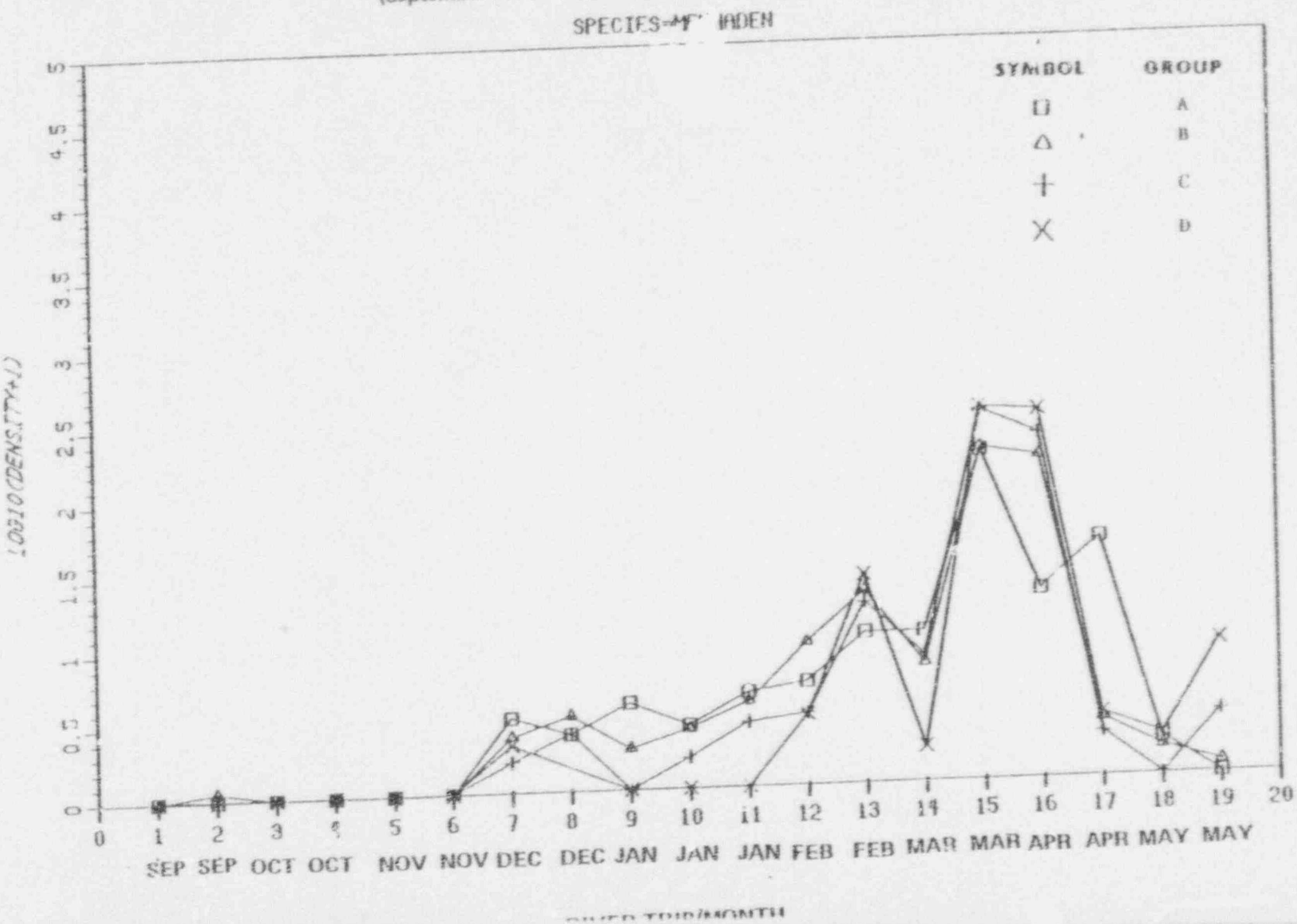


FIGURE 2.13 LOG 10 MEAN DENSITY BY GROUP FOR RIVER LARVAL FISH PROJECT.
(September 1978 - May 1979)

SPECIES=SHRIMP

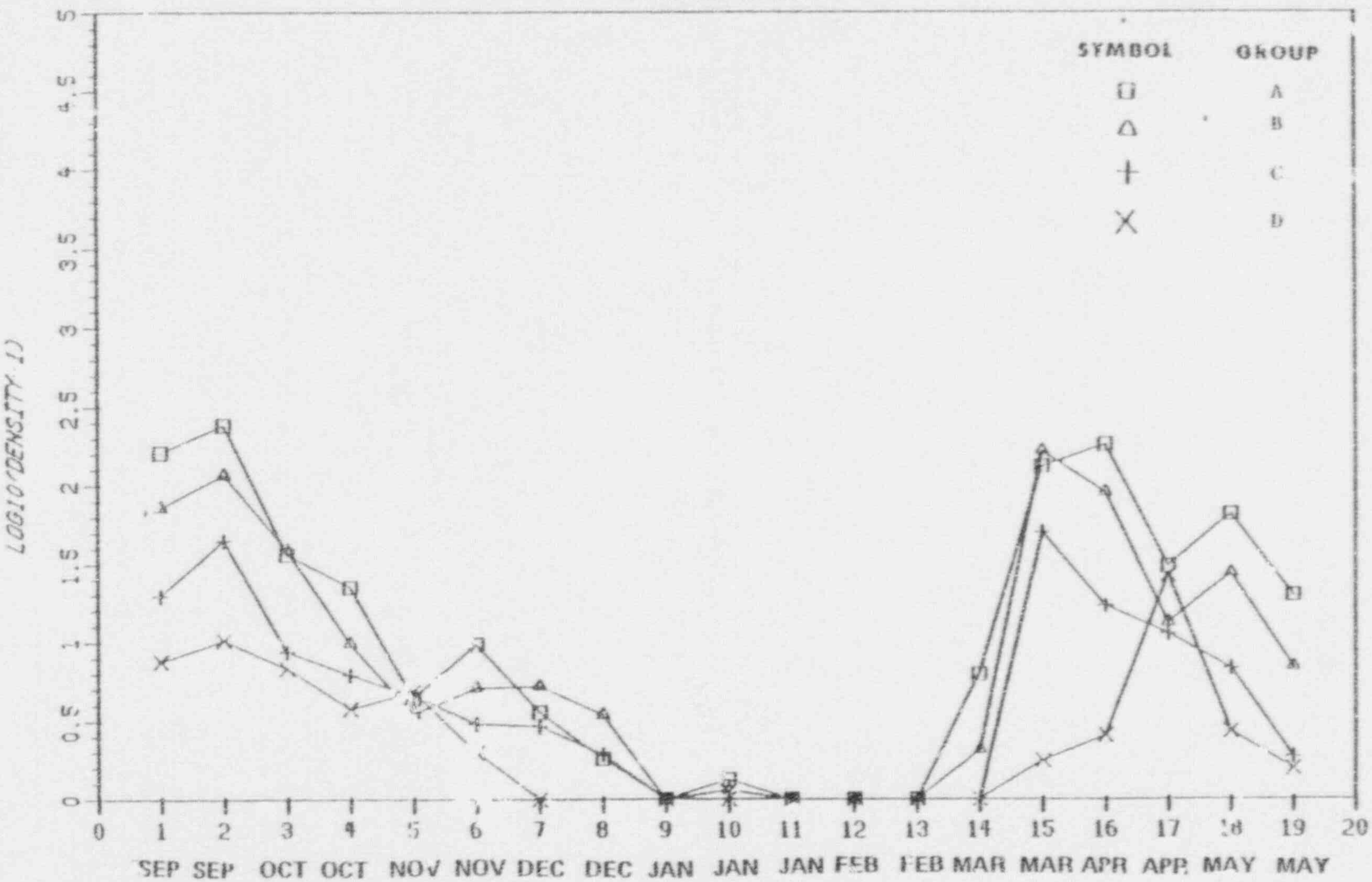


FIGURE 2.14 LOG 10 MEAN DENSITY BY GROUP FOR RIVER LARVAL FISH PROJECT.
(September 1978 - May 1979)

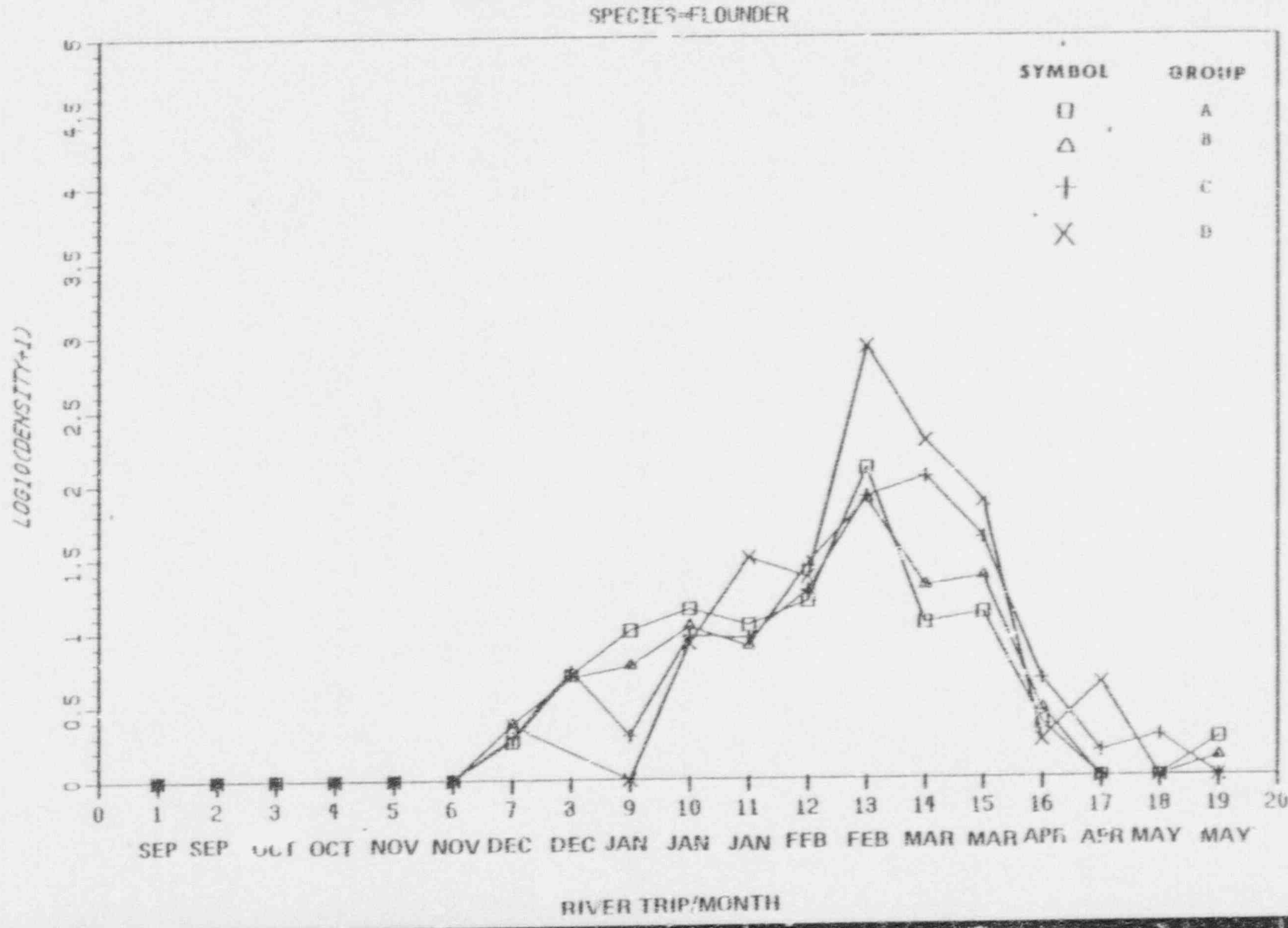
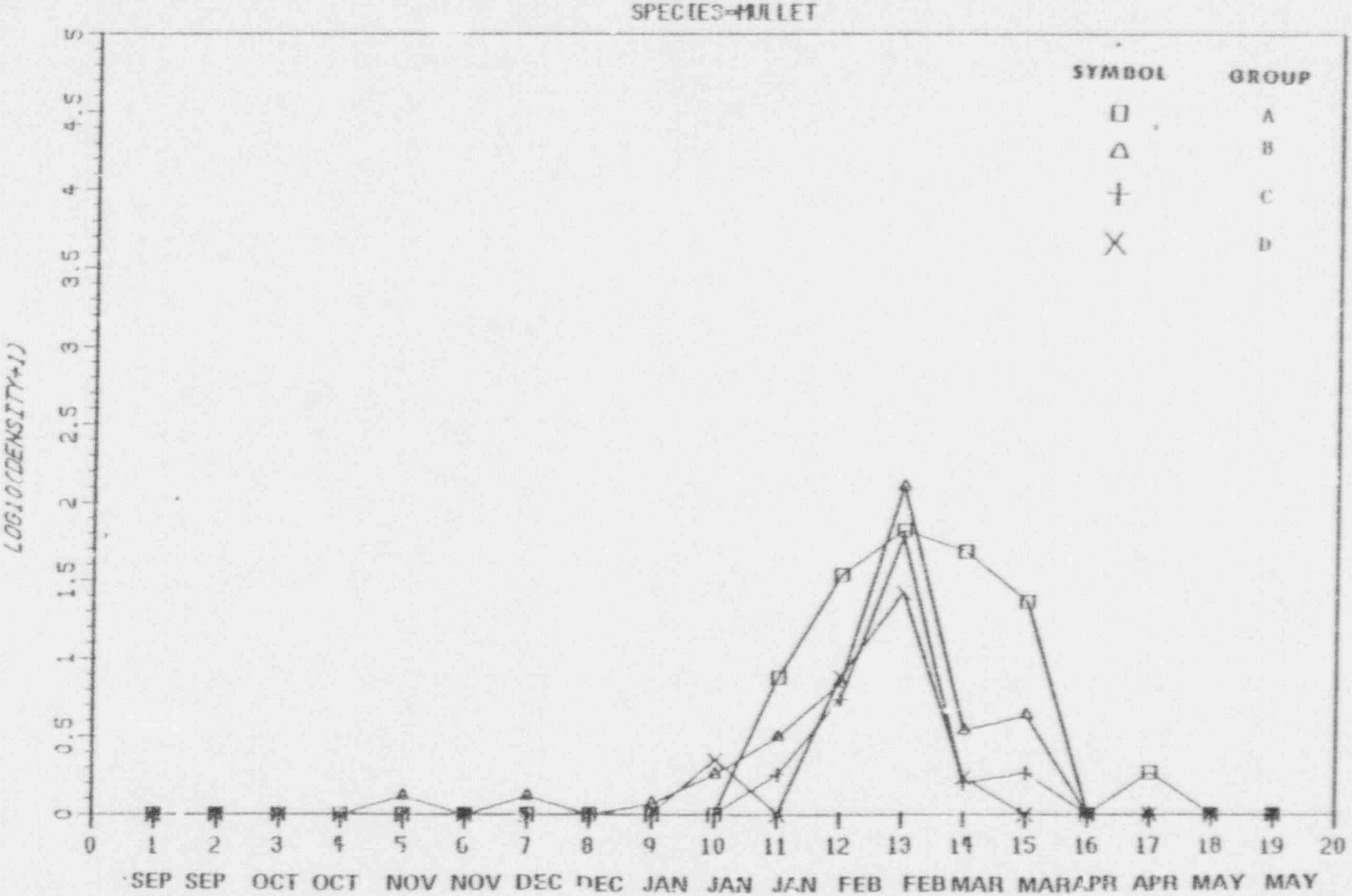


FIGURE 2.15 LOG 10 MEAN DENSITY BY GROUP FOR RIVER LARVAL FISH PROJECT.
(September 1978 - May 1979)



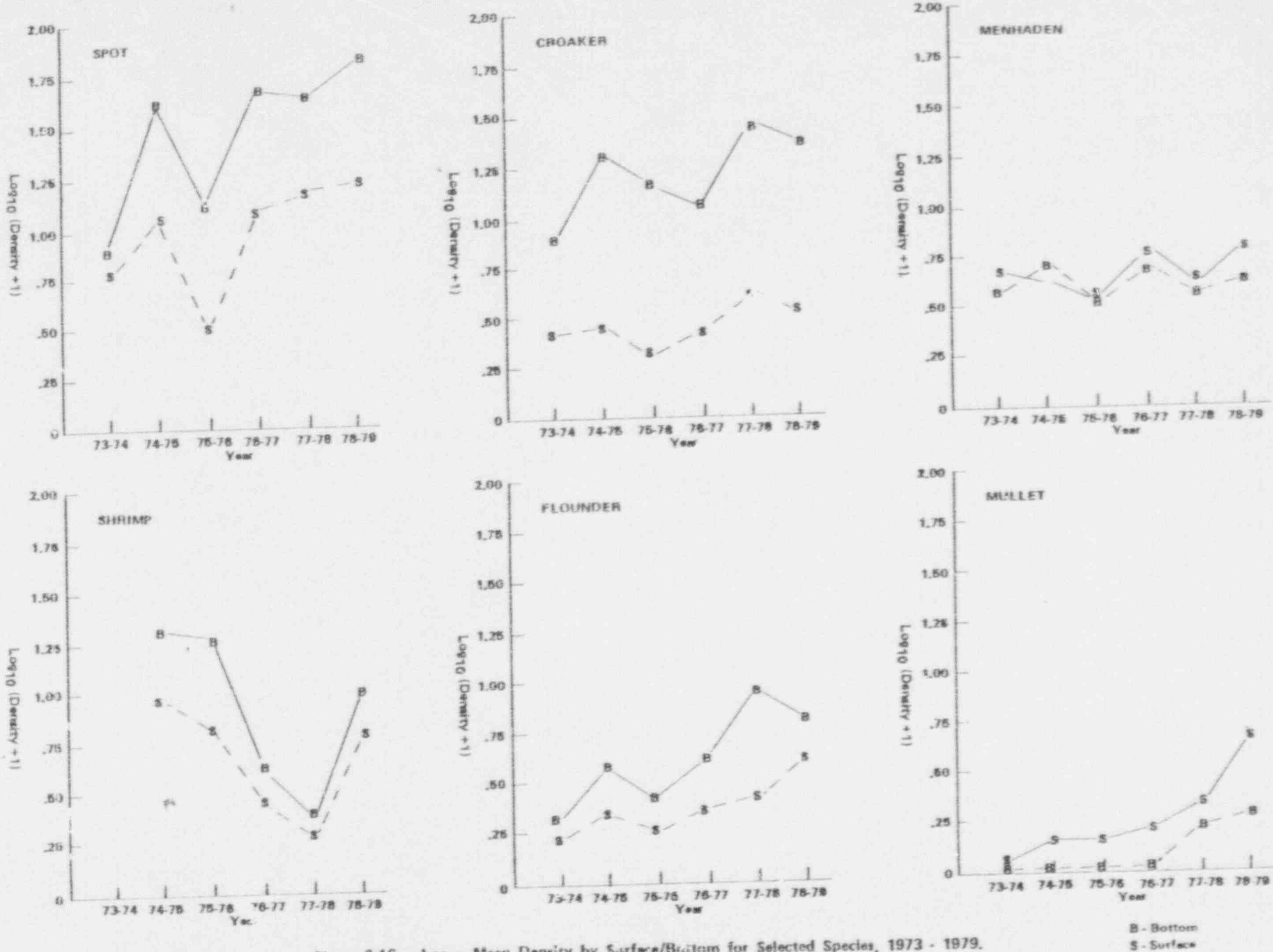


Figure 2.16 Log10 Mean Density by Surface/Bottom for Selected Species, 1973 - 1979.

2-37

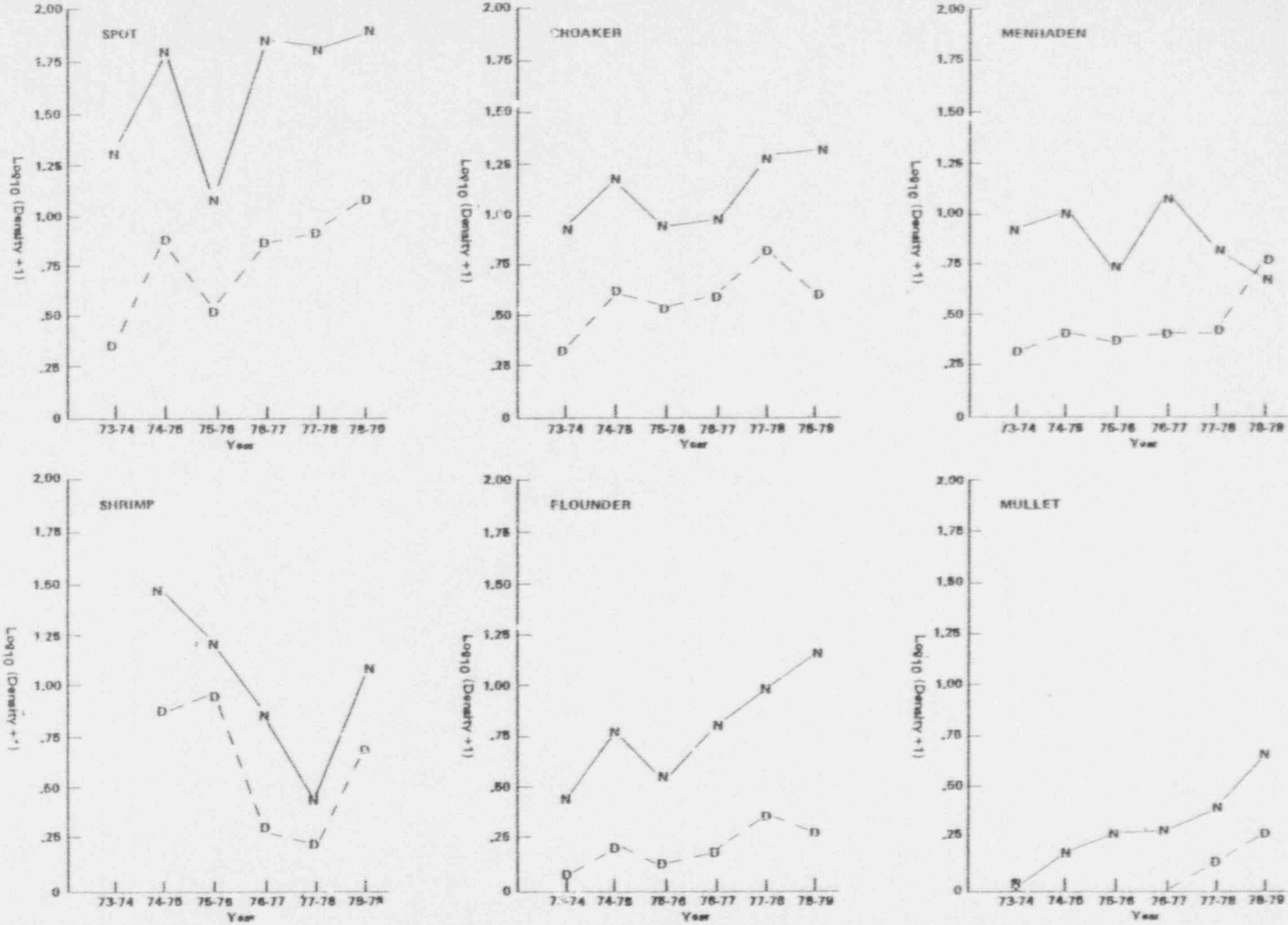


Figure 2.17 Log_{10} Mean Density by Day/Night for Selected Species, 1973 - 1979.

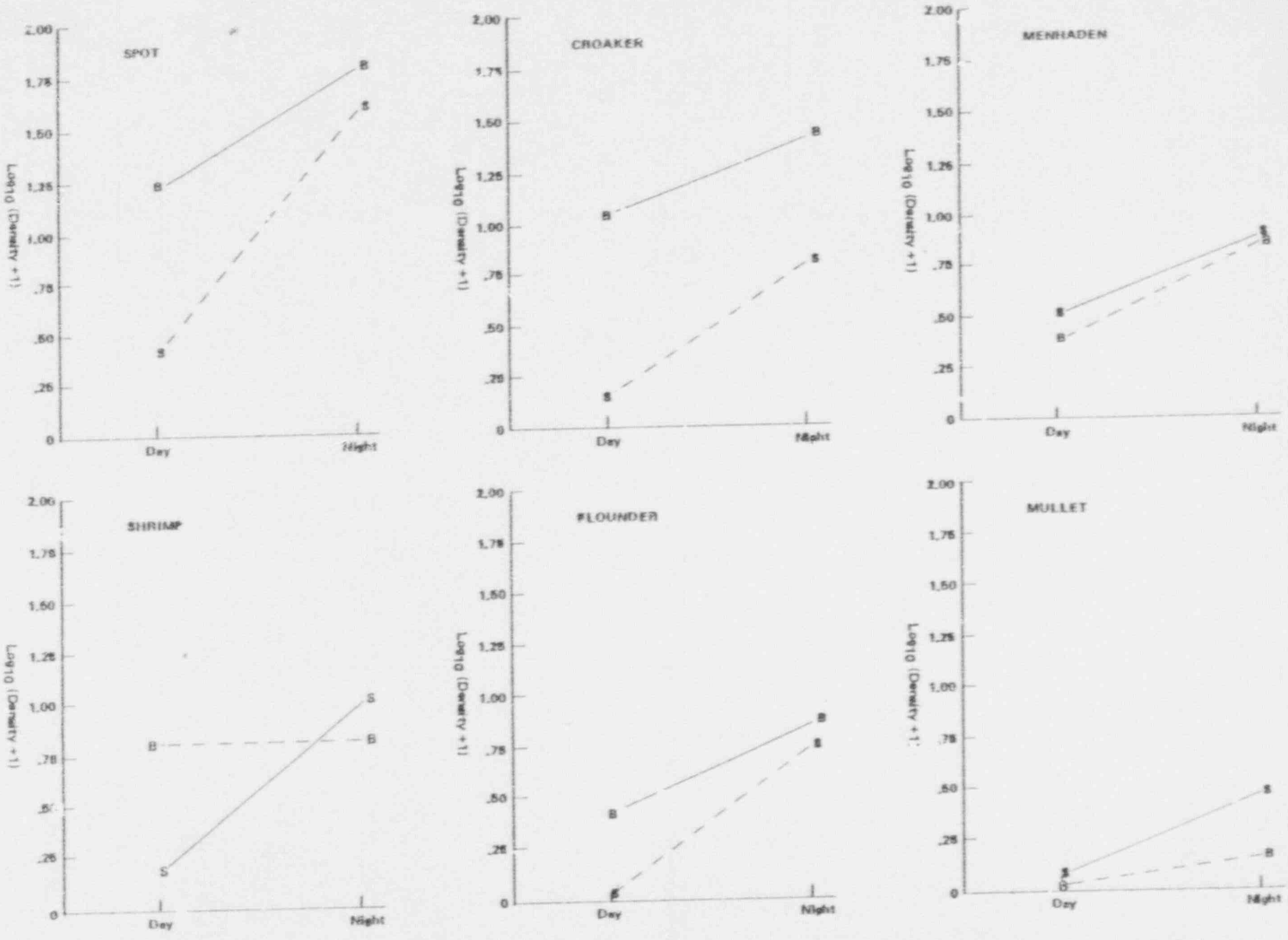
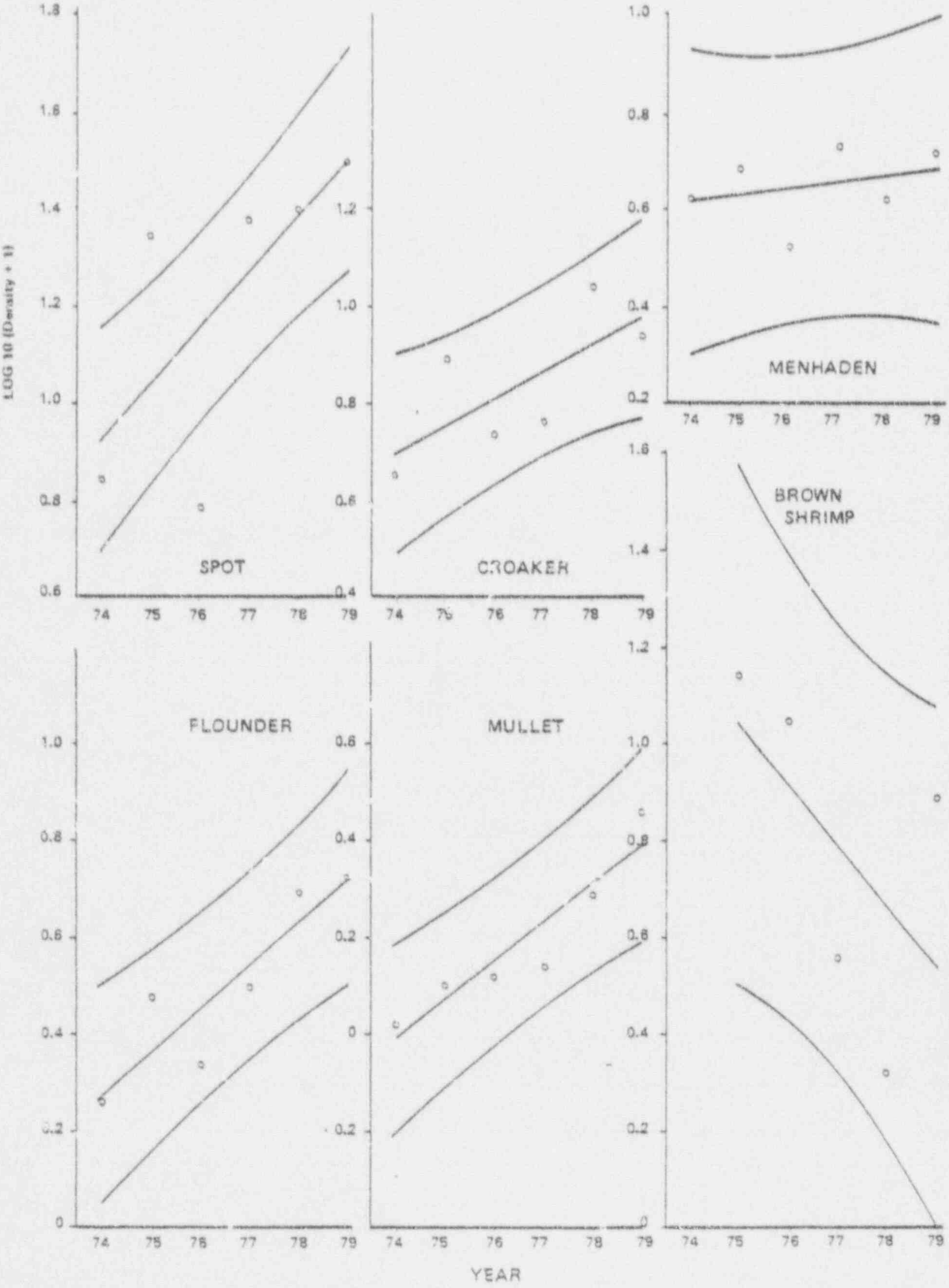


Figure 2.18 Log_{10} Mean Density by Surface/Bottom Versus Day/Night for Selected Species, 1973 - 1979.

Figure 2.19 River Trend Analysis, 1974 - 1979, Stations 21, 24, 25.



3.0 Entrainment

3.1 Introduction

To monitor the entrainment rate of the plant, sampling for larval and postlarval fishes, penaeid shrimp, and portunid crabs was conducted from one of the two discharge sluiceways. As presented in Hodson, Schneider, and Copeland (1977), the reasoning for using the discharge over the intake was based on the assumption that the larvae and water are thoroughly mixed during passage through the plant resulting in a homogeneous distribution of larvae in the discharge sluiceway. This eliminates the need for multilevel sampling in the discharge to adequately describe the BSEP entrainment rates. Samples collected in this manner permit the determination of the seasonality, abundance, and species composition of the larvae and postlarvae entrained by the BSEP.

Entrainment studies were conducted by NCSU from January 1974 through August 1978 (CFS, Vol. VII). CP&L continued the entrainment studies starting in September 1978 as part of the long-term monitoring program.

As mentioned in Section 6.1 of the Interpretive Report and Section 2.1 of this report, both a winter and a summer peak typically occur in the CFE. Summer samples contain large numbers of organisms and have not yet been analyzed. Therefore, this section covers only the data collected from September 1978 through May 1979 (Trips 1-39) concentrating on those species comprising the winter peak. Trends in densities of the major species entrained will be obtained by comparing the 1979 entrainment data with the densities of larvae entrained in the CFE since 1974. The statistical analyses and parameters looked at in this chapter were fashioned after those appearing in CFS Volume VII to facilitate comparison to previous years data.

3.2 Methods and Materials

Entrainment sampling was conducted by fishing two round, 1/2 meter (15.7 in.), 505 micron mesh plankton nets mounted side by side for 5 minutes just below the surface in the center of one of the discharge sluiceways. Flowmeters were mounted in the mouth of each net.

Replicate samples were collected on mid and slack tides over one 24-hour period each week. Sample collection was usually initiated on Tuesday morning and finished Wednesday morning of each week. Samples were preserved immediately in 10% formalin. Salinity and water temperature measurements were taken from water collected from the surface by a bucket prior to each collection.

In the lab, the samples, after being washed down to remove the formalin, were sorted and all larval and postlarval fish, shrimp postlarvae, and portunid crab megalops were retained. Larger life forms of these groups were also retained when they were encountered. All specimens were identified to the lowest practical taxon (Table 2.2), counted, and measured (total length, up to 100 per species). These data were recorded on computer data forms along with pertinent header information such as sample number, date of collection, temperature, salinity, volume of water sieved, etc. A quality control program identical to that described in Section 2.3 was also conducted on entrainment samples.

All larval fish collected by North Carolina State University during the previous 5 years were measured in standard length (SL). Therefore, in order to compare these sets of data, a conversion program was set up to convert total length to standard length (Table 2.3). All figures, tables, and analyses were done with these converted lengths. Larval fish collected after September 1, 1979, will be measured in standard length.

3.3 Results and Discussion

A total of 624 samples was collected over 39 sampling trips (weeks) between September 6, 1978, and May 30, 1979 (Table 3.1). Spot and croaker dominated the entrainment catch during this time period, representing 26.0% and 18.3%, respectively, of the total catch. Penaeid shrimp were third with 15.9%. The six representative winter species groups combined accounted for around 65% of the total catch while 2 summer species groups accounted for another 10% during the time period analyzed. These percentages are almost identical to those found in the larval fish program, although the individual percentages are different (see Section 2.4.2). A list of the total density and percent of the total catch is presented in Table 3.2.

3.3.1 Entrainment Densities and Volumes

Based on actual flow rates per pump, the mean flow through the Brunswick Steam Electric Plant from September 1978 to May 1979 ranged between 1.51 and 5.41 million cubic meters of water per day. The flow rate varied independent of the number of organisms available or season of the year and depended solely on the cooling water needs during plant operation. However, since cooling water needs depend in part on water temperature, maximum flows typically occur during the summer and early fall, while lower flows occur during the winter and early spring. Plant load and scheduled and unscheduled outages can alter this pattern.

In order to compute the total number of organisms entrained at BSEP, the mean density per 24-hour sampling period was multiplied by the mean flow per day during the week of sampling.

The mean density of total larval and postlarval fish entrained during the sampling period ranged between 24 and 1400/1000 m^3 (Table 3.3). The period of greatest abundance occurred from December to April. This period encompasses the expected winter recruitment periods of species such as spot, croaker, flounder, menhaden, mullet, and brown shrimp. The general pattern was the same as that observed since 1974 (Fig. 3.1 and CFS, Vol. VII), although it appeared that recruitment may have been extended a few weeks for some of the species. The period of entrainment also coincides with the period of occurrence in the CFE. Total organisms entrained per day during the sampling period ranged from a low of around 94,000/day in early November to a high of around 4.9 million/day in mid-May (Table 3.3). Although the maximum total number of organisms entrained/day appears large, the average was, of course, much lower.

A few spot were collected in entrainment near the end of November, but the period of abundance ranged from mid-December until the end of the sampling period. They reached a peak density of over 1000/1000 m^3 during the first part of March. This pattern was much the same as observed since 1974, although the densities appeared slightly higher than most of the previous years (Fig. 3.2). This is the same time span that spot were found in the main stem of the CFE (Fig. 2.10). The two figures parallel each other so closely that even a small decline observed in the lower part of the CFE at the end of March (Trip 15) was also observed in entrainment (Trip 30). The densities in the upper CFE (Groups C and D) did not show this decline. The maximum total entrainment for spot was 2.1 million/day which occurred in mid-March (Table 3.4).

Croaker were collected through the entire sampling period for both larval fish (Fig. 2.11) and entrainment (Fig. 3.3). In both programs densities were low initially but showed a small peak during late September before the main winter peak occurred. Densities in entrained water and in the river declined in mid-April, although a few croaker were caught through the end of May. The peak density of croaker in entrained water during the main period of recruitment was around 535/1000 m^3, which occurred in January (Table 3.5). This pattern was similar to that of previous years, except that the end of recruitment appeared to extend later into the season (Fig. 3.3). The maximum total entrainment for croaker was around 2.1 million/day which occurred in early January (Table 3.5).

The remaining representative species showed the same results. The appearance of a species in the larval fish samples was generally commensurate with its appearance in entrainment samples. The relative densities of the larvae in the two programs also coincided.

A decline in the CFE, particularly Groups A and B, was followed by a decline in entrainment densities (Figs. 3.4-3.7, Figs. 2.12-2.15).

The term "flounder" actually refers to three different species--southern, summer, and gulf flounder. However, to facilitate identification, these have been lumped together under Paralichthys spp. to characterize the general entrainment of flounder. They occurred in entrainment from late November to early April, reaching a peak density of about 123/1000 m^3 in late February (Table 3.6). The pattern was similar to that in previous years although densities appeared higher (Fig. 3.4). The maximum entrainment rate for flounder was around 333,000/day which occurred near the end of February (Table 3.6).

Atlantic menhaden appeared in the entrainment samples from February until late April. During their period of peak abundance (mid-March to mid-April), they reached a density of around 70/1000 m^3 (Table 3.7). This pattern was the same as observed in previous years (Fig. 3.5). The maximum entrainment rate for menhaden was around 141,000/day which occurred in mid-April (Table 3.7).

Mullet consist of two species (white and striped mullet) that were lumped to generally characterize the entrainment of mullet. Their period of abundance was from January to March with a peak density of about 116/1000 m^3 (Table 3.8). This was the same general period of abundance as observed in previous years (Fig. 3.6). The maximum entrainment rate of 313,000/day occurred near the end of February (Table 3.8).

Three species of penaeid shrimp were collected in entrainment--pink, brown, and white--but because of identification problems, were only identified to the generic level. Typically, brown shrimp appeared in the spring and pink and white appeared in the summer and fall, although a second spawn of browns can also occur during this period. Since brown shrimp appeared in the spring, they were the only species whose total period of abundance was covered by the sampling period. Their range of occurrence was from mid-March to the end of the sampling period, with peak abundance occurring around the end of March at almost 400/1000 m^3 (Table 3.9). As was noted with several of the previous species, the general pattern was similar to that of previous years, but the start of the spring recruitment was delayed by several weeks (Fig. 3.7). The maximum brown shrimp entrainment reached almost 800,000/day in late March (Table 3.9).

3.3.2 Length Frequency

The mean length of entrained organisms, as a general rule, increased during their recruitment season with considerable variation toward the end when densities began to decrease.

At the beginnning of recruitment into the estuary, spot appeared in the entrainment samples at a mean length of 10-11 mm. This mean length increased to reach a maximum size of about 22-23 mm. The largest mean lengths of entrained spot occurred in March when spot were at their highest densities. After that time as the densities decreased, the mean lengths also began to decrease and reached a minimum of 13 mm in early May (Fig. 3.8).

As would be expected, the size of the larvae being entrained closely matched the size of the larvae in the CFE. There were, however, some differences that are important in determining the source of the larvae entrained. For example, spot collected in the larval fish study from the lower CFE during the peak recruitment period ranged from 21-23 mm with spot from entrainment also in this size range. As recruitment slowed, the size of the spot in entrainment and in the lower river decreased to around 14 mm while those in the upriver section (Group D) were 22-33 mm in size, although their mean sizes also dropped. This indicated that entrainment of spot larvae was mainly from the lower estuary, while larvae in the upriver nursery were not affected by plant entrainment. Spot larvae entrained during the day were not significantly larger than those entrained at night (Table 3.10).

This same type of trend also occurred for croaker. In January, midway through recruitment, the mean length of the croaker found downstream and of those found in entrainment was around 13-14 mm. Those found upriver were about 15 mm in size during this same period. At the end of recruitment in May, the size of the croaker in all areas increased substantially in size, as can be seen from Figures 2.5 and 3.9, but their densities were relatively low. Croaker larvae that were entrained at night were significantly larger than those entrained during the day (Table 3.10).

Flounder is another bottom-oriented species group that would be expected to show larger sizes in the upper section of the river. Their lengths in entrainment and river larval fish sampling, however, remain close to the same size during the recruitment period. Flounder recruitment began in late November with mean lengths of 8-9 mm. During peak densities (mid-February to mid-March), they increased to a mean length of around 12-13 mm. As densities decreased, the mean length increased. At the end of recruitment, the size of the fish collected from Group D were 4-5 mm larger than those collected several weeks earlier. No flounder were entrained during this time. There was no significant difference between the lengths of flounder entrained during the day and those entrained at night (Table 3.10 and Figure 3.10).

At the start of recruitment, menhaden appeared in entrainment samples at a mean length of 27-28 mm. During their period of peak density (late March to early April), their mean length decreased to 25-27 mm (Fig. 3.11). They exhibited a great variability in mean length (20-31 mm) during periods of low density. The mean length of menhaden entrained at night was not significantly different from those entrained during the day (Table 3.10).

The mean length of entrained mullet, during peak entrainment, ranged from 20-22 mm. During periods of low density, they ranged from 18 mm up to 24 mm (Fig. 3.12). The mean lengths of mullet entrained during the day were significantly larger than those entrained at night (Table 3.10).

Brown shrimp first appeared in entrainment samples at a mean length of 11 mm in early March. During peak densities their mean length increased to 13 mm. As densities decreased, their mean length decreased to 10 mm (Fig. 3.13). There was no significant difference in the mean lengths of brown shrimp entrained at night compared to those entrained during the day (Table 3.10).

Shrimp and mullet were entrained at about the same length as those collected from the lower CFE (Figs. 2.7 and 2.9, Figs. 3.12-3.13).

3.3.3 Diel Variations

The densities of entrained organisms previously discussed in this chapter were based on means constructed from 24-hour periods and over several tidal conditions. There was considerable variation around each mean owing to the difference in densities over a 24-hour period. The densities of organisms entrained, as a general rule, were consistently much lower during the daytime than during the night (Fig. 3.14). These differences were found to be significant for all species (Table 3.11). A plot of the mean densities of total organisms for the 8 samples collected on Trip 28 (March 13-14) is presented in Figure 3.15.

The densities of spot were much higher at night than during daylight hours (Fig. 3.16). In March, when spot reached their maximum densities, the mean daytime density averaged 467/1000 m^3 while mean nighttime densities averaged 1513/1000 m^3. During the latter part of recruitment when spot were larger on the average, these diurnal differences were more pronounced. A plot of the mean densities of the 8 samples collected on Trip 31 (April 3-4) is presented in Figure 3.17.

Croaker exhibited diurnal patterns very similar to those of spot (Fig. 3.18). When croaker reached their highest densities in January, the mean daytime density averaged 98.8/1000 m^3 while mean nighttime densities averaged 561/1000 m^3. A plot of the mean densities from the 8 samples collected on Trip 32 (April 10-11) is presented in Figure 3.19.

The difference in daytime and nighttime entrainment densities for flounder was pronounced (Fig 3.20). Typically, no flounder were entrained during the day, but at peak densities their mean nighttime entrainment densities averaged 165/1000 m^3. A plot of mean densities from the 8 samples collected on Trip 30 (March 27-28) demonstrates this fact (Fig. 3.21).

The day/night entrainment densities for mennaden were also significantly different. During the period of peak abundance, the mean daytime densities averaged 19.5/1000 m^3 while mean nighttime densities averaged 88/1000 m^3. A plot of mean day/night entrainment densities for 1978-1979 shows this difference to be true for menhaden for most of their recruitment season although on occasion daytime densities exceed nighttime densities (Fig. 3.22). A plot of the mean densities from Trip 30 (March 27-28) is presented in Figure 3.23.

Mullet exhibited higher nighttime entrainment densities than daytime densities. During peak recruitment (March), mean daytime densities averaged 45/1000 m^3 while mean densities at night averaged 78/1000 m^3 (Fig. 3.24). Diurnal density differences were not as pronounced at the end of recruitment as they were during the peak. A plot of the mean densities collected on Trip 27 (March 6-7) is presented in Figure 3.25.

The predominant diurnal trend in entrainment for brown shrimp postlarvae was for densities to be higher during the nighttime than during daytime. During peak abundance (mid-March to mid-April) mean daytime densities averaged 113/1000 m^3 and mean nighttime densities averaged 279/1000 m^3. Daytime densities were consistently lower than nighttime densities of entrained brown shrimp throughout the recruitment season (Fig. 3.26). A plot of the mean densities from Trip 32 (April 10-11) is presented in Figure 3.27.

In Section 2.4.5 of this report, it was brought out that typically more larvae are caught at night than during the day. These diel differences were significant for all species examined in the larval fish portion of this report except menhaden. It was also mentioned that gear avoidance could account for a portion of this difference. The number of larvae entrained was greater at night than during the daytime for all of the species examined. Spot, croaker, flounder, and shrimp densities were consistently higher at night, while mullet and menhaden densities were sometimes higher during the day.

Considering the size of the intake structure and the turbulence of the water in the discharge weir, it is inconceivable that gear avoidance could be a factor in entrainment sampling. Since the day/night difference is evident in both the river and entrainment data, the larvae are not available to either the plant or the larval nets during the day. The bottom species (croaker, spot, flounder, and shrimp) are probably close to the bottom where water movement is relatively slow. Thus, they are not entrained by the plant, flushed from the estuary, or even caught by the larval sled, which does not sample the bottom 15 cm (6 in.). This could also explain why the sum of river larval surface and bottom densities are considerably lower during the day than at night.

The day/night differences for menhaden and mullet are less clear as to the mechanism they use to avoid entrainment. Menhaden and mullet are considered surface species, and it would be unlikely that they would migrate to the bottom during the day. They may, however, remain at the surface but move into the shallows where, like the bottom, the water does not move very fast. Schools of small mullet have in fact been seen along the shore of the intake in several inches of water. This mechanism would not appear to work in the main stem of the CFE, leaving the day/night density differences for menhaden and mullet a function of some other response. (See Section 2.4.3 of this report.)

3.3.4 Flow Reduction

The plant flow rate during the sampling period ranged from 1.5 to 5.4 million cubic meters/day. Normally 6-8 intake pumps are operating to cool the plant's condensers, but reduced plant load or outages may reduce this number. As described in Section 3.2.1 of the Interpretive

Report, certain modifications could be undertaken to allow the plant to operate at near full capacity with reduced flow requirements. Using ambient water temperature as a guideline, the flow requirements could be reduced to around 2.25 million cubic meters of water per unit per day from mid-April to the end of November, with an additional 466,000 cubic meters per day required if ambient water temperatures reached 29°C (85°F). The flow could be reduced to 1.5 million cubic meters of water per unit per day between December 1 and around April 15.

If this flow reduction scheme had been used during the 1978-79 sampling period, the number of larvae entrained could have been substantially reduced. The maximum number of larvae entrained could have been reduced as shown below.

	Maximum Number (x 10^3) of Larvae Entrained Per Day		
Species	1978-1979 Actual	1978-79 Under Flow Reduction	% Reduction
Spot	2132	1584	25.8
Croaker	2101	1165	44.6
Flounder	333	185	44.5
Menhaden	147	103	30.0
Mullet	313	174	44.4
Shrimp	799	594	25.7

Peak recruitment for most of these species coincide with the period of coldest water temperature permitting the largest reduction in plant flow.

3.3.5 Trend Analysis - Entrainment - 1975-1979

The larval abundance in BSEP entrainment was subjected to a trend analysis (Table 3.12). Entrainment density decreases were observed for menhaden (10%), croaker (11%), and brown shrimp (almost 24%). Flounder entrainment increased 20%, spot increased 10.6%, and mullet increased 10%. As stated in the Interpretive Report, Section 5.3.2.7, statistical analysis for these species suggests that some of these trends can be explained in terms of the year-to-year abundance in density or to the random sampling or both. The combined evidence of increased river larval fish densities (Fig. 3.28) and decreases in some entrainment species densities (Fig. 3.29) suggests a healthy estuary with no increases in plant entrainment impact.

Trend lines, including 95% confidence interval estimates of the true population densities, are plotted in Figure 3.29. As outlined in the Interpretive Report, Section 5.3.2.7, differences among years were partitioned into a trend component proportional to the size of the linear increase (or decrease) and a deviation component proportional to the size of the year-to-year fluctuations around the trend line. The error component used to judge the significance of the first two was computed from the discrepancy between sampling periods within years. The percent change per year is calculated from the slope of the trend line and the relative standard deviation is the square root of the error mean square expressed as percent of average density. The latter is included because it represents the intrinsic random error encountered with each species. The logarithm of the densities was used in the analysis throughout.

3.4 Conclusions

The six representative species selected for discussion in this chapter represent approximately 65% of the total number of larvae entrained. These species are ocean spawners whose larvae and young use the estuary as a nursery ground. In response to different environmental cues, the larvae are transported to shallow nursery grounds in the marshes and to deep water nursery areas in the vicinity of the saltwater/freshwater interface. Migration to these areas remove the larvae from within the immediate vicinity of the plant and enable them to avoid entrainment. A negative response to light enables some larvae to orient themselves toward the bottom. This helps those larvae within the vicinity of the plant to avoid entrainment during the day since cooling water is primarily drawn from the surface layers.

The mean density of total larval and postlarval fish entrained from September 1978 through May 1979 ranged between 24 and 1400/1000 m^3. Based on actual plant flows, the total number entrained ranged from 94,000/day in early November to 4.9 million/day in mid-May. Typically, more organisms were collected at night than during the day. As in previous years, the peak abundance of spot, croaker, flounder, menhaden, mullet, and brown shrimp occurred during this time period.

Spot were entrained from mid-December through late May, with peak densities of over 1000/1000 m^3 in early March. Using plant flows the entrainment rate of spot peaked at 2.1 million/day, although this number could have been decreased by 26% under flow reduction. Spot first appeared in the entrainment samples at a mean length of 10-11 mm and reached a maximum size of 22-23 mm in March. Their size decreased again near the end of recruitment. The densities of spot entrained were much higher at night than during the daytime.

Croaker entrainment spanned the entire sampling period, peaking in January at around 535/1000 m^3. Based on actual plant flows, a maximum of 2.1 million croaker were entrained per day. This number could have been reduced 45% under flow reduction. Croaker entrained in September were 6-7 mm in size. They increased in size to 15 mm in January before decreasing to 11-12 mm as recruitment decreased. Average daytime densities were typically much lower than nighttime densities.

Flounder were entrained from late November to early April, reaching a peak density of around 123/1000 m^3 in late February. Based on actual plant flows, the maximum entrainment rate reached 333,000/day. This number could have been reduced by 45% under flow reduction. Flounder were first entrained at 8-9 mm in size, increasing to only 12-13 mm before decreasing in size as recruitment tailed off. Most flounder were entrained at night and only a few were entrained during the day.

Menhaden were entrained from February until late April with a peak of 70/1000 m^3 occurring in mid-April. A maximum of 141,000 were entrained per day, but this number could have been reduced by 30% under flow reduction. Menhaden first appeared at a mean length of 27-28 mm and decreased to 25-27 mm during peak recruitment. They exhibited a great variability in mean length (20-31 mm) during periods of low density. Typically, nighttime densities exceeded daytime densities.

Mullet were entrained from January to March with a peak density of around 116/1000 m^3. Based on plant flows, a maximum of 313,000 were entrained per day. This number could have been reduced 44% under flow reduction. Mullet ranged in size from 18 mm to 24 mm with 20-22 mm the mean size during the period of peak abundance. Nighttime densities exceeded daytime densities.

Shrimp (3 species) typically exhibit two peaks of abundance--one in the summer and fall and the second during the spring. The spring peak, consisting of brown shrimp, peaked at 400/1000 m^3 near the end of March. Based on plant flows, this translated into a maximum of 800,000/day, although flow reduction could have reduced it by 26%. Brown shrimp averaged 13 mm in length during peak densities, dropping to 10 mm as densities decreased. Daytime densities were consistently lower than nighttime densities.

The plant has been withdrawing water from the estuary since early 1974. During this time, population estimates for 5 out of 6 of the dominant winter species in the estuary showed an overall increase in abundance. Entrainment on the other hand decreased for 3 species and increased for 3 species. These trends in abundance for both river and entrainment suggest a healthy estuary with negligible plant impact.

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

1

IMAGE EVALUATION TEST TARGET (MT-3)

150mm

6"

3.5 References

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Table 3.1 Trip numbers, sampling dates and analysis periods of larvae and postlarvae entrained at the BSEP, 1978-1979.

Trip	Sampling Date	Analysis Period
1	6 Sept 78	1
2	12 Sept 78	2
3	19 Sept 78	3
4	26 Sept 78	4
5	3 Oct 78	5
6	10 Oct 78	6
7	17 Oct 78	7
8	24 Oct 78	8
9	31 Oct 78	9
10	7 Nov 78	10
11	14 Nov 78	11
12	21 Nov 78	12
13	28 Nov 78	13
14	5 Dec 78	14
15	12 Dec 78	15
16	18 Dec 78	16
17	27 Dec 78	17
18	3 Jan 79	18
19	9 Jan 79	19
20	16 Jan 79	20
21	23 Jan 79	21
22	30 Jan 79	22
23	6 Feb 79	23
24	13 Feb 79	24
25	20 Feb 79	25
26	27 Feb 79	26
27	6 Mar 79	27
28	13 Mar 79	28
29	20 Mar 79	29
30	27 Mar 79	30
31	3 Apr 79	31
32	10 Apr 7.	32
33	18 Apr 79	33
34	24 Apr 79	34
35	1 May 79	35
36	8 May 79	36
37	15 May 79	37
38	22 May 79	38
39	29 May 79	39

TABLE 3.2 TOTAL DENSITY AND PERCENT TOTAL OF FISH AND PENAEID SHRIMP COLLECTED IN THE ENTRAINMENT LARVAL FISH PROJECT, SEPTEMBER 1978 TO MAY 1979.

SPECIES SCIENTIFIC NAME	SPECIES COMMON NAME	DENSITY	PERCENT
LEIOSTOMUS XANTHURUS	SPOT	120661.23	26.02
MICROPOGON UNDULATUS	*ATLANTIC CROAKER	84684.25	18.26
PENAEUS SPECIES	PENAEID SHRIMP	73456.50	15.84
ATHERINIDAE	SILVERSIDES	44229.14	9.54
GOBIOSOMA SPECIES	GOBIOSOMA SPECIES	24756.88	5.34
ANCHOA SPECIES	ANCHOVY SPECIES	15961.88	3.44
ANCHOA MITCHILLI	BAY ANCHOVY	9338.21	2.01
MUGIL CEPHALUS	STRIPED MULLET	8192.88	1.77
LAGODON RHOMBOIDES	PINFISH	5523.66	1.19
GOBIOSOMA GINSBURGI	SEABOARD GOBY	5312.09	1.15
GOBIONELLUS BOLEOSOMA	DARTER GOBY	5270.54	1.14
PARALICHTHYS LETHOSTIGMA	SOUTHERN FLOUNDER	4587.91	0.99
BREVOORTIA TYRANNUS	ATLANTIC MENHADEN	4944.24	0.37
PARALICHTHYS SPECIES	FLOUNDER	3555.47	0.85
MICROGOBIUS SPECIES	MICROGOBIUS SPECIES	3942.26	0.85
ANCHOA HEPSETUS	STRIPED ANCHOVY	3143.35	0.68
BLENNIIDAE	COMBTOOTH BLENNIES	2386.72	0.51
SYMPHURUS PLAGIUSA	BLACKCHEEK TONGUEFISH	2259.57	0.49
ANGUILLA ROSTRATA	AMERICAN EEL	1245.06	0.27
PARALICHTHYS ALBIGUTTA	GULF FLOUNDER	909.78	0.20
BAIRDIELLA CHRYSURA	SILVER PERCH	724.31	0.16
CITHARICHTHYS SPECIES	WHIFF	542.45	0.12
CYNOSCION REGALIS	WEAKFISH	509.87	0.11
ELOPS LEPTOCEPHALUS	LADYFISH LARVAE	499.15	0.11
GOBIONELLUS SPECIES	GOBIONELLUS SPECIES	469.46	0.15
GOBIONELLUS HASTATUS	SHARPTAIL GOBY	457.95	0.10
GOBIONELLUS SHUFELDTI	FRESHWATER GOBY	448.24	0.10
MYROPHIS PUNCTATUS	SPECKLED WORM EEL	384.66	0.08
POGONIAS CROMIS	BLACK DRUM	319.72	0.07
MENTICIRRHUS SPECIES	KINGFISH	305.44	0.07
CYNOSCION NEBULOSUS	SPOTTED SEATROUT	299.54	0.06
GOBIESOX STRUMOSUS	SKILLETFISH	229.93	0.05
ORTHOPRISTIS CHRYSOPTERA	PIGFISH	209.63	0.05
SYNGNATHUS FUSCUS	NORTHERN PIPEFISH	185.83	0.04
SCIAENOPS OCELLATA	RED DRUM	177.96	0.04
TRINECTES MACULATUS	HOGCHOKER	174.46	0.04
UNKNOWN TRIGLIDAE	SEAROBIN	167.23	0.04
EUCINOSTOMUS SPECIES	MOJARRA	157.02	0.03
PARALICHTHYS DENTATUS	SUMMER FLOUNDER	125.16	0.03
DORMITATOR MACULATUS	FAT SLEEPER	111.31	0.02
STRONGYLURA MARINA	ATLANTIC NEEDLEFISH	99.18	0.02
UNKNOWN SCIAENIDAE	DRUM	73.41	0.02
MEGALOPS ATLANTICA	TARPON	65.32	0.01
SYNODUS FOETENS	INSHORE LIZARDFISH	62.74	0.01
OPHICHTHUS GOMESI	SHRIMP EEL	56.75	0.01
FUNDULUS HETEROCLITUS	MUMMICHOG	42.94	0.01
GOBIOSOMA BOSCI	NAKED GOBY	36.73	0.01
SYMPHURUS CIVITATUS	OFFSHORE TONGUEFISH	36.13	0.01
MEMBRAS MARTINICA	ROUGH SILVERSIDE	32.54	0.01
MUGIL CUREMA	WHITE MULLET	32.38	0.01
PEPRILUS ALEPIDOTUS	HARVESTFISH	31.39	0.01

TABLE 3.2 TOTAL DENSITY AND PERCENT TOTAL OF FISH AND PENAEID SHRIMP COLLECTED IN THE ENTRAINMENT LARVAL FISH PROJECT, SEPTEMBER 1978 TO MAY 1979.

SPECIES SCIENTIFIC NAME	SPECIES COMMON NAME	DENSITY	PERCENT
MYCTEROPERCA SPECIES	GROUPER	31.13	0.01
ARCHOSARGUS PROBATOCEPHALUS	SHEEPSHEAD	30.88	0.01
UNKNOWN LUTJANIDAE	SNAPPER	18.21	0.00
GOBIOSOMA ROBUSTUM	CODE GOBY	17.92	0.00
TAUTOGA ONITIS	TAUTOG	17.12	0.00
CHLOROSCOMBRUS CHRYSURUS	ATLANTIC BUMPER	16.42	0.00
LUTJANUS GRISEUS	GRAY SNAPPER	14.37	0.00
FUNDULUS MAJALIS	STRIPED KILLIFISH	14.12	0.00
SPHOEROIDES MACULATUS	NORTHERN PUFFER	14.12	0.00
UNKNOWN FISH	UNKNOWN FISH	14.10	0.00
UNKNOWN OPHIDIIDAE	CUSK EEL OR BROTULA	13.44	0.00
MENIDIA MENIDIA	ATLANTIC SILVERSIDE	13.35	0.00
	TOTAL	463648.31	92.99

TABLE 3.3 ENTRAINMENT RATES, SEPTEMBER 1978 TO MAY 1979, FOR TOTAL FISH

TRIP	YEAR	FLOWS FROM WEEK OF	MEAN FLOW/DAY (M^3 X10^6)	SAMPLE DATE	MEAN DENSITY/DAY (#/1000 M^3)	ENTRAINED/DAY (MEAN #X10^3)
1	1978	SEP 2 - SEP 8	5.350	SEP 6	460.946	2465.958
2	1978	SEP 9 - SEP 15	3.925	SEP 12	335.222	1315.898
3	1978	SEP 16 - SEP 22	2.761	SEP 19	316.278	873.383
4	1978	SEP 23 - SEP 29	4.013	SEP 26	627.340	2517.411
5	1978	SEP 30 - OCT 6	5.212	OCT 3	180.450	940.469
6	1978	OCT 7 - OCT 13	5.408	OCT 10	88.311	477.545
7	1978	OCT 14 - OCT 20	5.408	OCT 17	88.571	478.553
8	1978	OCT 21 - OCT 27	5.408	OCT 24	88.155	476.703
9	1978	OCT 28 - NOV 3	5.408	OCT 31	132.502	716.512
10	1978	NOV 4 - NOV 10	3.978	NOV 7	23.619	93.953
11	1978	NOV 11 - NOV 17	3.915	NOV 14	37.126	145.348
12	1978	NOV 18 - NOV 24	4.429	NOV 21	41.239	182.640
13	1978	NOV 25 - DEC 1	5.016	NOV 28	62.152	311.755
14	1978	DEC 2 - DEC 8	5.212	DEC 5	124.673	649.755
15	1978	DEC 9 - DEC 15	5.408	DEC 12	375.751	2031.887
16	1978	DEC 16 - DEC 22	5.408	DEC 19	350.330	1893.668
17	1978	DEC 23 - DEC 29	5.408	DEC 27	279.103	1509.260
18	1979	DEC 30 - JAN 5	5.408	JAN 3	421.289	2278.136
19	1979	JAN 6 - JAN 12	5.408	JAN 9	205.247	1109.879
20	1979	JAN 13 - JAN 19	3.476	JAN 16	726.782	2526.492
21	1979	JAN 20 - JAN 26	2.704	JAN 23	635.944	1719.444
22	1979	JAN 27 - FEB 2	2.704	JAN 30	1021.750	2762.573
23	1979	FEB 3 - FEB 9	2.704	FEB 6	604.061	1633.241
24	1979	FEB 10 - FEB 16	2.704	FEB 13	778.444	2104.731
25	1979	FEB 17 - FEB 23	2.704	FEB 20	819.698	2216.273
26	1979	FEB 24 - MAR 2	2.704	FEB 27	1014.802	2743.787
27	1979	MAR 3 - MAR 9	1.510	MAR 6	1380.982	2085.359
28	1979	MAR 10 - MAR 16	2.019	MAR 13	1404.933	2836.068
29	1979	MAR 17 - MAR 23	2.019	MAR 20	1268.688	2561.036
30	1979	MAR 24 - MAR 30	2.019	MAR 27	594.936	1201.567
31	1979	MAR 31 - APR 6	2.019	APR 3	1108.577	2238.635
32	1979	APR 7 - APR 13	2.051	APR 10	1095.935	2247.936
33	1979	APR 14 - APR 20	2.704	APR 18	481.237	1301.288
34	1979	APR 21 - APR 27	2.704	APR 24	606.046	1638.609
35	1979	APR 28 - MAY 4	3.119	MAY 1	899.816	2806.243
36	1979	MAY 5 - MAY 11	3.976	MAY 8	1196.764	4758.488
37	1979	MAY 12 - MAY 18	4.734	MAY 15	1035.889	4903.849
38	1979	MAY 19 - MAY 25	5.277	MAY 22	644.130	3399.171
39	1979	MAY 26 - JUN 1	3.663	MAY 29	897.455	3287.631

TABLE 3.4 ENTRAINMENT RATES, SEPTEMBER 1978 TO MAY 1979, FOR SPOT

TRIP	YEAR	FLOWS FROM WEEK OF	MEAN FLOW/DAY (M^3 X10^6)	SAMPLE DATE	MEAN DENSITY/DAY (#/1000 M^3)	ENTRAINED/DAY (MEAN #X10^3)
1	1978	SEP 2 - SEP 8	5.330	SEP 6	0.000	0.000
2	1978	SEP 9 - SEP 15	3.025	SEP 12	0.000	0.000
3	1978	SEP 16 - SEP 22	2.761	SEP 19	0.000	0.000
4	1978	SEP 23 - SEP 29	4.013	SEP 26	0.000	0.000
5	1978	SEP 30 - OCT 6	5.212	OCT 3	0.000	0.000
6	1978	OCT 7 - OCT 13	5.404	OCT 10	0.000	0.000
7	1978	OCT 14 - OCT 20	5.408	OCT 17	0.000	0.000
8	1978	OCT 21 - OCT 27	5.408	OCT 24	0.000	0.000
9	1978	OCT 28 - NOV 3	5.408	OCT 31	0.000	0.000
10	1978	NOV 4 - NOV 10	3.978	NOV 7	0.000	0.000
11	1978	NOV 11 - NOV 17	3.915	NOV 14	0.000	0.000
12	1978	NOV 18 - NOV 24	4.429	NOV 21	0.000	0.000
13	1978	NOV 25 - DEC 1	5.016	NOV 28	1.031	5.173
14	1978	DEC 2 - DEC 8	5.212	DEC 5	0.000	0.000
15	1978	DEC 9 - DEC 15	5.408	DEC 12	0.978	5.289
16	1978	DEC 16 - DEC 22	5.408	DEC 19	1.031	5.577
17	1978	DEC 23 - DEC 29	5.408	DEC 27	26.621	143.412
18	1978	DEC 30 - JAN 5	5.408	JAN 3	3.338	18.052
19	1979	JAN 6 - JAN 12	5.408	JAN 9	57.808	312.599
20	1979	JAN 13 - JAN 19	3.476	JAN 16	155.350	574.802
21	1979	JAN 20 - JAN 26	2.704	JAN 23	137.268	806.329
22	1979	JAN 27 - FEB 2	2.704	JAN 30	359.914	1511.172
23	1979	FEB 3 - FEB 9	2.704	FEB 6	338.019	913.925
24	1979	FEB 10 - FEB 16	2.704	FEB 13	421.279	1139.039
25	1979	FEB 17 - FEB 23	2.704	FEB 20	389.626	1053.457
26	1979	FEB 24 - MAR 2	2.704	FEB 27	338.144	1455.016
27	1979	MAR 3 - MAR 9	1.510	MAR 5	1040.717	1571.539
28	1979	MAR 10 - MAR 16	2.019	MAR 13	1056.109	2131.911
29	1979	MAR 17 - MAR 23	2.019	MAR 20	934.605	1926.081
30	1979	MAR 24 - MAR 30	2.019	MAR 27	335.435	643.183
31	1979	MAR 31 - APR 6	2.019	APR 3	846.191	1708.162
32	1979	APR 7 - APR 13	2.051	APR 10	330.819	617.028
33	1979	APR 14 - APR 20	2.704	APR 18	222.481	601.538
34	1979	APR 21 - APR 27	2.704	APR 24	117.044	316.460
35	1979	APR 28 - MAY 4	3.[illegible]19	MAY 1	16.460	81.333
36	1979	MAY 5 - MAY 11	3.975	MAY 8	4.335	19.225
37	1979	MAY 12 - MAY 18	4.734	MAY 15	1.740	8.236
38	1979	MAY 19 - MAY 25	5.277	MAY 22	0.816	4.306
39	1979	MAY 26 - JUN 1	3.663	MAY 29	1.771	6.480

TABLE 3.5 ENTRAINMENT RATES, SEPTEMBER 1978 TO MAY 1979, FOR CROAKER

TRIP	YEAR	FLOWS FROM WEEK OF	MEAN FLOW/DAY (M^3 X10^6)	SAMPLE DATE	MEAN DENSITY/DAY (#/1000 M^3)	ENTRAINED/DAY (MEAN #X10^3)
1	1978	SEP 2 - SEP 8	5.350	SEP 6	0.000	0.000
2	1978	SEP 9 - SEP 15	3.925	SEP 12	6.273	24.625
3	1978	SEP 16 - SEP 22	2.761	SEP 19	1.945	5.371
4	1978	SEP 23 - SEP 29	4.013	SEP 26	44.216	177.433
5	1978	SEP 30 - OCT 6	5.212	OCT 3	11.826	61.636
6	1978	OCT 7 - OCT 13	5.408	OCT 10	8.838	47.794
7	1978	OCT 14 - OCT 20	5.408	OCT 17	1.177	6.365
8	1978	OCT 21 - OCT 27	5.408	OCT 24	12.961	70.098
9	1978	OCT 28 - NOV 3	5.408	OCT 31	41.123	222.374
10	1978	NOV 4 - NOV 10	3.978	NOV 7	7.608	30.262
11	1978	NOV 11 - NOV 17	3.915	NOV 14	11.915	46.648
12	1978	NOV 18 - NOV 24	4.429	NOV 21	5.590	24.758
13	1978	NOV 25 - DEC 1	5.016	NOV 28	25.194	126.374
14	1978	DEC 2 - DEC 8	5.212	DEC 5	65.523	341.492
15	1978	DEC 9 - DEC 15	5.408	DEC 12	313.322	1694.302
16	1978	DEC 16 - DEC 22	5.408	DEC 18	205.954	1113.703
17	1978	DEC 23 - DEC 29	5.408	DEC 27	210.190	1136.609
18	1979	DEC 30 - JAN 5	5.408	JAN 3	388.508	2100.673
19	1979	JAN 6 - JAN 12	5.408	JAN 9	132.156	714.641
20	1979	JAN 13 - JAN 19	3.476	JAN 16	534.630	1858.416
21	1979	JAN 20 - JAN 26	2.704	JAN 23	384.618	1039.918
22	1979	JAN 27 - FEB 2	2.704	JAN 30	411.989	1113.922
23	1979	FEB 3 - FEB 9	2.704	FEB 6	225.103	608.626
24	1979	FEB 10 - FEB 16	2.704	FEB 13	244.148	660.120
25	1979	FEB 17 - FEB 23	2.704	FEB 20	248.473	671.873
26	1979	FEB 24 - MAR 2	2.704	FEB 27	190.473	514.993
27	1979	MAR 3 - MAR 9	1.510	MAR 6	27.799	41.979
28	1979	MAR 10 - MAR 16	2.019	MAR 13	205.588	415.010
29	1979	MAR 17 - MAR 23	2.019	MAR 20	152.725	308.301
30	1979	MAR 24 - MAR 30	2.019	MAR 27	100.715	203.309
31	1979	MAR 31 - APR 6	2.019	APR 3	121.834	246.042
32	1979	APR 7 - APR 13	2.051	APR 10	625.348	1284.534
33	1979	APR 14 - APR 20	2.704	APR 17	166.544	450.337
34	1979	APR 21 - APR 27	2.704	APR 24	38.061	102.907
35	1979	APR 28 - MAY 4	3.119	MAY 1	18.200	56.760
36	1979	MAY 5 - MAY 11	3.976	MAY 8	30.697	122.016
37	1979	MAY 12 - MAY 18	4.734	MAY 15	15.937	75.445
38	1979	MAY 19 - MAY 25	5.277	MAY 22	25.054	132.214
39	1979	MAY 26 - JUN 1	3.663	MAY 29	29.595	108.414

TABLE 3.6 ENTRAINMENT RATES, SEPTEMBER 1978 TO MAY 1979, FOR FLOUNDER

TRIP	YEAR	FLOWS FROM WEEK OF	MEAN FLOW/DAY ($M^3 \times 10^6$)	SAMPLE DATE	MEAN DENSITY/DAY (#/1000 M^3)	ENTRAINED/DAY (MEAN #$\times 10^3$)
1	1978	SEP 2 - SEP 8	3.330	SEP 6	0.000	0.000
2	1978	SEP 9 - SEP 15	3.925	SEP 12	0.000	0.000
3	1978	SEP 16 - SEP 22	2.761	SEP 19	0.000	0.000
4	1978	SEP 23 - SEP 29	4.013	SEP 26	0.000	0.000
5	1978	SEP 30 - OCT 6	5.212	OCT 3	0.000	0.000
6	1978	OCT 7 - OCT 13	5.408	OCT 10	0.000	0.000
7	1978	OCT 14 - OCT 20	5.408	OCT 17	0.000	0.000
8	1978	OCT 21 - OCT 27	5.408	OCT 24	0.000	0.000
9	1978	OCT 28 - NOV 3	5.408	OCT 31	0.000	0.000
10	1978	NOV 4 - NOV 10	3.279	NOV 7	0.000	0.000
11	1978	NOV 11 - NOV 17	3.915	NOV 14	0.000	0.000
12	1978	NOV 18 - NOV 24	4.429	NOV 21	0.000	0.000
13	1978	NOV 25 - DEC 1	5.016	NOV 28	0.964	4.838
14	1978	DEC 2 - DEC 8	5.212	DEC 5	7.147	37.249
15	1978	DEC 9 - DEC 15	5.408	DEC 12	3.238	17.509
16	1978	DEC 16 - DEC 22	5.408	DEC 18	27.119	146.647
17	1978	DEC 23 - DEC 29	5.408	DEC 27	10.462	56.574
18	1979	DEC 30 - JAN 5	5.408	JAN 3	10.932	59.116
19	1979	JAN 6 - JAN 12	5.408	JAN 9	4.694	25.384
20	1979	JAN 13 - JAN 19	3.476	JAN 16	2.795	9.719
21	1979	JAN 20 - JAN 26	2.704	JAN 23	23.492	63.516
22	1979	JAN 27 - FEB 2	2.704	JAN 30	11.555	31.242
23	1979	FEB 3 - FEB 9	2.704	FEB 6	18.684	50.517
24	1979	FEB 10 - FEB 16	2.704	FEB 13	31.137	84.187
25	1979	FEB 17 - FEB 23	2.704	FEB 20	87.440	236.417
26	1979	FEB 24 - MAR 2	2.704	FEB 27	123.111	332.864
27	1979	MAR 3 - MAR 9	1.510	MAR 6	94.713	143.021
28	1979	MAR 10 - MAR 16	2.019	MAR 13	56.711	114.480
29	1979	MAR 17 - MAR 23	2.019	MAR 20	25.822	52.126
30	1979	MAR 24 - MAR 30	2.019	MAR 27	39.445	79.626
31	1979	MAR 31 - APR 6	2.019	APR 3	18.185	36.708
32	1979	APR 7 - APR 13	2.051	APR 10	0.000	0.000
33	1979	APR 14 - APR 20	2.704	APR 18	0.998	2.699
34	1979	APR 21 - APR 27	2.704	APR 24	0.000	0.000
35	1979	APR 28 - MAY 4	3.119	MAY 1	0.000	0.000
36	1979	MAY 5 - MAY 11	3.976	MAY 8	0.000	0.000
37	1979	MAY 12 - MAY 18	4.734	MAY 15	0.000	0.000
38	1979	MAY 19 - MAY 25	5.277	MAY 22	0.000	0.000
39	1979	MAY 26 - JUN 1	3.563	MAY 29	0.000	0.000

TABLE 3.7 ENTRAINMENT RATES, SEPTEMBER 1978 TO MAY 1979, FOR MENHADEN

TRIP	YEAR	FLOWS FROM WEEK OF	MEAN FLOW/DAY (M^3 X10^6)	SAMPLE DATE	MEAN DENSITY/DAY (#/1000 M^3)	ENTRAINED/DAY (MEAN #X10^3)
1	1978	SEP 2 - SEP 8	5.350	SEP 6	0.000	0.000
2	1978	SEP 9 - SEP 15	3.925	SEP 12	0.000	0.000
3	1978	SEP 16 - SEP 22	2.761	SEP 19	0.000	0.000
4	1978	SEP 23 - SEP 29	4.013	SEP 26	0.000	0.000
5	1978	SEP 30 - OCT 6	5.212	OCT 3	0.000	0.000
6	1978	OCT 7 - OCT 13	5.408	OCT 10	0.000	0.000
7	1978	OCT 14 - OCT 20	5.408	OCT 17	0.000	0.000
8	1978	OCT 21 - OCT 27	5.408	OCT 24	0.000	0.000
9	1978	OCT 28 - NOV 3	5.408	OCT 31	0.000	0.000
10	1978	NOV 4 - NOV 10	3.978	NOV 7	0.000	0.000
11	1978	NOV 11 - NOV 17	3.915	NOV 14	0.000	0.000
12	1978	NOV 18 - NOV 24	4.429	NOV 21	0.000	0.000
13	1978	NOV 25 - DEC 1	5.016	NOV 29	0.000	0.000
14	1978	DEC 2 - DEC 8	5.212	DEC 5	0.000	0.000
15	1978	DEC 9 - DEC 15	5.408	DEC 12	0.000	0.000
16	1978	DEC 16 - DEC 22	5.408	DEC 18	0.000	0.000
17	1978	DEC 23 - DEC 29	5.409	DEC 27	2.063	11.154
18	1979	DEC 30 - JAN 5	5.408	JAN 3	0.000	0.000
19	1979	JAN 6 - JAN 12	5.408	JAN 9	0.000	0.000
20	1979	JAN 13 - JAN 19	3.476	JAN 16	0.951	3.307
21	1979	JAN 20 - JAN 26	2.704	JAN 23	1.063	2.874
22	1979	JAN 27 - FEB 2	2.704	JAN 30	0.000	0.000
23	1979	FEB 3 - FEB 9	2.704	FEB 6	1.184	3.200
24	1979	FEB 10 - FEB 16	2.704	FEB 13	0.000	0.000
25	1979	FEB 17 - FEB 23	2.704	FEB 20	6.582	17.796
26	1979	FEB 24 - MAR 2	2.704	FEB 27	4.530	12.249
27	1979	MAR 3 - MAR 9	1.510	MAR 6	5.006	7.559
28	1979	MAR 10 - MAR 16	2.019	MAR 13	2.549	5.144
29	1979	MAR 17 - MAR 23	2.019	MAR 20	32.847	66.307
30	1979	MAR 24 - MAR 30	2.019	MAR 27	64.029	129.252
31	1979	MAR 31 - APR 6	2.019	APR 3	52.358	105.692
32	1979	APR 7 - APR 13	2.051	APR 10	68.818	141.156
33	1979	APR 14 - APR 20	2.704	APR 18	7.963	21.529
34	1979	APR 21 - APR 27	2.704	APR 24	2.824	7.636
35	1979	APR 28 - MAY 4	3.119	MAY 1	0.000	0.000
36	1979	MAY 5 - MAY 11	3.976	MAY 8	0.000	0.000
37	1979	MAY [illegible] - MAY 18	4.734	MAY 15	0.000	0.000
38	1979	MAY [illegible] - MAY 25	5.277	MAY 22	0.000	0.000
39	1979	MAY [illegible] - JUN 1	3.663	MAY 29	0.000	0.000

TABLE 3.8 ENTRAINMENT RATES, SEPTEMBER 1978 TO MAY 1979, FOR MULLET

TRIP	YEAR	FLOWS FROM WEEK OF	MEAN FLOW/DAY ($M^3 X10^6$)	SAMPLE DATE	MEAN DENSITY/DAY (#/1000 M^3)	ENTRAINED/DAY (MEAN #X10^3)
1	1978	SEP 2 - SEP 8	5.300	SEP 5	0.000	0.000
2	1978	SEP 9 - SEP 15	3.025	SEP 12	0.000	0.000
3	1978	SEP 16 - SEP 22	2.761	SEP 19	0.000	0.000
4	1978	SEP 23 - SEP 29	4.313	SEP 26	0.000	0.000
5	1978	SEP 30 - OCT 6	5.212	OCT 3	0.000	0.000
6	1978	OCT 7 - OCT 13	5.408	OCT 10	0.000	0.000
7	1978	OCT 14 - OCT 20	5.408	OCT 17	0.000	0.000
8	1978	OCT 21 - OCT 27	5.408	OCT 24	0.000	0.000
9	1978	OCT 28 - NOV 3	5.408	OCT 31	0.000	0.000
10	1978	NOV 4 - NOV 10	3.078	NOV 7	0.000	0.000
11	1978	NOV 11 - NOV 17	3.915	NOV 14	1.184	4.634
12	1978	NOV 18 - NOV 24	4.429	NOV 21	0.000	0.000
13	1978	NOV 25 - DEC 1	5.016	NOV 28	0.000	0.000
14	1978	DEC 2 - DEC 8	5.212	DEC 5	1.211	6.313
15	1978	DEC 9 - DEC 15	5.408	DEC 12	1.026	5.549
16	1978	DEC 16 - DEC 22	5.408	DEC 19	0.000	0.000
17	1978	DEC 23 - DEC 29	5.408	DEC 27	0.000	0.000
18	1979	DEC 30 - JAN 5	5.408	JAN 3	0.000	0.000
19	1979	JAN 6 - JAN 12	5.408	JAN 9	0.000	0.000
20	1979	JAN 13 - JAN 19	3.476	JAN 16	0.883	3.069
21	1979	JAN 20 - JAN 26	2.704	JAN 23	3.045	8.233
22	1979	JAN 27 - FEB 2	2.704	JAN 30	19.514	52.762
23	1979	FEB 3 - FEB 9	2.704	FEB 6	12.880	34.826
24	1979	FEB 10 - FEB 16	2.704	FEB 13	47.483	128.384
25	1979	FEB 17 - FEB 23	2.704	FEB 20	71.380	192.996
26	1979	FEB 24 - MAR 2	2.704	FEB 27	115.929	313.445
27	1979	MAR 3 - MAR 9	1.510	MAR 6	83.492	126.078
28	1979	MAR 10 - MAR 16	2.019	MAR 13	12.878	25.996
29	1979	MAR 17 - MAR 23	2.019	MAR 20	110.995	224.059
30	1979	MAR 24 - MAR 30	2.019	MAR 27	16.113	32.527
31	1979	MAR 31 - APR 6	2.019	APR 3	8.029	16.207
32	1979	APR 7 - APR 13	2.051	APR 10	4.184	8.582
33	1979	APR 14 - APR 20	2.704	APR 18	0.962	2.600
34	1979	APR 21 - APR 27	2.704	APR 24	0.906	2.449
35	1979	APR 28 - MAY 4	3.119	MAY 1	1.145	3.570
36	1979	MAY 5 - MAY 11	3.976	MAY 8	0.000	0.000
37	1979	MAY 12 - MAY 18	4.734	MAY 15	0.000	0.000
38	1979	MAY 19 - MAY 25	5.277	MAY 22	0.000	0.000
39	1979	MAY 26 - JUN 1	3.663	MAY 29	0.840	3.077

TABLE 3.9 ENTRAINMENT RATES, SEPTEMBER 1978 TO MAY 1979, FOR SHRIMP

TRIP	YEAR	FLOWS FROM WEEK OF	MEAN FLOW/DAY ($M^3 \times 10^6$)	SAMPLE DATE	MEAN DENSITY/DAY (#/1000 M^3)	ENTRAINED/DAY (MEAN #$\times 10^3$)
1	1978	SEP 2 - SEP 8	5.360	SEP 6	300.143	1625.722
2	1978	SEP 9 - SEP 15	3.925	SEP 12	337.065	1323.130
3	1978	SEP 16 - SEP 22	2.761	SEP 19	244.251	674.484
4	1978	SEP 23 - SEP 29	4.313	SEP 26	1395.659	7506.558
5	1978	SEP 30 - OCT 6	5.212	OCT 3	240.660	1254.267
6	1978	OCT 7 - OCT 13	5.408	OCT 10	142.948	772.998
7	1978	OCT 14 - OCT 20	5.408	OCT 17	193.968	1048.887
8	1978	OCT 21 - OCT 27	5.408	OCT 24	30.078	162.646
9	1978	OCT 28 - NOV 3	5.408	OCT 31	20.557	111.162
10	1978	NOV 4 - NOV 10	3.978	NOV 7	10.994	42.735
11	1978	NOV 11 - NOV 17	3.915	NOV 14	7.713	30.198
12	1978	NOV 18 - NOV 24	4.429	NOV 21	8.707	38.562
13	1978	NOV 25 - DEC 1	5.015	NOV 28	2.673	13.408
14	1978	DEC 2 - DEC 8	5.212	DEC 5	9.616	50.116
15	1978	DEC 9 - DEC 15	5.408	DEC 12	4.233	22.889
16	1978	DEC 16 - DEC 22	5.408	DEC 18	1.978	10.095
17	1978	DEC 23 - DEC 29	5.408	DEC 27	2.187	11.828
18	1979	DEC 30 - JAN 5	5.408	JAN 3	1.036	5.605
19	1979	JAN 6 - JAN 12	5.408	JAN 9	0.000	0.000
20	1979	JAN 13 - JAN 19	3.476	JAN 16	0.000	0.000
21	1979	JAN 20 - JAN 26	2.704	JAN 23	0.000	0.000
22	1979	JAN 27 - FEB 2	2.704	JAN 30	0.000	0.000
23	1979	FEB 3 - FEB 9	2.704	FEB 6	0.000	0.000
24	1979	FEB 10 - FEB 16	2.704	FEB 13	0.000	0.000
25	1979	FEB 17 - FEB 23	2.704	FEB 20	0.000	0.000
26	1979	FEB 24 - MAR 2	2.704	FEB 27	0.000	0.000
27	1979	MAR 3 - MAR 9	1.510	MAR 6	0.000	0.000
28	1979	MAR 10 - MAR 16	2.019	MAR 13	0.000	0.000
29	1979	MAR 17 - MAR 23	2.019	MAR 20	25.652	51.783
30	1979	MAR 24 - MAR 30	2.019	MAR 27	395.809	799.000
31	1979	MAR 31 - APR 6	2.019	APR 3	262.394	529.681
32	1979	APR 7 - APR 13	2.051	APR 10	171.718	352.222
33	1979	APR 14 - APR 20	2.704	APR 18	92.726	250.709
34	1979	APR 21 - APR 27	2.704	APR 24	21.886	59.174
35	1979	APR 28 - MAY 4	3.119	MAY 1	50.930	158.833
36	1979	MAY 5 - MAY 11	3.976	MAY 8	61.017	242.611
37	1979	MAY 12 - MAY 18	4.734	MAY 15	10.324	48.872
38	1979	MAY 19 - MAY 25	5.277	MAY 22	7.639	40.311
39	1979	MAY 26 - JUN 1	3.663	MAY 29	36.470	133.601

Table 3.10 Results of analysis of variance for entrainment - September 1978 to May 1979. (Mean Length)

Source	Mean Length					
	Spot	Croaker	Menhaden	Flounder	Mullet	Brown Shrimp
Trip	***	***	***	***	**	***
Day/Night	ns	*** N>D	ns	ns	** N>D	ns
Trip*Day/Night	**	ns	ns	ns	ns	*
Tide	ns	ns	ns	ns	ns	ns
Trip*Tide	ns	ns	ns	ns	**	ns
Day/Night* Tide	ns	ns	ns	ns	ns	ns
$\bar{X}$	21.79	16.50	30.35	15.11	26.90	11.94
S^2	2.26	2.03	1.01	1.92	0.93	0.24
R^2	.904	.709	.834	.728	.680	.717

* $.01 < p \leq .05$

** $.001 < p \leq .01$

*** $p \leq .001$

NOTE: Analysis done with total lengths.

Table 3.11 Results of analysis of variance for entrainment - September 1978 to May 1979. (Density)

Source	Density Log 10 (Density +10)					
	Spot	Croaker	Menhaden	Flounder	Mullet	Brown Shrimp
Trip	***	***	ns	***	***	***
Day/Night	***	***	***	***	***	***
Day/Night	N>D	N>D	N>D	N>D	N>D	N>D
Trip*	***	***	***	***	**	***
Tide	***	***	ns	ns	ns	***
	3 715	3 715				31 75
Trip* Tide	*	***	ns	ns	***	***
Day/Night* Tide	ns	ns	ns	ns	**	***
$\bar{X}$	. 302	2.083	1.596	1.485	1.530	2.001
S^2	.092	.112	1.091	1.085	.115	.055
R^2	.876	.800	.727	.743	.680	.897
Trips	20-34	15-33	29-32	21-31	22-29	29-33

* $.01 < p \leq .05$

** $.001 < p \leq .01$

*** $p \leq .001$

Table 3.12 Entrainment Trend Analysis - 1975-1979

SPECIES	MEAN SQUARES TREND	MEAN SQUARES DEVIATION	MEAN SQUARES ERROR	% CHANGE/YEAR
Spoc	.01919	.03860**	.00746	+10.6
Croaker	.02684	.04045**	.00732	-11.2
Menhaden	.02063	.00853	.01196	- 9.9
Flounder	.06404**	.00100	.00298	+20.2
Mullet	.01761	.00207	.00524	+10.1
Brown shrimp	.13769*	.04087	.01969	-23.7

* *

SPECIES	B_1	B_0 (=UNWEIGHTED $\overline{X}$)	MINIMUM	MAXIMUM	±2 (STANDARD DEVIATION +2	±1	0
Spot	+0.438	1.8708	1.7832	1.9585	.2185	.1970	.189
Croaker	-.0518	1.8226	1.7190	1.9262	.2164	.1951	.187
Menhaden	-.0454	1.3902	1.2994	1.4810	.2767	.2494	.239
Flounder	+.0800	1.12394	1.0794	1.3995	1381	.1245	.119
Mullet	+.0420	1.2048	1.1208	1.2887	.1831	.1651	.158
Brown shrimp	-.1173	1.6316	1.3969	.1.8663	.3550	.3200	.307

* Significance level = 0.05
** Significance level = 0.01

FIGURE 3.1 LOG 10 MEAN DENSITY OF LARVAE ENTRAINED, 1974 TO 1979.

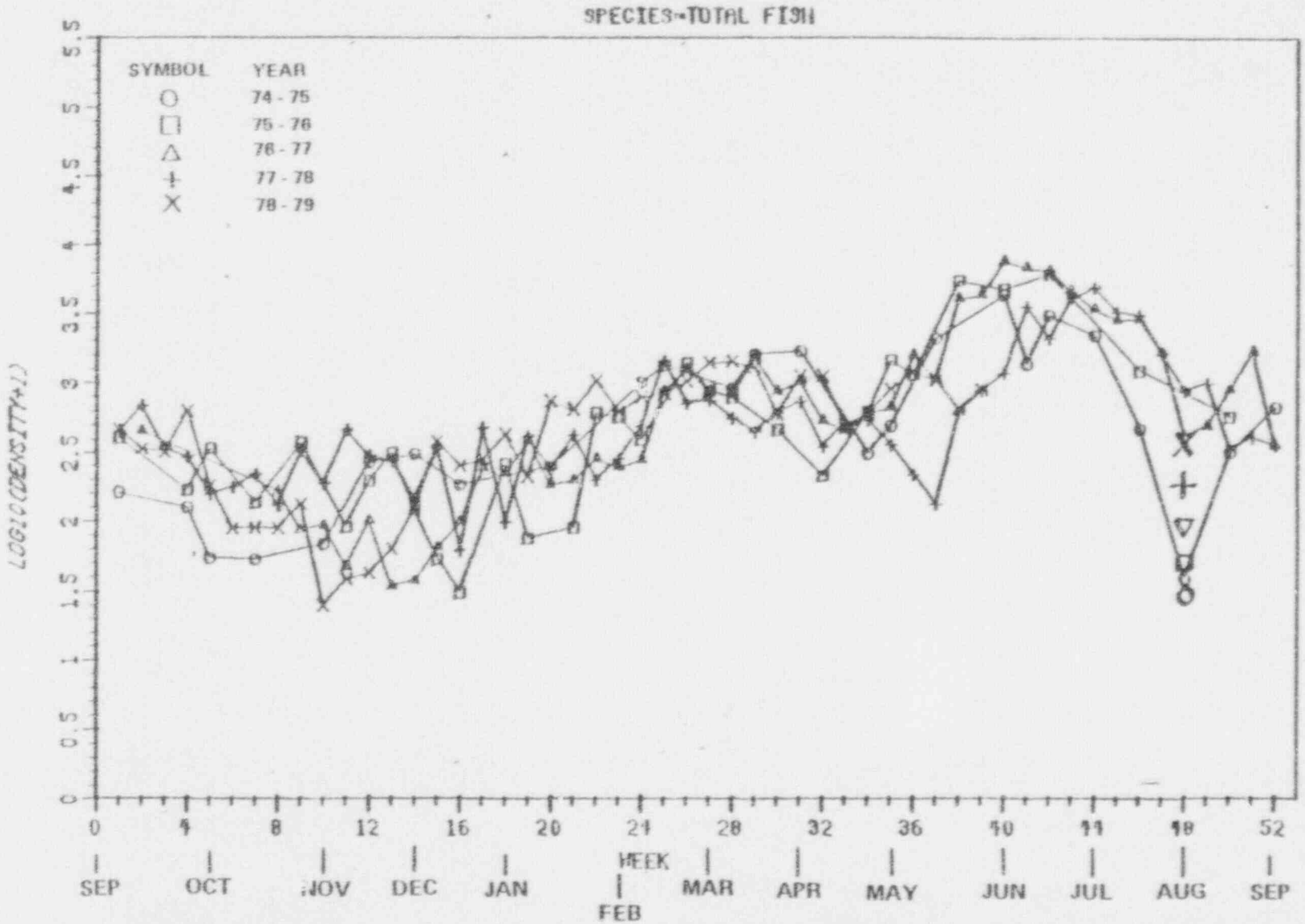

FIGURE 3.2 LOG 10 MEAN DENSITY OF LARVAE ENTRAINED, 1974 TO 1979.

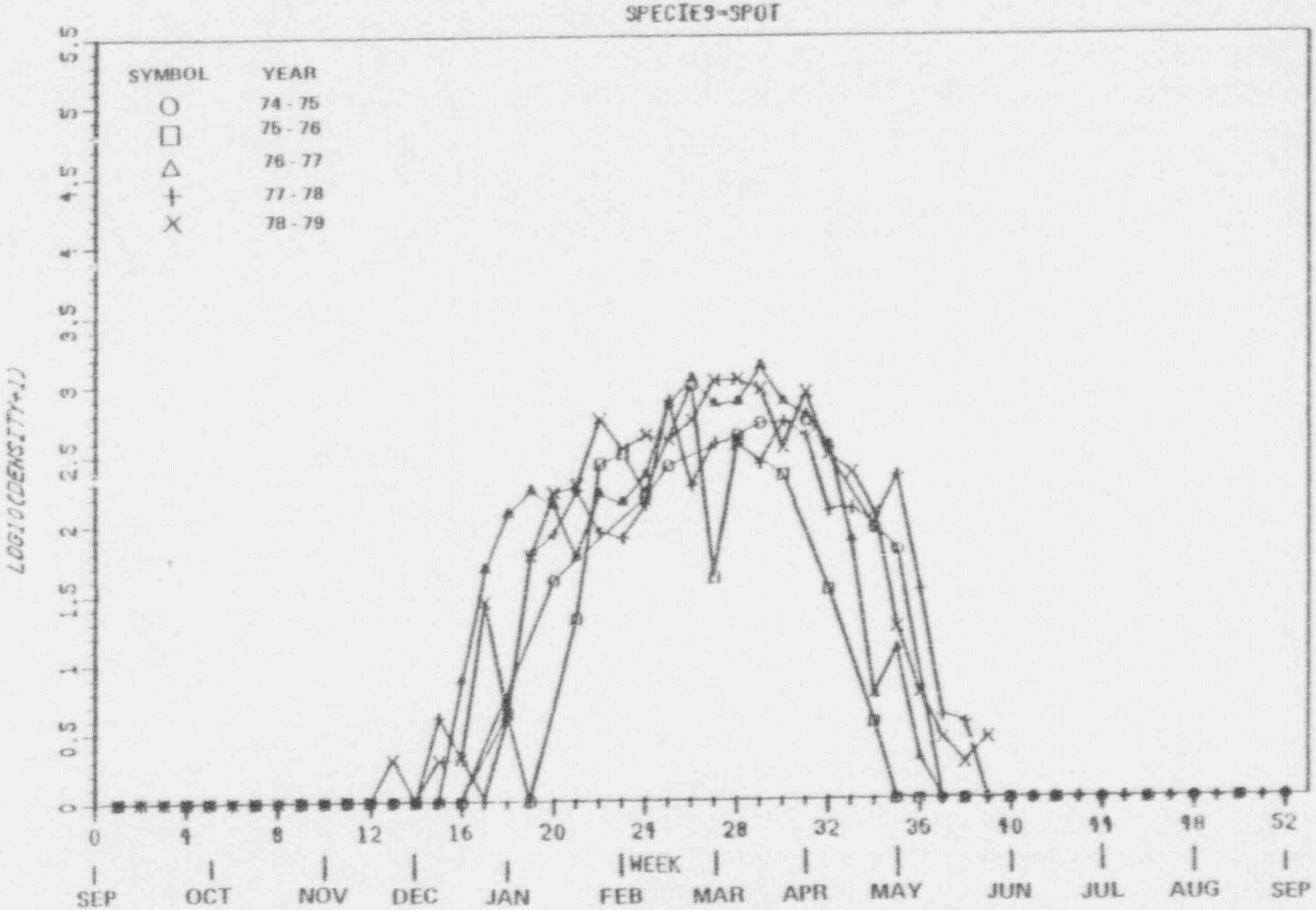

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FIGURE 3.3 LOG 10 MEAN DENSITY OF LARVAE ENTRAINED, 1974 TO 1979.

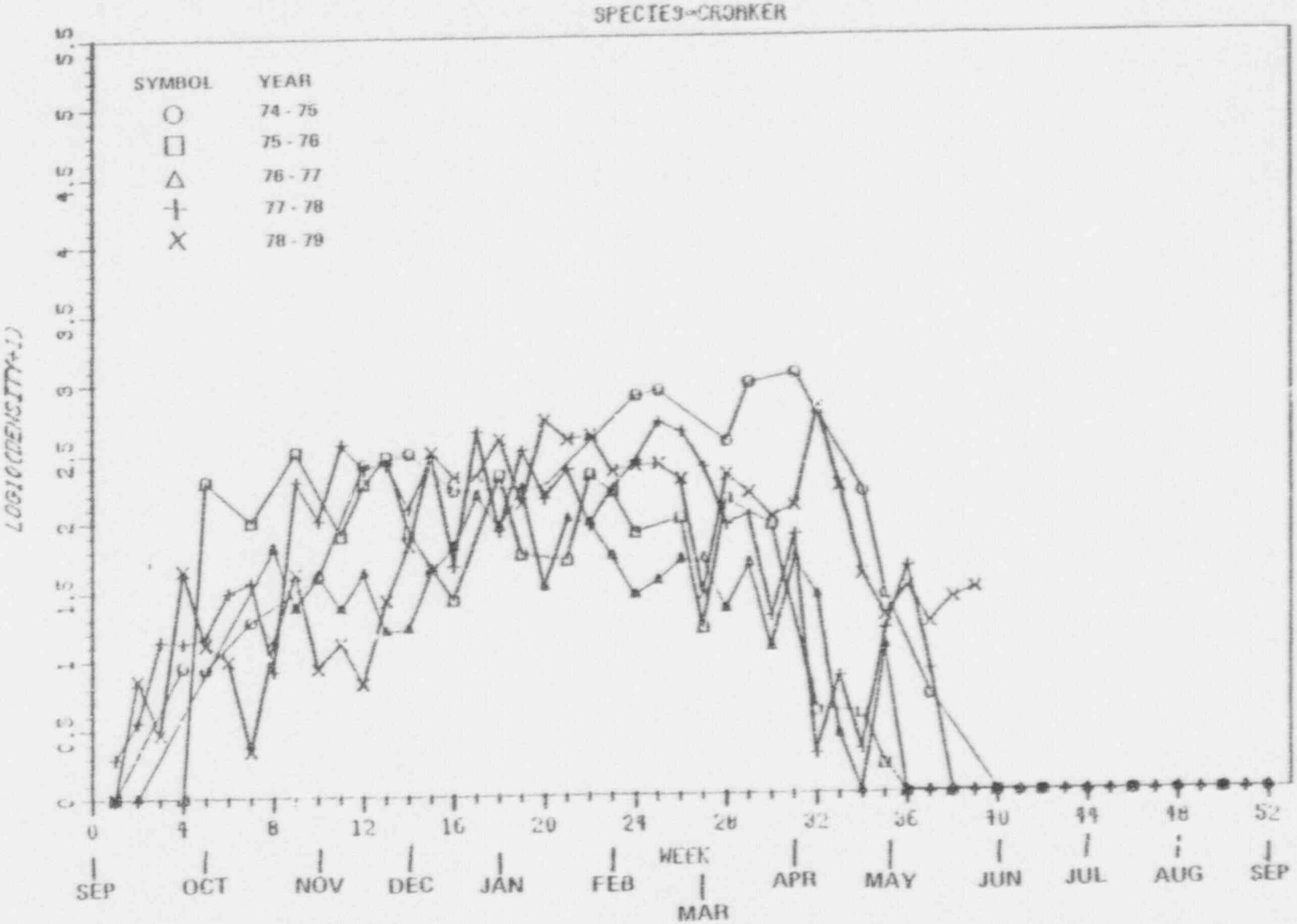


FIGURE 3.4 LOG 10 MEAN DENSITY OF LARVAE ENTRAINED, 1974 TO 1979.

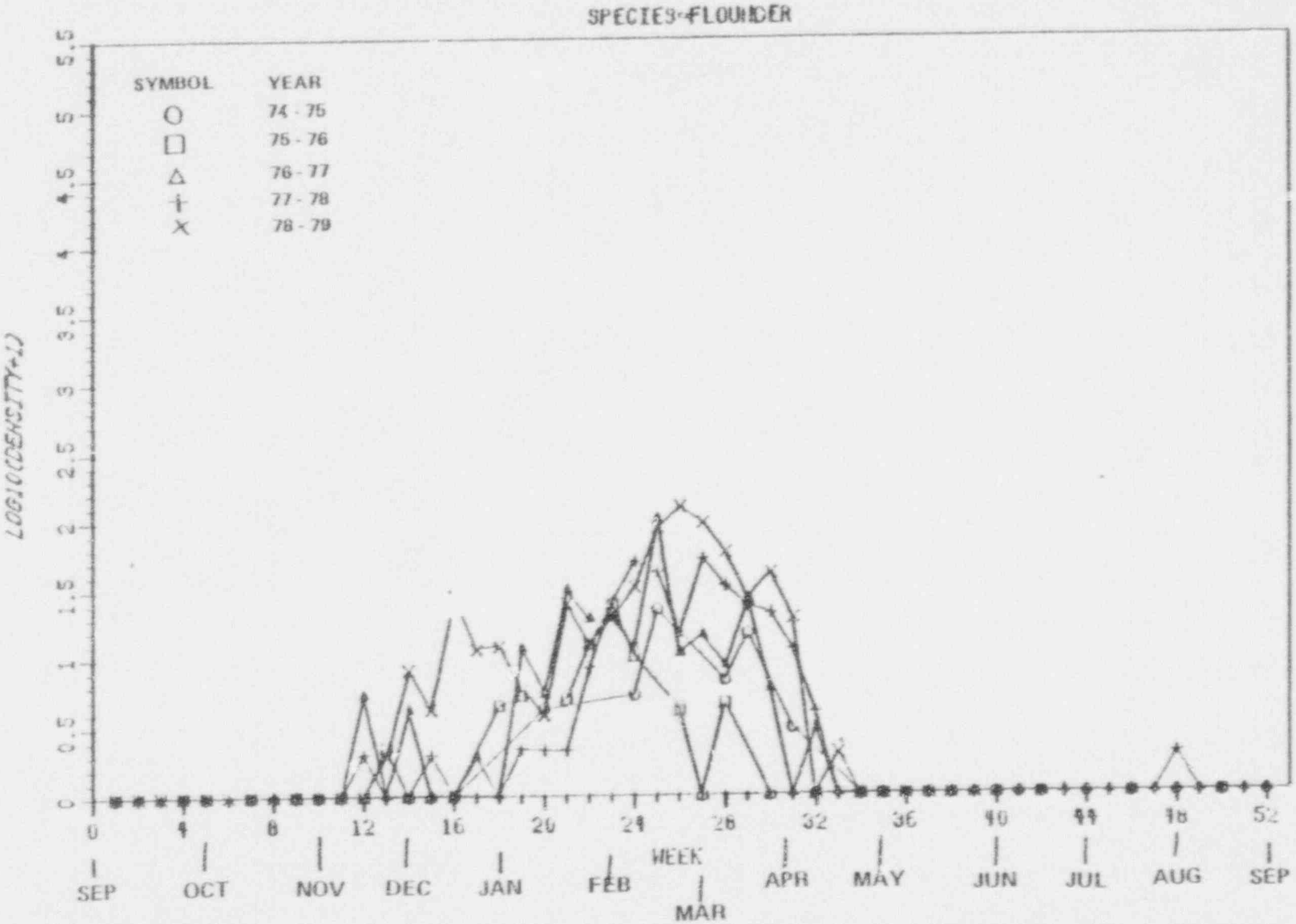


FIGURE 3.5 LOG 10 MEAN DENSITY OF LARVAE ENTRAINED, 1974 TO 1979.

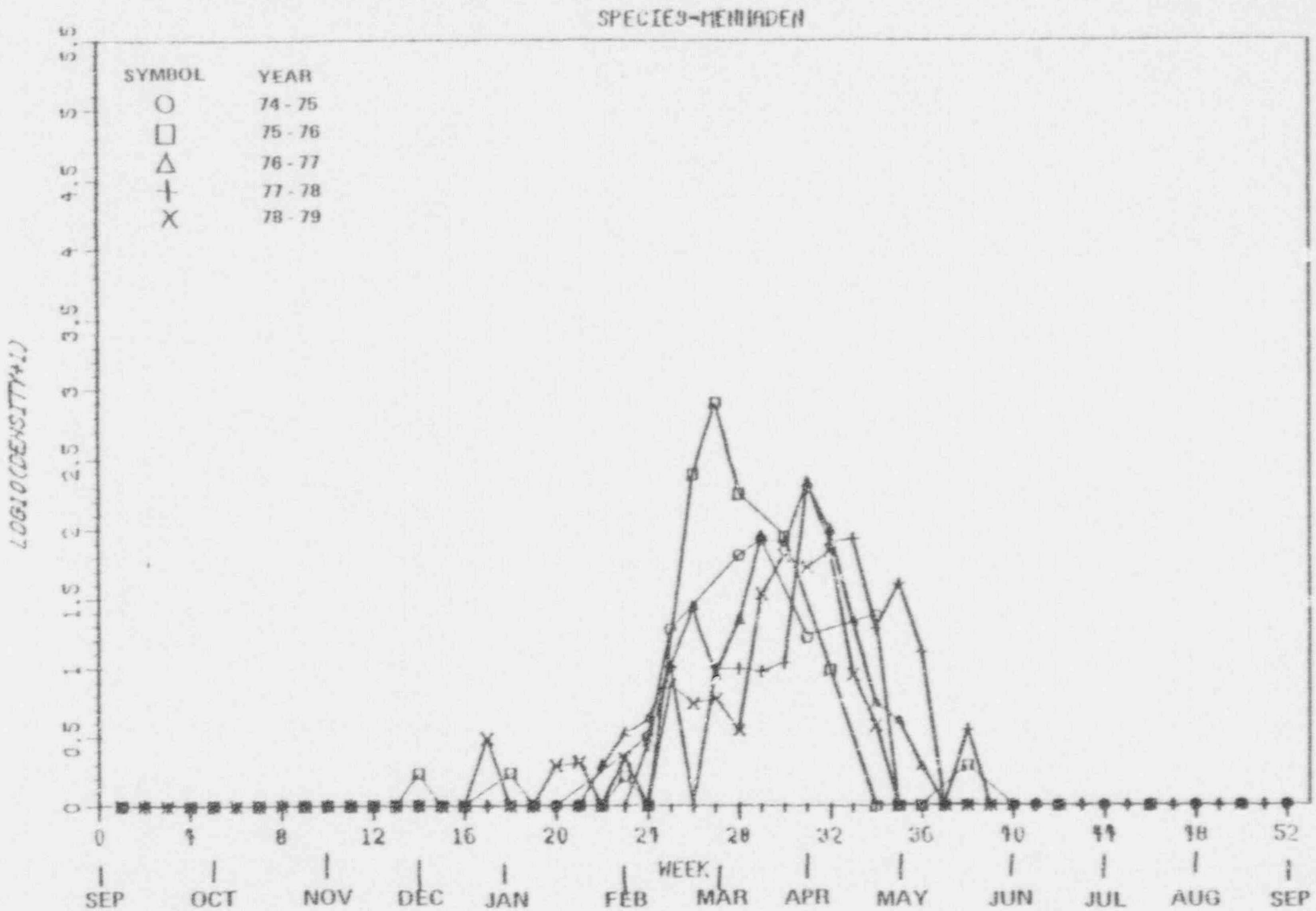


FIGURE 3.6 LOG 10 MEAN DENSITY OF LARVAE ENTRAINED, 1974 TO 1979.

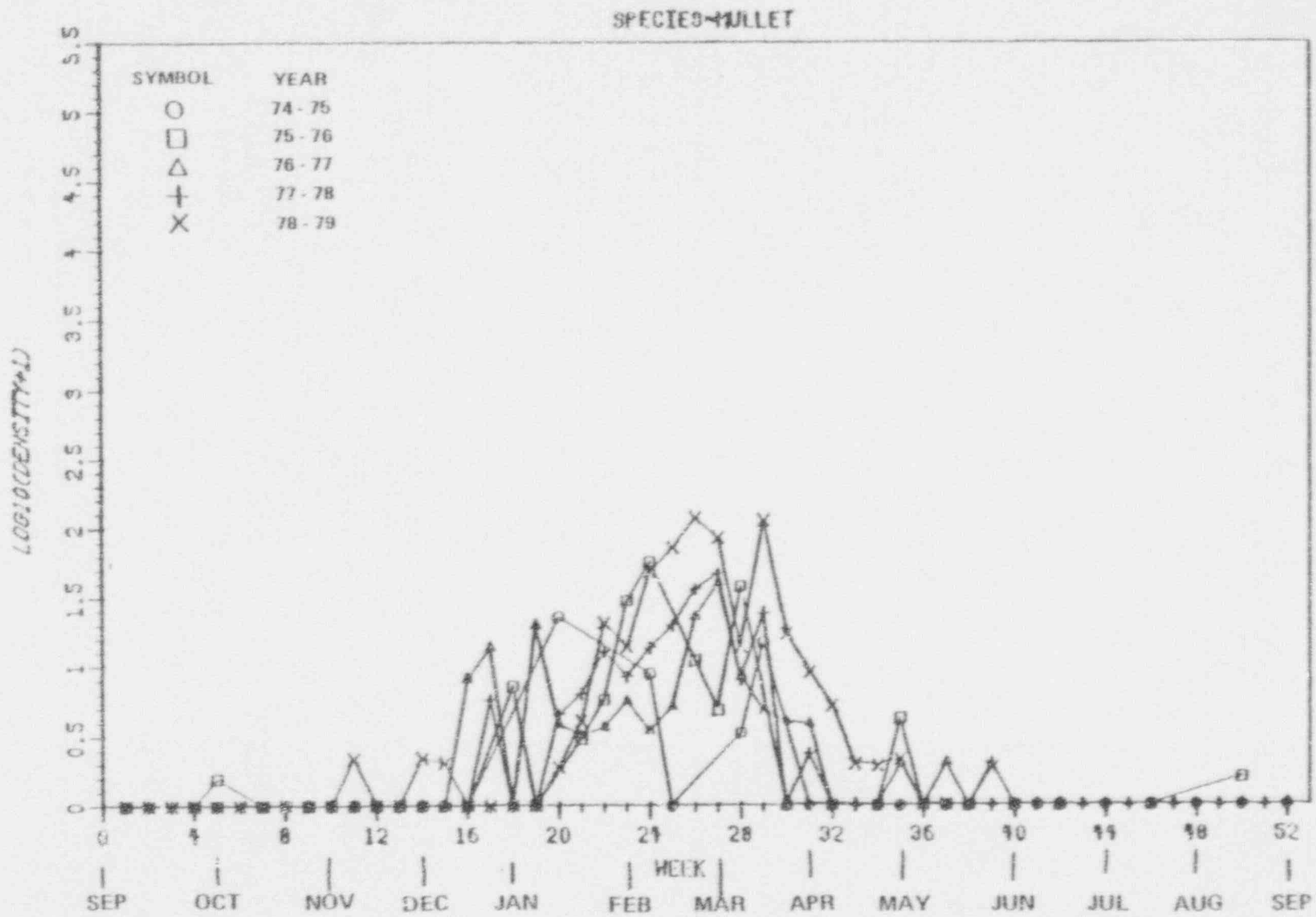


FIGURE 3.7 LOG 10 MEAN DENSITY OF LARVAE ENTRAINED, 1974 TO 1979.

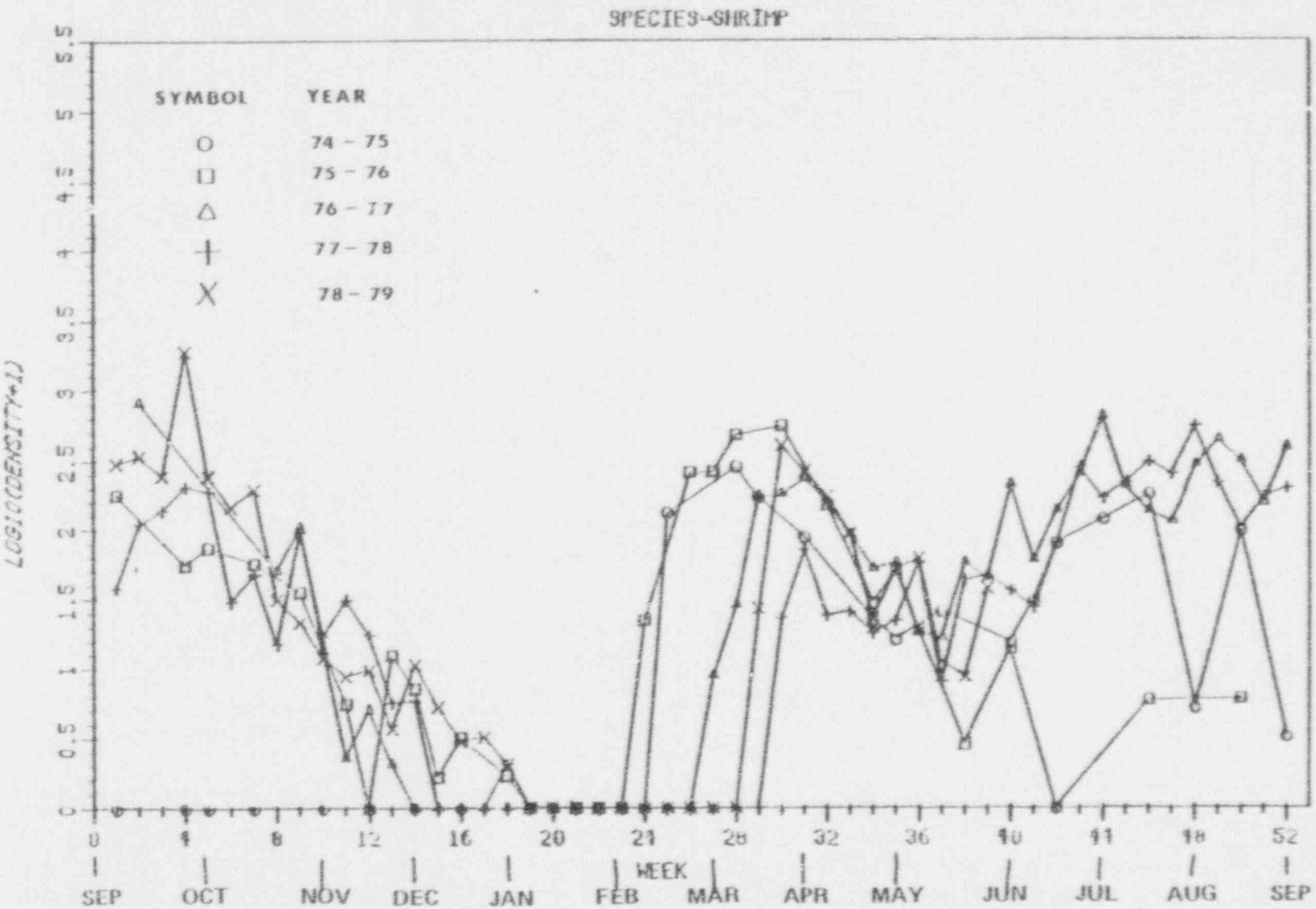


FIGURE 3.8 MEAN LENGTH BY DAY-NIGHT OF LARVAE ENTRAINED(SEP 1978-MAY 1979).

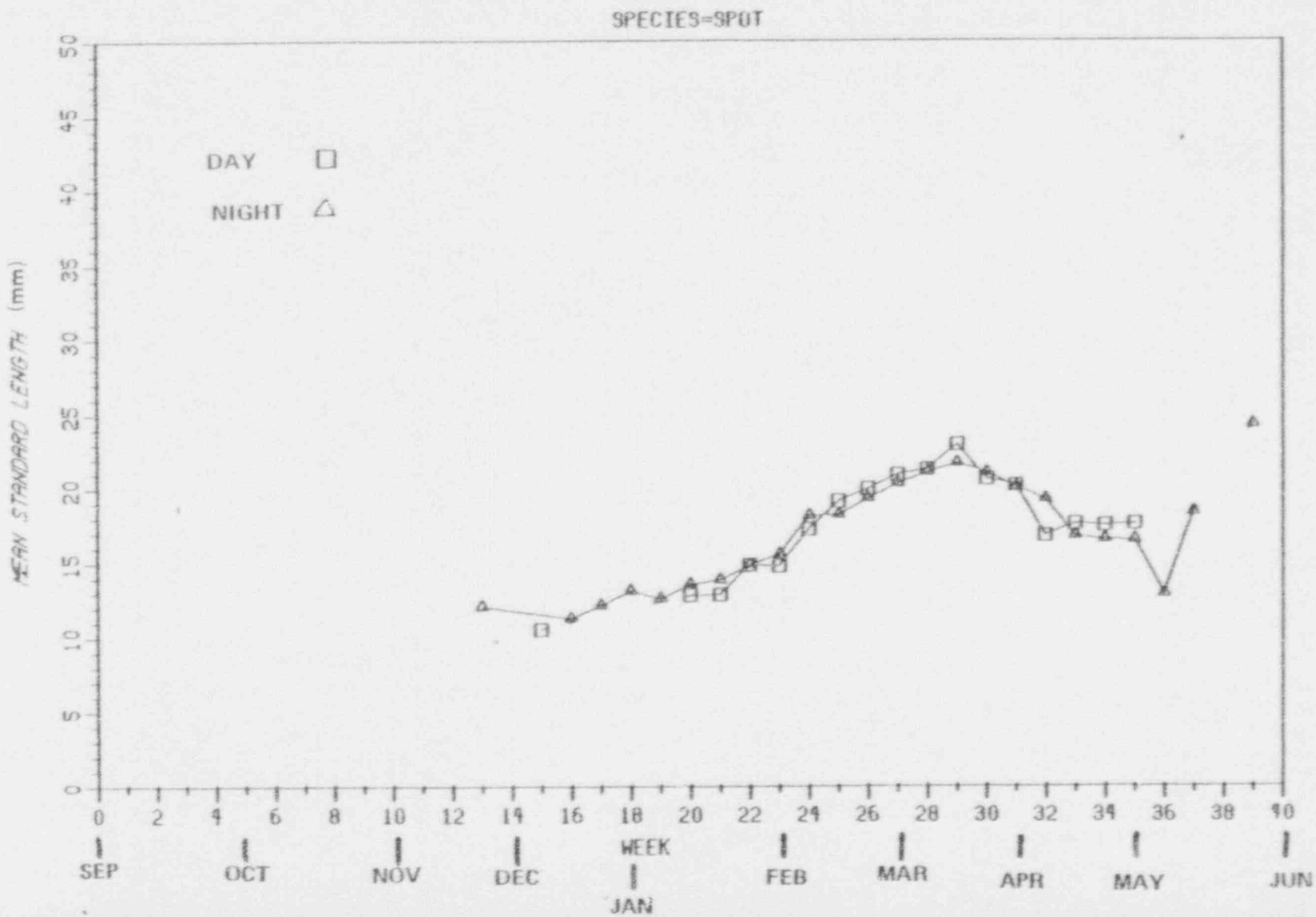


FIGURE 3.9 MEAN LENGTH BY DAY-NIGHT OF LARVAE ENTRAINED(SEP 1978-MAY 1979).

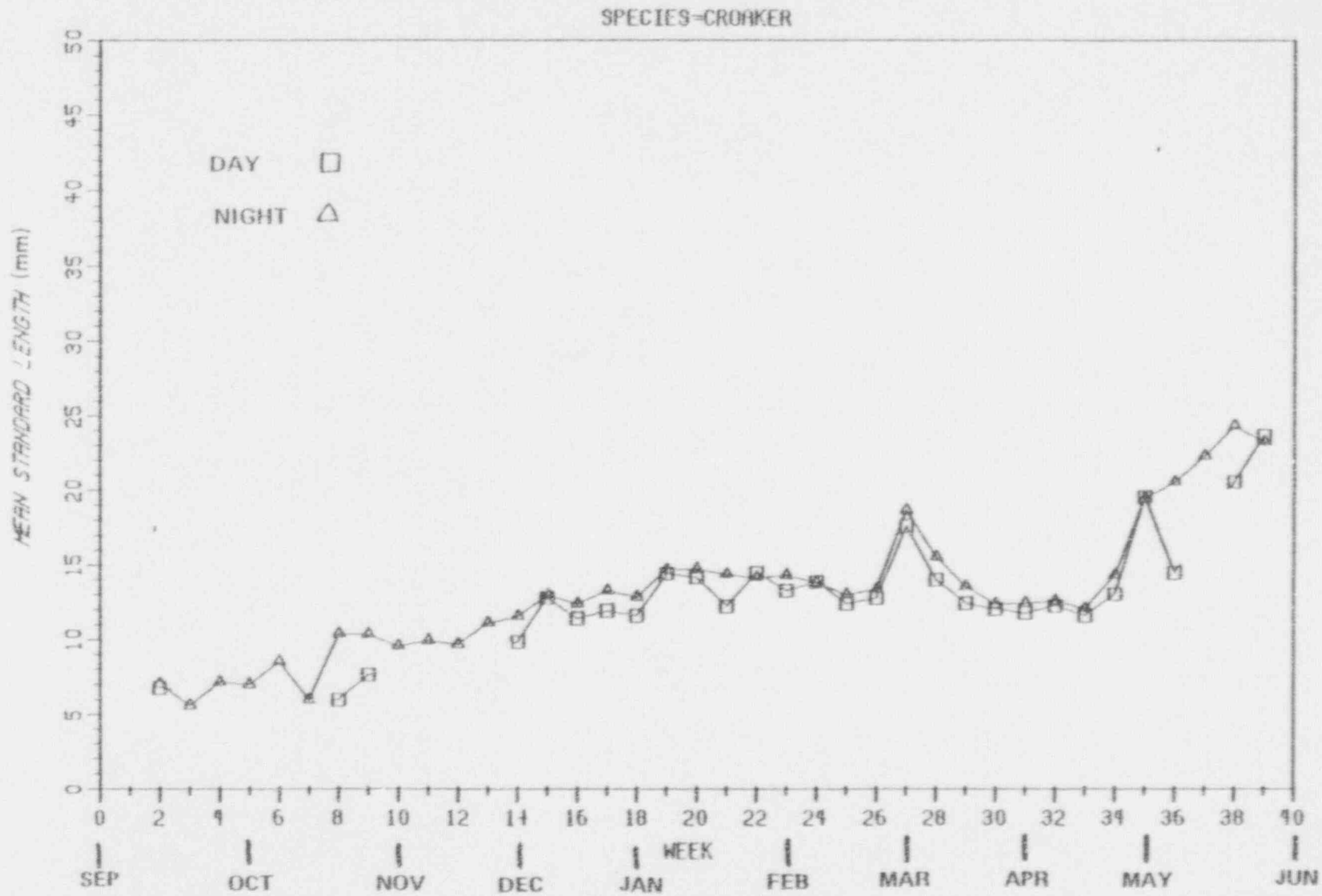


FIGURE 3.10 MEAN LENGTH BY DAY-NIGHT OF LARVAE ENTRAINED(SEP 1978-MAY 1979).

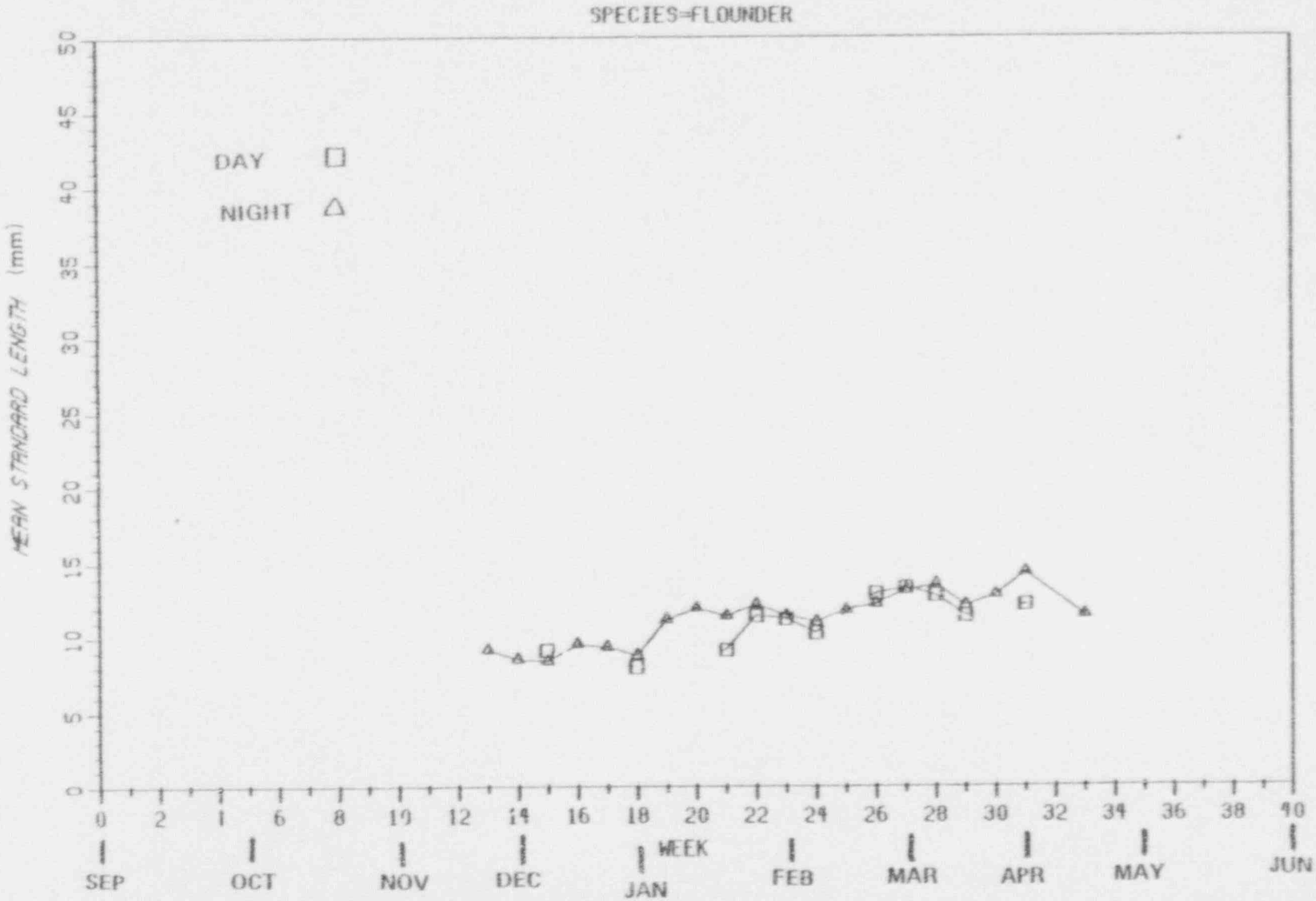


FIGURE 3.11 MEAN LENGTH BY DAY-NIGHT OF LARVAE ENTRAINED(SEP 1978-MAY 1979).

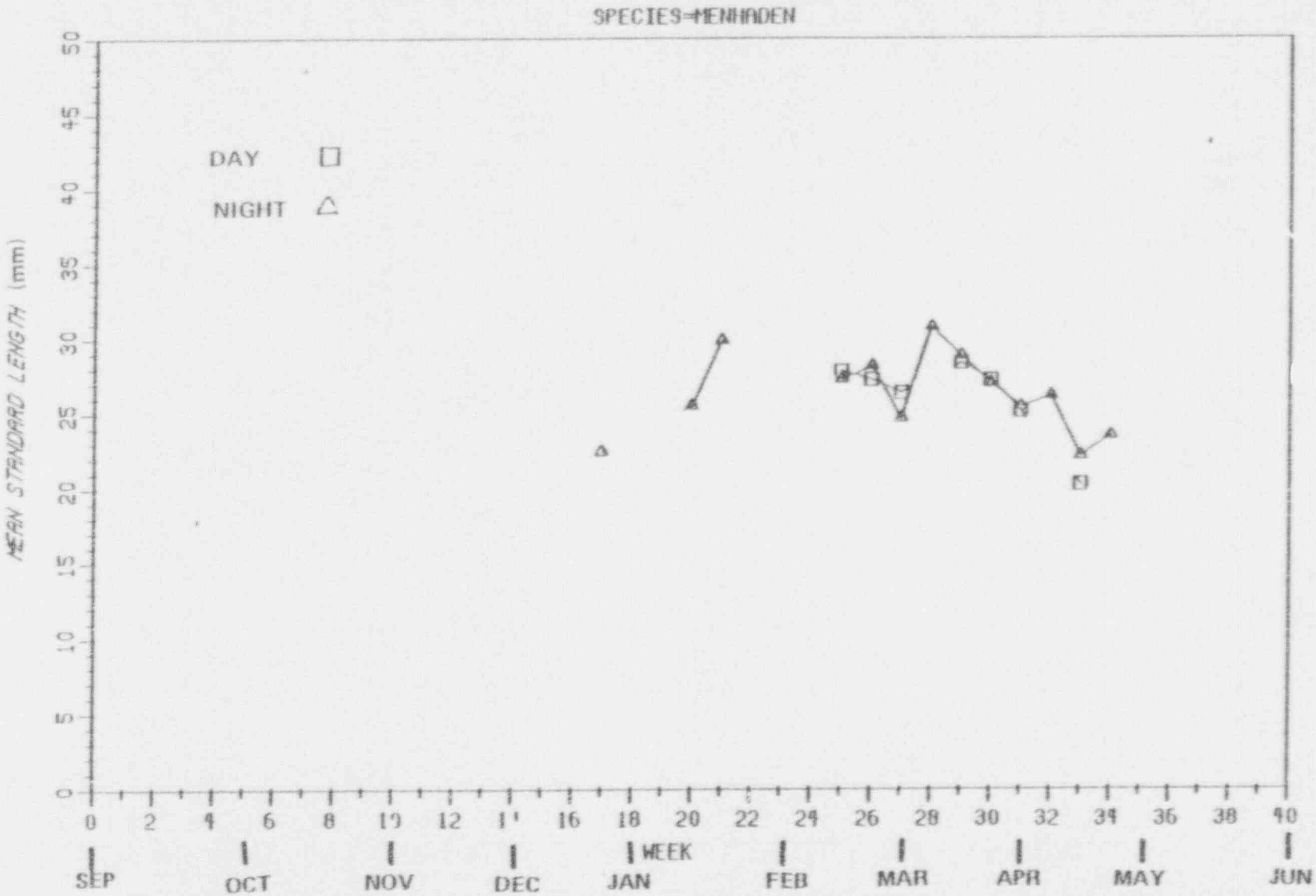


FIGURE 3.12 MEAN LENGTH BY DAY-NIGHT OF LARVAE ENTRAINED(SEP 1978-MAY 1979).

SPECIES=MULLET

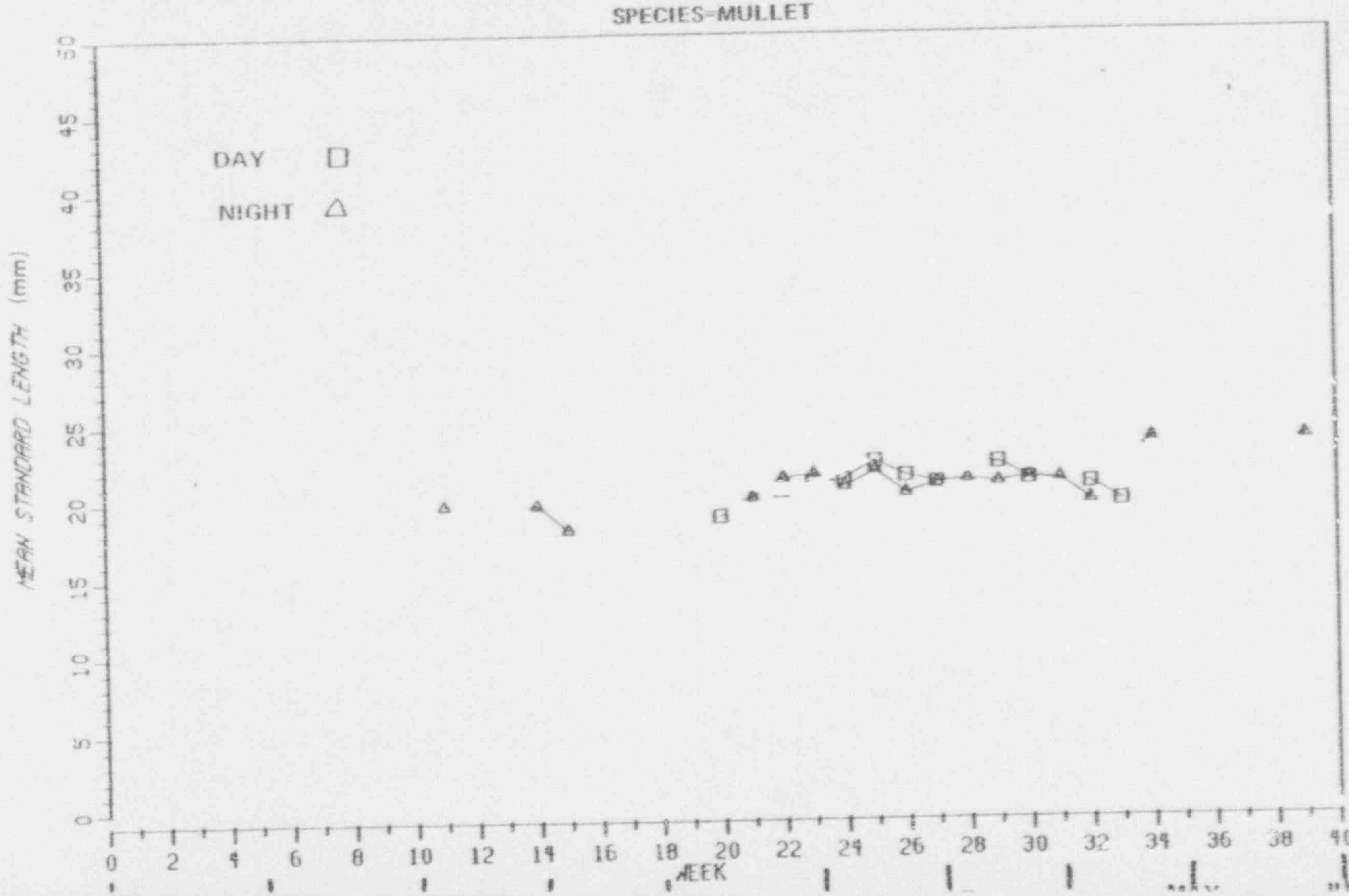


FIGURE 3.13 MEAN LENGTH BY DAY-NIGHT OF LARVAE ENTRAINED(SEP 1978-MAY 1979).

SPECIES=SHRIMP

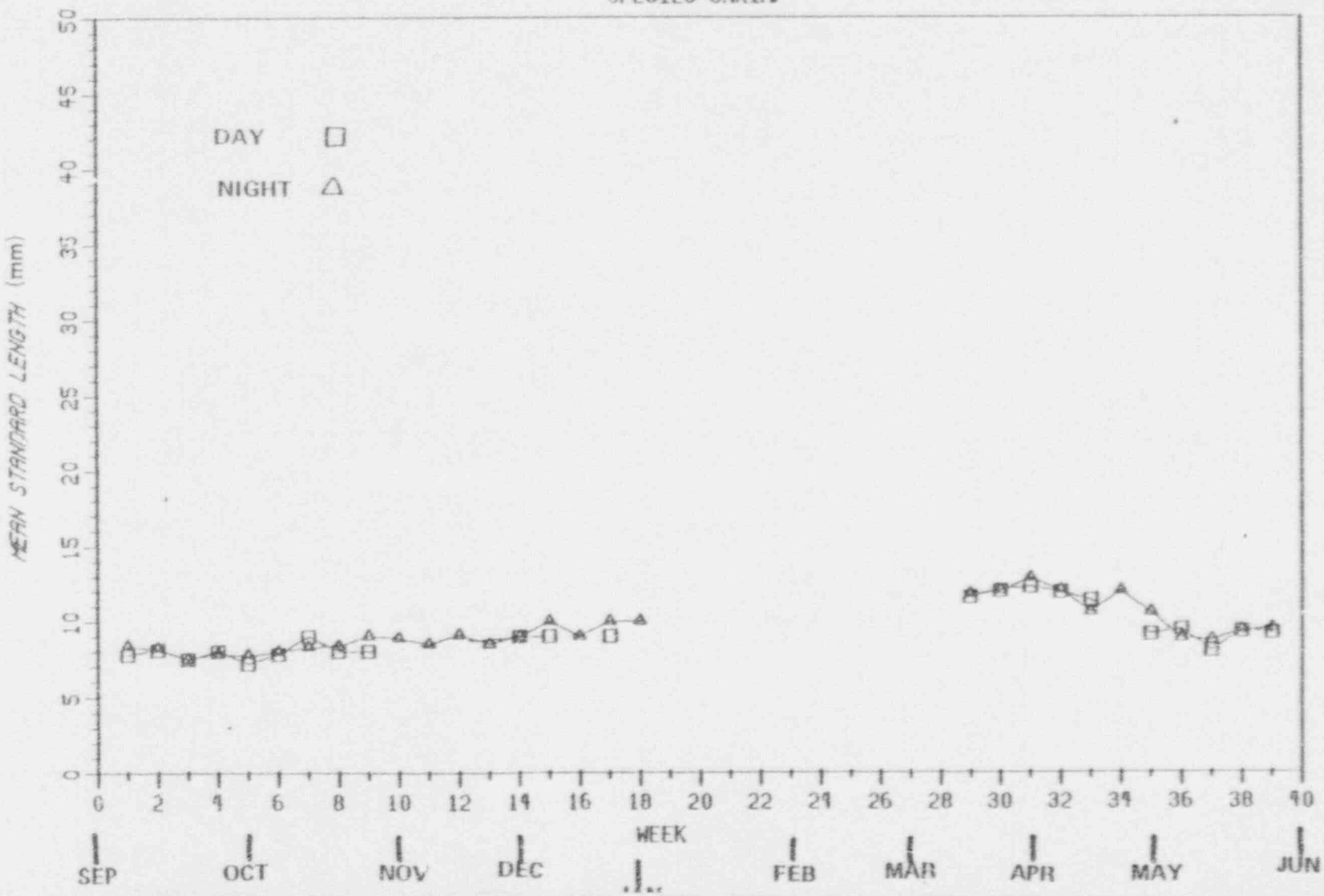


FIGURE 3.14 LOG10 MEAN DENSITY BY DAY-NIGHT OF LARVAE ENTRAINED, 1978-1979.

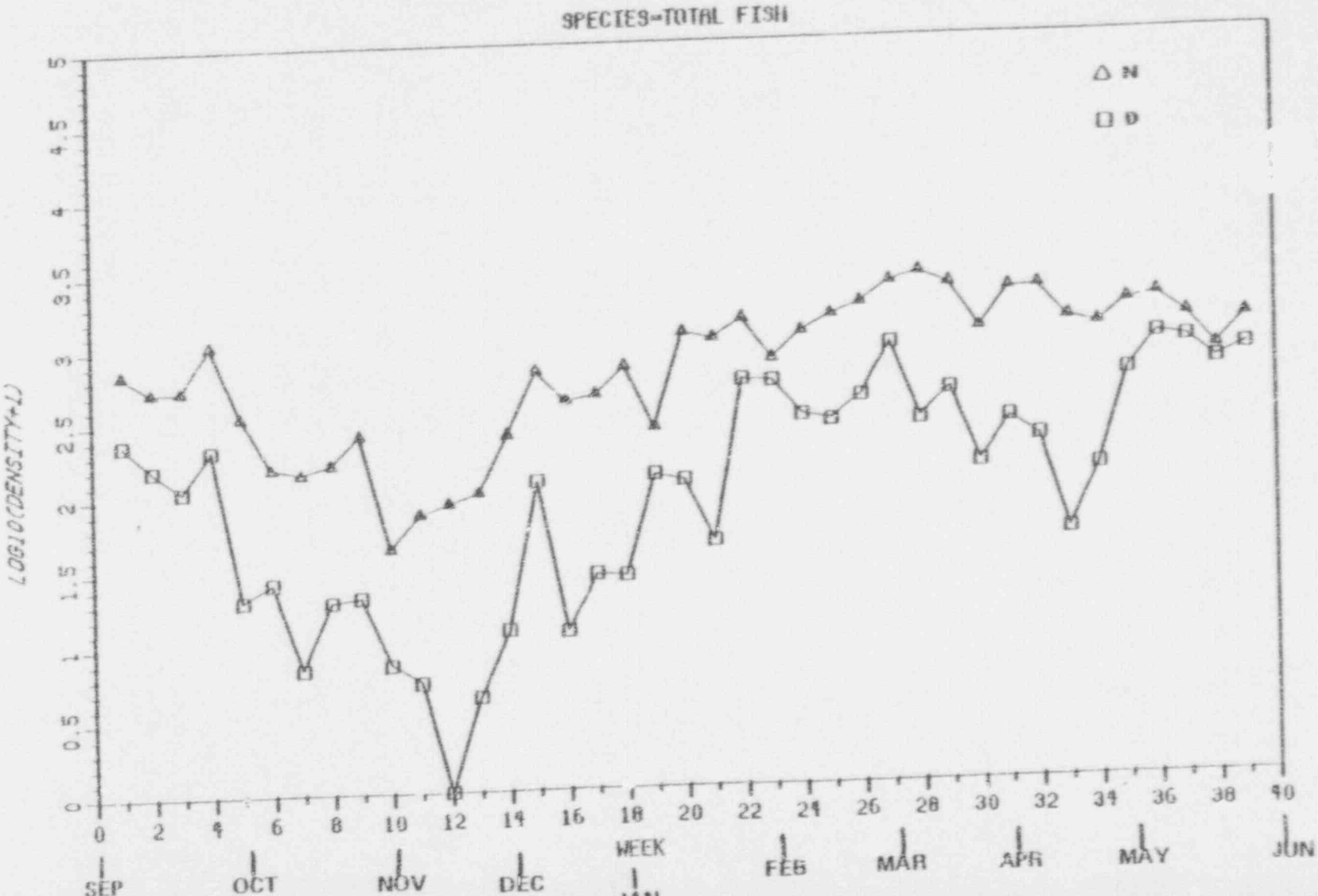


FIGURE 3.15 DIURNAL LOG 10 DENSITY OF LARVAE ENTRAINED, MARCH 13-14, 1979.

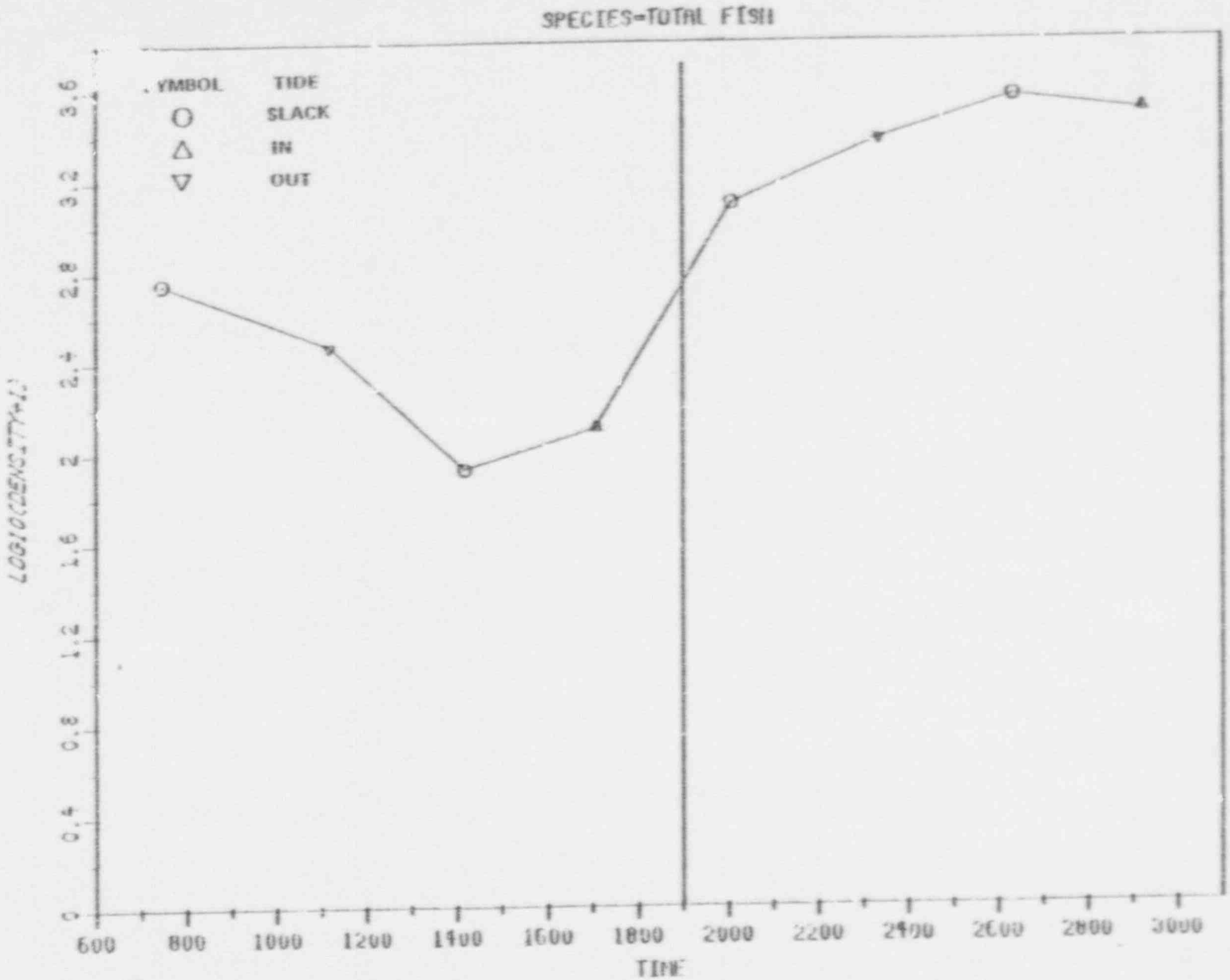


FIGURE 3.16 LOG10 MEAN DENSITY BY DAY-NIGHT OF LARVAE ENTRAINED, 1978-1979.

SPECIES=SPOT

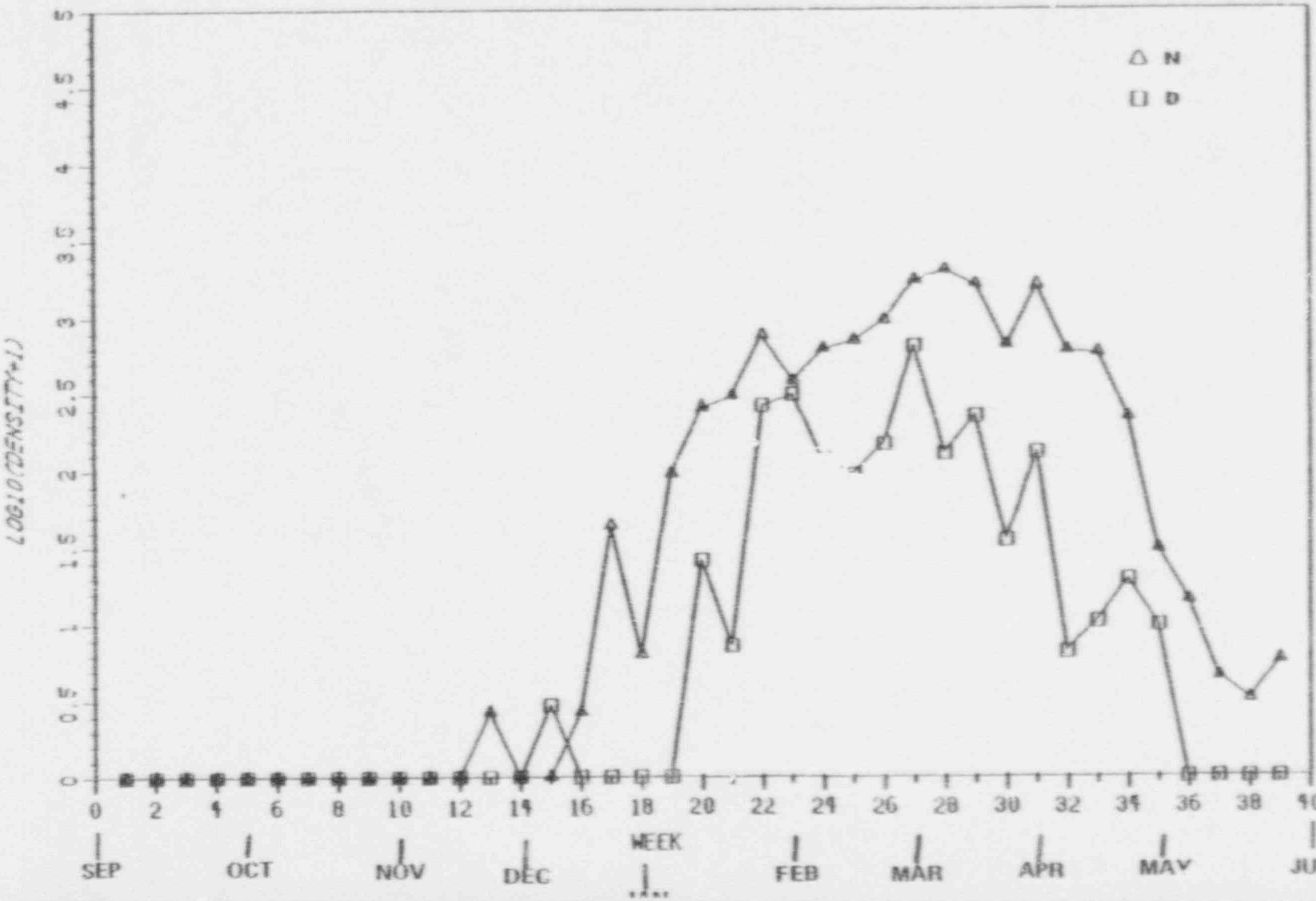


FIGURE 3.17 DIURNAL LOG 10 DENSITY OF LARVAE ENTRAINED, APRIL 3-4, 1979.

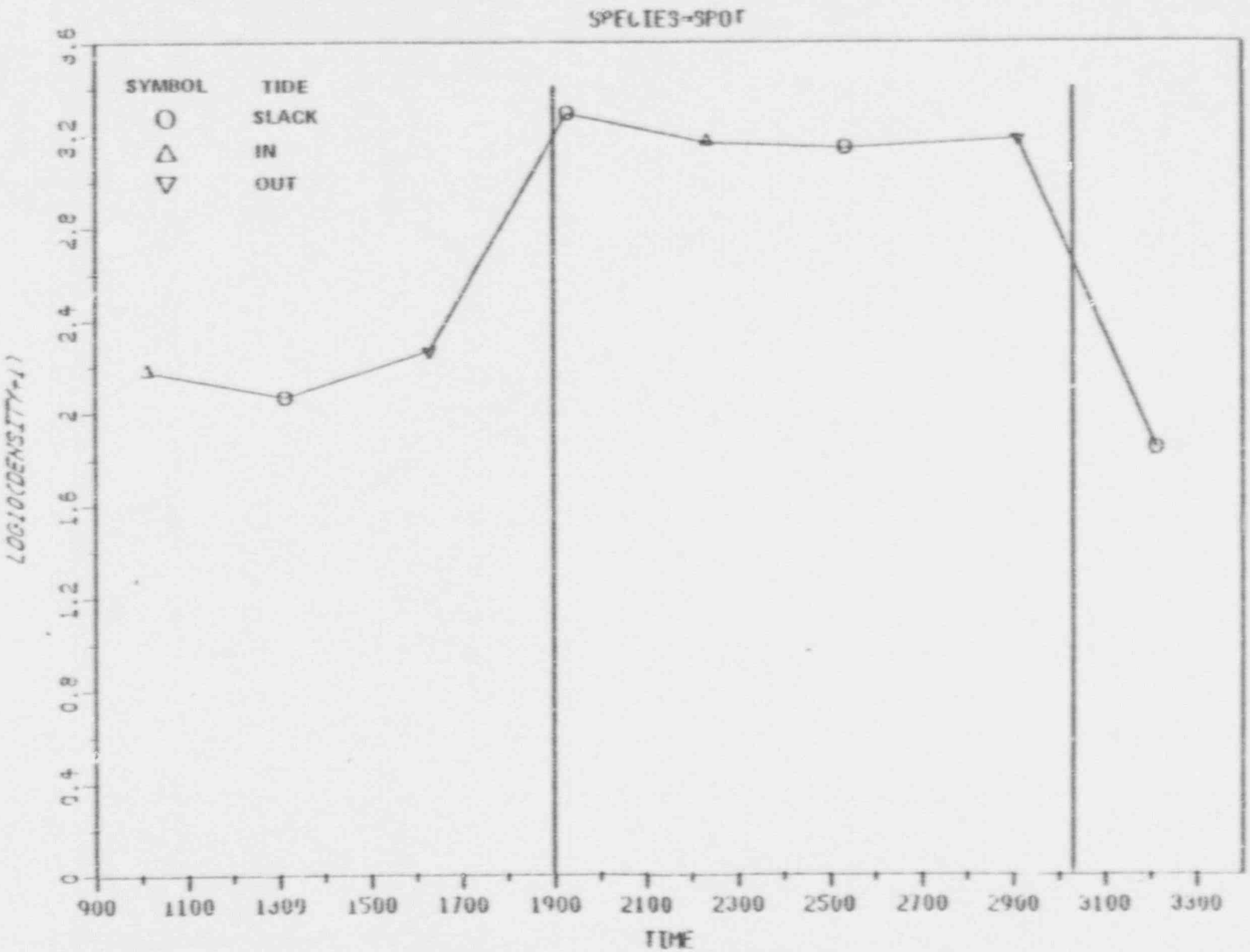


FIGURE 3.18 LOG10 MEAN DENSITY BY DAY-NIGHT LARVAE ENTRAINED, 1978-1979.

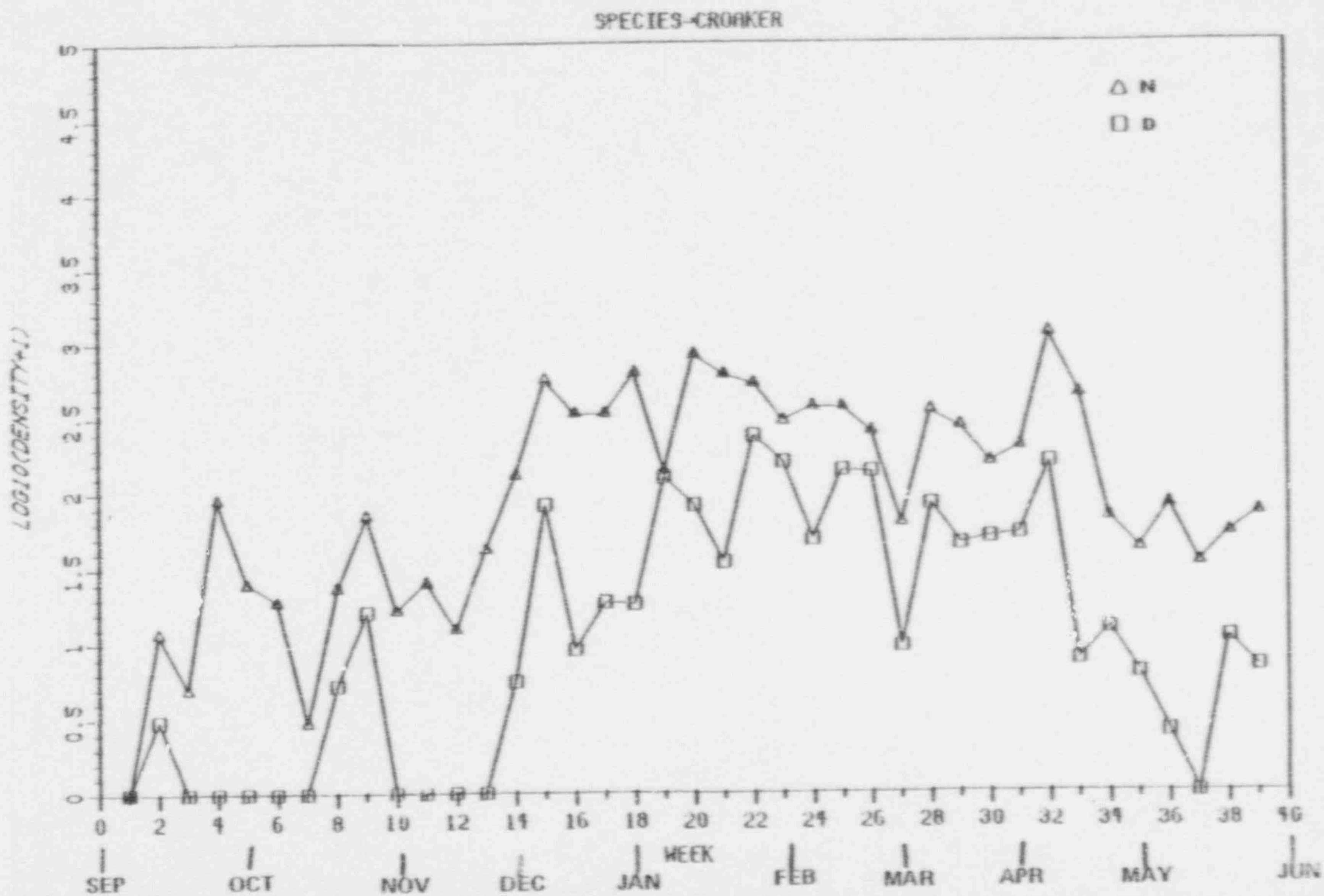


FIGURE 3.19 DIURNAL LOG 10 DENSITY OF LARVAE ENTRAINED, APRIL 10-11, 1979.

SPECIES=CROAKER

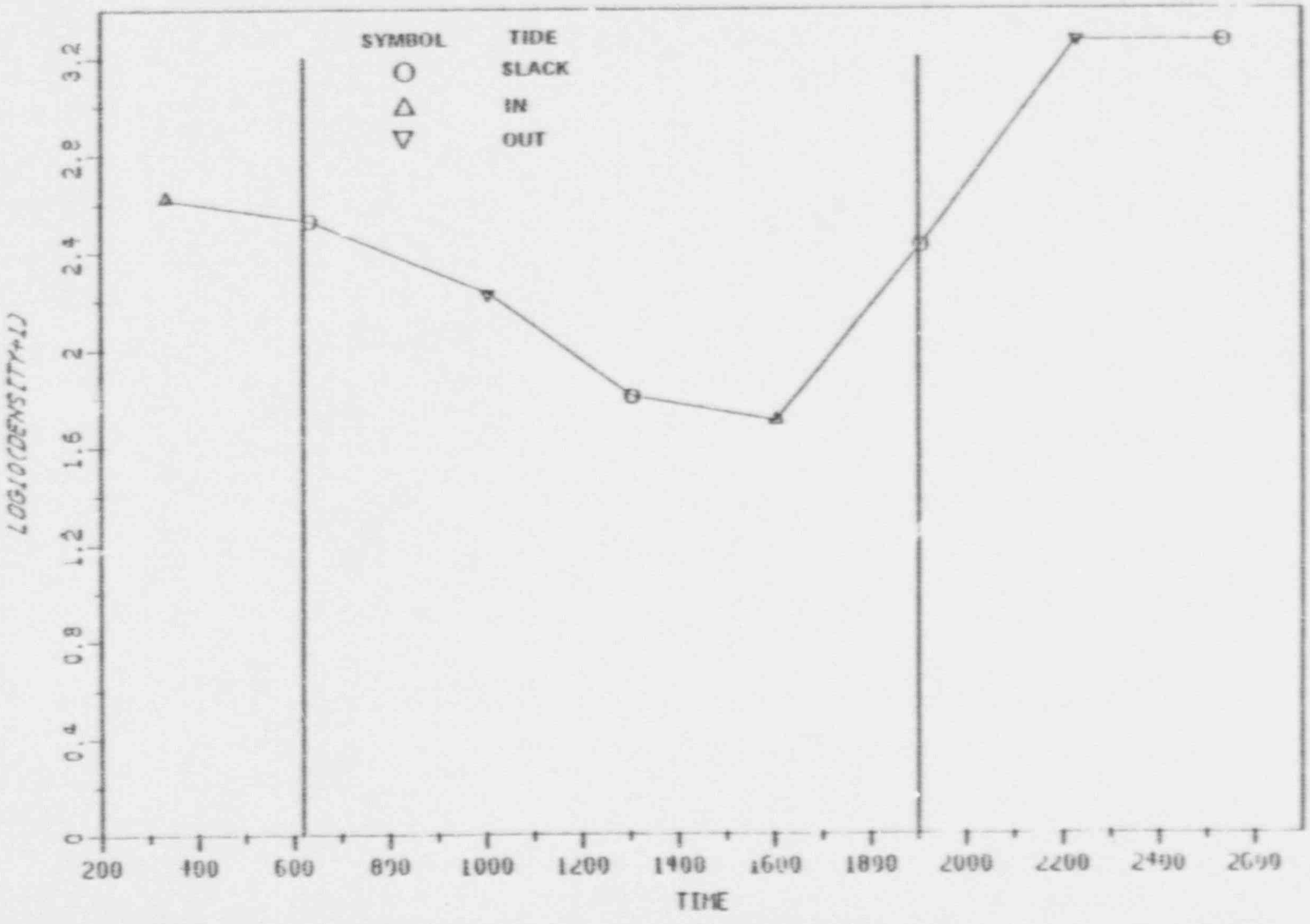


FIGURE 3.20 LOG10 MEAN DENSITY BY DAY-NIGHT OF LARVAE ENTRAINED, 1978-1979.

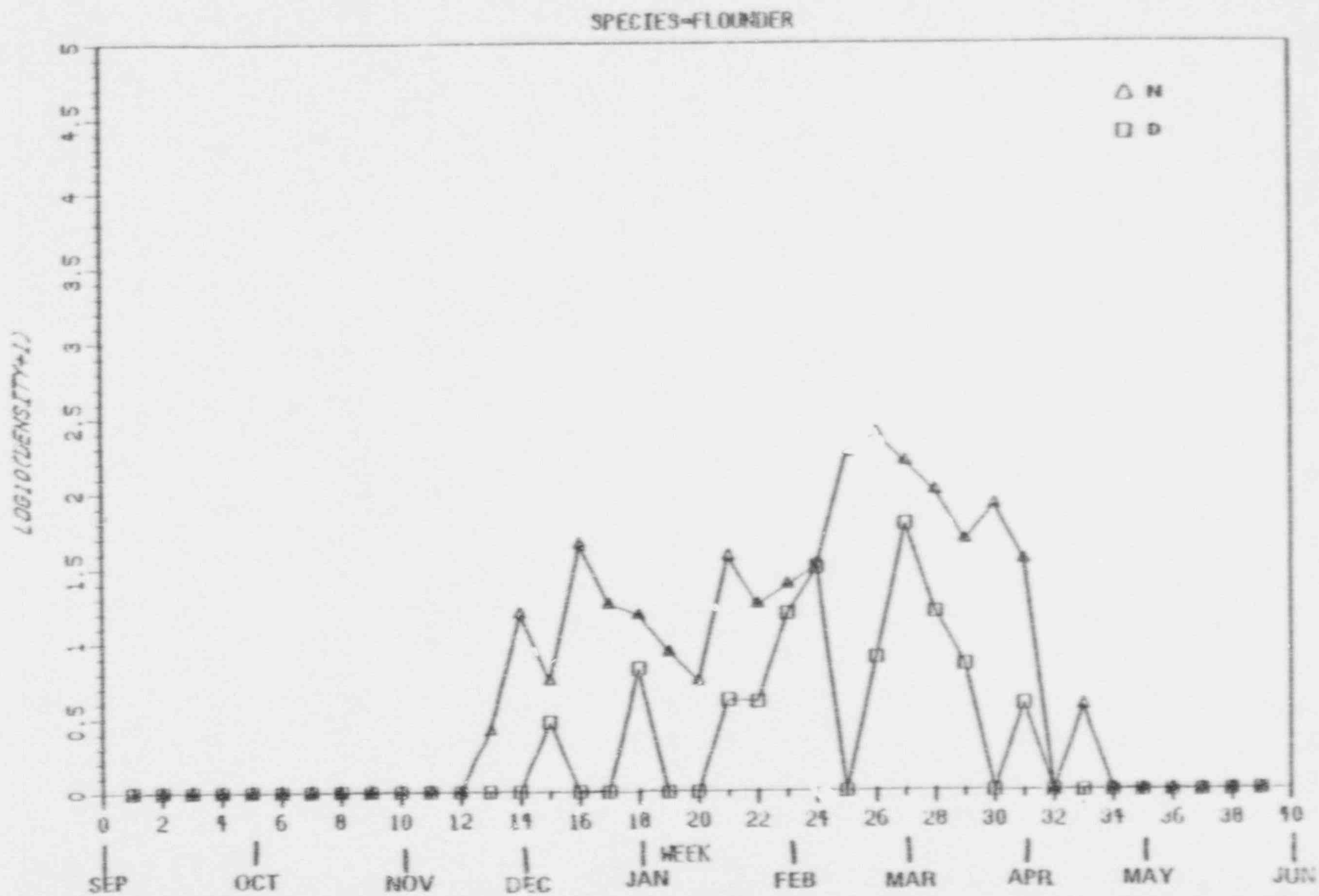


FIGURE 3.21 DIURNAL LOG 10 DENSITY OF LARVAE ENTRAINED, MARCH 27-28, 1979.

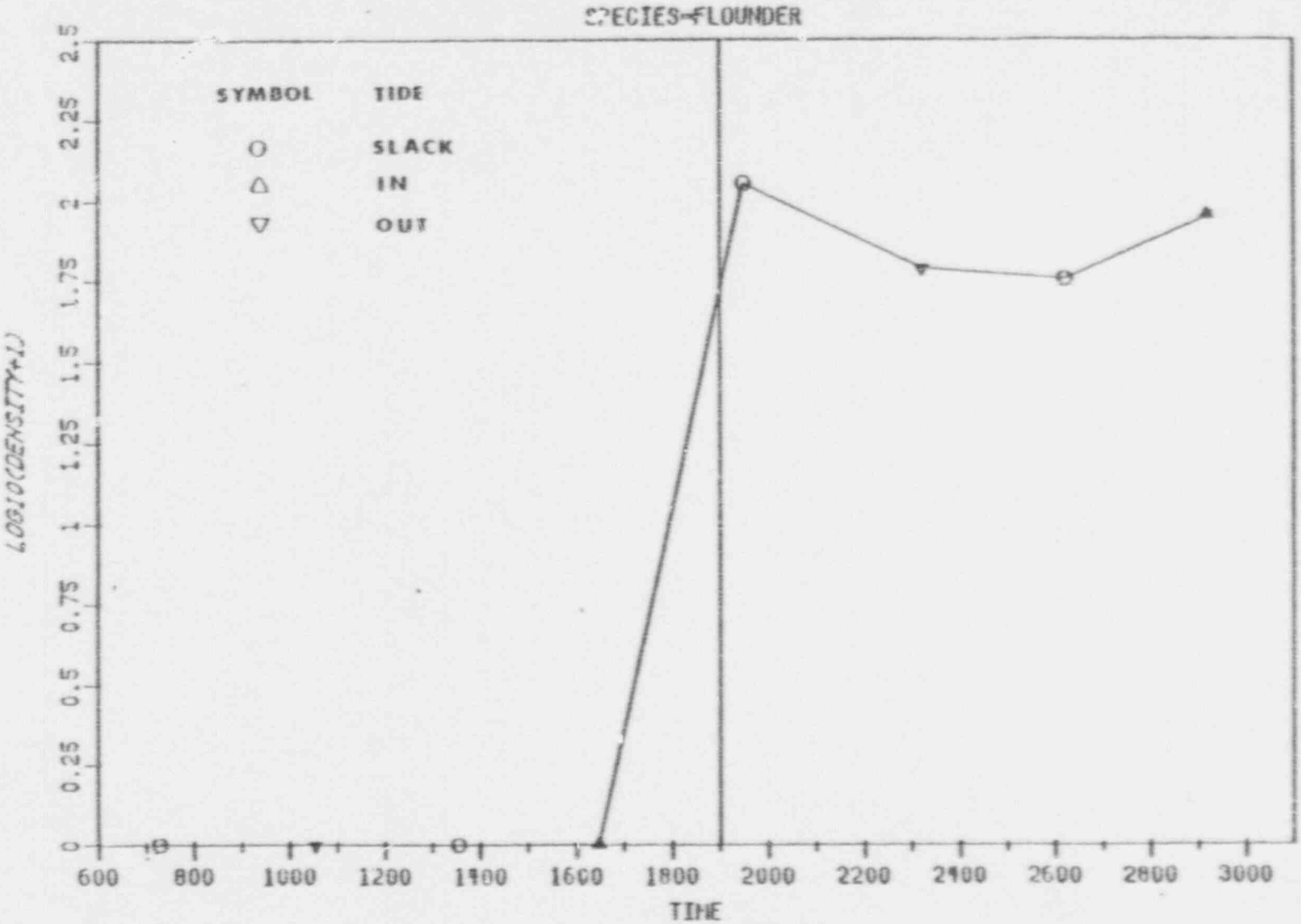


FIGURE 3.22 LOG10 MEAN DENSITY BY DAY-NIGHT OF LARVAE ENTRAINED, 1978-1979.

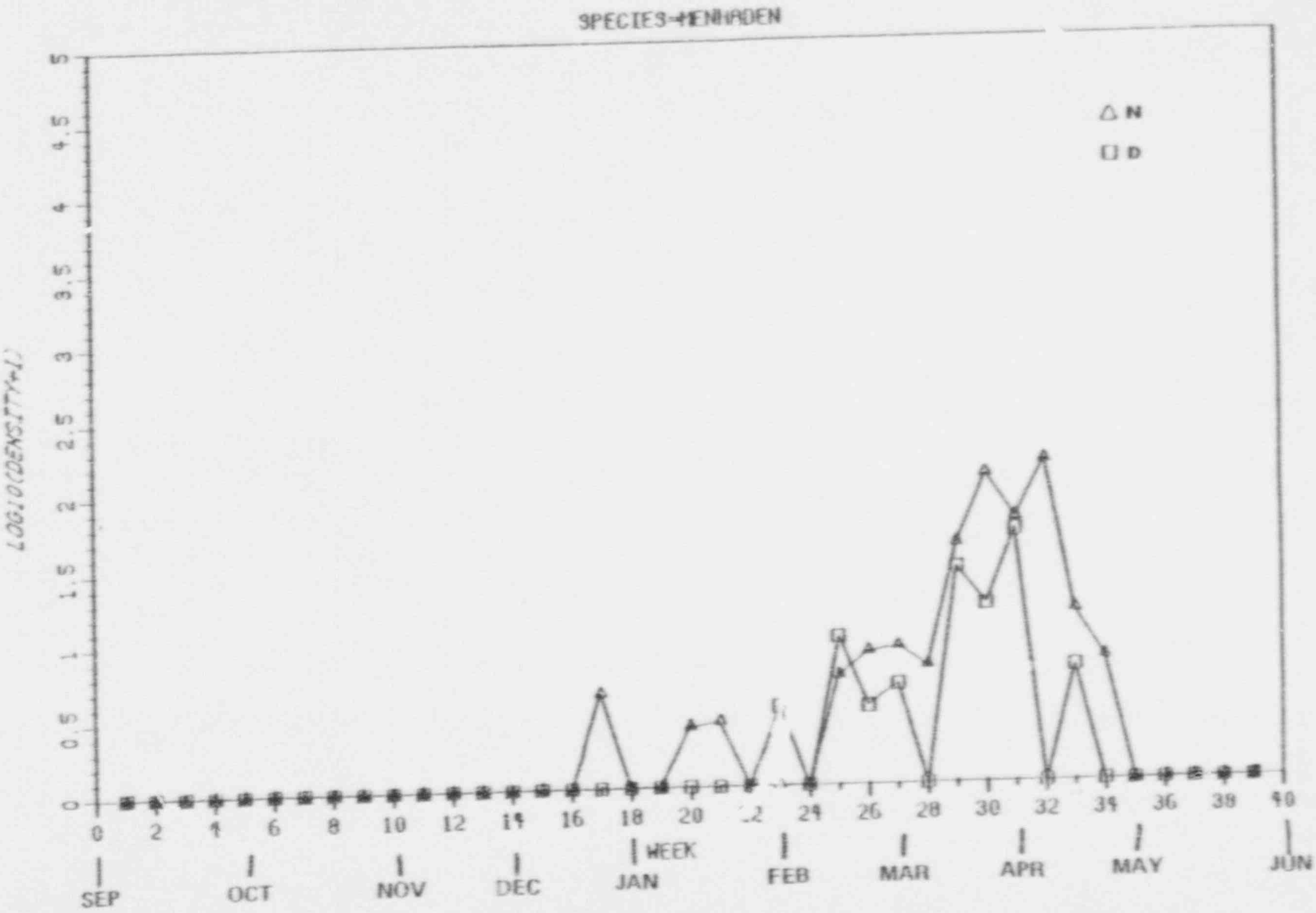


FIGURE 3.23 DIURNAL LOG 10 DENSITY OF LARVAE ENTRAINED, MARCH 27-28, 1979.

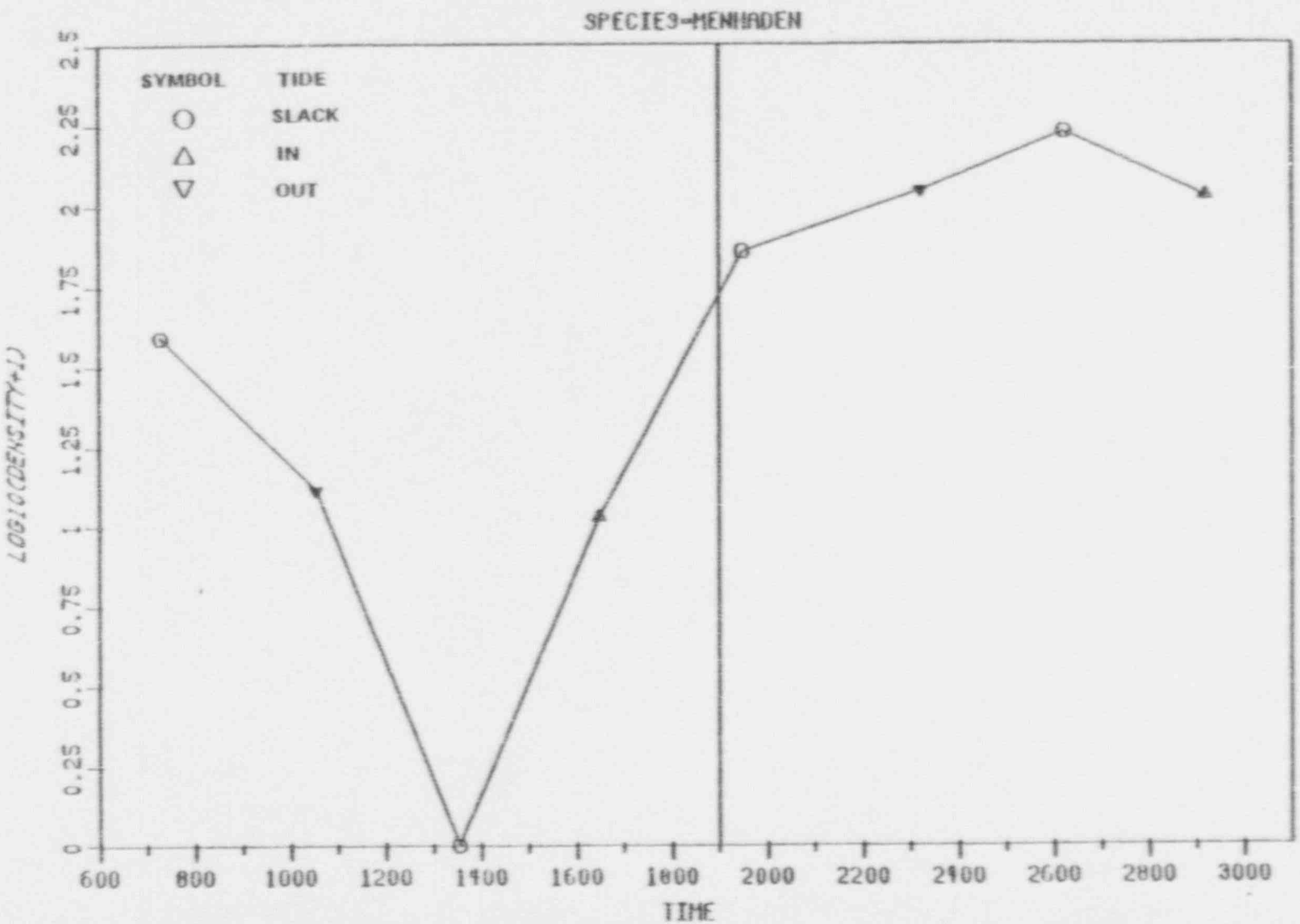


FIGURE 3.24 LOG10 MEAN DENSITY BY DAY-NIGHT OF LARVAE ENTRAIN 1978-1979.

SPECIES-MULLET

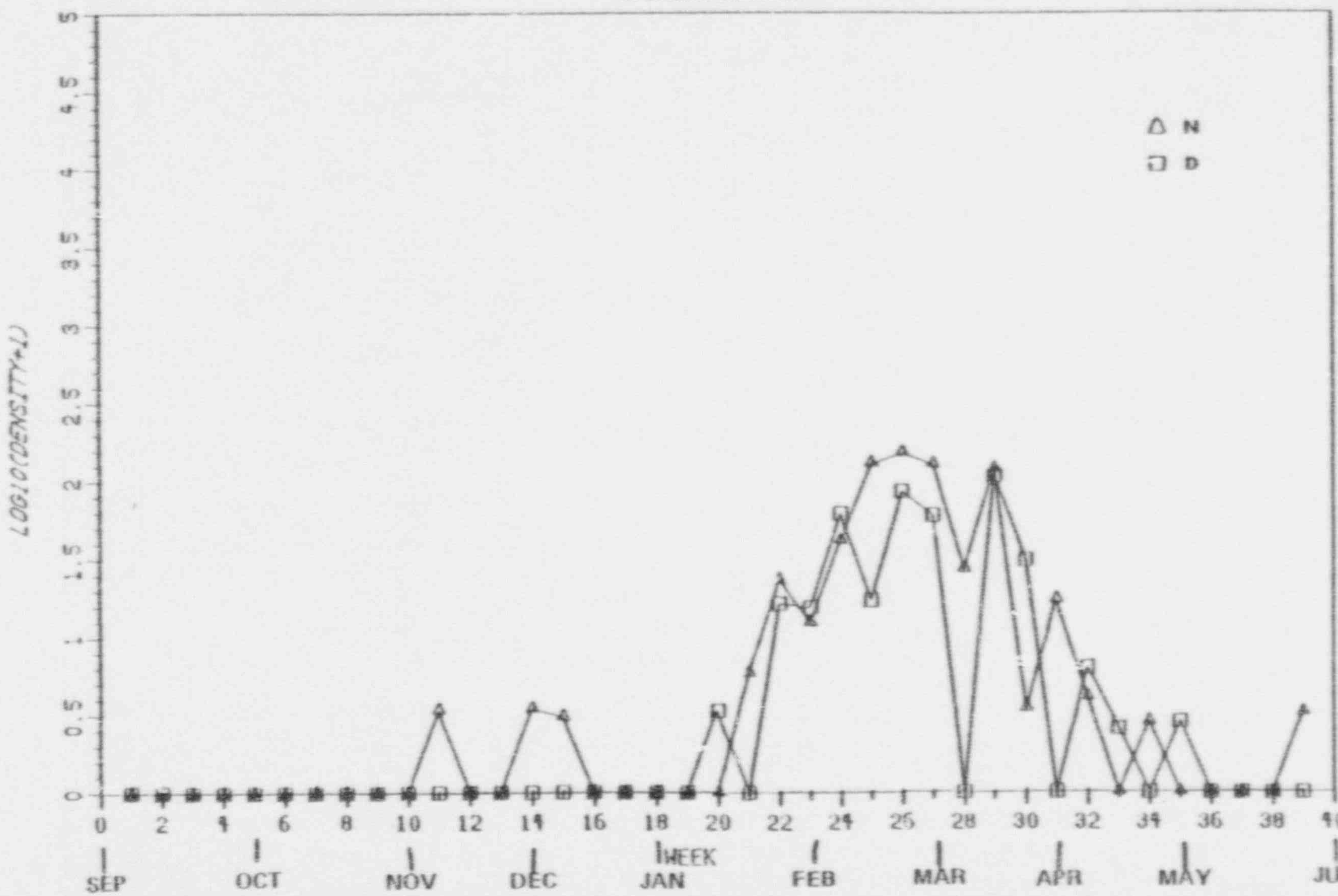


FIGURE 3.25 DIURNAL LOG 10 DENSITY OF LARVAE ENTRAINED, MARCH 6-7, 1979.

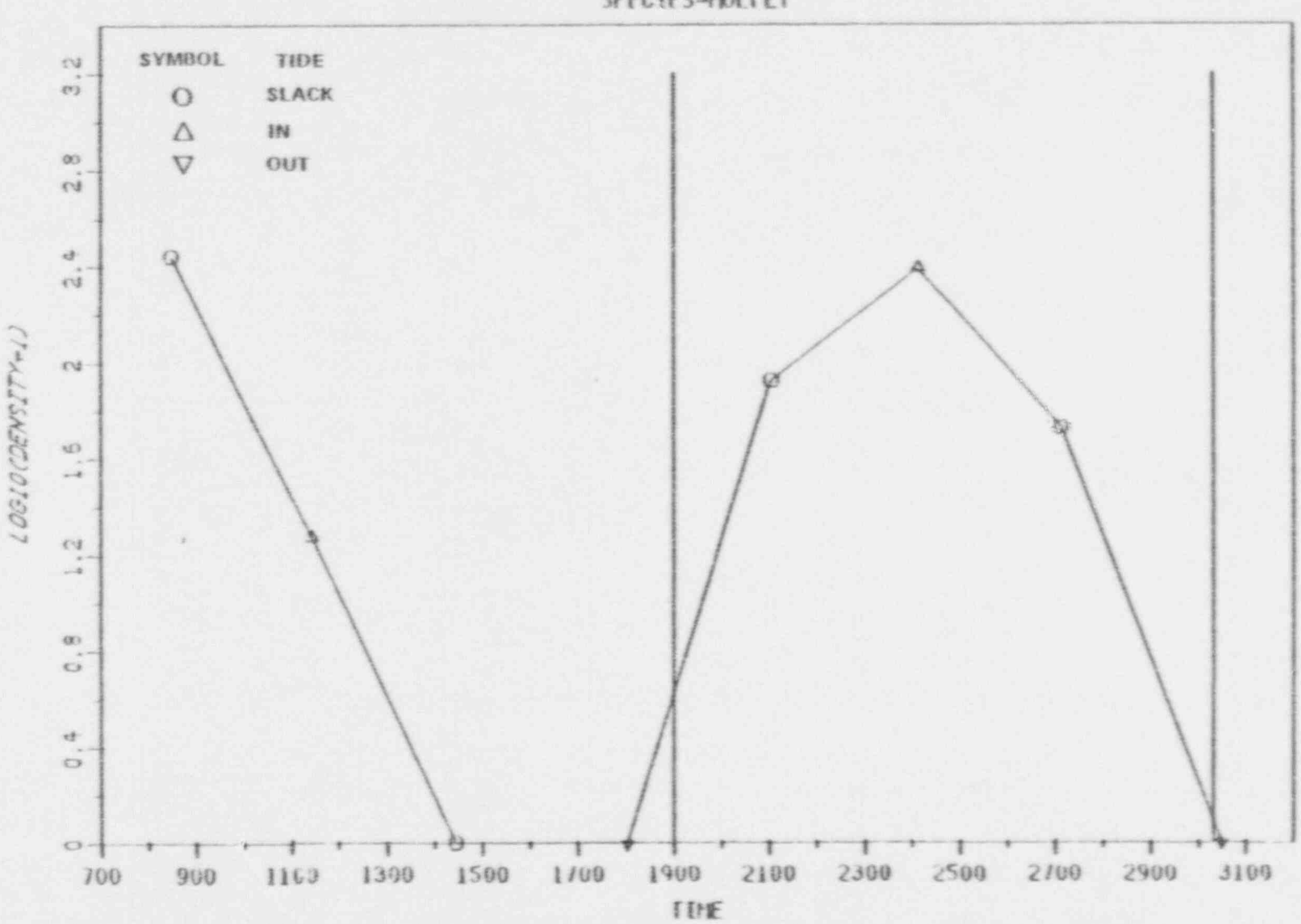


FIGURE 3.26 LOG10 MEAN DENSITY BY DAY-NIGHT OF LARVAE ENTRAINED, 1978-1979.

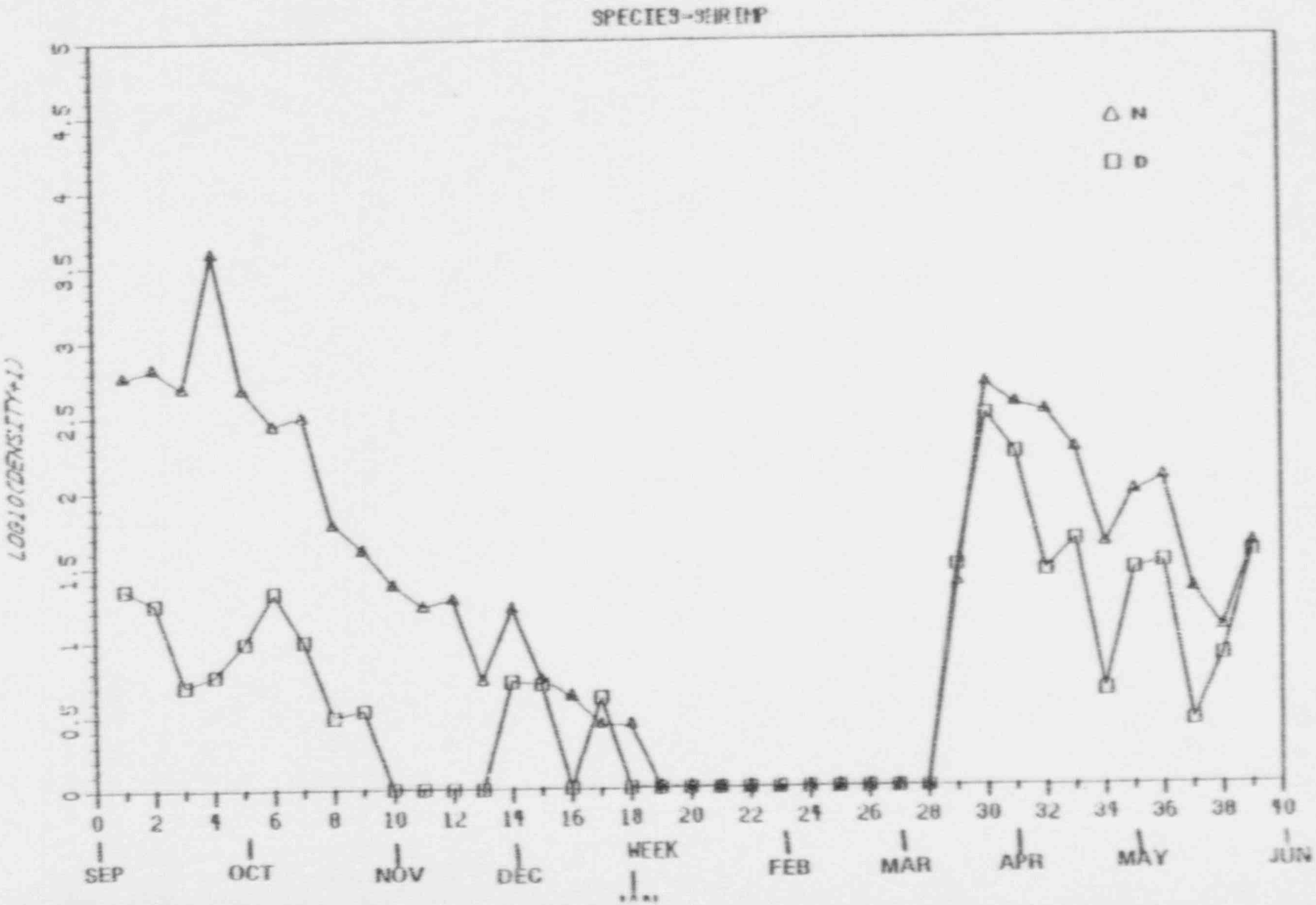


FIGURE 3.27 DIURNAL LOG 10 DENSITY OF LARVAE ENTRAINED, APRIL 10-11, 1979.

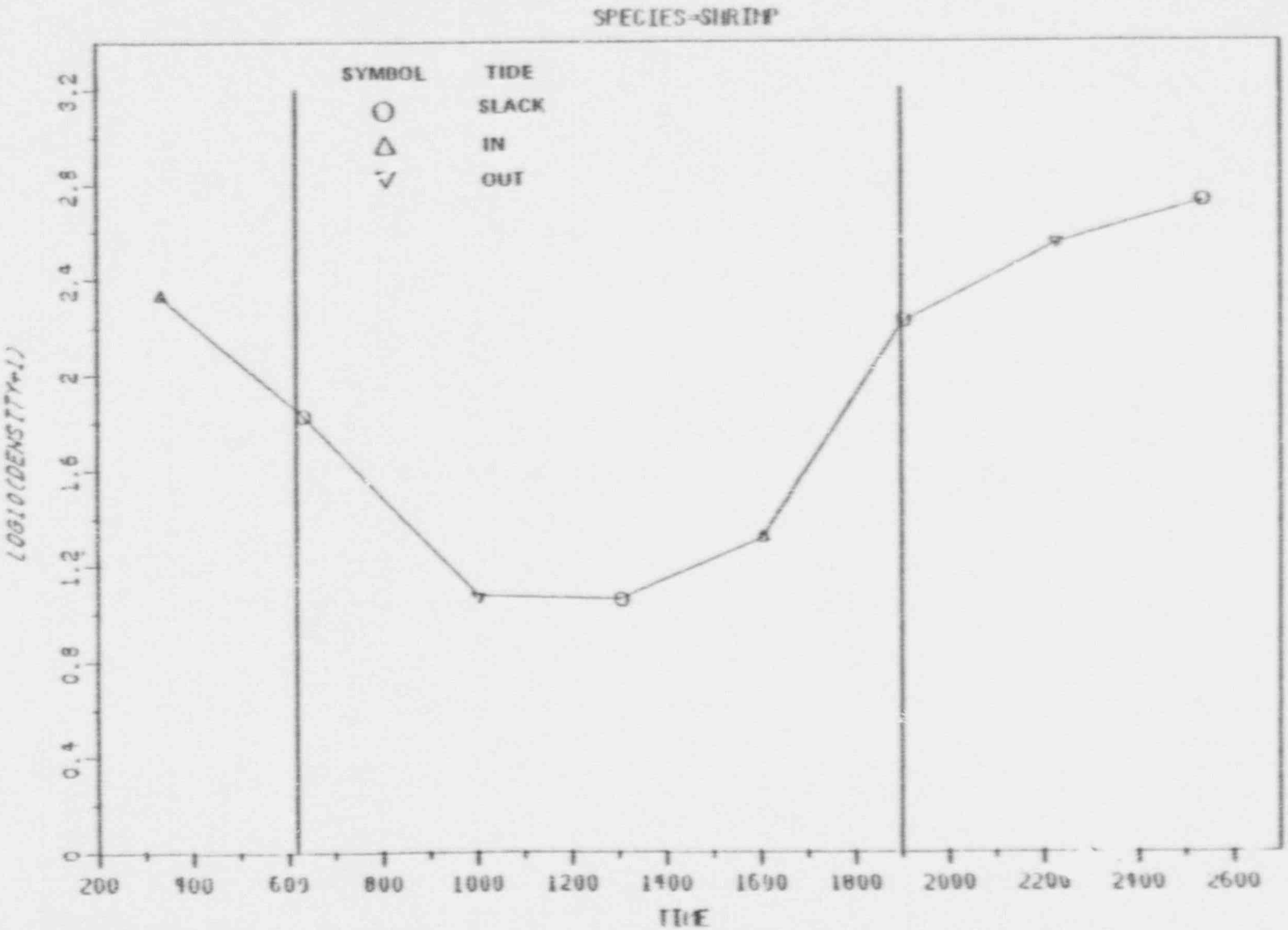


FIGURE 3.28 River Trend Analysis, 1974 - 1979, Stations 21, 24, 25.

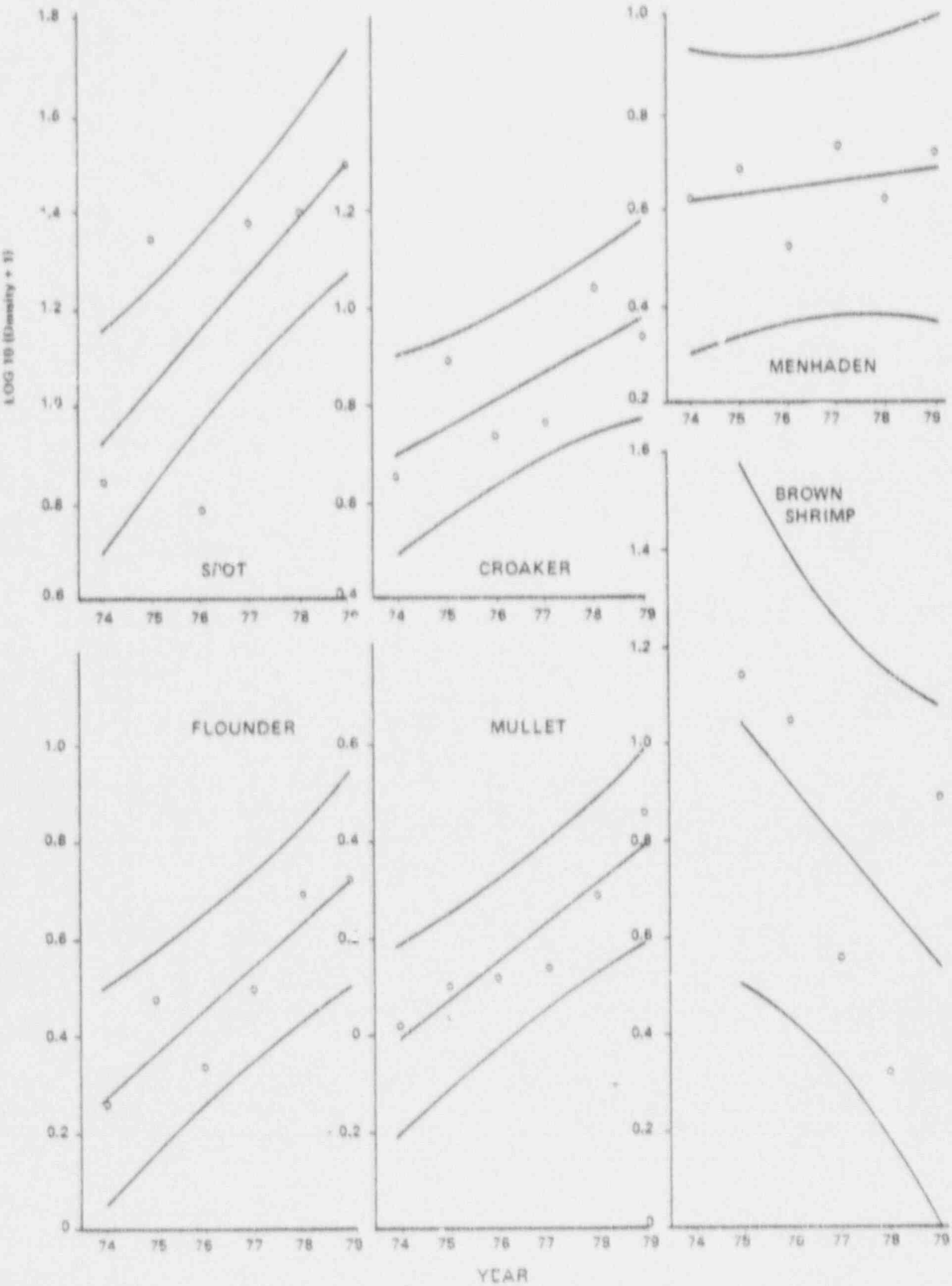
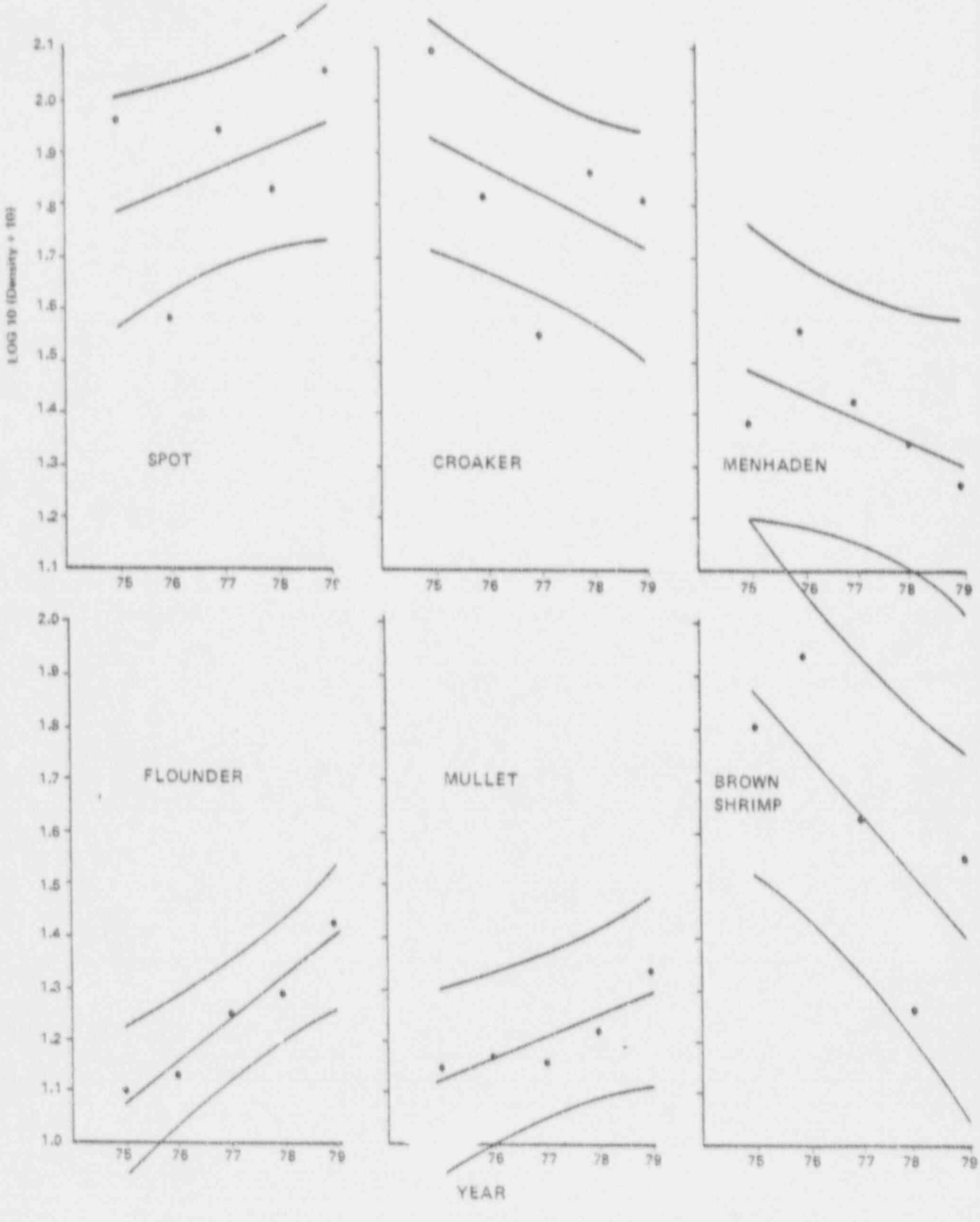


FIGURE 3.29 Entrainment density by year (trend)



4.0 Nekton Monitoring

4.1 Introduction

This portion of Carolina Power & Light (CP&L) Company's long-term monitoring program is a continuation of the previous nekton sampling program conducted by the University of North Carolina, although substantially reduced in scope. In general this program provides catch per unit effort (CPUE) data which serve as a measure of the long-term changes in juvenile and adult populations of nekton in the Cape Fear estuary (CFE).

The major objectives of this program are to determine the relative seasonal abundance, species composition, and size distribution of the juvenile and adult fish and shellfish of the lower Cape Fear River.

The results of this program can be compared with results from previous nekton studies (CFS, Vols. XIV and XV) so that changes in size distribution, species abundance, and species composition may be determined.

4.2 Description of Sampling Stations

Sampling station locations extended from the freshwater drainage canal, approximately 3.36 km (2.1 miles) west of Southport, to Cape Fear River Buoy 23, approximately 8.8 km (5.5 miles) northeast of Southport. Samples were collected at nine stations within this geographical area (Fig. 4.1).

Station 1 was located in the freshwater drainage canal (FDC) between the first and second bends. This station was chosen because the FDC is a dredged canal like the intake canal but without the direct influence of the plant. Small trawl and gill net samples were collected at this station.

Station 2 was located in a slough east of Buoy 18 and north of a spoil island on the east side of the ship channel. This was the same location as UNC's 18E station. Only the large trawl was used at this station.

Station 3 was located in the ship channel between Buoys 19 and 21. This is also a large trawl station and was the same as UNC's Station 19.

Station 4 was located in the intake canal from the junction of Walden Creek and the intake canal eastward toward the Cape Fear River. This station was sampled with the large trawl, small trawl, and gill net. It was the equivalent of UNC's 19W station.

Station 5 was located in the intake canal from the intake screens at the plant northeastward to near the first bend (uppermost) of the canal. This station was equivalent to UNC's Station CS and was also sampled with the large trawl, small trawl, and gill net.

Station 6 was in the intake canal from its junction with Walden Creek westward toward the plant to the vicinity of the old Wilmington highway. It was the same as UNC's Station CB2. Only small trawl and gill net samples were collected at this station.

Station 7 was in Walden Creek between the bridge and the first bend. Gill net and small trawl samples were collected at this station. This station was not sampled in t UNC program but was sampled by NCSU from 1975-1976 (Huish and Geaghan 1979).

Station 8 was located near the entrance to a small cove 1 mile (1.6 km) northeast of the mouth of Walden Creek and just west of Buoy 23 at the north end of Snows Marsh. This was UNC's Station 23W. Gill nets and small trawls were used at this station.

Station 9 was located in the ship canal between Buoy 23 and the southern entrance to Sunny Point Military Supply Depot. This was a large trawl station corresponding to UNC's Station 23.

A summary of the sampling gear and equivalent UNC stations is presented in Table 4.1.

4.3 Methods and Materials

Adult and juvenile fish and shellfish were sampled in the lower CFE once every three weeks from January 1979 through August 1979. During the sample week, each station was sampled three times with either the small trawl and gill net or large trawl, and in two instances all three gears. Sampling trip dates and efforts are listed in Table 4.2.

The large trawl was a 12.5 m (41-foot) semiballoon otter trawl with a 47.6 mm (1 7/8-inch) stretch mesh body and a 38.1 mm (1 1/2-inch) stretch mesh intermediate and codend. This trawl and the other gears used were identical to those used in the UNC nekton program. The small trawl was a 6.4 m (21-foot) semiballoon otter trawl with a 38.1 mm (1 1/2-inch) stretch mesh webbing. The codend was rigged with a 12.7 mm (1/2-inch) stretch mesh inner liner. The gill nets were 91.4 m (100 yards) long, 65 meshes deep, and constructed of a 83 mm (3 1/4-inch) stretch mesh monofilament.

Salinity and temperature measurements (surface and bottom) were taken each time a station was visited. Water samples were taken with a 2-liter brass Kemmerer water sampler. Temperature was measured in degrees Celsius with a Fisher immersion thermometer, and salinity was measured in parts per thousand (ppt) with an American Optical refractometer.

Trawl samples consisted of fish and shellfish captured in a 15-minute tow. The catches were sorted according to species, and a minimum and maximum total length, total number, and total weight were recorded. If the species was one of the dominant and/or commercially important species (bay anchovy, croaker, summer flounder, southern flounder, menhaden, striped mullet, white mullet, spot, weakfish, spotted seatrout, white shrimp, pink shrimp, or brown shrimp), up to 25 total lengths were recorded from each sample.

When extremely large samples were collected, subsampling was utilized. A sample was subsampled by filling an 8.5 liter plastic bucket from which the numbers, lengths, and weights of each species were recorded. The rest of the catch was weighed and released overboard. The total number of fishes caught in each tow was obtained by multiplying the number of fish of each species in the subsample by a factor determined by dividing the weight of all the fish by the weight of the subsample. This technique was identical to that used by UNC (Schwartz et al. 1979b).

Samples not worked up in the field were labeled, placed in plastic bags, put on ice, and worked up in the lab at a later time.

Gill net samples consisted of fish captured in a 24-hour set. (Blue crabs were not recorded for gill net data purposes because in most instances they were attracted to a net by the fish in it rather than being captured by the net.) Gill net samples were worked up in the same manner as trawl samples, although because of the small sample size they were never subsampled.

4.4 Results and Discussion

4.4.1 Hydrography

The average water temperature in the lower Cape Fear estuary (Fig. 4.2) declined during the first 3 trips of this study to a low of approximately 6°C (February 20-22). Water temperature increased steadily over the next 7 trips, except in one instance, to a maximum of approximately 30°C (Trip 10, July 17-19). A slight decline of the water temperature occurred during the last 2 trips. These temperatures were comparable to UNC data (Schwartz et al. 1979a, Schwartz et al. 1979b).

Salinities in the lower Cape Fear estuary ranged from a low of 2 ppt to a high of 30 ppt. As expected, salinities were higher in the lower reaches of the study area and lower in the higher reaches. In general, salinities were lower during the winter and early spring trips and higher during the late spring and summer trips (Fig. 4.3). Similar patterns were observed during the years 1973-1978 (UNC Schwartz et al. 1979a, Schwartz et al. 1979b).

4.4.2 General Trends

A total of 223,039 fish and 145,818 invertebrates of 103 species was collected from January 1979 through August 1979 with all gears. Two loggerhead turtles, 1 green sea turtle, and 13 diamondback terrapins were also caught.

Of the total numbers of fish and invertebrates captured, 39,231 fish and 8,578 invertebrates were caught in 148 large trawl samples along with 1 green sea turtle and 4 terrapins. The most abundant fishes caught in large trawls were menhaden (61.1%), croaker (13.4%), spot (8.0%), and weakfish (5.9%). The most abundant invertebrates were brown shrimp (50.7%), blue crabs (33.5%), and pink shrimp (5.6%).

In 216 small trawl samples, 181,428 fish, 137,240 invertebrates, 2 loggerhead turtles, and 4 diamondback terrapins were caught. Spot was the most abundant fish (44.1%), followed by croakur (26.6%), bay anchovy (18.8%), weakfish (2.9%), and menhaden (2.1%). Of the invertebrates caught in small trawls, 95,972 (70%) were grass shrimp. The majority of these (77%) were caught in 9 small trawl efforts at Station 7 in Walden Creek. Brown shrimp (20.1%) were the second most abundant invertebrate, while blue crabs accounted for 5.5% of the small trawl invertebrates.

In 144 gill net efforts, 2,380 fish and 5 diamondback terrapins were caught. Menhaden comprised 64.4% of the total catch, while sharpnose sharks, spot, and bluefish account for 10.6%, 9.4%, and 4.9%, respectively.

A list of the number, species, and the percentage of the total organisms collected by each gear is presented in Table 4.3. A ranking by gear of the 10 most abundant fish caught in the CFE is presented in Table 4.4.

4.4.3 Species Accounts

Total Organisms

The CPUE of total organisms with the large trawl was significantly greater at Station 5 than at Stations 2, 3, 4, and 9 (Table 4.5). The CPUE at Station 2 was significantly lower than other large trawl stations.

The CPUE of total organisms with the small trawl was significantly higher at Station 5 than the other small trawl stations (Table 4.5). The small trawl CPUE was lowest at Station 8.

The highest CPUE for gill nets also occurred at Station 5 although there was no significant difference between the CPUE's at Station 5 and the CPUE's at Stations 4 and 1. The lowest CPUE for gill nets was at Station 7.

For purposes of this discussion, the CPUE data for some species was separated into two groups--young-of-the-year and juvenile/adult. The young of the year are Age 0 fish, while the juveniles and adults are Age I and older fish.

Spot

Spot were overall the most abundant finfish caught from January through August 1979. A total of 83,342 were caught, 96% with the small trawl.

In general spot were most abundant in small trawl samples in April and May when both Age 0 and Age I fish were present (Figs. 4.4 and 4.7). In large trawls Age 0 spot were most abundant from June-August, whereas older spot were generally most abundant in January (Figs. 4.5-4.6). These patterns result from the fact that Age 0 and Age I spot move into shallow areas where they are susceptible to the small trawl during spring and early summer months. As they move out of these nursery areas into the open estuary, they become more abundant in large trawl catches. Schwartz reported catching Age 0 spot from February to May (CFS, Vol. XIV).

Length frequency distributions from trawl data show that the spot present in the CFE in January were yearlings, the majority of which were 85-120 mm long (Figs. 4.8-4.9). In February approximately 75% of the spot caught in small trawls were Age 0 (20-30 mm) with a few Age I fish still present. By the time of peak abundance, 99% of the spot present in the small trawl catches were Age 0 (20-50 mm).

The peak growth period for spot was from May to August (Fig. 4.8). From the time spot first entered the samples in February (at 20 mm - 30 mm) until the end of the study period in August, they increased in size by approximately 70 mm to a mean length of 95 mm.

The CPUE of Age 0 spot was generally highest in the Intake Canal and/or adjacent areas. The CPUE of young-of-the-year spot with small trawl was significantly higher at Stations 5 and 6 (Intake Canal) than at the other small trawl stations (Table 4.5). Stations 1 and 4 had significantly higher CPUE's than Stations 7 and 8. The CPUE of young-of-the-year spot with the large trawl was higher at Station 5 (Intake Canal) than elsewhere. The CPUE at Station 4 (Outer End of Intake Canal) was higher than Stations 2, 3, and 9. The CPUE of adult spot was highest at Station 5 with both the large and small trawls.

Of the 224 spot caught in gill nets, 83% of them were caught at Station 5 from January to May. The majority of these spot were from 260 mm - 280 mm in length (Figs. 4.10 and 4.11). It appears that spot of this size were trapped in the intake canal after the diversion device was completed because almost no other spot were taken at other stations after the completion of the diversion device.

Croaker

Croaker was the secon.. most abundant fish caught, with all gears, in the Cape Fear estuary during the study period. A total of 48,322 croakers was caught in the small trawl, 5,250 in the large trawl, and 33 in the gill nets resulting in a total for all gears of 53,605 (Table 4.3).

Croakers were found in the estuary during the entire study period with the peak abundance occurring in May and June when both Age 0 and yearlings were present (Figs. 4.12-4.14). The majority of croakers caught during this time was in the 40-45 mm range. Croakers were caught at 20-30 mm from January until May and reached lengths of 110-125 mm by the end of August (Fig. 4.15). Schwartz (CFS vols. XIVd and XV) reports catching croakers at the same size during the same time interval.

Gill net catches of croaker remained at about the same level during the study period. Their mean length was approximately 280 mm TL.

Except for the Ship Channel stations (3 and 9), the deeper areas of the estuary generally had the largest catches of croaker. Large trawl data showed a significantly higher CPUE of young-of-the-year croaker at Station 5. The CPUE for young-of-the-year croaker with the small trawl was higher at Station 1 followed by Station 5. The CPUE at Stations 1 and 5 were significantly different from each other, and the catches were significantly higher than those at other stations (Table 4.5). Large trawl catches of Age I adult and older croaker were significantly higher at Stations 2 and 5 than at other stations.

Bay Anchovy

Bay anchovy was the third most abundant fish found in the Cape Fear estuary during the study period with a total of 34,949 caught, the majority (34,164) in small trawls. Peak abundance occurred in early summer when small trawl catches were dominated by young-of-the-year (Fig. 4.16-4.17).

Bay anchovies ranged in size from 25-95 mm TL with the majority from 55-65 mm TL. Length frequency data show the older anchovies disappeared from the catch as the catch of young-of-the-year anchovies increased (Fig. 4.17). The fact that the older anchovies disappear from the catch may indicate that this is an annual species. Schwartz (CFS, Vol. XIV) reported Age 0 bay anchovies appearing primarily from August to October. Age 0 bay anchovies were picked up during this study with the small trawl beginning in June. Schwartz, however, did not use a small trawl during the summer months which is the gear most likely to catch these small fish.

The CPUE for bay anchovies was significantly higher at Stations 1, 5, and 4 than other small trawl stations (Table 4.5). (Analysis of large trawl data was not performed because of the low number of anchovies caught with this gear.) Stations 4 and 5 (Intake Canal) and 1 (Freshwater Drainage Canal) are in dredged canals of approximately the same depth.

Menhaden

Menhaden ranked as the fourth most abundant fish caught with all gears. A total of 29,271 menhaden was caught from January to August, of which 23,987 were caught in the large trawl (most abundant fish caught), 3,752 in the small trawl, and 1,532 in the gill nets (most abundant fish caught) (Tables 4.3 and 4.4).

The peak of abundance occurred during February and was dominated by 90-105 mm TL fish (Figs. 4.18-4.21). Schwartz reported the peak as occurring from January to March (CFS, Vol. XIV).

Age 0 menhaden appeared in the small trawl samples at around 35 mm TL in April and were present at increasing lengths until the end of June when they disappeared from the samples (Figs. 4.22-4.23).

Menhaden caught in the gill nets were older fish and ranged in length from 260 - 320 mm TL for the months of January-July. In August the gill net catches were dominated by smaller menhaden in the 165 - 185 mm TL range (Fig. 4.24).

The small trawl CPUE of Age I and older menhaden was significantly higher at Stations 4 and 5 than the other small trawl stations. The CPUE for the large trawl was significantly higher at Stations 9 and 3 (channel stations) than at the other stations. The gill net CPUE was significantly higher at Station 4 than at the other stations (Table 4.5).

Trout

This group consists of two similar species of the family Sciaenidae, the spotted seatrout and the weakfish. Of the two species, the weakfish is the more abundant in this area.

Weakfish ranked as the fifth most abundant fish caught during the study period. Out of a total of 7,954 weakfish caught, 2,692 were caught in large trawls, 5,257 were caught in small trawls, and only 5 were caught in gill nets.

Few weakfish were present in the study area until April and May (Figs. 4.25-4.28). At this time Age I fish were caught in both the large and small trawls (Figs. 4.29 and 4.30). Beginning in June, Age 0 fish were caught with the small trawl. By the middle of July, weakfish (most of which were Age 0) had reached their peak of abundance.

Weakfish present in April and May were in the range of 135-215 mm. The Age 0 weakfish that entered the small trawl catches in June were in the 20 - 65 mm range. In August the modal length of these Age 0 weakfish was 90 mm although 20 - 30 mm fish were still being collected, indicating a continual recruitment during this time (Figs. 4.29 and 4.30).

Age 0 weakfish tended to be more abundant at the deeper stations in the estuary. The CPUE of young-of-the-year weakfish with the small trawl was significantly higher at Stations 5, 8, and 1 than at the other small trawl stations (Table 4.5). The CPUE of young-of-the-year with the large trawl was significantly higher at Stations 9, 5, and 3 than at Stations 4 and 2.

One hundred and ten spotted seatrout were captured in trawls. Of these 81% were caught in January and February (Figs. 4.31 and 4.32). At this time the spotted seatrout ranged from 100 - 350 mm TL (Figs. 4.33 and 4.34). Of the 48 spotted seatrout caught in the gill nets, 32 were caught in April (Fig. 4.35). The range of lengths of these fish was from 170 - 405 mm, with 40% at 400 mm and over (Fig. 4.36).

Flounder

Two species of commercially important flounder, southern flounder and summer flounder, were found in the study area. The southern flounder was found in greater abundance with 1,172 collected by all gears as compared to only 335 summer flounder caught with all gears (Table 4.3).

Two peaks of abundance of southern flounder were observed during the study period. The first peak, in January, (Figs. 4.37-4.38) consisted primarily of juveniles in the 100-150 mm TL size range (Figs. 4.39 and 4.40). The second peak of abundance appeared in June (Figs. 4.41-4.42) and consisted mostly of young-of-the-year fish in the 50-100 mm TL size range (Figs. 4.41 and 4.42). These young-of-the-year first appeared in the small trawl samples in April at 35-50 mm TL (Figs. 4.39 and 4.40). Schwartz (CFS, Vol. XIV) reports these same size southern flounder appearing in the Cape Fear between March and May.

The peak abundance of summer flounder occurred in May (Fig. 4.43) and consisted almost entirely of young-of-the-year fish, most of which were in the 45-80 mm TL size range (Fig. 4.44). These fish first appeared in the small trawl samples in some abundance in late April in the 35-50 mm TL range.

Southern flounder were generally more abundant in the Intake Canal. The CPUE for young-of-the-year southern flounder with the small trawl was significantly higher at Stations 6 and 5 than at Stations 1, 4, 7, and 8 (Table 4.5). The same was also true for Age I and older southern flounder caught in the small trawl. The CPUE for adult southern flounder with the large trawl was significantly higher at Station 5 than the other large trawl stations.

Mullet

There are two species of mullet in the lower Cape Fear area, the striped mullet and the white mullet. Very few specimens were caught of both species (125 striped and 15 white), so they will be treated as one.

Mullet were caught in the trawls primarily in the first two months of the study period. The peak of abundance occurred at the end of February (Trip 3). On this trip almost 60% of the total number of mullet caught (in all gears) were caught in small trawls (Figs. 4.45 and 4.46). They ranged in size from 25-240 mm, although over half were less than 35 mm (Fig. 4.47). Mullet of this same size were also taken in the larval fish program during this time (see Section 2.4.6).

Other Finfish

Eighty other species of finfish were caught. Included in this list are blackcheek tonguefish (*Symphurus plagiusa*), the sixth most abundant fish, and spotted hake (*Urophycis regius*), the seventh most abundant fish (Table 4.4). Some of these species, however, were only represented by a few specimens (Table 4.3).

Shrimp

The shrimp included in this group are the commercially important shrimp of the family Penaeidae. The species are brown shrimp, pink shrimp, and white shrimp. Of these three, the white shrimp is usually the more abundant species in the Cape Fear estuary. White shrimp were not caught in large numbers because the study period ended in August and white shrimp are predominantly caught in September and October. Their numbers have also been reduced because of the severe winters of 1976-77 and 1977-78 (CFS, Vol. XV).

Brown shrimp ranked as the second most abundant invertebrate (grass shrimp ranked first) caught during the study period. A total of

31,947 was captured, the majority (86%) with the small trawl (Table 4.3). Brown shrimp were not found in any abundance in the samples until the middle of May (Trip 7) when 40-55 mm shrimp were caught in the small trawl (Fig. 4.48). On Trip 8 (June 3 and 4) 75 - 100 mm TL shrimp were caught in both the large and small trawls (Figs. 4.48 and 4.49). The peak of abundance of brown shrimp occurred in June although good numbers were caught through the end of the study period (Figs. 4.50 and 4.51). Brown shrimp caught in the small trawl increased in size from a mean length of approximately 50 mm in May to a length of approximately 125 mm in late August (Fig. 4.48).

Walden Creek, the Intake Canal, and the FDC had the larger catches of brown shrimp. Small trawl catches were higher at Station 5 which was not significantly different from Station 1 (Table 4.5). Catches at Stations 1, 6, and 7 were significantly higher than at Stations 8 and 4. The large trawl CPUE for brown shrimp was significantly higher at Station 5 than the other large trawl stations.

Pink shrimp ranked as the fifth most abundant invertebrate. A total of 2,272 were caught, 79% with the small trawl. Pink shrimp were most abundant in January. After January they were found in very few numbers (except at Station 1) until July and August (Figs. 4.52 and 4.53).

In January the lengths of pink shrimp ranged from 25-190 mm with the mode at 90 mm (Figs. 4.54 and 4.55). Those caught during the first of August in the small trawl ranged in length from 25 - 85 mm with a modal length of 50 mm. At the end of August their lengths ranged from 45 - 120 mm with a mode of 70 mm.

The CPUE of pink shrimp with the small trawl was highest at Station 1 which was significantly different from the catch at Station 5 (Table 4.5). The catch at these two stations was significantly higher than the catch at the other small trawl stations. Pink shrimp catches with the large trawl were higher at Station 5. Except for Station 2, the catches at Station 5 were significantly higher than the catches at Stations 9 and 3.

White shrimp were not caught abundantly until August (Figs. 4.56 and 4.57). They appeared in small trawl samples (primarily at Stations 1 and 7) at the first of August at a range of 65 - 135 mm and a modal length of 105 mm and increased in size to 115 mm in three weeks (Fig. 4.58). This same trend also appeared in the impingement data (see Section 5.3.2.2).

Blue Crabs

Blue crabs were the third most abundant invertebrate caught, ranking behind grass and brown shrimp. A total of 10,477 was caught in both the large and small trawls. As with impingement, the period of peak abundance in 1979 occurred from the middle of March to the first of April (Figs. 4.59 and 4.60). The lowest CPUE occurred just previous to this period and corresponds to the time of the lowest temperatures recorded during the study period. It is noted (CFS, Vol. XVII) that blue crabs tend to burrow into the mud during cold weather and to a large extent escape the trawls used in sampling.

... catches of blue crabs tended to be highest at stations located in ... Intake Canal. The small trawl catches at Stations 6, 4, and 5 were ...gher and significantly different from the catch at Stations 7 and 1 (Table 4.5). Large trawl catches at Stations 4, 5, and 2 were higher than at the other large trawl stations, and the CPUE at Stations 4, 5 and 6 was significantly greater than at Stations 9 and 3.

Other Shellfish

This group includes shellfish (8 species) other than the commercial Penaeid shrimp and blue crabs. Species include hardback shrimp (Trachypenaeus constrictus), grass shrimp (Palaemonetes spp.), mantis shrimp (Squilla empusa), and other swimming crabs (Portunus spp.).

Grass shrimp was the most abundant species in this group, comprising 98% of all other shellfish. On an overall basis, grass shrimp comprised 66% of the total shellfish caught (includes Penaeid shrimp and blue crabs). Of the 95,978 grass shrimp caught, 68,728 were caught in small trawls in Walden Creek (Station 7) from January to April.

Miscellaneous Species

This group includes all other species not included elsewhere. These species are the brief squid (Lolliguncula brevis), the green sea turtle (Chelonia mydias), the diamondback terrapin (Malaclemys terrapin), and the loggerhead turtle (Caretta caretta caretta). One loggerhead was caught May 15 in Walden Creek in the small trawl, and one was caught May 16 at Station 6 in the small trawl. (These records were inadvertently omitted from Table 4.3.) A green sea turtle was caught with the large trawl on May 15 at Station 2. The brief squid was by far the dominant member of this group and was the fourth overall most abundant invertebrate caught.

4.5 Comparison of 1979 Catch Per Unit Effort With Earlier Years

A detailed comparison of the CPUE for the dominant species collected in this study with the CPUE's presented by Dr. Schwartz for the years 1974 through 1978 is not possible at this time for several reasons. The number of stations sampled in the UNC program varied from 10 to 22 with considerable emphasis placed on ocean and channel stations. The reduced 1979 program sampled only 9 stations, 7 of which had been sampled by UNC in previous years. The emphasis, however, was placed on the shallow stations where larger numbers of juveniles and fewer numbers of deeper water forms (e.g., ardrum) were collected. A comparison between years was further complicated by the change in sampling frequency. The UNC program concentrated its effort during the spring and fall months and only sparingly sampled during the summer and winter months. The reduced CP&L program evened the sampling out over the entire year. Consequently, the disproportional sampling scheme resulted in seemingly higher catches of winter spawners and lower catches of summer spawners.

With these conditions kept in mind, the following comparison is given, which shows the overall CPUE's of the dominant species for the combined time period 1973 through 1978, 1978, and January-August 1979 (CFS, Vol. XV, Table 31b-c).

SMALL TRAWL CPUE's

	1973-78	1978	1979
Spot	30.16	10.28	370.34
Bay Anchovy	17.76	11.81	158.17
Croaker	13.65	5.98	223.71
Tonguefish	3.62	3.04	14.72
Hogchoker	2.71	3.25	2.43
Stardrum	1.79	0.01	0.33
Spotted Hake	1.99	3.02	3.69
Menhaden	1.69	3.40	17.32

LARGE TRAWL CPUE's

	1973-78	1978	1979
Stardrum	11.33	70.40	4.42
Croaker	52.89	20.98	35.47
Menhaden	84.06	265.85	162.07
Spot	42.57	50.55	21.11
Pinfish	13.98	5.99	0.42
Weakfish	15.91	43.68	18.19
Spotted Hake	32.23	11.49	6.39

Note that even taking into consideration the problems in making these comparisons, the 1979 data appears to be as high or higher than in previous years.

As soon as the UNC data base is available in a form that is compatible with the CP&L data base, a more detailed comparison will be made. This comparison will consider the differences in sampling frequency and station locations allowing a direct year-to-year comparison.

4.6 Conclusions

The average water temperature was lowest at 6°C during February and highest at 30°C during July. The average salinities ranged from 2 ppt to 30 ppt and were generally lower during the winter and early spring trips and higher during the late spring and summer trips.

A total of 223,039 fish and 145,818 invertebrates was caught, most of these with the small trawl. The ten most abundant fish, in order of decreasing abundance, were spot, croaker, bay anchovy, menhaden, weakfish, tonguefish, spotted hake, southern flounder, stardrum (Stellifer lancelatus), and silver perch (Bairdiella chrysura). The five most abundant invertebrates caught, in order of decreasing abundance, were grass shrimp, brown shrimp, blue crabs, brief squid, and pink shrimp.

With the small trawls, catches tended to be higher at Stations 1 and/or 5. Areas of this type probably serve as nursery areas for most estuarine depended species during at least part of their stay in the estuary. Both of these stations are in man-made, soft bottom canals, intermediate in depths to the channel and tidal creek stations.

Spot was the most abundant fish collected for all gears combined. In general they were most abundant in small trawl samples in April and May when both Age 0 and Age 1 fish were present. In large trawls, Age 0 spot were most abundant from June to August, whereas older spot were generally most abundant in January. The CPUE of Age 0 spot was generally highest in the intake canal and/or adjacent areas. The CPUE of young-of-the-year spot in the small trawl was generally higher at Stations 5 and 6 than the other small trawl stations. The CPUE of older spot was higher at Station 5, followed by Stations 1 and 4, than the other small trawl stations.

Croakers were the second most abundant finfish and were present in the estuary during the entire study period. They were caught from January until May at 20-30 mm. Peak of abundance occurred in May and June when catches of croaker were dominated by 40-45 mm fish. Except for the ship channel stations (3 and 9), the deeper areas of the estuary generally had the largest catches of croaker. The CPUE of young-of-the-year croaker with the small trawl was generally highest at Station 1, followed by Station 5.

Bay anchovy was the third most abundant finfish caught. The peak of abundance occurred in early summer with catches during this time dominated by Age 0 fish ranging in size from 30 to 50 mm. The anchovies' CPUE for the small trawl was higher at Stations 1, 5, and 4 than the other small trawl stations.

Menhaden was the fourth most abundant fish caught with all gears, although they ranked first in large trawls and gill nets. The peak of abundance of menhaden occurred during February and was dominated by 90-105 mm TL fish. Age 0 menhaden appeared in small trawl samples at around 35 mm TL in April and were present in increasing lengths until June when they left the sampling area. The highest CPUE of older menhaden with the small trawl occurred at Stations 4 and 5 with the large trawl at Stations 9 and 3, and with the gill nets at Station 4.

Weakfish ranked fifth in abundance and were caught in much greater abundance than spotted seatrout. Weakfish, most of which were Age 0, reached their peak of abundance in mid-July. Weakfish entered the small trawl catches at 20-65 mm in June and reached a modal length of 90 mm by August. Weakfish (Age 0) tended to be more abundant at the deeper stations in the estuary. The CPUE of Age 0 with small trawl was generally higher at Stations 5, 8, and 1, than at Stations 4, 6, and 7.

Southern flounder were caught in greater abundance than summer flounder. Young-of-the-year southern flounder were caught in trawl samples in April at 35-50 mm and reached a peak in June at a range of 50-100 mm TL. The CPUE for both young-of-the-year and older southern flounder was higher at Stations 6 and 5 than at the other stations.

Mullet were primarily caught in trawls in January and February and ranged in length from 25 to 360 mm, although over half were less than 35 mm. This size range (25-35 mm) was the same general size as the mullet collected in the larval fish sampling program.

Grass shrimp were the most abundant invertebrate numbering over 95,000. The majority of these (77%), however, were collected in nine small trawls at a single station (Walden Creek).

Brown shrimp was the second most abundant invertebrate. They were not caught after January until the middle of May when they were caught in small trawls at 40-55 mm. Their peak of abundance occurred in June at a size of 75-100 mm. The CPUE for brown shrimp in the large and small trawl was highest at Station [illegible]. Large catches were also collected at Station 1 in the small trawl.

Pink shrimp displayed two peaks of abundance, one in January and one in August. In January they ranged in size from 25-190 mm with a modal length of 90 mm. In August they ranged in size from 25-85 mm with a modal length of 50 mm. Their CPUE in the small trawl was generally higher at Stations 1 and 5 than the other small trawl stations.

White shrimp were most abundant in August, at which time they ranged in size from 65 to 135 mm with a modal length of 105 mm. Their peak of abundance, however, probably occurred later in the fall.

The peak of abundance of blue crabs occurred from the middle of March to the first of April. The small trawl Stations 6, 4, and 5 had generally higher catches of blue crabs than the other small trawl stations, with the large trawl catches generally higher at Stations 4, 5, and 2 than elsewhere.

4.7 References

1. Huish, Melvin T. and James P. Geaghan. 1979. A study of adult and juvenile fishes of the lower Cape Fear River near the Brunswick Steam Electric Plant 1975-1976 (Vol. XIII of Carolina Power & Light Company's Cape Fear River Studies). North Carolina Cooperative Fishery Research Unit. North Carolina State University. 148 p.
2. Schwartz, F. J. et al. 1979a. An ecological study of fishes and invertebrate macrofauna utilizing the Cape Fear River estuary, Carolina Beach Inlet, and adjacent Atlantic Ocean. Institute of Marine Sciences. University of North Carolina. (Vol. XIV, Cape Fear Studies). 571 p.
3. ____________ 1979b. An ecological study of fishes and invertebrate macrofauna utilizing the Cape Fear River estuary, Carolina Beach Inlet, and adjacent Atlantic Ocean. Institute of Marine Sciences. University of North Carolina. (Vol. XV, Cape Fear Studies). 326 p.

TABLE 4.1 CP&L/UNC STATIONS WITH RESPECTIVE CP&L GEAR TYPES

CP&L STATION	UNC STATION	CP&L GEAR TYPE
1		Small trawl, gill net
2	18E	Large trawl
3	19	Large trawl
4	CM	Large trawl, small trawl, gill net
5	CS	Large trawl, small trawl, gill net
6	CB2	Small trawl, gill net
7		Small trawl, gill net
8	23W	Small trawl, gill net
9	23	Large trawl

TABLE 4.2   Nekton sampling trips and effort

TRIP	DATE	EFFORT LT	EFFORT ST	EFFORT GN
1	January 8 - January 11	15	18	12
2	January 30 - February 1	15	18	12
3	February 20 - February 22	12[1]	18	12
4	March 13 - March 16	12[1]	18	12
5	April 3 - April 5	12[1]	18	12
6	April 24 - April 26	12[1]	18	12
7	May 14 - May 16	12[1]	18	12
8	June 4 - June 7	15	18	12
9	June 24 - June 27	15	18	12
10	July 17 - July 19	0[2]	18	12
11	August 7 - August 10	15	18	12
12	August 28 - August 30	13[3]	18	12
	TOTAL	148	216	144

[1] Station 5 was not sampled while diversion device was in effect.

[2] Boat failure - Ms. SLUICE inoperative

[3] Gear failure - trawl too badly torn to be mended quickly and used again during the sampling period.

TABLE 4.3 NEKTON STUDY SPECIES TOTAL NUMBER AND PERCENT TOTAL BY GEAR TYPE, JANUARY-AUGUST, 1979.

SPECIES TAXONOMIC NAME	SPECIES COMMON NAME	LARGE TRAWL NUMBER	LARGE TRAWL %	SMALL TRAWL NUMBER	SMALL TRAWL %	GILL NET NUMBER	GILL NET %
ACIPENSER OXYRHYNCHUS	ATLANTIC STURGEON	1	0.00	0	0.00	6	0.25
ALOSA AESTIVALIS	BLUEBACK HERRING	12	0.03	15	0.00	33	1.38
ALOSA MEDIOCRIS	HICKORY SHAD	2	0.00	1	0.00	0	0.00
ALOSA PSEUDOHARENGUS	ALEWIFE	2	0.00	0	0.00	0	0.00
ALOSA SAPIDISSIMA	AMERICAN SHAD	15	0.03	17	0.01	11	0.46
ALOSA SPECIES	SHAD SPECIES	0	0.00	1	0.00	0	0.00
ALPHEUS SPP	SNAPPING SHRIMP	2	0.00	45	0.01	0	0.00
ANCHOA HEPSETUS	STRIPED ANCHOVY	47	0.10	297	0.09	0	0.00
ANCHOA MITCHILLI	BAY ANCHOVY	785	1.64	34164	10.72	0	0.00
ANCHOA SPP	ANCHOVY SPP	0	0.00	2	0.00	0	0.00
ANCYLOPSETTA QUADROCELLATA	OCELLATED FLOUNDER	18	0.04	7	0.00	0	0.00
ANGUILLA ROSTRATA	AMERICAN EEL	1	0.00	186	0.06	0	0.00
ARCHOSARGUS PROBATOCEPHALUS	SHEEPSHEAD	2	0.00	40	0.01	0	0.00
ARIUS FELIS	SEA CATFISH	2	0.00	0	0.00	0	0.00
ASTROSCOPUS GUTTATUS	NORTHERN STARGAZER	0	0.00	4	0.00	0	0.00
ASTROSCOPUS Y-GRAECUM	SOUTHERN STARGAZER	3	0.01	15	0.00	0	0.00
BAIRDIELLA CHRYSURA	SILVER PERCH	275	0.58	239	0.07	0	0.00
BREVOORTIA TYRANNUS	ATLANTIC MENHADEN	23987	50.17	3752	1.18	1532	63.96
CALLINECTES SPP.	BLUE CRABS	2872	6.01	7605	2.39		
CARANX HIPPOS	CREVALLE JACK	0	0.00	3	0.00	0	0.00
CARCHARHINUS MILBERTI	SANDBAR SHARK	1	0.00	0	0.00	0	0.00
CENTROPRISTES PHILADELPHICA	ROCK SEA BASS	2	0.00	2	0.00	0	0.00
CENTROPRISTES STRIATA	BLACK SEA BASS	4	0.01	0	0.00	0	0.00
CHAETODIPTERUS FABER	ATLANTIC SPADEFISH	62	0.13	45	0.01	0	0.00
CHASMODES BOSQUIANUS	STRIPED BLENNY	0	0.00	20	0.01	0	0.00
* CHELONIA MYDAS	GREEN SEA TURTLE	1	0.00	0	0.00	0	0.00
CHILOMYCTERUS SCHOEPFI	STRIPED BURRFISH	0	0.00	1	0.00	0	0.00
CHLOROSCOMBRUS CHRYSURUS	ATLANTIC BUMPER	7	0.01	12	0.00	2	0.08
CITHARICHTHYS SPILOPTERUS	BAY WHIFF	78	0.16	174	0.05	0	0.00
CRANGON SEPTEMSPINOSA	SAND SHRIMP	0	0.00	15	0.00	0	0.00
CYNOSCION NEBULOSUS	SPOTTED SEATROUT	23	0.05	87	0.03	48	2.00
CYNOSCION REGALIS	WEAKFISH	2692	5.63	5257	1.65	5	0.21
DASYATIS SABINA	ATLANTIC STINGRAY	15	0.03	6	0.00	0	0.00
DIAPTERUS OLISTHOSTOMUS	IRISH POMPANO (MOJARRA)	0	0.00	16	0.01	0	0.00
DOROSOMA CEPEDIANUM	GIZZARD SHAD	5	0.01	9	0.00	19	0.79
ELOPS SAURUS	LADYFISH	1	0.00	2	0.00	4	0.17
ERIMYZON SUCETTA	LAKE CHUBSUCKER	0	0.00	0	0.00	1	0.04
ETROPUS CROSSOTUS	FRINGED FLOUNDER	15	0.07	97	0.03	0	0.00
FUNDULUS HETEROCLITUS	MUMMICHOG	0	0.00	10	0.00	0	0.00
GOBIESOX STRUMOSUS	SKILLETFISH (CLINGFISH)	1	0.00	11	0.00	0	0.00
GOBIONELLUS BOLEOSOMA	DARTER GOBY	0	0.00	52	0.02	0	0.00
GOBIONELLUS HASTATUS	SHARPTAIL GOBY	0	0.00	20	0.01	0	0.00
GOBIOSOMA BOSCI	NAKED GOBY	0	0.00	24	0.01	0	0.00
GOBIOSOMA GINSBURGI	SEABOARD GOBY	0	0.00	4	0.00	0	0.00
HIPPOCAMPUS ERECTUS	LINED SEAHORSE	1	0.00	0	0.00	0	0.00
HYPSOBLENNIUS HENTZI	FEATHER BLENNY	5	0.01	13	0.00	0	0.00
HYPSOBLENNIUS IONTHAS	FRECKLED BLENNY	0	0.00	86	0.03	0	0.00
ICTALURUS CATUS	WHITE CATFISH	0	0.00	6	0.00	3	0.13
LAGODON RHOMBOIDES	PINFISH	62	0.13	228	0.07	1	0.04
LARIMUS FASCIATUS	BANDED DRUM	1	0.00	1	0.00	0	0.00
LEIOSTOMUS XANTHURUS	SPOT	3124	6.53	79994	25.10	224	9.34
LEPISOSTEUS OSSEUS	LONGNOSE GAR	0	0.00	1	0.00	31	1.29

TABLE 4.3 (CONTINUED)

SPECIES TAXONOMIC NAME	SPECIES COMMON NAME	LARGE TRAWL NUMBER	LARGE TRAWL %	SMALL TRAWL NUMBER	SMALL TRAWL %	GILL NET NUMBER	GILL NET %
LOLLIGUNCULA BREVIS	BRIEF SQUID	357	0.75	2611	0.82	0	0.00
MALACLEMYS TERRAPIN	DIAMONDBACK TERRAPIN	4	0.01	4	0.00	5	0.21
MEMBRAS MARTINICA	ROUGH SILVERSIDE	0	0.00	1	0.00	0	0.00
MENIDIA BERYLLINA	TIDEWATER SILVERSIDE	0	0.00	20	0.01	0	0.00
MENIDIA MENIDIA	ATLANTIC SILVERSIDE	2	0.00	233	0.07	0	0.00
MENTICIRRHUS AMERICANUS	SOUTHERN KINGFISH	16	0.03	79	0.01	2	0.08
MENTICIRRHUS SAXATILIS	NORTHERN KINGFISH	2	0.00	5	0.00	0	0.00
MENTICIRRHUS SPP	KINGFISH	0	0.00	9	0.00	0	0.00
MICROGOBIUS GULOSUS	CLOWN GOBY	0	0.00	3	0.00	0	0.00
MICROGOBIUS SPP.	MICROGOBIUS SPP.	0	0.00	1	0.00	0	0.00
MICROGOBIUS THALASSINUS	GREEN GOBY	0	0.00	11	0.00	0	0.00
MICROPOGONIAS UNDULATUS	CROAKER	5250	10.98	48322	15.16	33	1.38
MONACANTHUS HISPIDUS	PLANEHEAD FILEFISH	2	0.00	9	0.00	0	0.00
MUGIL CEPHALUS	STRIPED MULLET	7	0.01	102	0.03	16	0.67
MUGIL CUREMA	WHITE MULLET	0	0.00	10	0.00	5	0.21
MYROPHIS PUNCTATUS	SPECKLED WORM EEL	0	0.00	1	0.00	0	0.00
OPHICHTHUS GOMESI	SHRIMP EEL	1	0.00	3	0.00	0	0.00
OPHIDIIDAE	CUSK-EEL	4	0.01	107	0.03	0	0.00
OPHIDION WELSHI	CRESTED CUSK-EEL	5	0.01	223	0.07	0	0.00
OPISTHONEMA OGLINUM	ATLANTIC THREAD HERRING	8	0.02	1	0.00	5	0.21
OPSANUS TAU	OYSTER TOADFISH	18	0.04	428	0.13	0	0.00
ORTHOPRISTIS CHRYSOPTERA	PIGFISH	2	0.00	0	0.00	0	0.00
PALAEMONETES SPP	GRASS SHRIMP	6	0.01	55972	30.12	0	0.00
PARALICHTHYS DENTATUS	SUMMER FLOUNDER	53	0.11	280	0.09	2	0.08
PARALICHTHYS LETHOSTIGMA	SOUTHERN FLOUNDER	201	0.42	957	0.30	14	0.58
PARALICHTHYS SPP	PARALICHTHYS SPP	0	0.00	1	0.00	0	0.00
PENAEUS AZTECUS	BROWN SHRIMP	4348	9.09	27599	8.66	0	0.00
PENAEUS DUORARUM	PINK SHRIMP	480	1.00	1792	0.56	0	0.00
PENAEUS SETIFERUS	WHITE SHRIMP	299	0.61	239	0.07	0	0.00
PEPRILUS ALEPIDOTUS	HARVESTFISH	32	0.07	12	0.00	4	0.17
PEPRILUS TRIACANTHUS	BUTTERFISH	178	0.37	8	0.00	0	0.00
POGONIAS CROMIS	BLACK DRUM	2	0.00	12	0.00	5	0.21
POMATOMUS SALTATRIX	BLUEFISH	18	0.04	9	0.00	117	4.88
PORTUNUS SPP	BROWN EAR CRABS	13	0.03	2	0.00	0	0.00
PRIONOTUS CAROLINUS	NORTHERN SEAROBIN	4	0.01	0	0.00	0	0.00
PRIONOTUS SCITULUS	LEOPARD SEAROBIN	5	0.01	7	0.00	0	0.00
PRIONOTUS TRIBULUS	BIGHEAD SEAROBIN	151	0.32	482	0.15	0	0.00
RHINOPTERA BONASUS	COWNOSE RAY	3	0.01	0	0.00	0	0.00
RHIZOPRIONODON TERRAENOVAE	ATLANTIC SHARPNOSE SHARK	37	0.08	5	0.00	253	10.55
SCIAENOPS OCELLATA	RED DRUM	0	0.00	4	0.00	2	0.08
SCOMBEROMORUS MACULATUS	SPANISH MACKEREL	19	0.04	0	0.00	1	0.04
SCOPHTHALMUS AQUOSUS	WINDOWPANE	75	0.16	101	0.03	0	0.00
SELENE SETAPINNIS	MOONFISH	1	0.00	1	0.00	0	0.00
SELENE VOMER	LOOKDOWN	82	0.17	167	0.05	0	0.00
SICYONIA SPP	ROCK SHRIMP	0	0.00	1	0.00	0	0.00
SPHOEROIDES MACULATUS	NORTHERN PUFFER	0	0.00	5	0.00	0	0.00
SQUILLA EMPUSA	MANTIS SHRIMP	181	0.38	225	0.07	0	0.00
STELLIFER LANCEOLATUS	STAR DRUM	654	1.37	71	0.02	0	0.00
SYMPHURUS PLAGIUSA	BLACKCHEEK TONGUEFISH	13	0.03	3179	1.00	0	0.00
SYMPHURUS SPP	TONGUEFISH	11	0.02	23	0.01	0	0.00
SYNGNATHUS FUSCUS	NORTHERN PIPEFISH	1	0.00	0	0.00	0	0.00
SYNGNATHUS LOUISIANAE	CHAIN PIPEFISH	0	0.00	4	0.00	0	0.00

TABLE 4.3 (CONTINUED)

SPECIES TAXONOMIC NAME	SPECIES COMMON NAME	LARGE TRAWL NUMBER	LARGE TRAWL %	SMALL TRAWL NUMBER	SMALL TRAWL %	GILL NET NUMBER	GILL NET %
SYNODUS FOETENS	INSHORE LIZARDFISH	9	0.02	24	0.01	0	0.00
TRACHYPENAEUS CONSTRICTUS	TRACHYPENAEUS CONSTRICTUS	15	0.03	1131	0.35	0	0.00
TRICHIURUS LEPTURUS	ATLANTIC CUTLASSFISH	25	0.05	0	0.00	0	0.00
TRIGLIDAE	SEA ROBIN SPP	0	0.00	1	0.00	0	0.00
TRINECTES MACULATUS	HOGCHOKER	61	0.13	524	0.16	0	0.00
UNID. WITH COMMENT	UNIDENTIFIED WITH COMMENT	0	0.00	0	0.00	1	0.04
UPOGEBIA AFFINIS	MUD SHRIMP	5	0.01	3	0.00	0	0.00
URANOSCOPIDAE	STARGAZER	0	0.00	1	0.00	0	0.00
UROPHYCIS FLORIDANUS	SOUTHERN HAKE	62	0.13	325	0.10	0	0.00
UROPHYCIS REGIUS	SPOTTED HAKE	946	1.98	796	0.25	0	0.00
UROPHYCIS SPP.	MIXED HAKE	0	0.00	1	0.00	0	0.00
	SUBTOTAL						
	Fish	39,231		181,428		2,380	
	Invertebrates	8,578		137,240		0	
	Green Sea Turtle	1		0		0	
	Terrapins	4		4		5	
	TOTAL	47,814	100.00	318,672	100.00	2,385	100.00

TABLE 4.4 RANKING, BY GEAR, OF THE 10 MOST ABUNDANT FISH CAUGHT IN THE CAPE FEAR ESTUARY, JANUARY-AUGUST 1979

SPECIES		RANK			
COMMON NAME	TAXONOMIC NAME	OVERALL	LT	ST	GN
Spot	Leiostomus xanthurus	1	3	1	2
Croaker	Micropogonias undulatus	2	2	2	6
Bay Anchovy	Anchoa mitchilli	3	7	3	_*
Menhaden	Brevoortia tyrannus	4	1	5	1
Weakfish	Cynoscion regalis	5	4	4	14
Tonguefish	Symphurus plagiusa	6	33	6	_*
Spotted Hake	Urophycis regius	7	5	8	_*
Southern Flounder	Paralichthys lethosigma	8	9	7	11
Star Drum	Stellifer lanceolatus	9	7	27	_*
Silver Perch	Bairdiella chryoura	10	8	15	_*

*None caught in gill nets

Table 4.5 Results of ANOVA and Duncan Multiple Range comparison for nekton CPUE data

			Source						
Species	Age	Gear	Trip	Station	Trip & Station	$\bar{X}$	S^2	(R^2)	Trips Analyzed
Total organisms		Small tr.	***	*** 517648	***	2.8[illegible]5	.099	.808	1-12
		Large tr.	*** ***	*** 59342	**	[illegible].176	.149	.716	1-12
		Gill net	***	*** 451867	***	0.963	.059	.892	1-12
Bay anchovy		Small tr.	***	*** 154687	***	1.532	.251	.817	1-12
Pink shrimp		Small tr.	***	*** 154876	***	0.466	.106	.866	1-7, 11, 12
		Large tr.	***	* 52493	*	0.063	.147	.732	1-7, 11, 12
Brown shrimp		Small tr.	***	*** 516784	***	1.942	.127	.865	8-12
		Large tr.	***	*** 54923	*	0.911	.379	.745	7-12
Blue crabs		Small tr.	***	*** 645871	***	1.218	.114	.791	1-12
		Large tr.	**	*** 45293	ns	0.913	.285	.517	1-12

Table 4.5
Continued

Species	Age	Gear	Trip	Source Station	Trip & Station	$\bar{X}$	S^2	(R^2)	Trips Analyzed
Menhaden	Adult	Small tr.	***	*** 458761	***	0.337	.232	.726	1-8
	Adult	Large tr.	***	*** 93452	***	1.167	.218	.881	1-12
	Adult	Gill net	***	*** 485167	***	0.694	.066	.908	1-12
Weakfish	Young	Small tr.	***	*** 581647	***	1.325	0.155	.869	9-12
	Young	Large tr.	***	*** 95342	*	1.005	0.300	.760	9-12
	Adult	Large tr.	***	** 39542	**	-0.094	.104	.625	1-12
Spot	Young	Small tr.	***	*** 561487	***	1.656	.332	.800	3-12
	Adult	Small tr.	***	*** [illegible]14867	***	0.537	.128	.863	1-12
	Young	Large tr.	***	*** 54293	ns	0.476	.211	.801	7-12
	Adult	Large tr.	***	* 54293	***	0.307	.182	.707	1-12

Table 4.5
Continued

Species	Age	Gear	Trip	Source Station	Trip & Station	$\bar{X}$	S^2	(R^2)	Trips Analyzed
Croaker	Young	Small tr.	***	*** 156487	***	1.440	.196	.868	1-12
	Adult	Small tr.	***	*** 157846	***	0.089	.085	.754	1-11
	Young	Large tr.	***	*** 59342	*	0.716	.330	.770	5-12
	Adult	Large tr.	ns	** 25934	**	0.026	.171	.484	1-12
Summer flounder	Young	Small tr.	***	*** 564817	***	-0.017	.071	.768	5-12
Southern flounder	Young	Small tr.	***	*** 657184	***	0.049	.054	.866	6-12
	Adult	Small tr.	***	*** 564178	***	0.235	.091	.781	1-12
	Adult	Large tr.	**	*** 54293	ns	-0.042	.116	.526	1-12

[1] Station 5 large trawl is missing Trips 3-7

[2] No large trawl samples were made on Trip 10

ns $p > .05$
* $.05 \leq p < .01$
** $.01 < p < .001$
*** $p \leq .001$

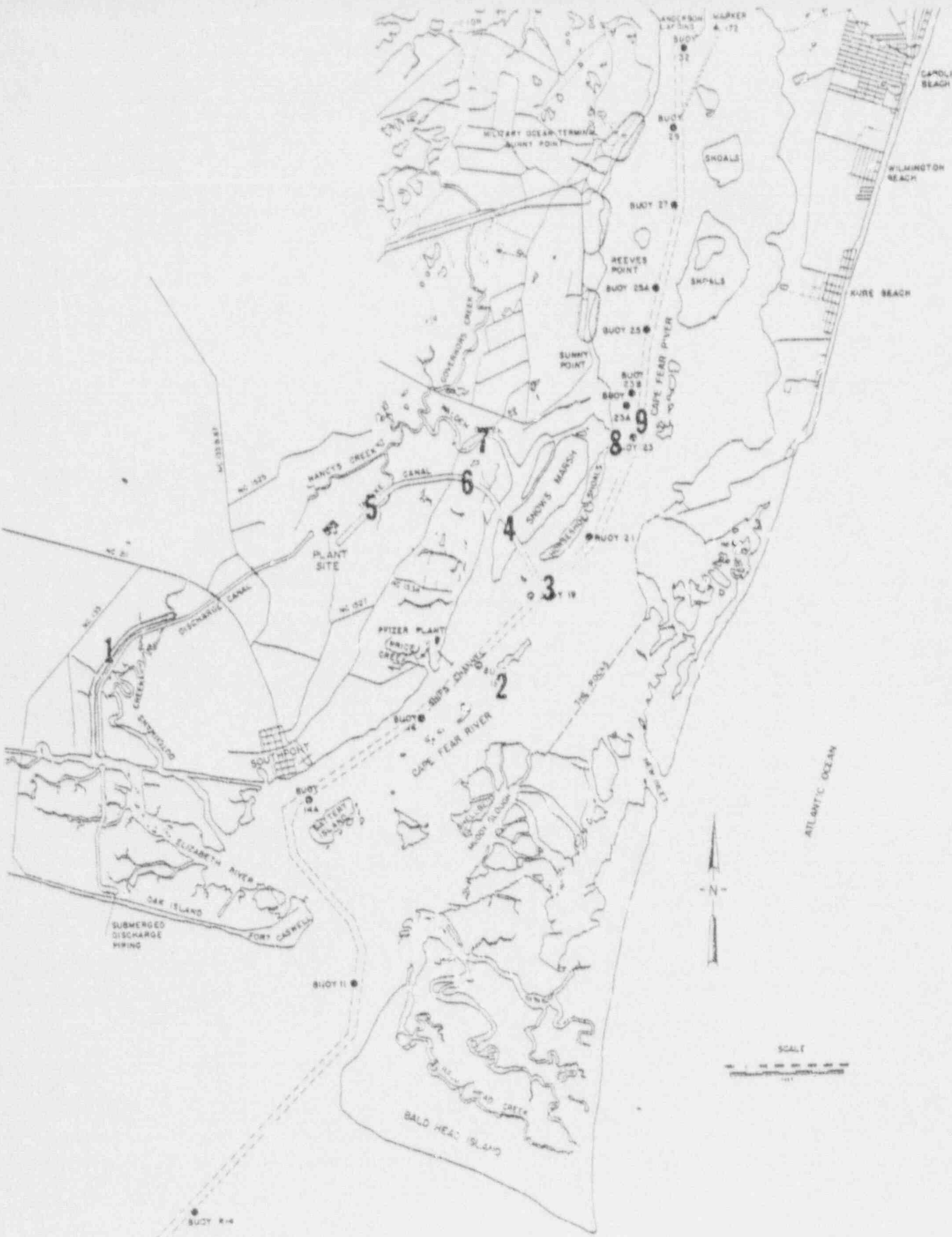


Figure 4.1 Map of CP&L Nekton Sampling Stations.

FIGURE 4.2 . AVERAGE WATER TEMPERATURES (C) BY STATION
FOR NEKTON STUDY JAN 1979 - AUG 1979

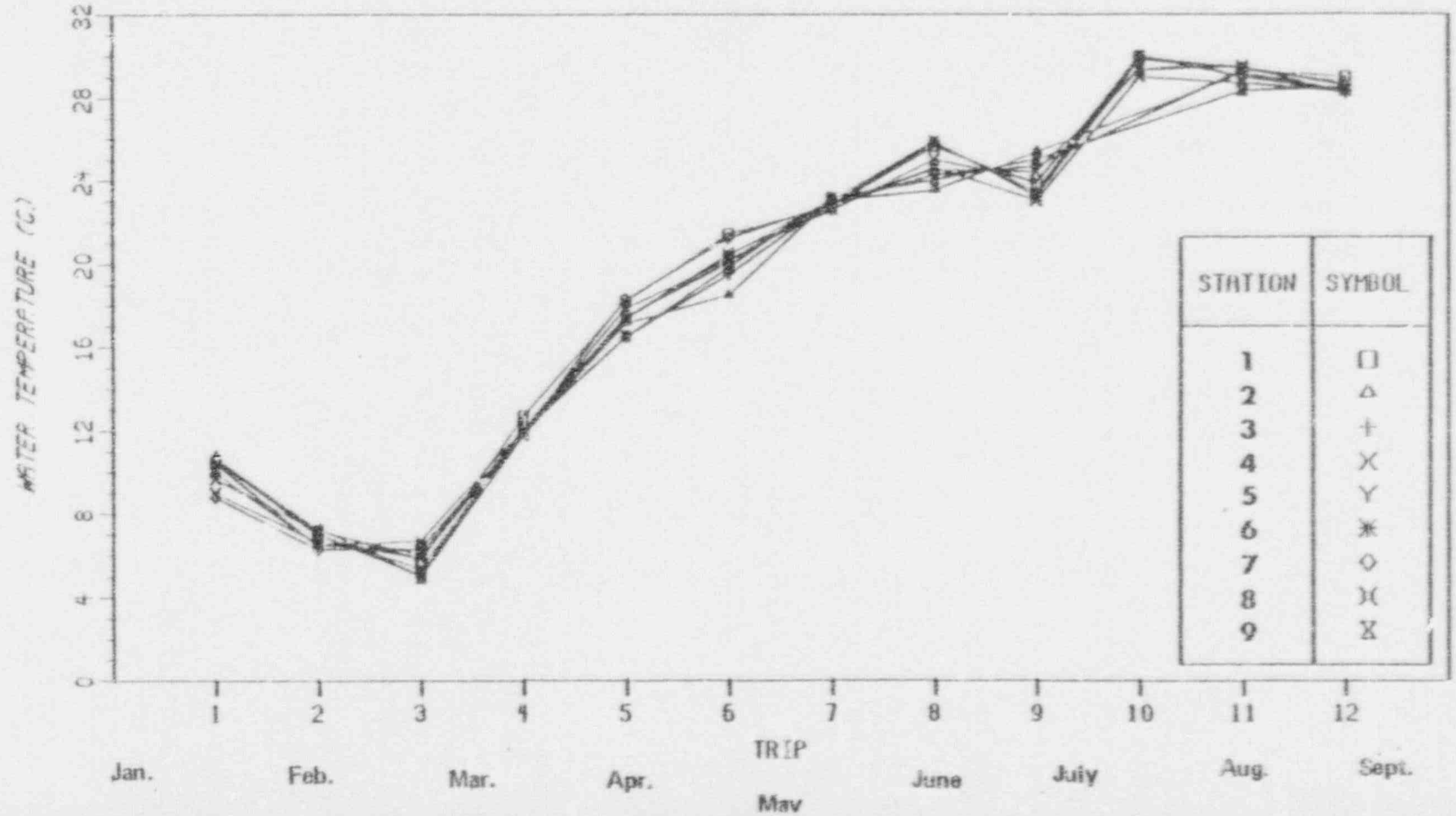


FIGURE 4.3 . AVERAGE SALINITIES (PPT) BY STATION

FOR NEKTON STUDY JAN 1979 - AUG 1979

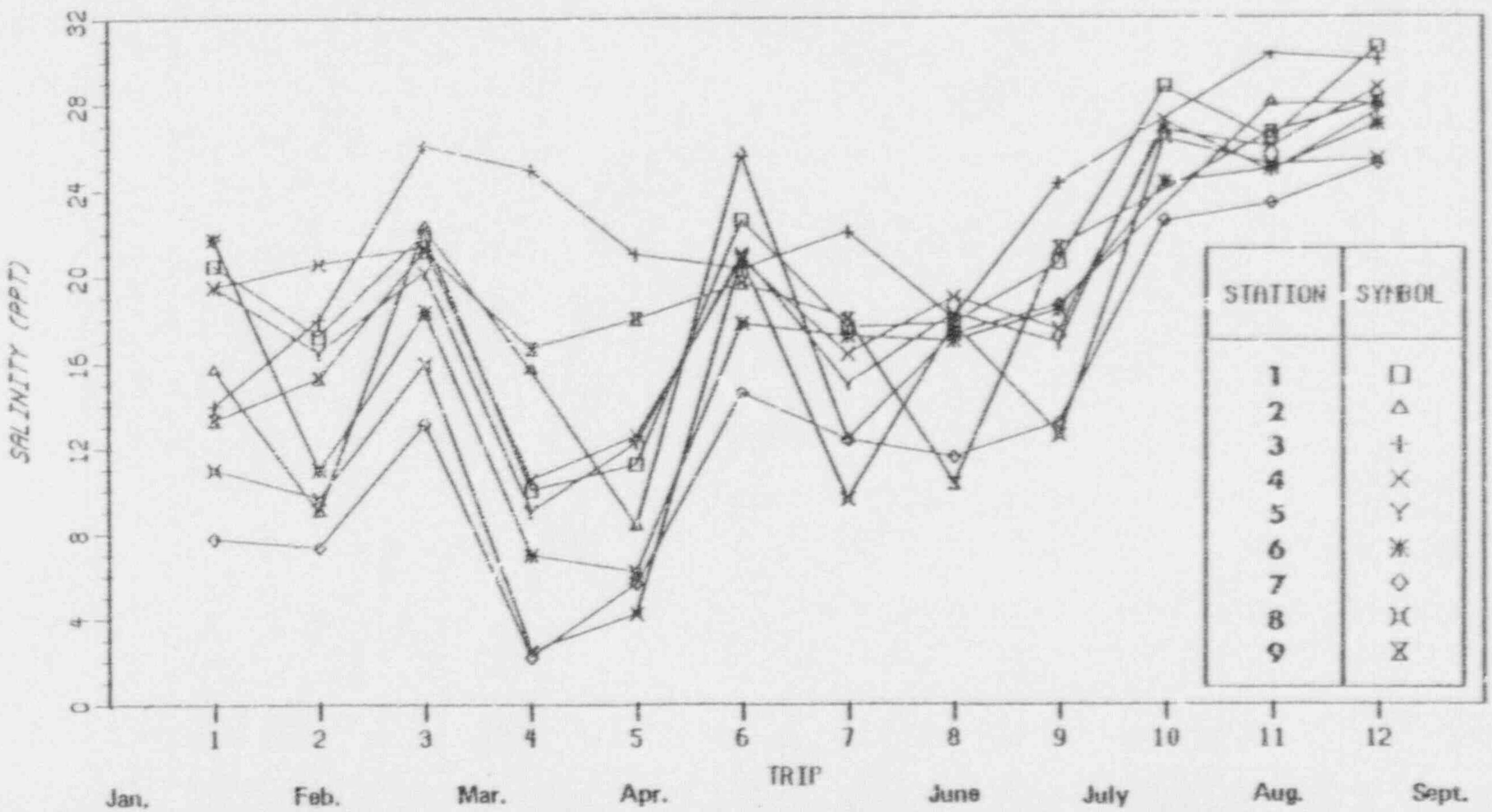


FIGURE 4.4 . AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=SPOT AGE=YOUNG OF YEAR

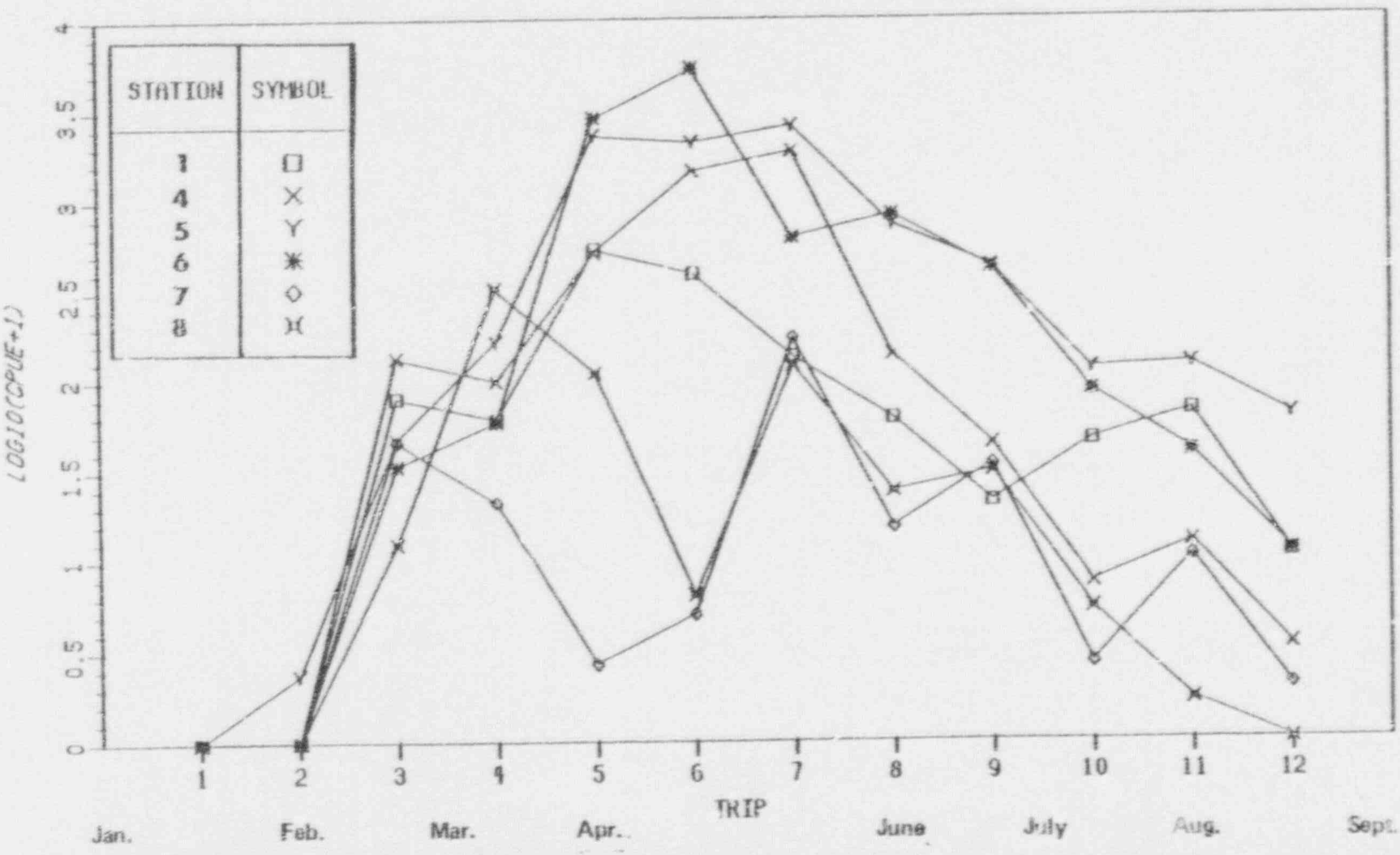


FIGURE 4.5 . AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION
FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979
SPECIES=SPOT AGE=YOUNG OF YEAR

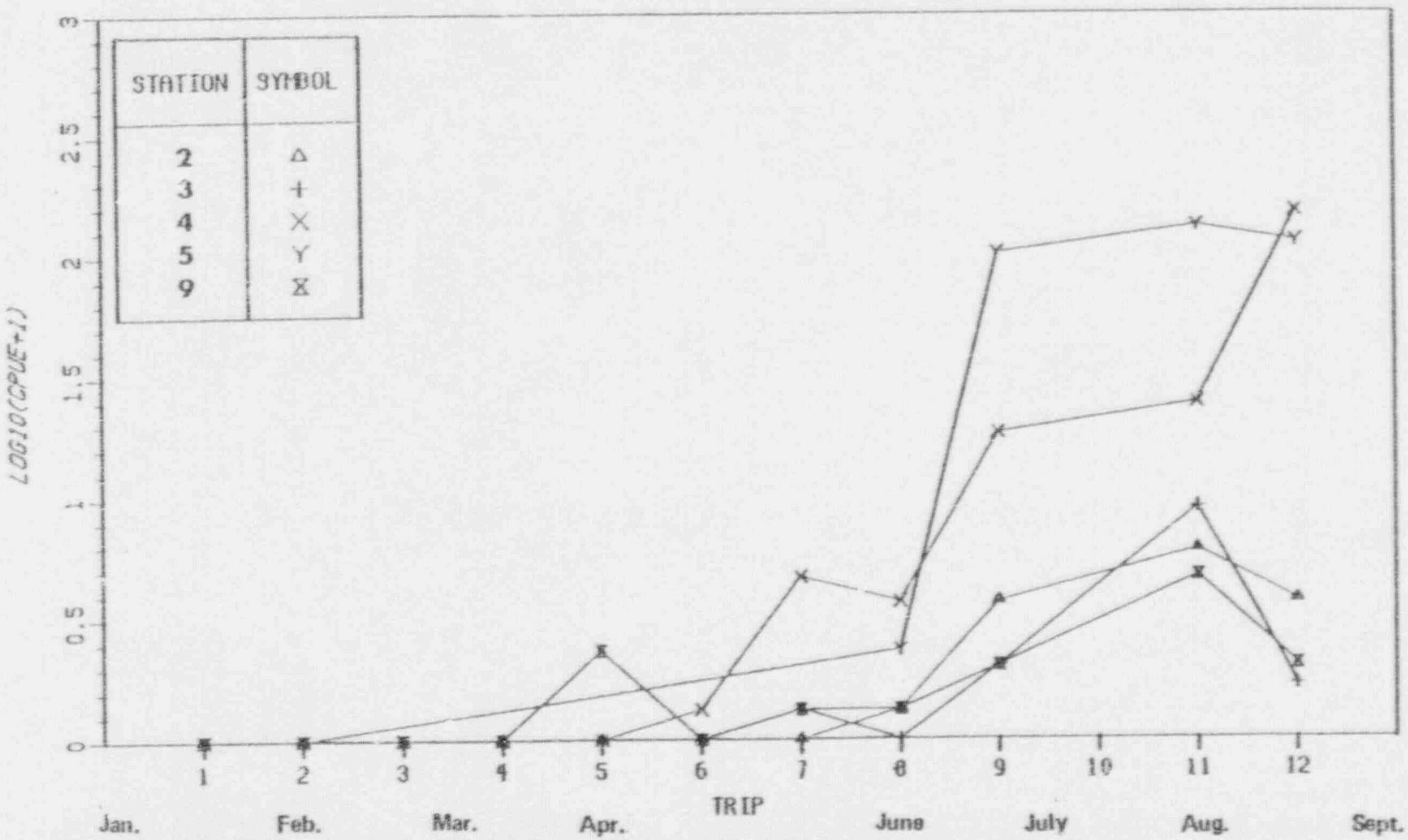


FIGURE 4.6 . AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=SPOT AGE=JUVENILE & ADULT

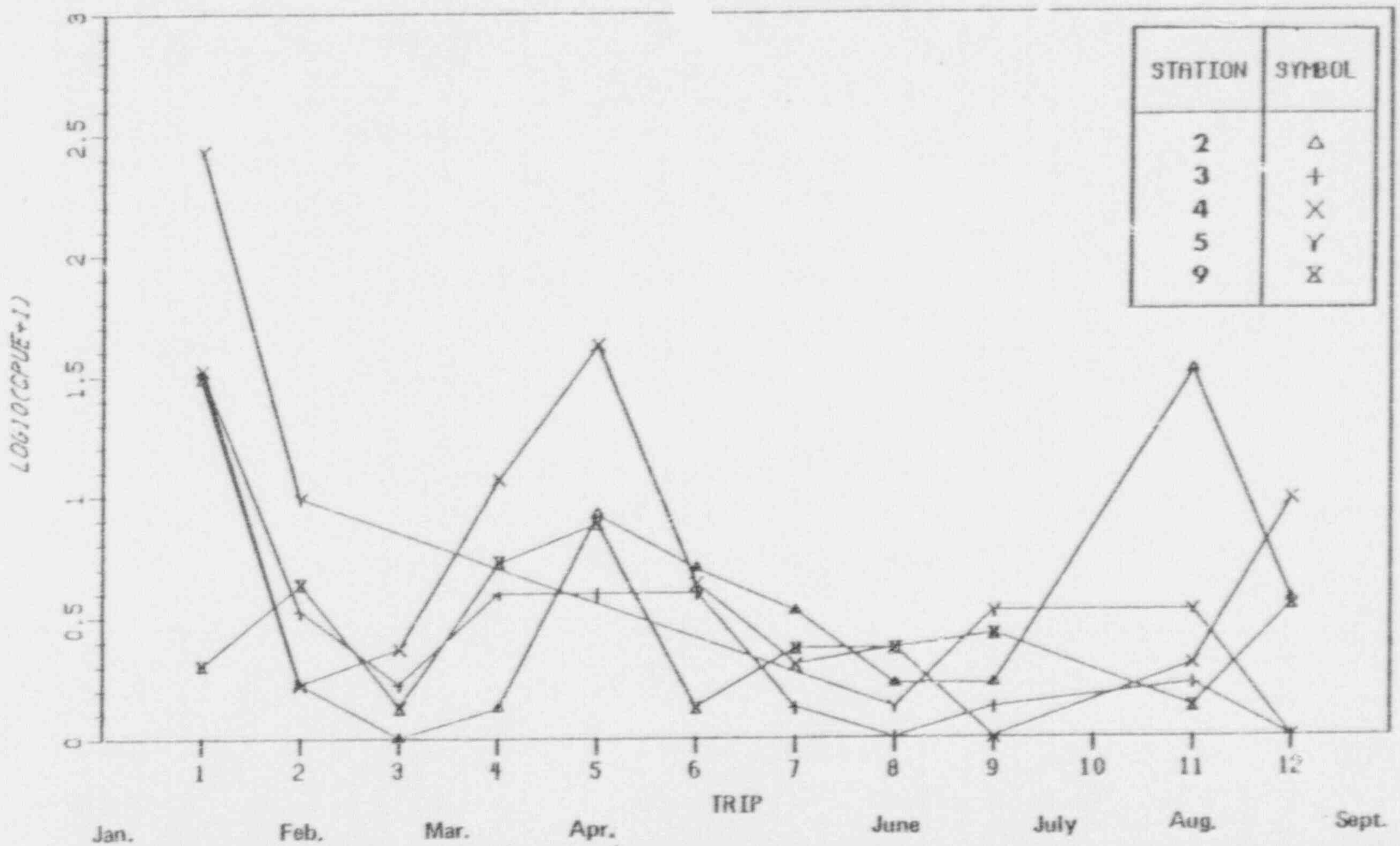
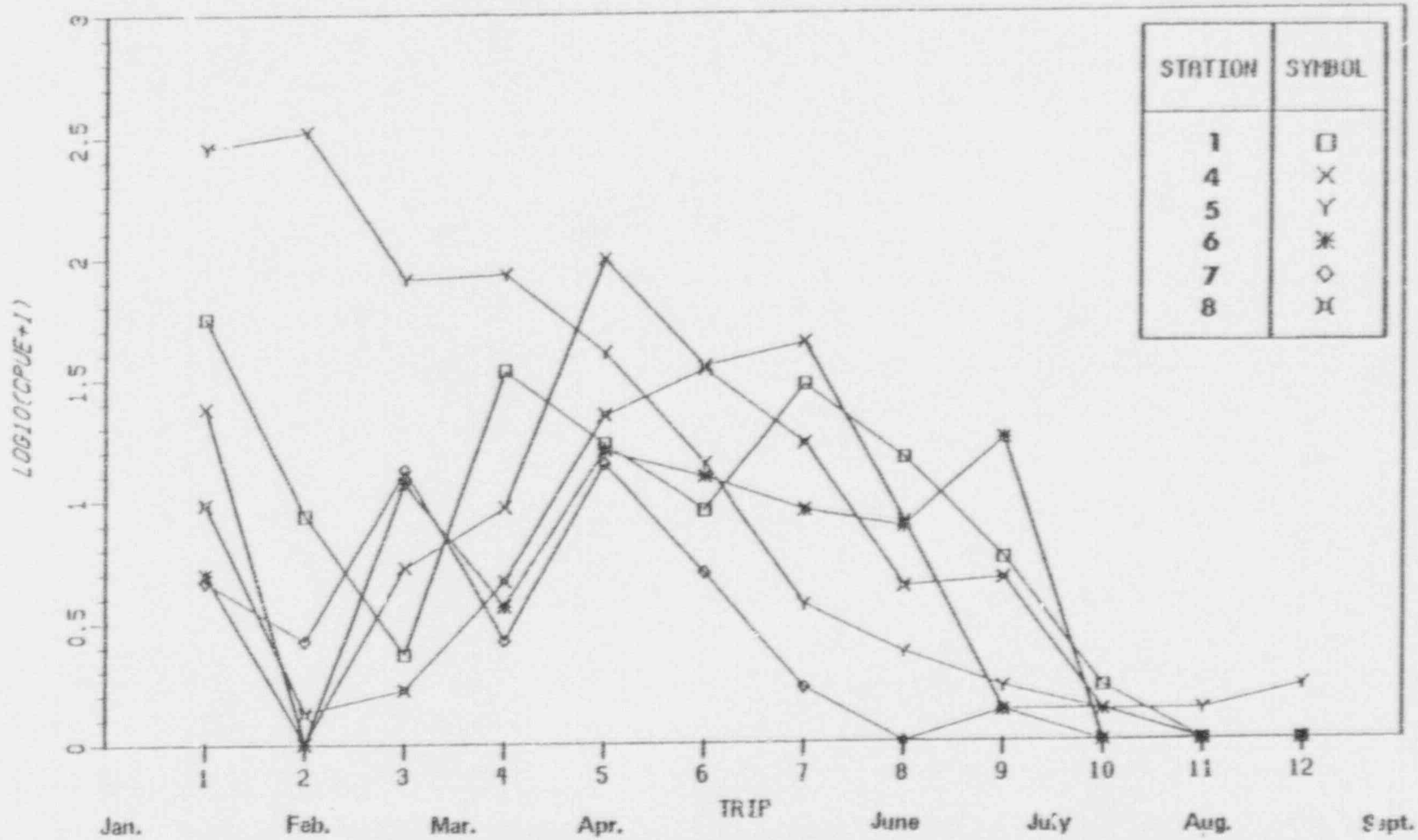


FIGURE 4.7 . AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=SPOT AGE=JUVENILE & ADULT



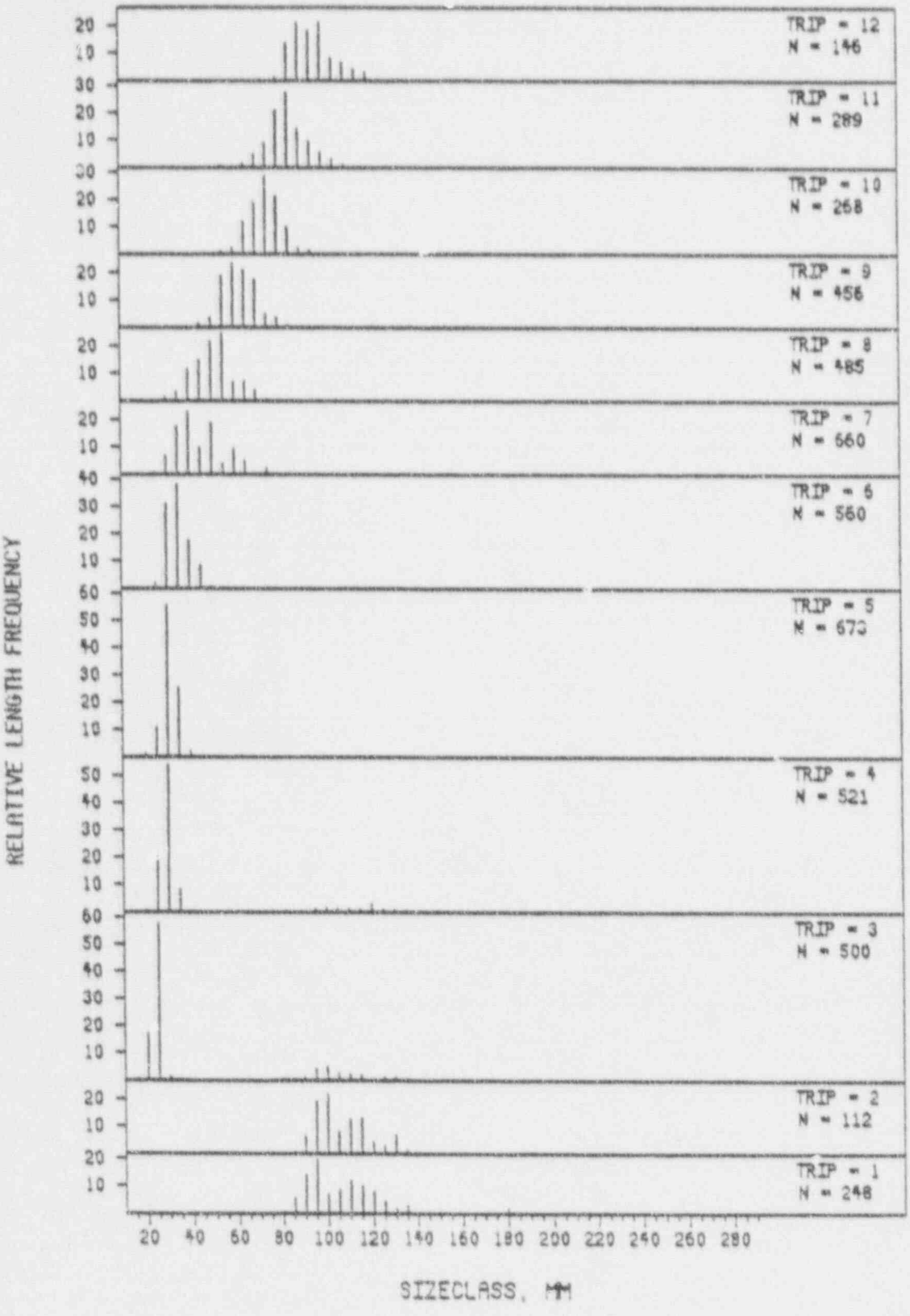


FIGURE 4.8 RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, SMALL TRAWLS SPECIES = SPOT

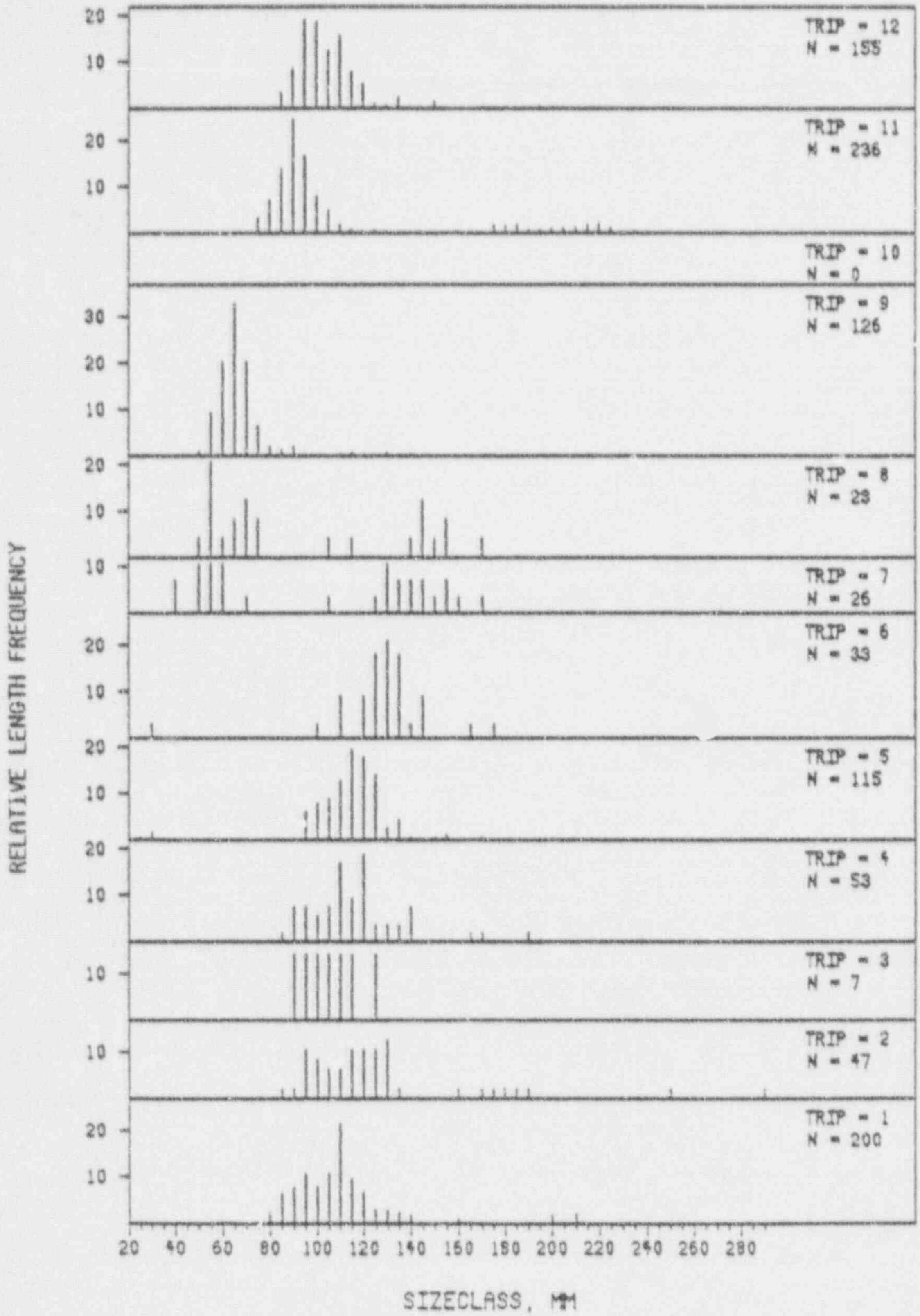
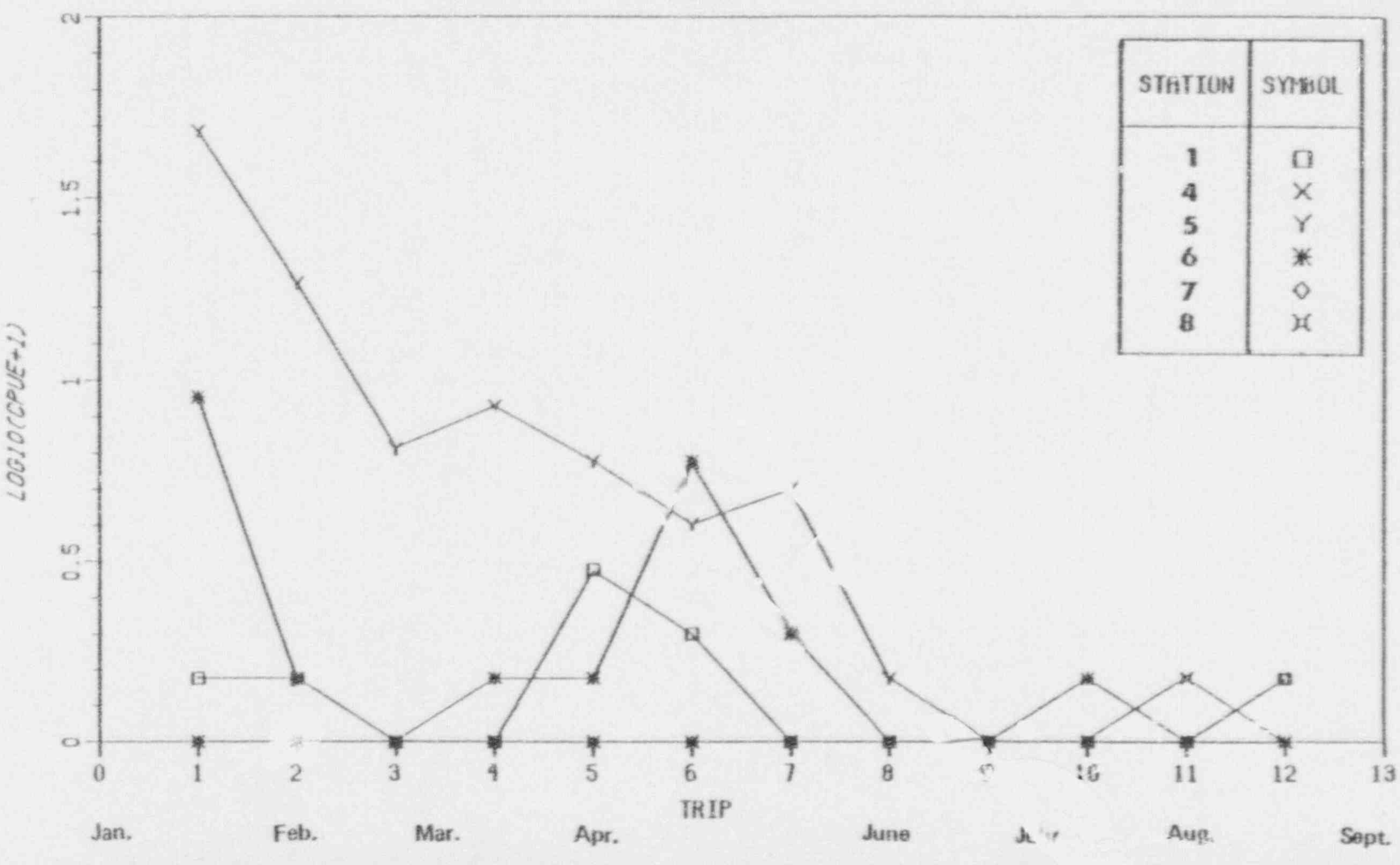


FIGURE 4.9 RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, LARGE TRAWLS SPECIES = SPOT

FIGURE 4.10. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR GILL NETS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=SPOT



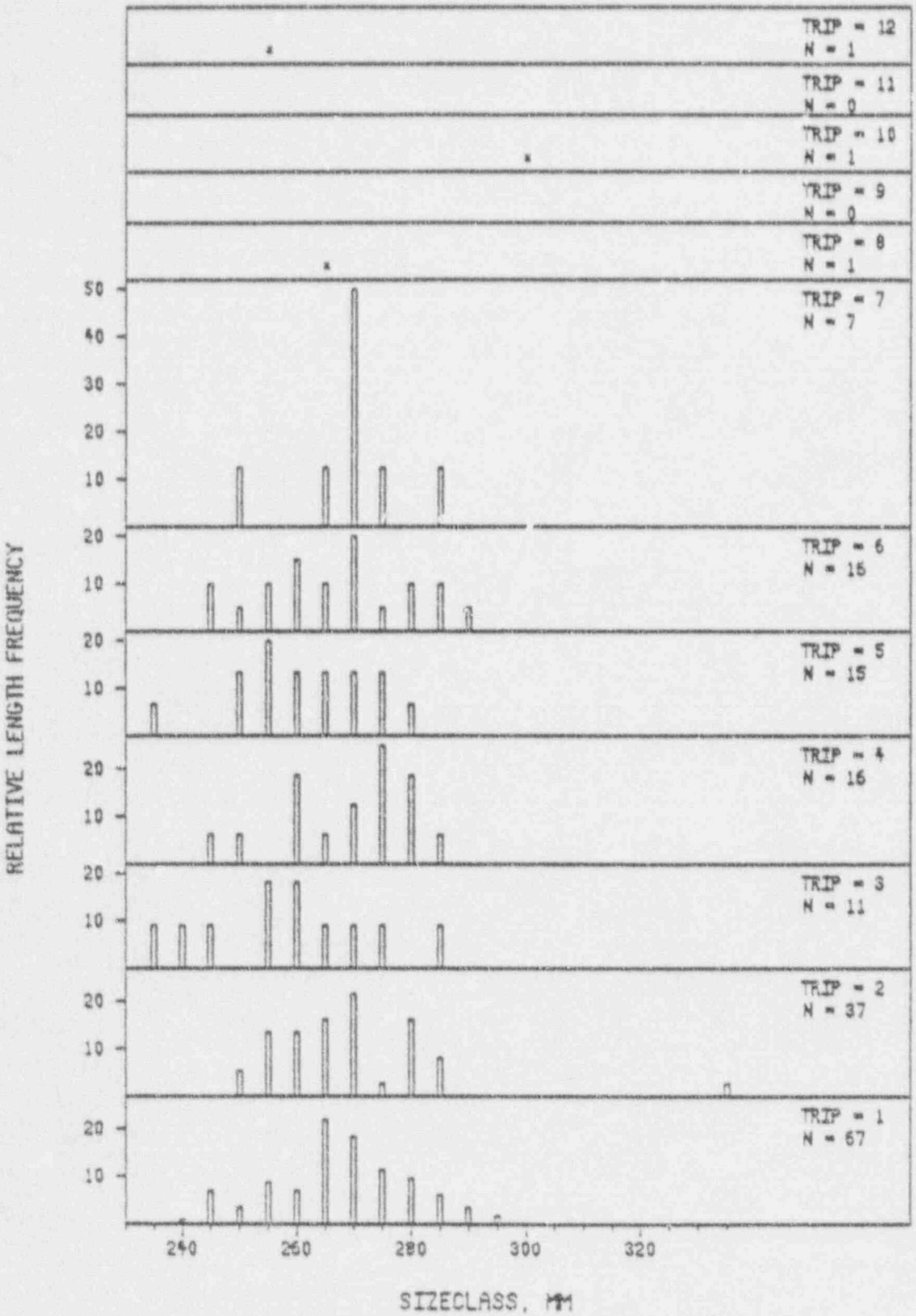


FIGURE 4.11. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, GILL NETS SPECIES = SPOT

FIGURE 4.12. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=CROAKER AGE=YOUNG OF YEAR

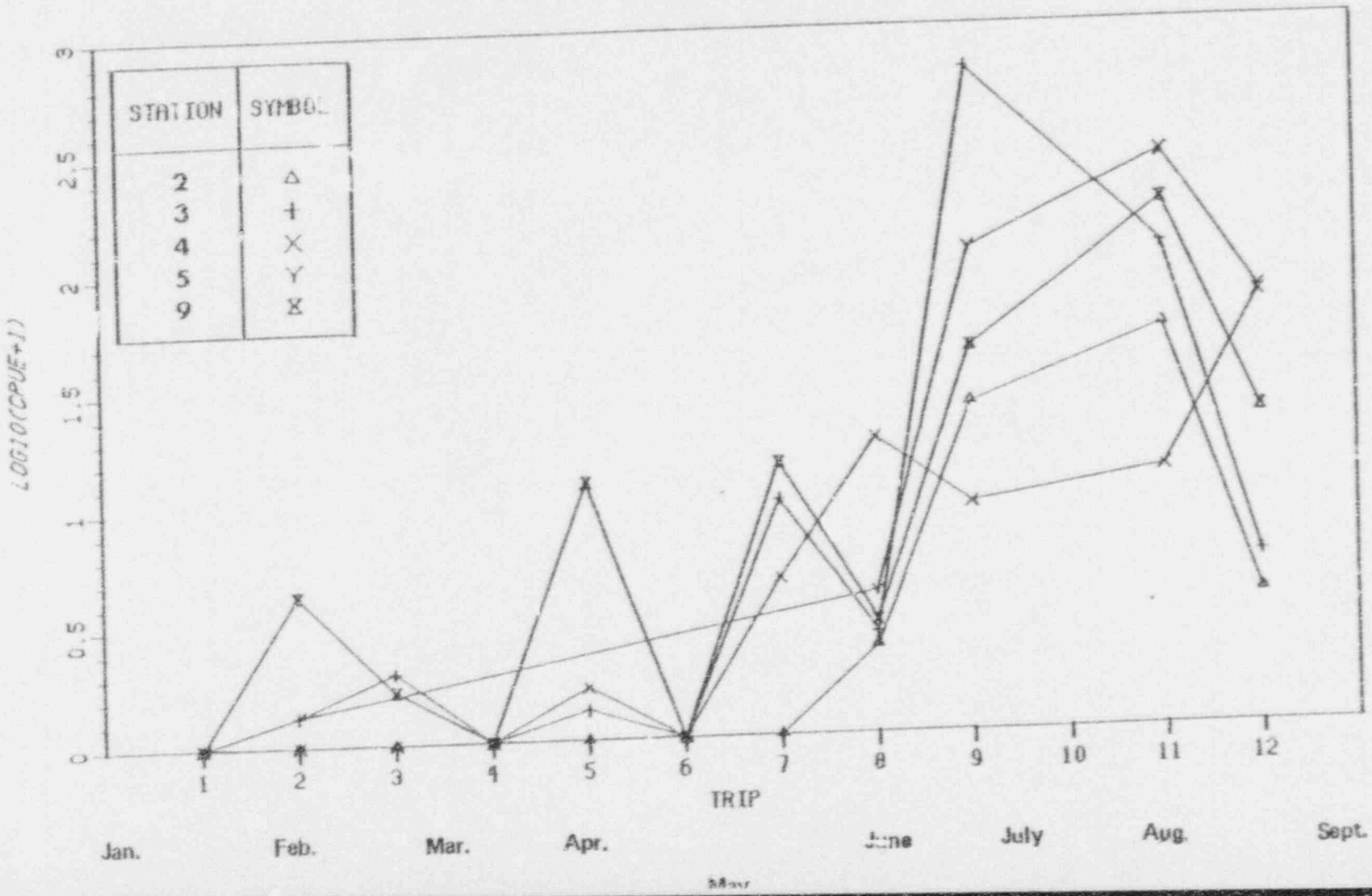


FIGURE 4.13. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=CROAKER AGE=YOUNG OF YEAR

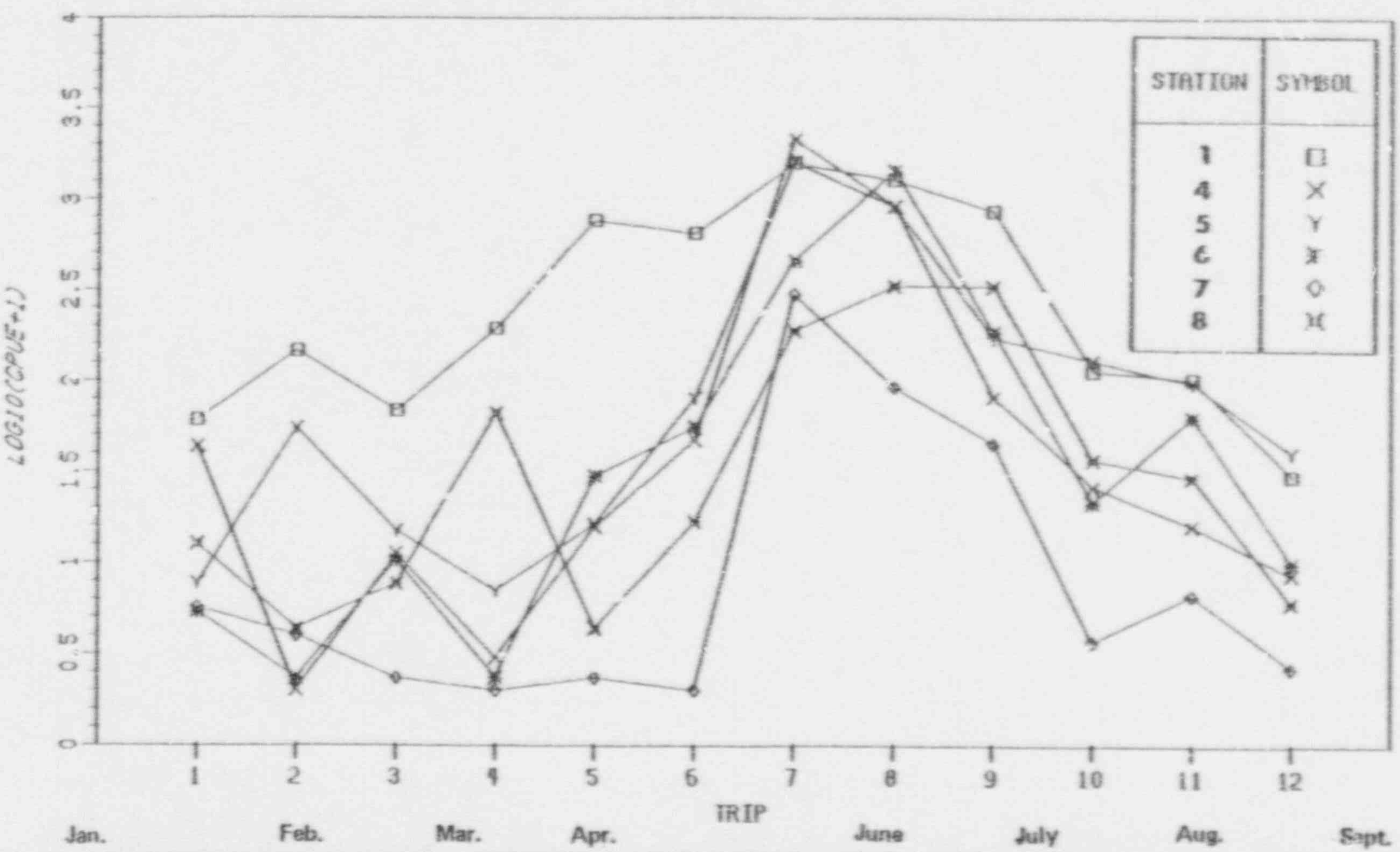
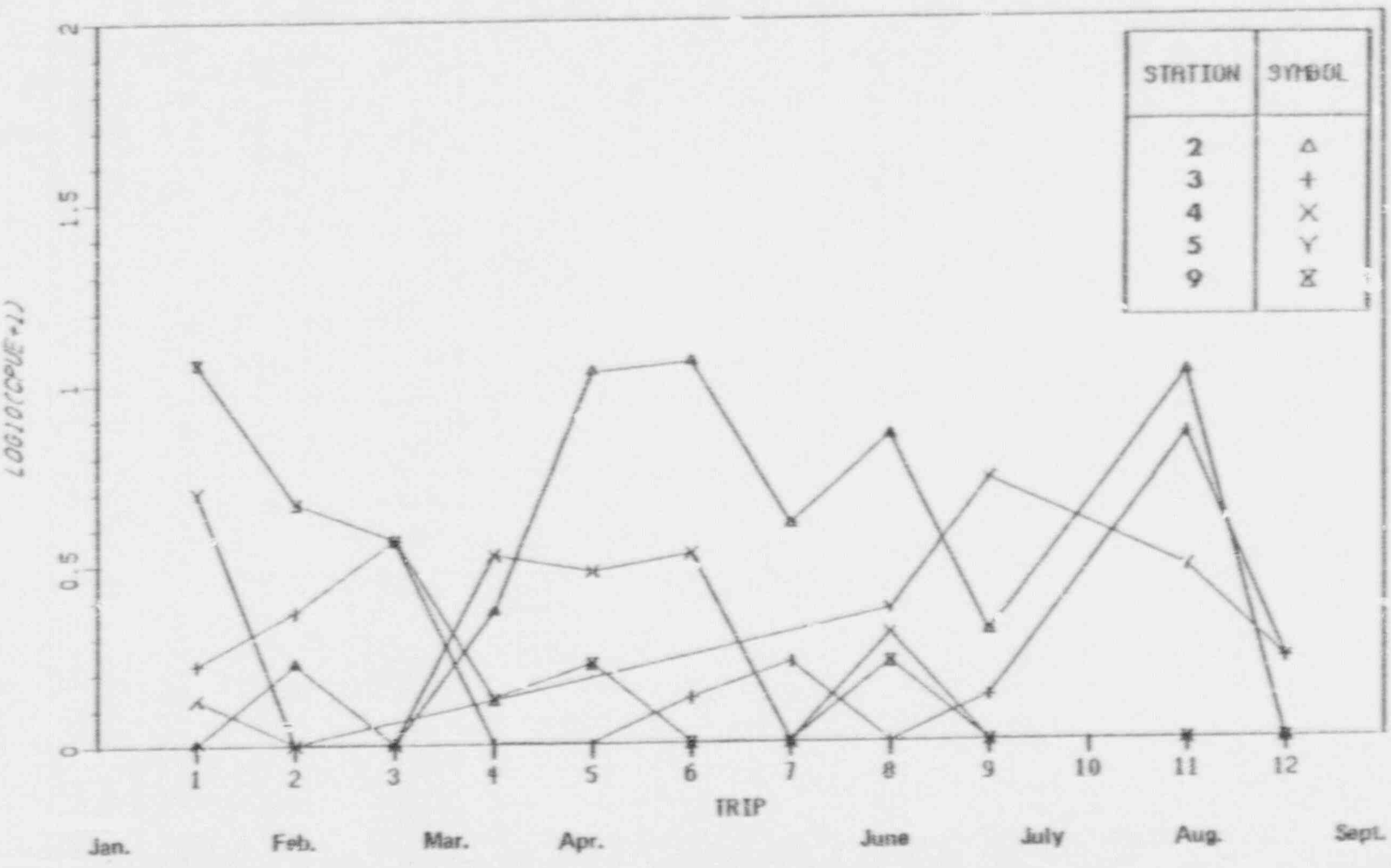


FIGURE 4.14. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=CROAKER AGE=JUVENILE & ADULT



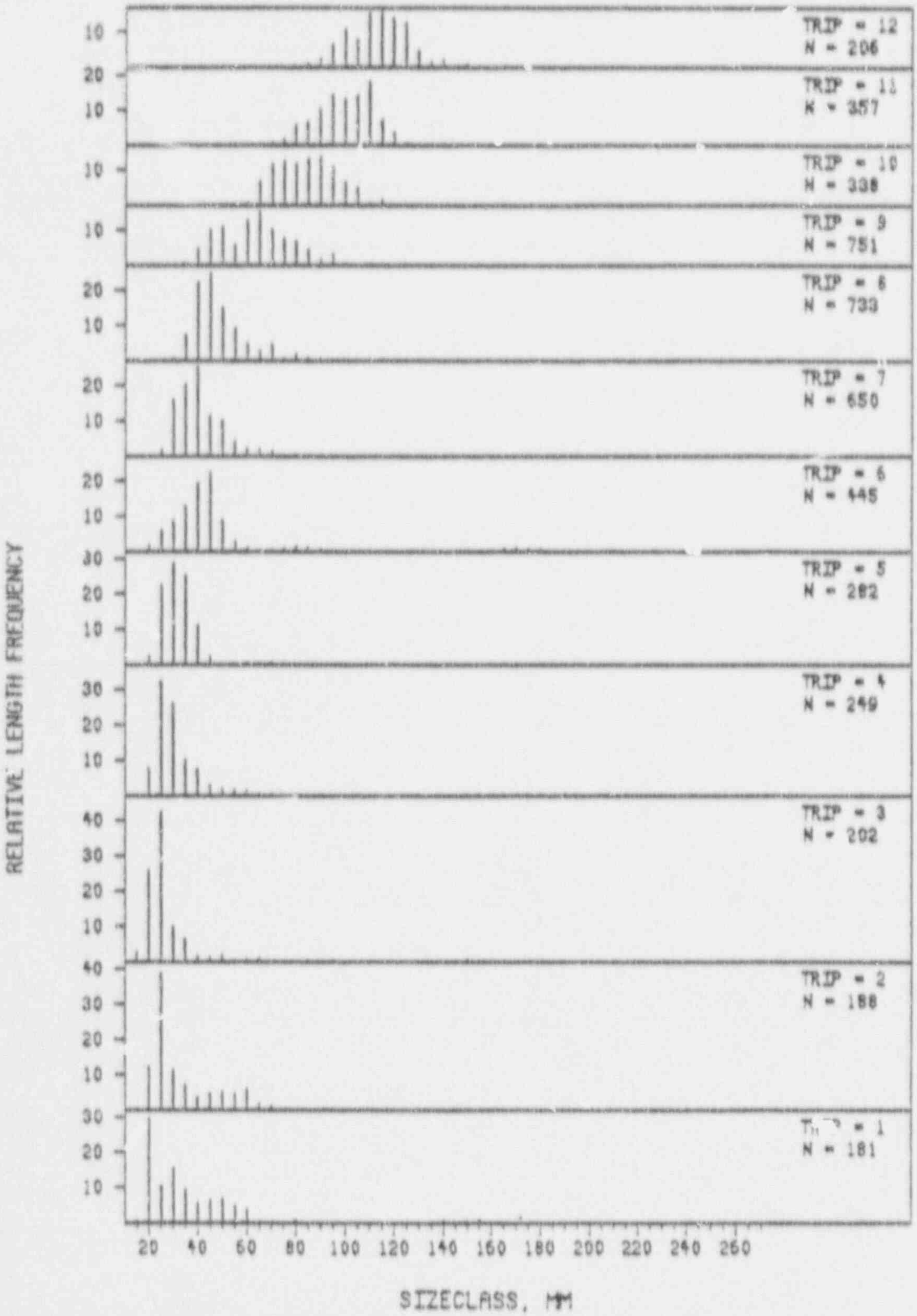
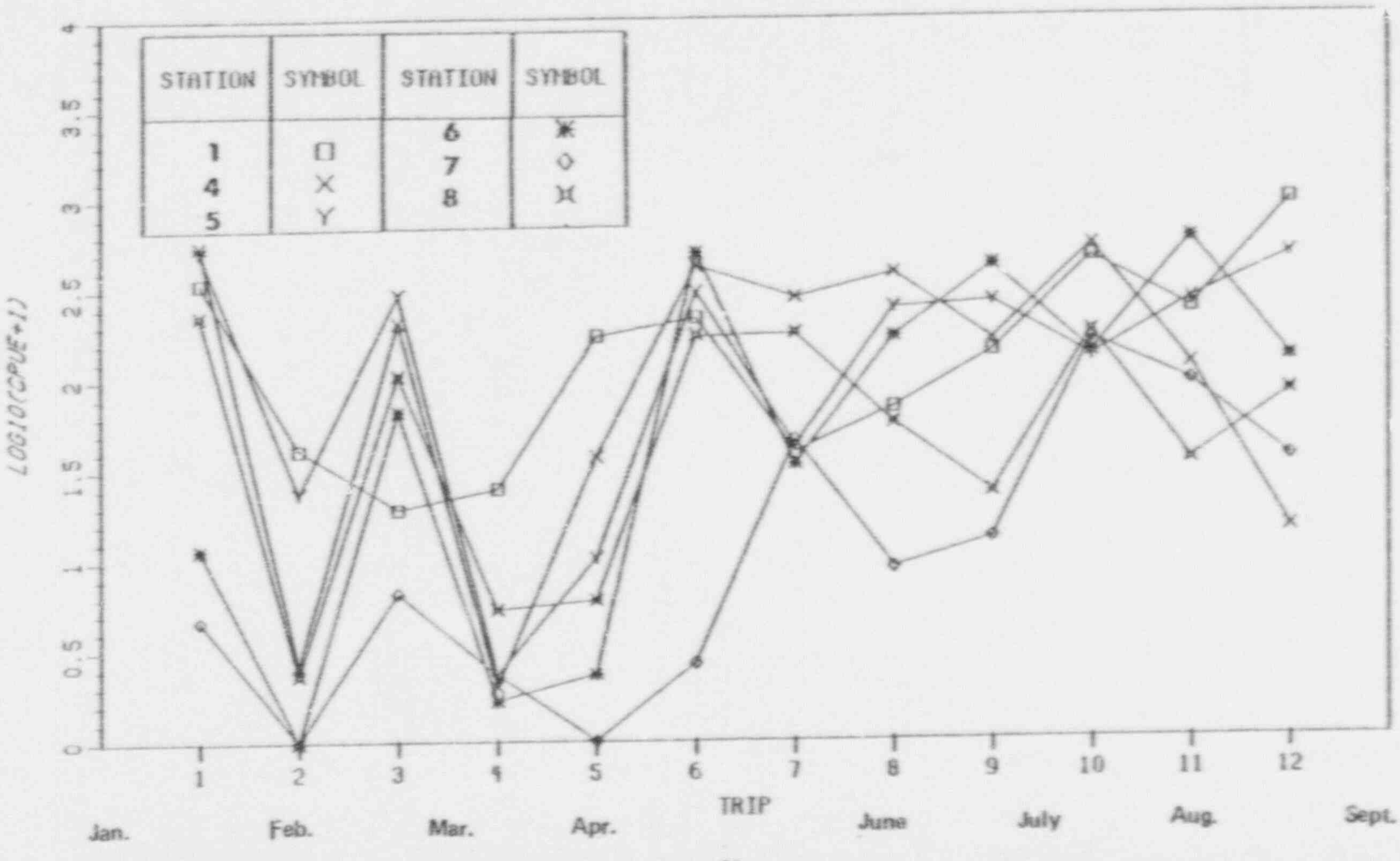


FIGURE 4.15 RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, SMALL TRAWLS SPECIES = CROAKER

FIGURE 4.16. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=BAY ANCHOVY



4-45

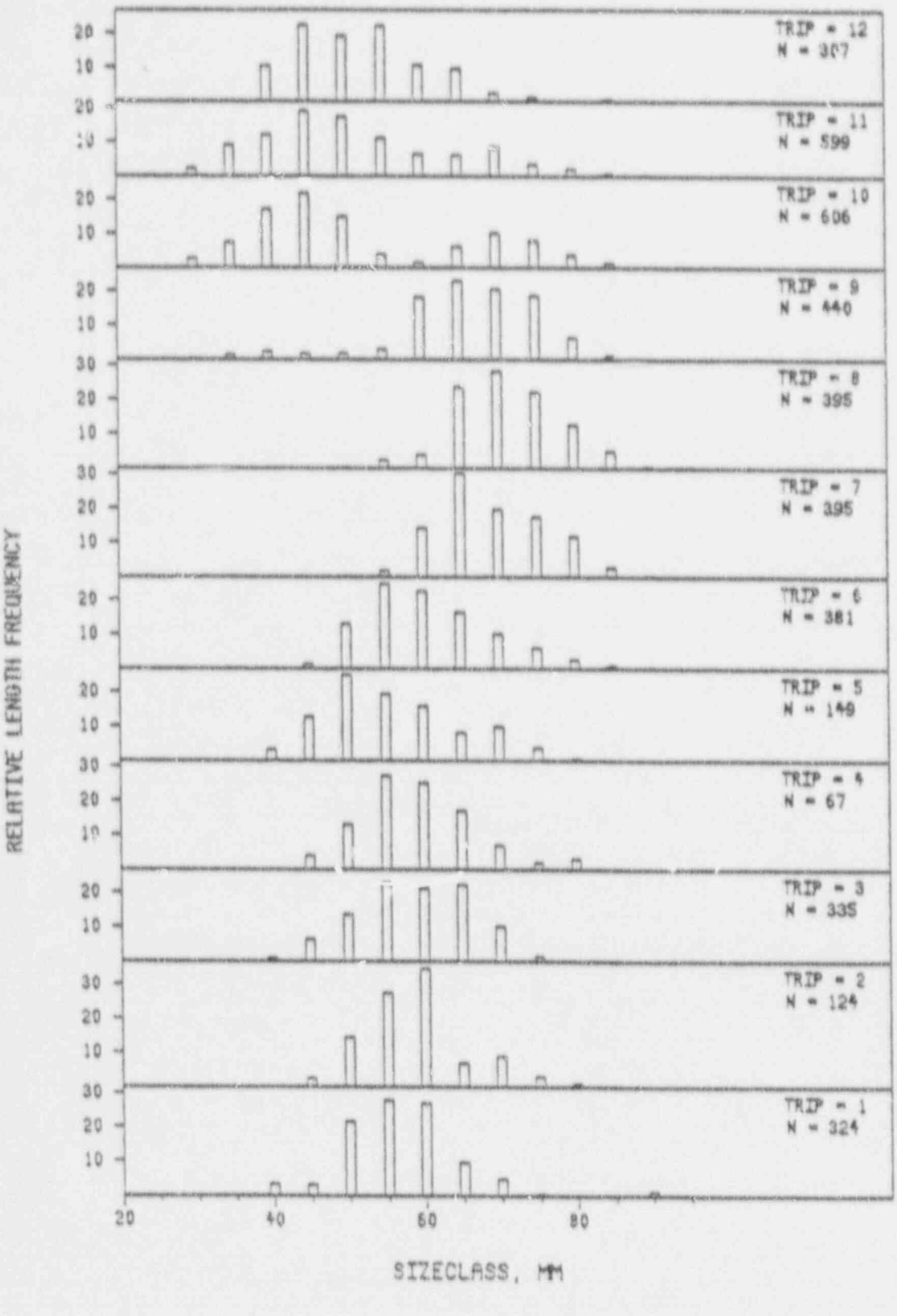


FIGURE 4.17 RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, SMALL TRAWLS SPECIES = BAY ANCHOVY

FIGURE 4.18. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION
FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979
SPECIES=MENHADEN AGE=JUVENILE & ADULT

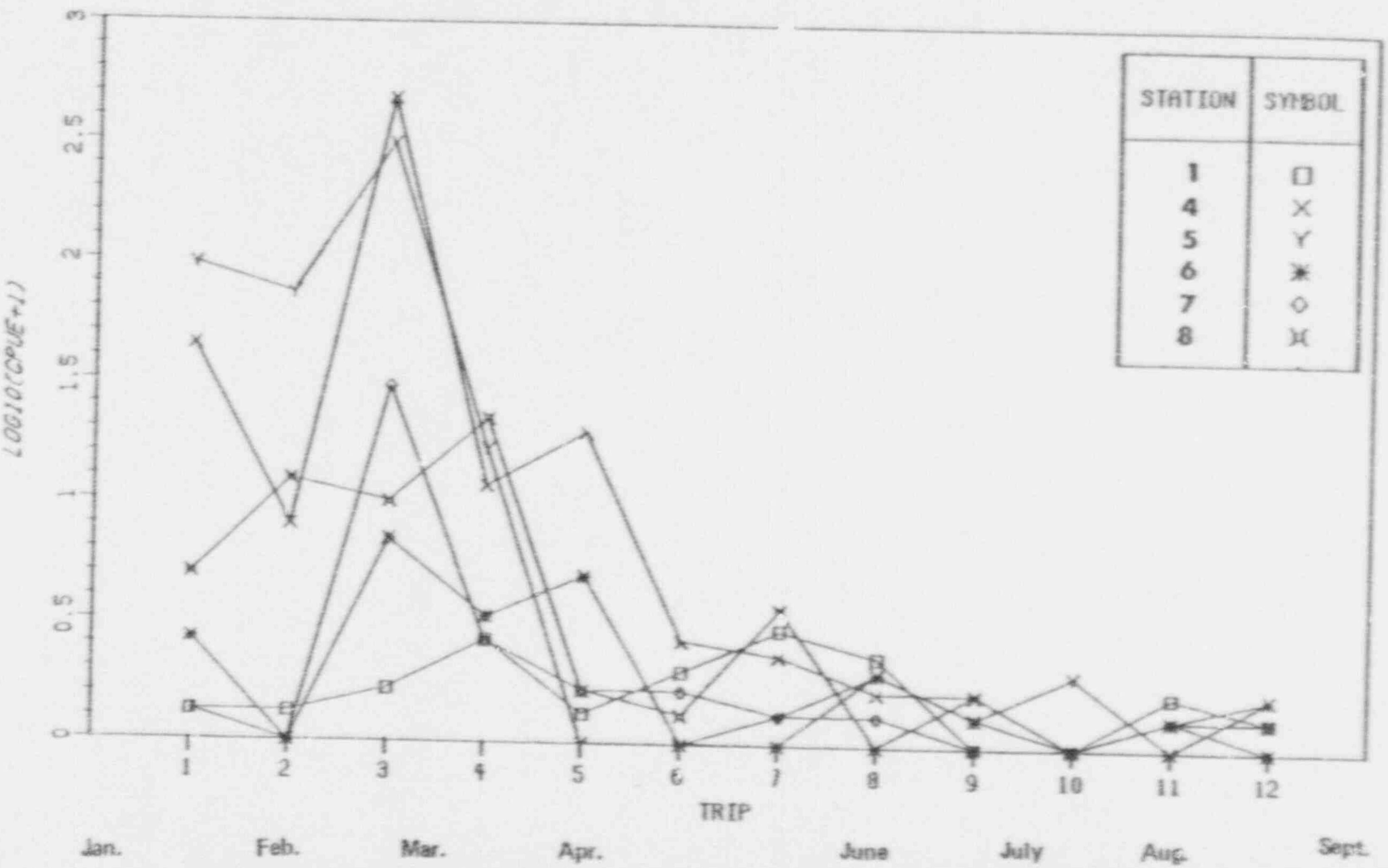


FIGURE 4.19. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=MENHADEN AGE=JUVENILE & ADULT

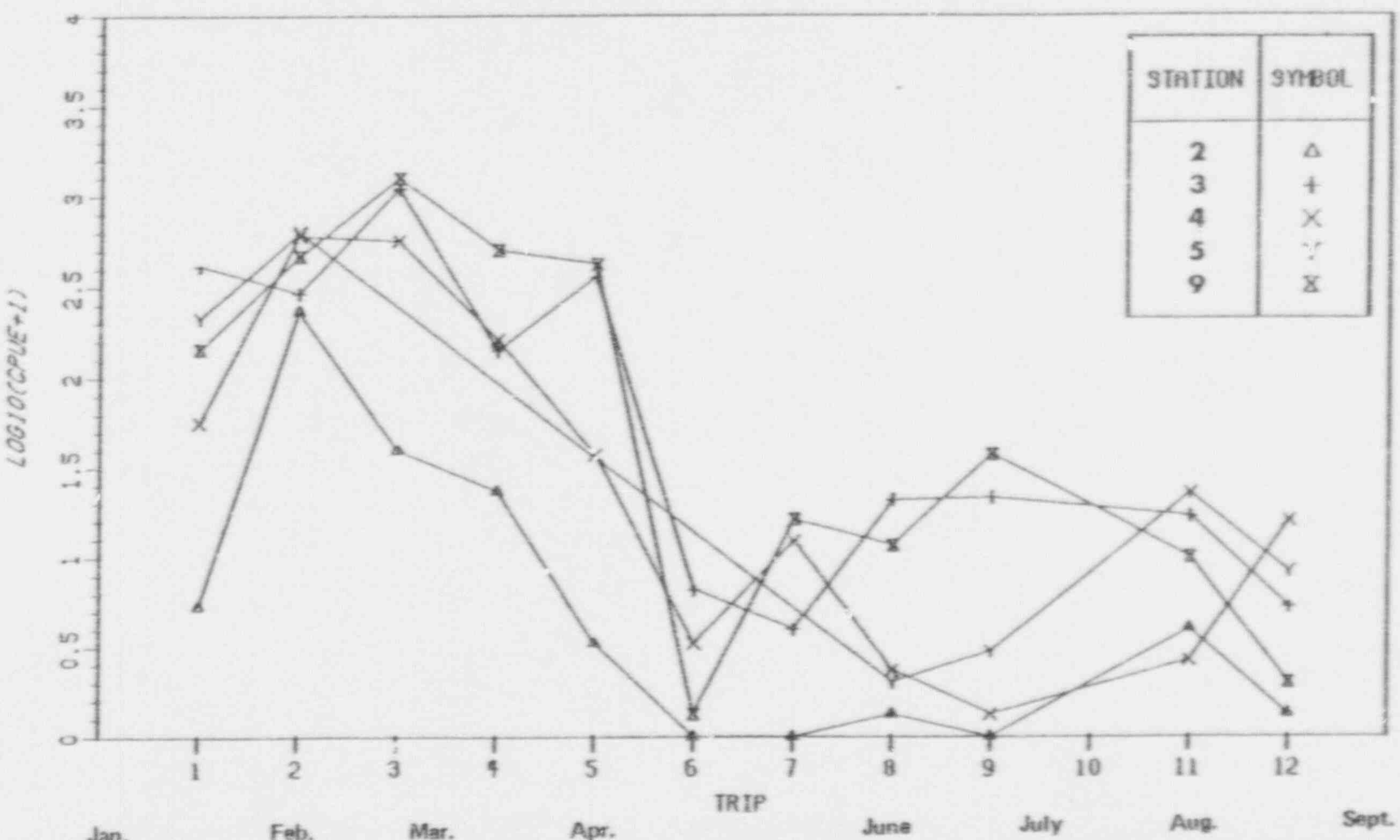


FIGURE 4.20. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION
FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979
SPECIES=MENHADEN AGE=YOUNG OF YEAR

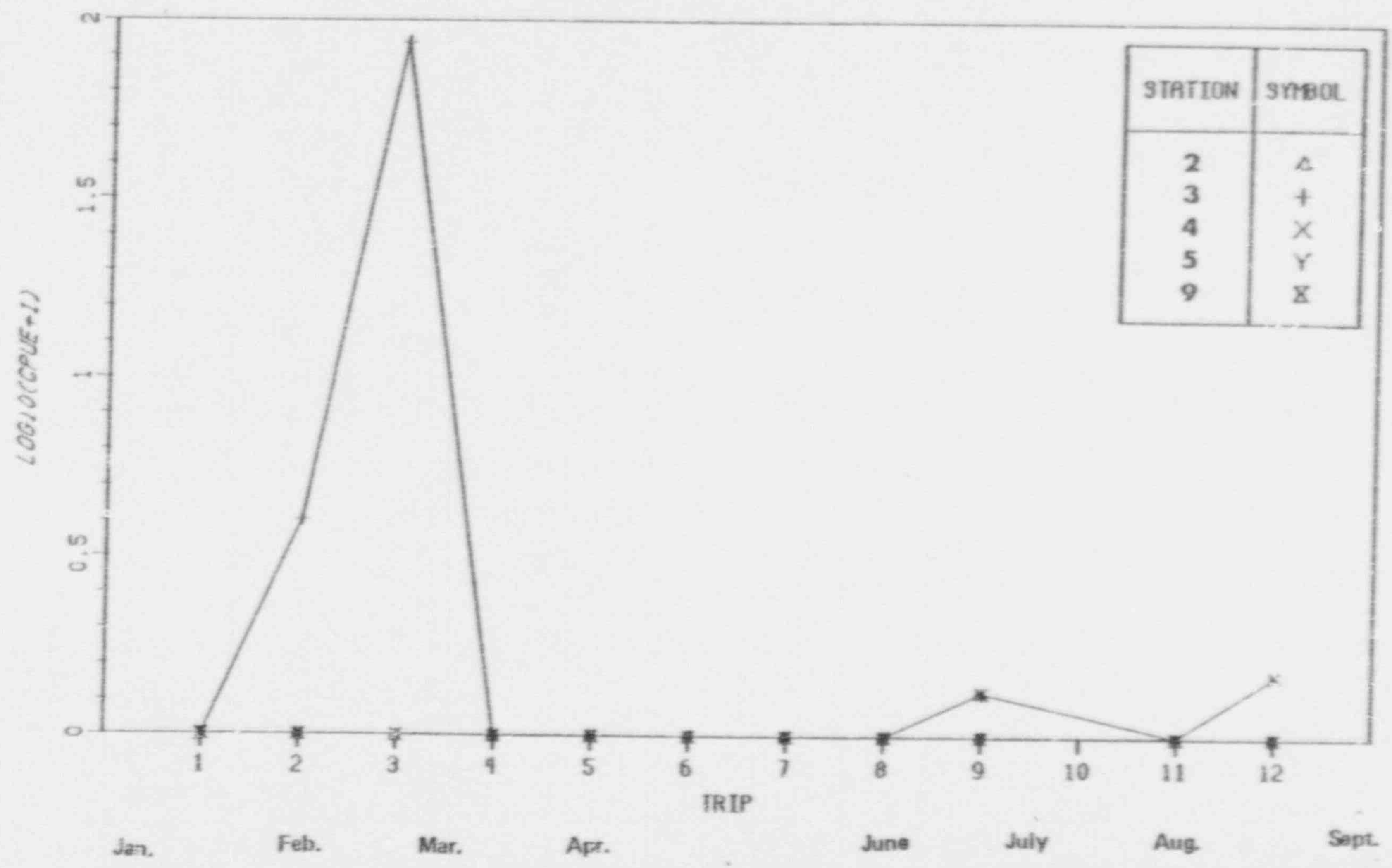
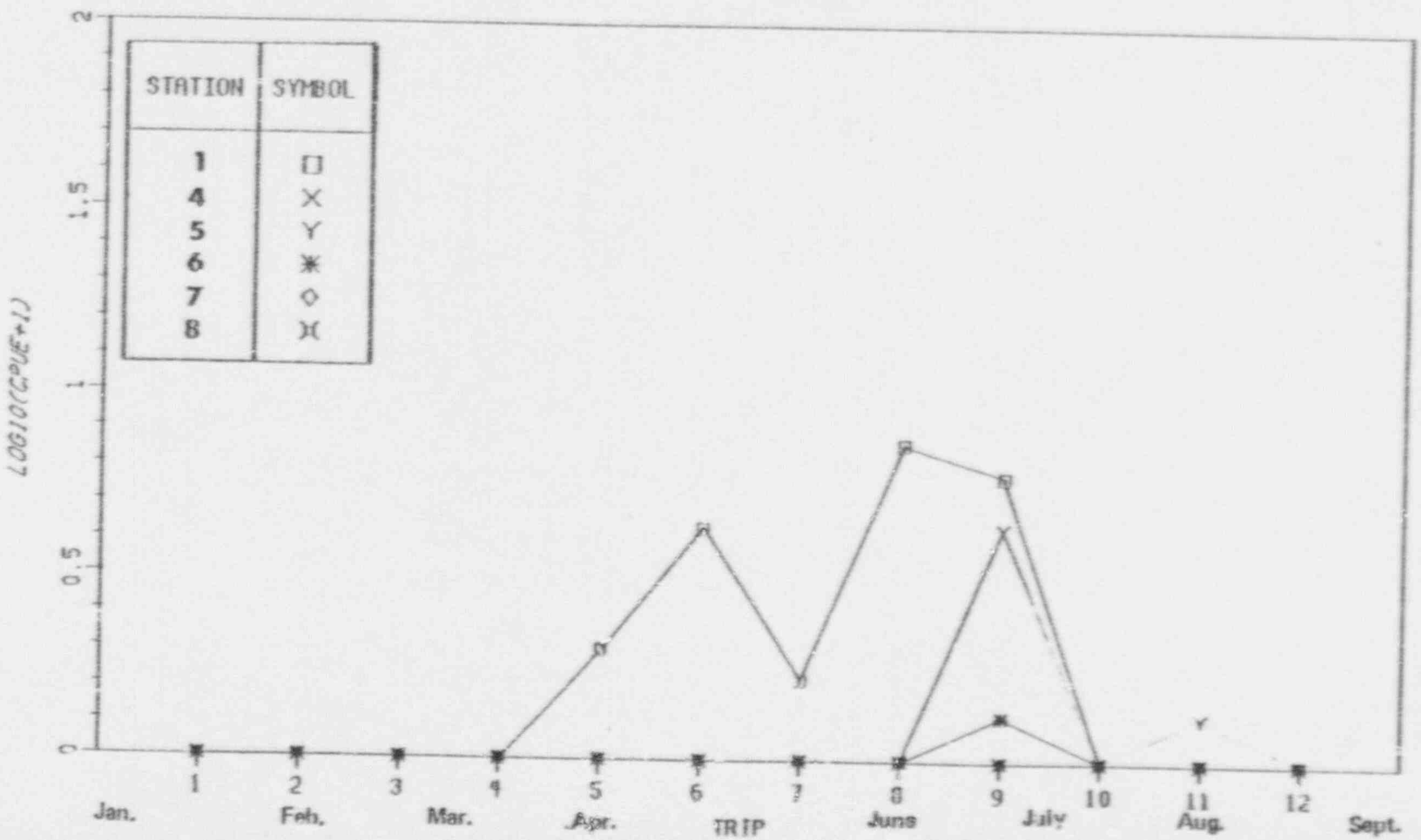


FIGURE 4.21. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES-MENHADEN AGE-YOUNG OF YEAR



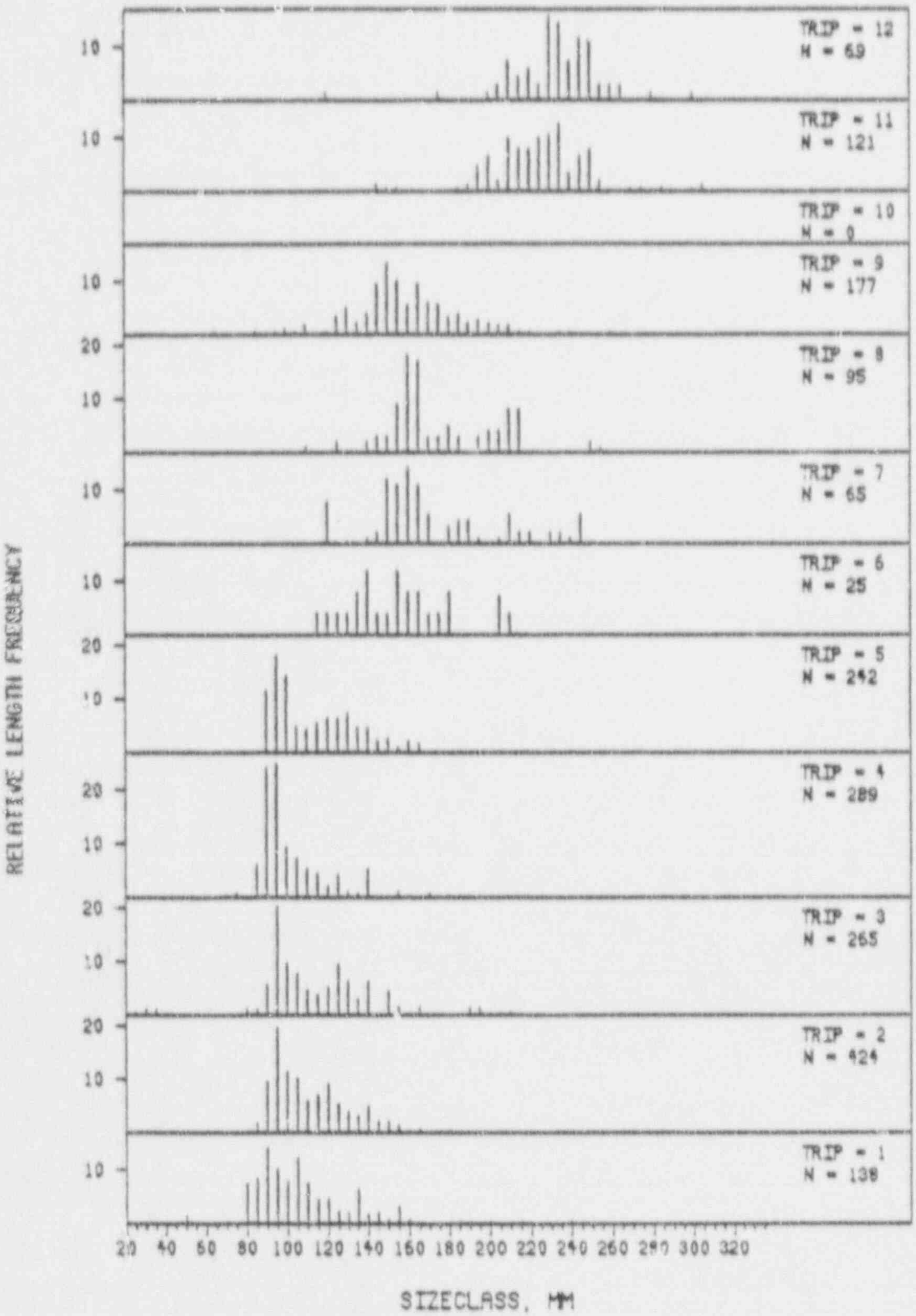


FIGURE 4.22 RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, LARGE TRAWLS SPECIES = MENHADEN

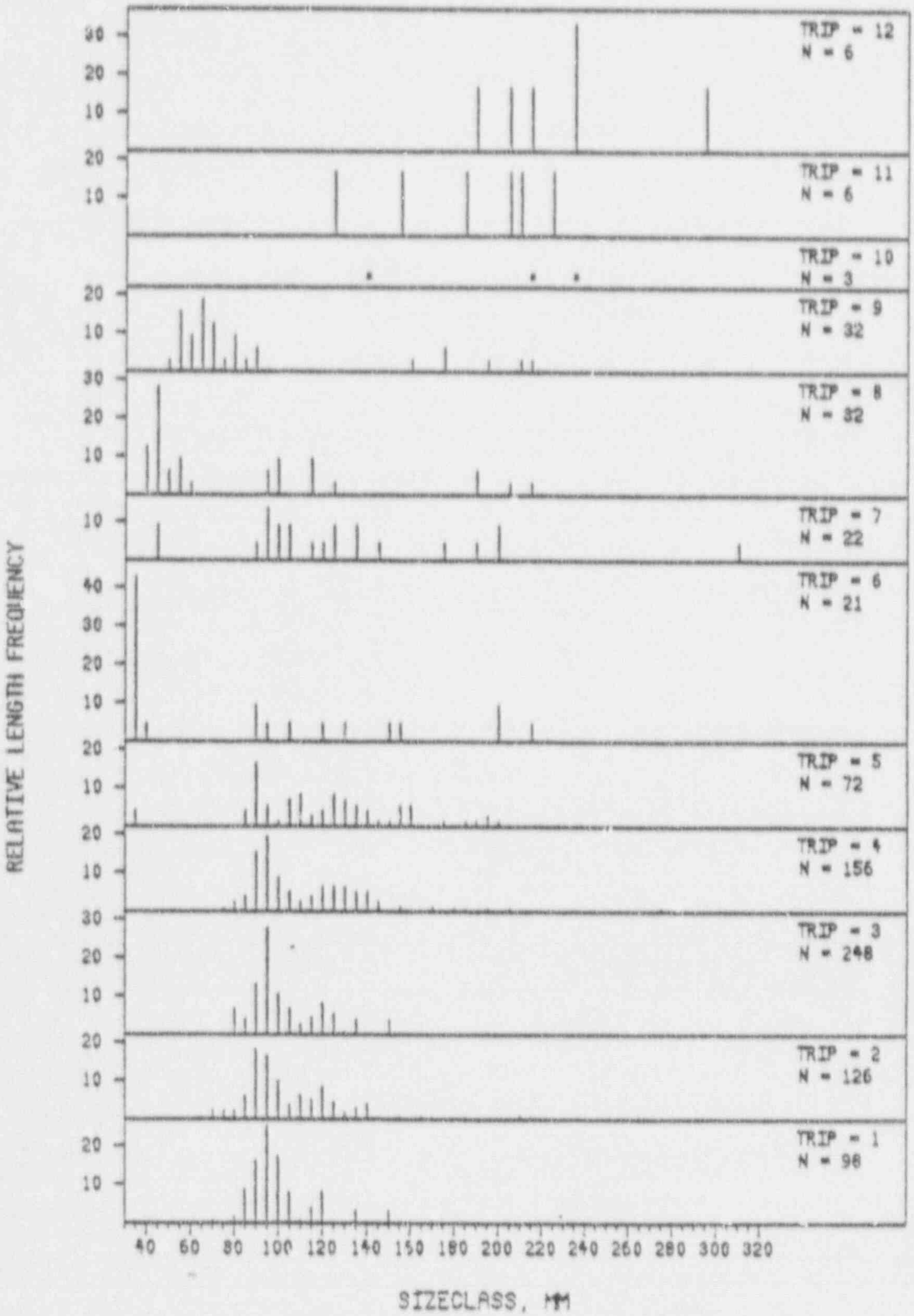


FIGURE 4.23 RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN–AUG 1979, SMALL TRAWLS SPECIES = MENHADEN

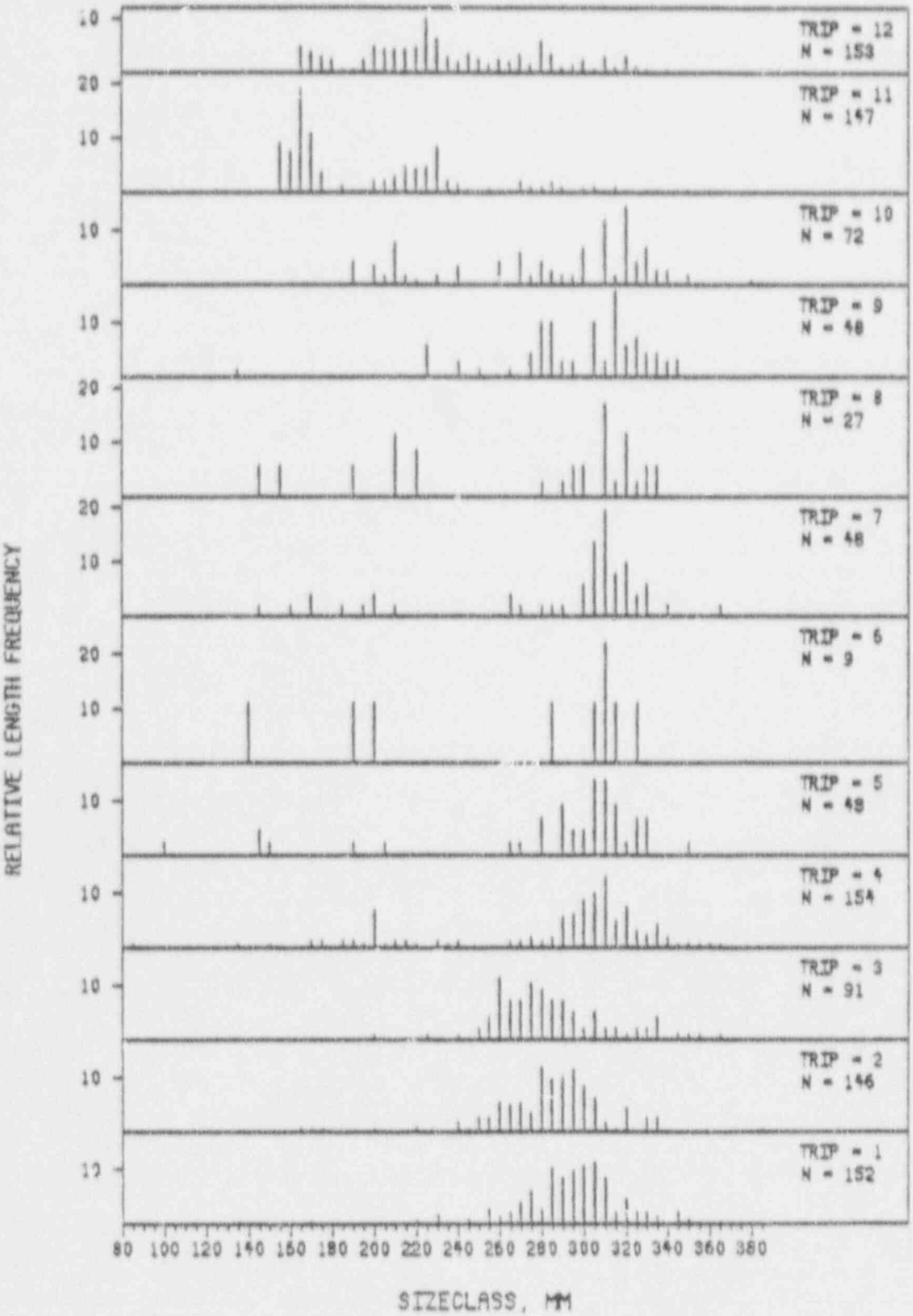


FIGURE 4.24. RFLATIVE LENGTH FREQUENCY BY SAMPLING TRIP
..R NEKTON STUDY, JAN-AUG 1979, GILL NETS
SPECIES = MENHADEN

FIGURE 4.25. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=WEAKFISH AGE=YOUNG OF YEAR

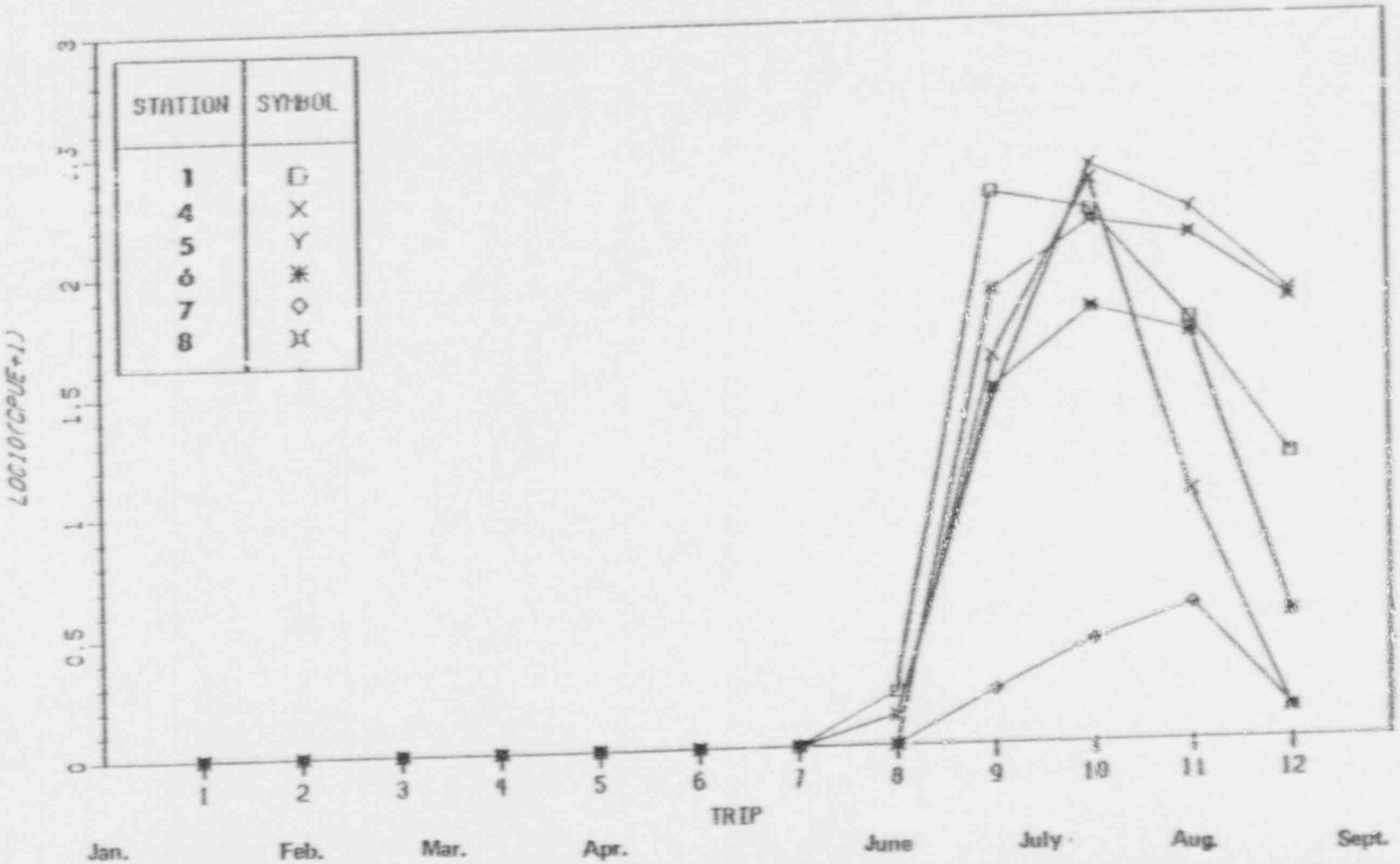


FIGURE 4.26. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=WEAKFISH AGE=YOUNG OF YEAR

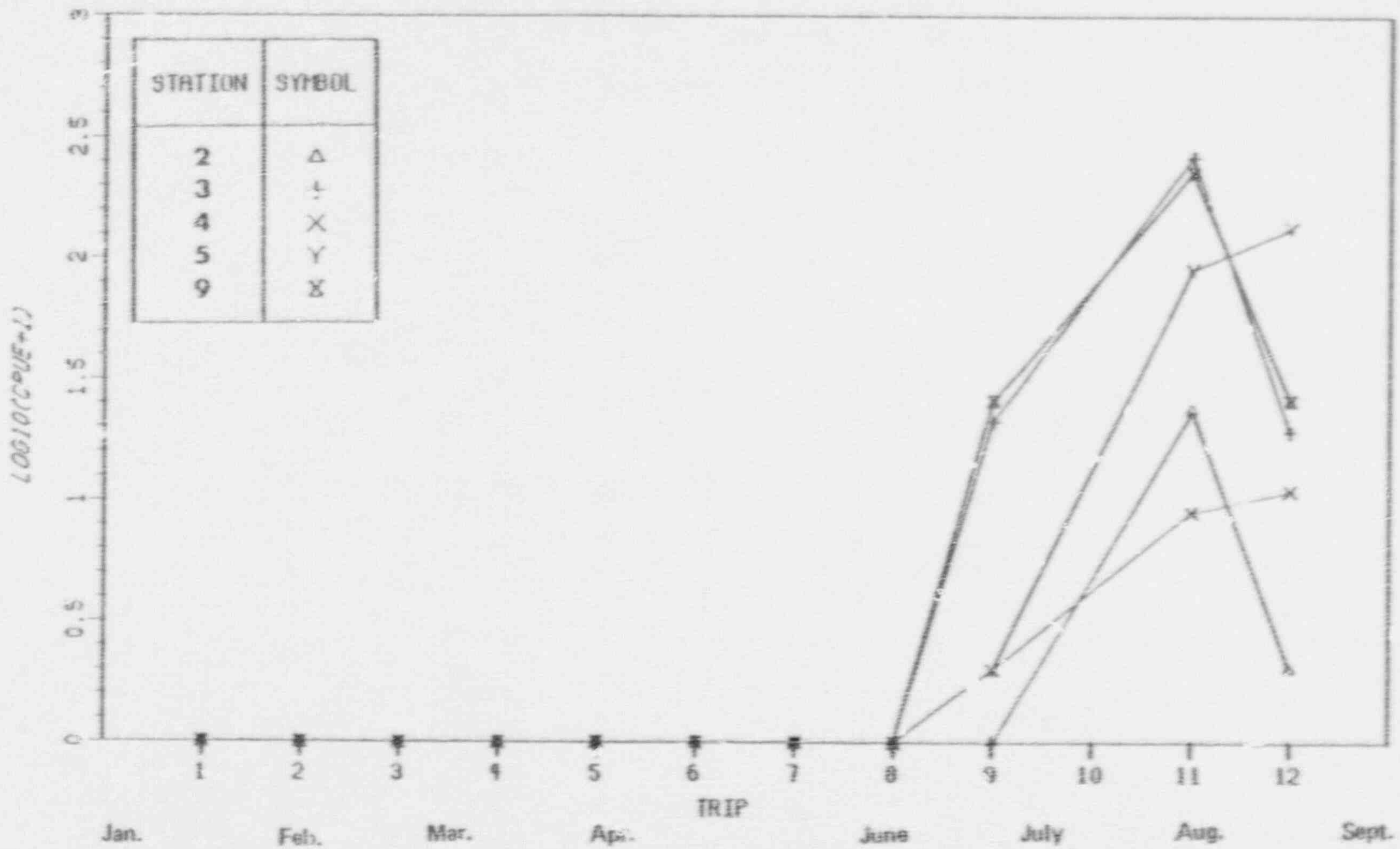


FIGURE 4.27. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=WEAKFISH AGE=JUVENILE & ADULT

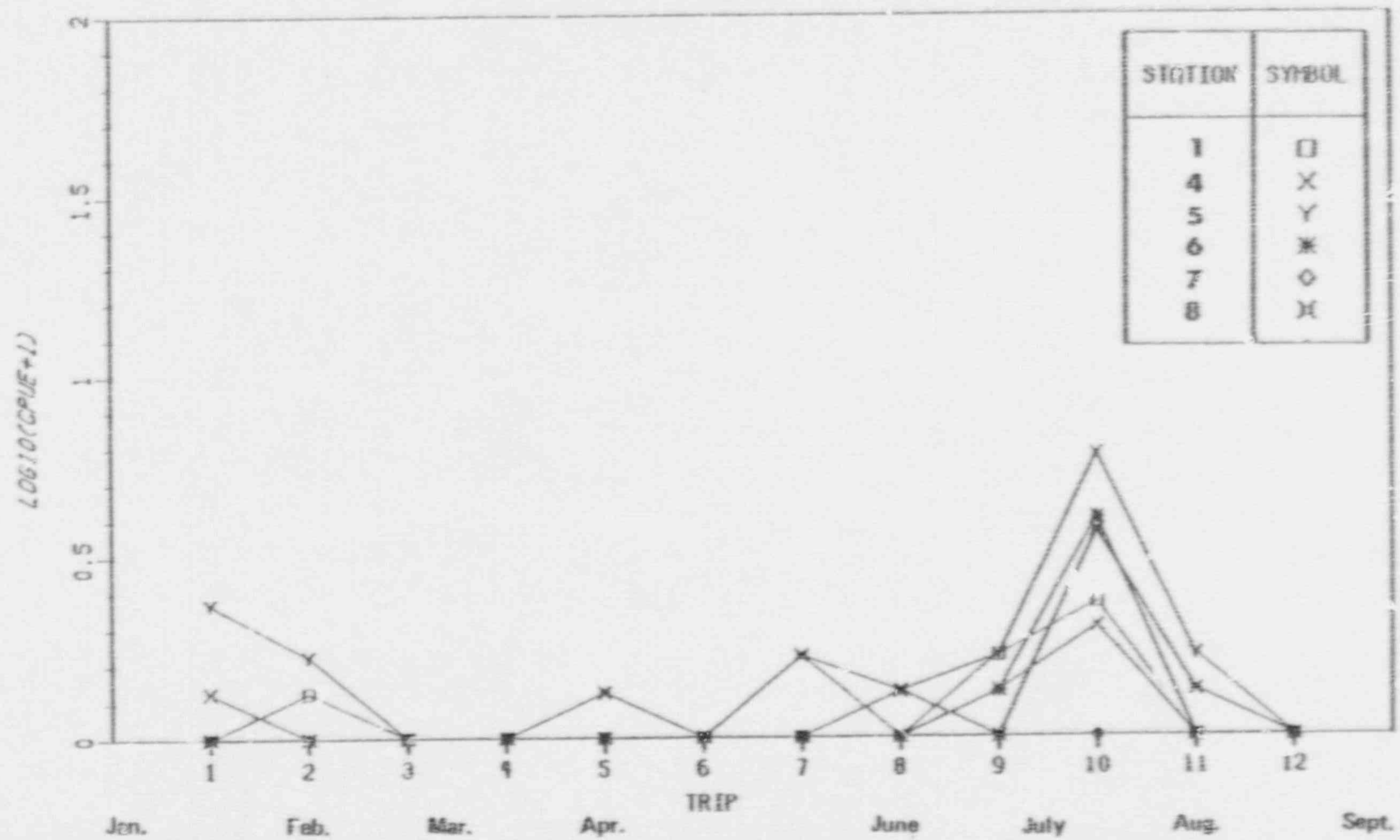
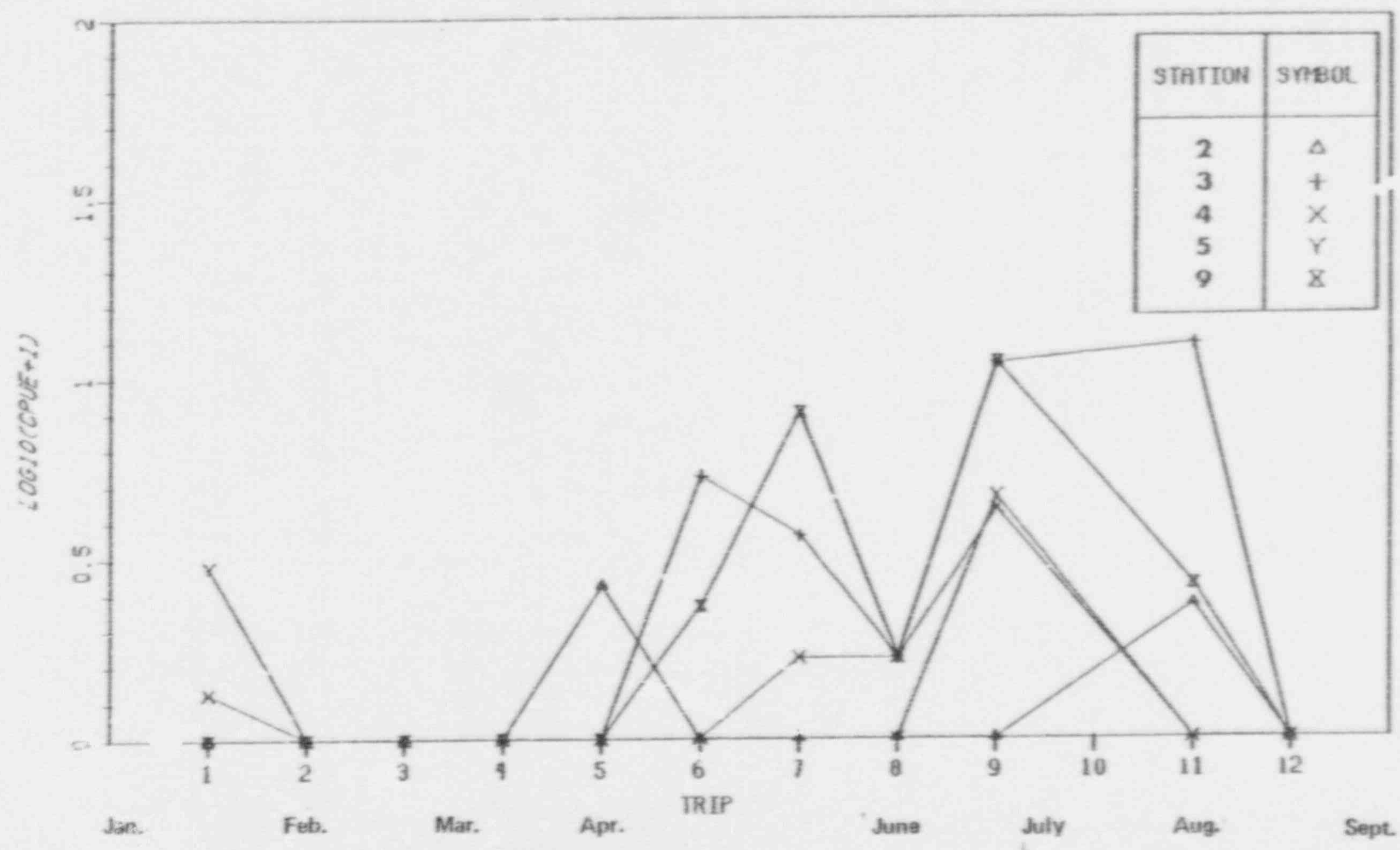


FIGURE 4.28. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=WEAKFISH AGE=JUVENILE & ADULT



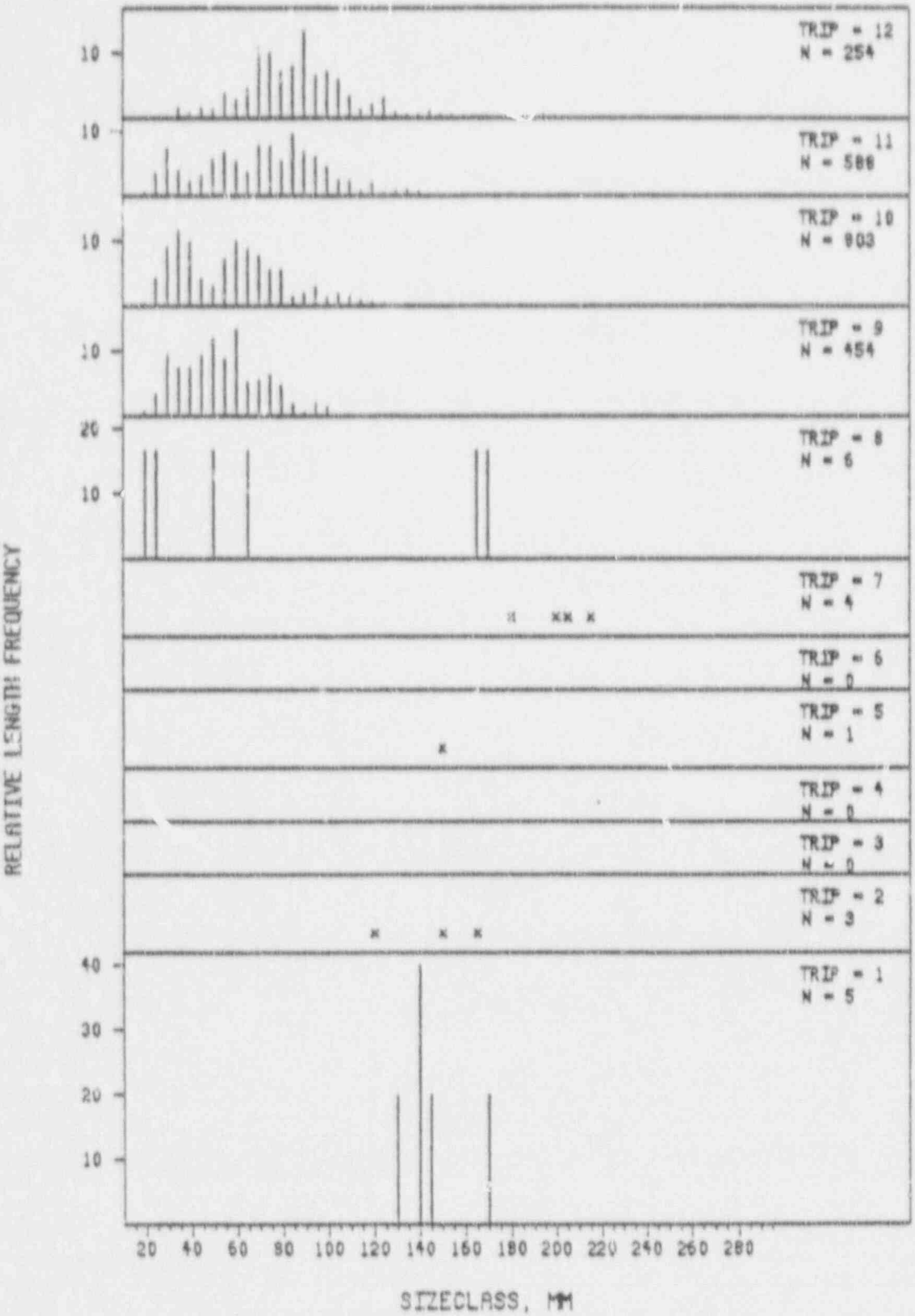


FIGURE 4.29. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, SMALL TRAWLS SPECIES = WEAKFISH

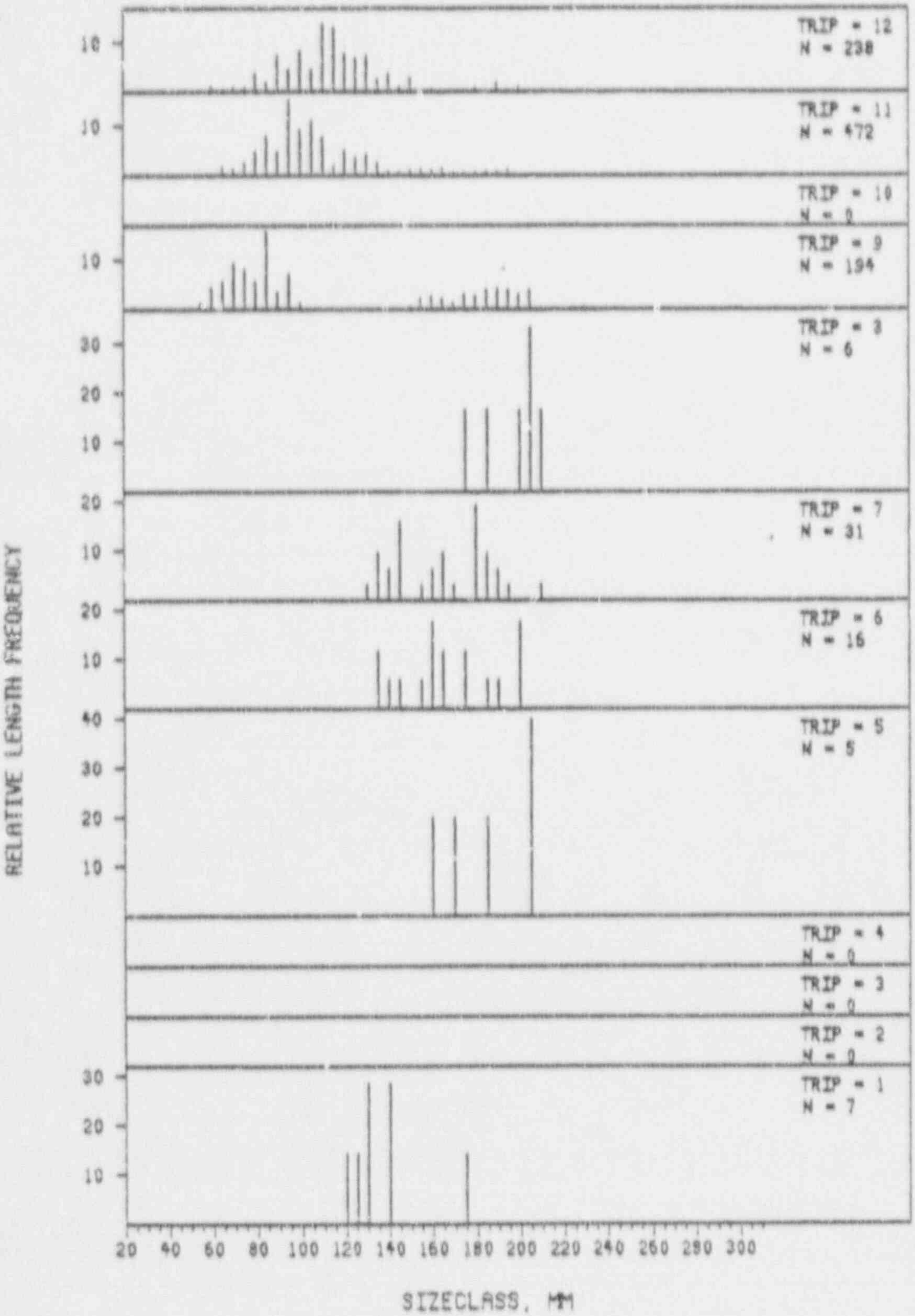


FIGURE 4.30. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, LARGE TRAWLS SPECIES = WEAKFISH

FIGURE 4.31. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION
FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979
SPECIES=SPOTTED SEATROUT

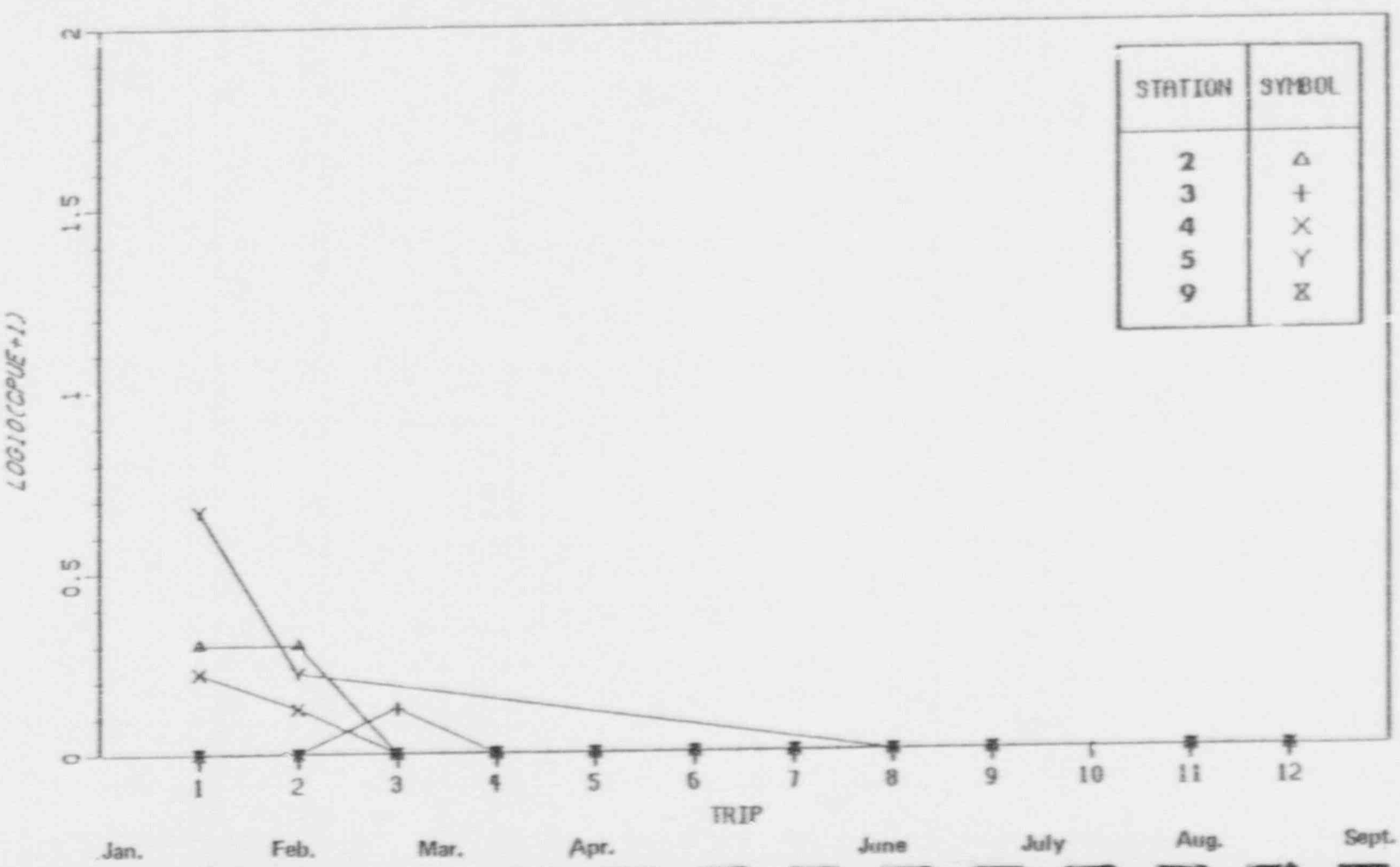
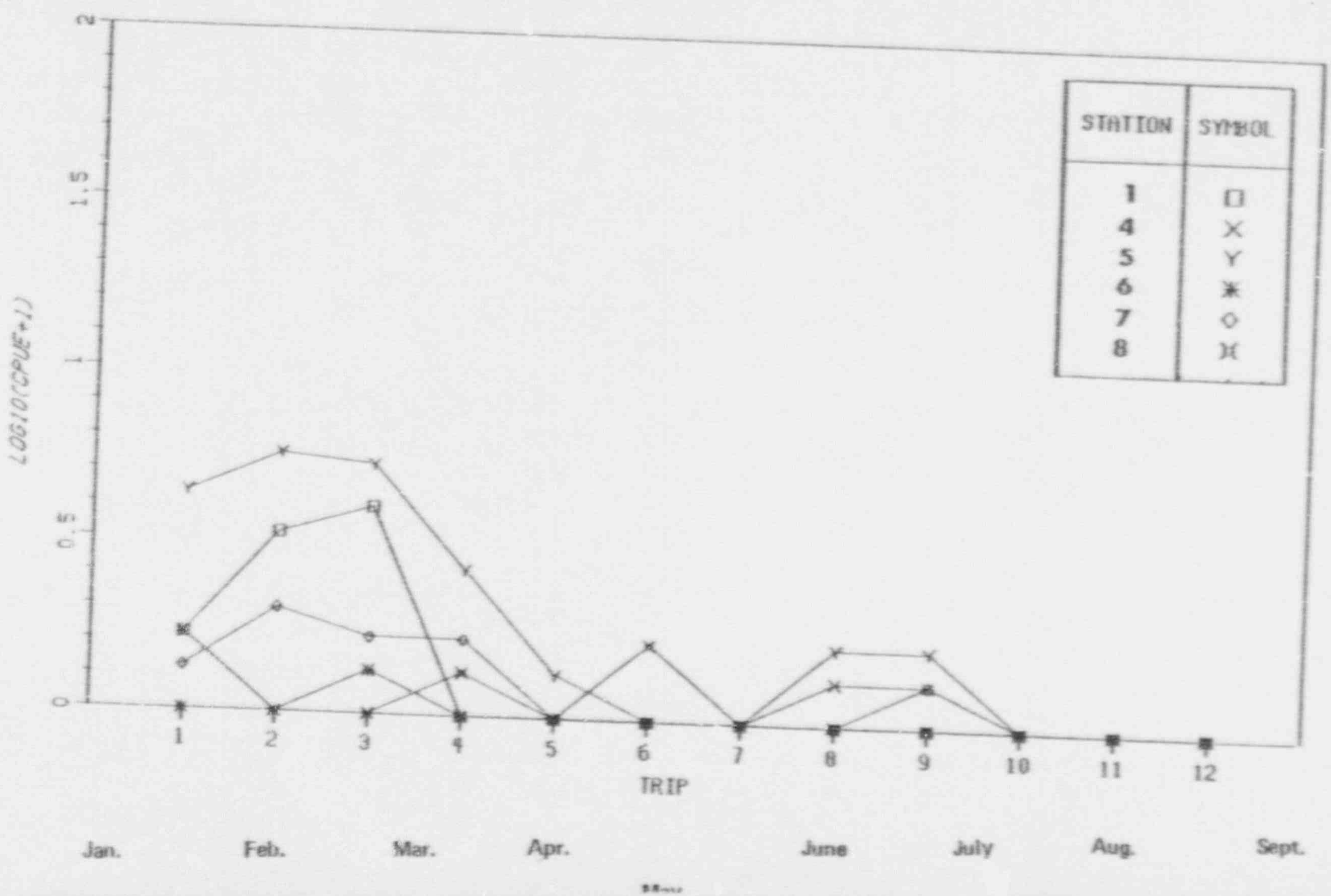


FIGURE 4.32 . AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=SPOTTED SEATROUT



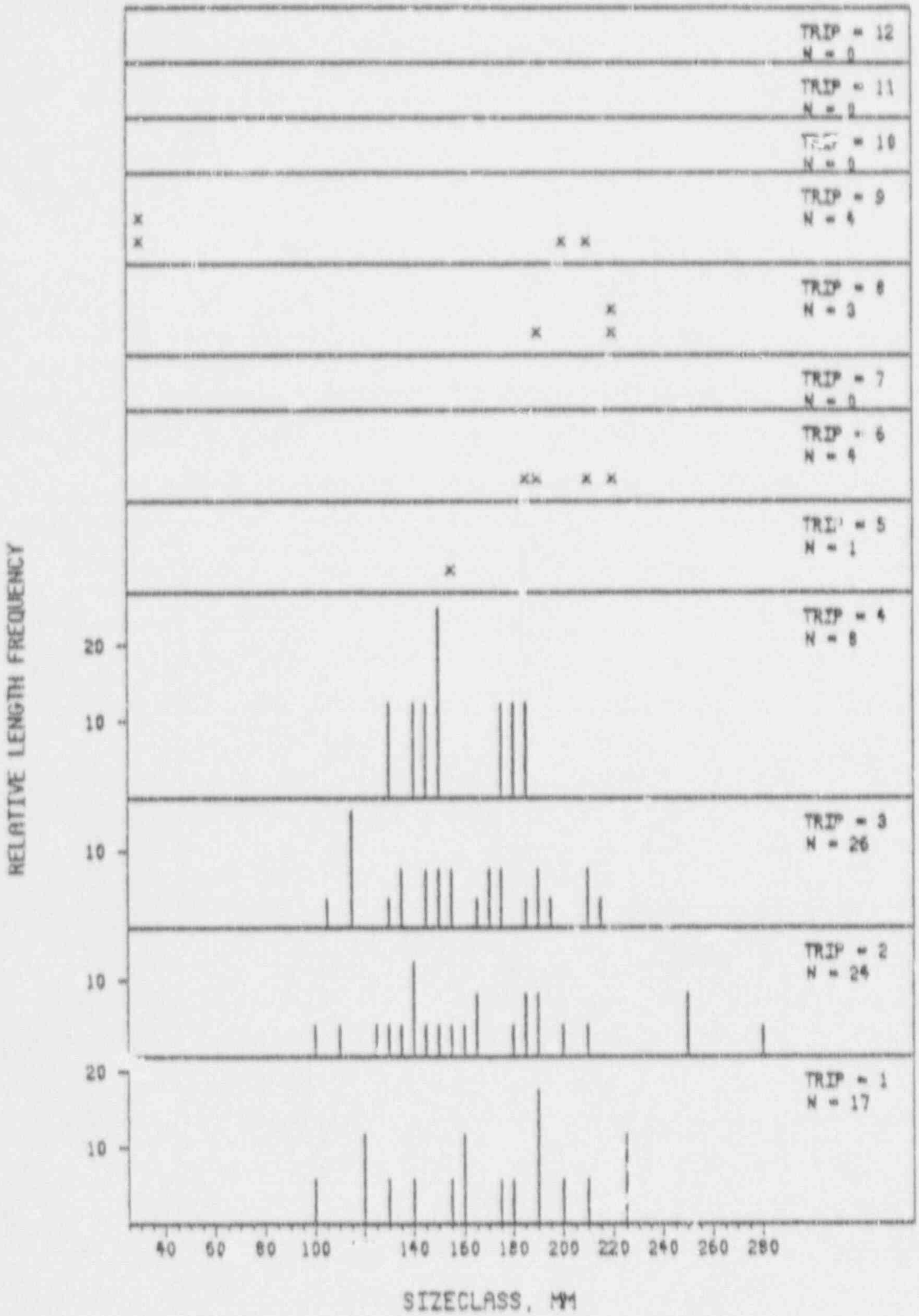


FIGURE 4.33. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, SMALL TRAWLS SPECIES = SPOTTED SEATROUT

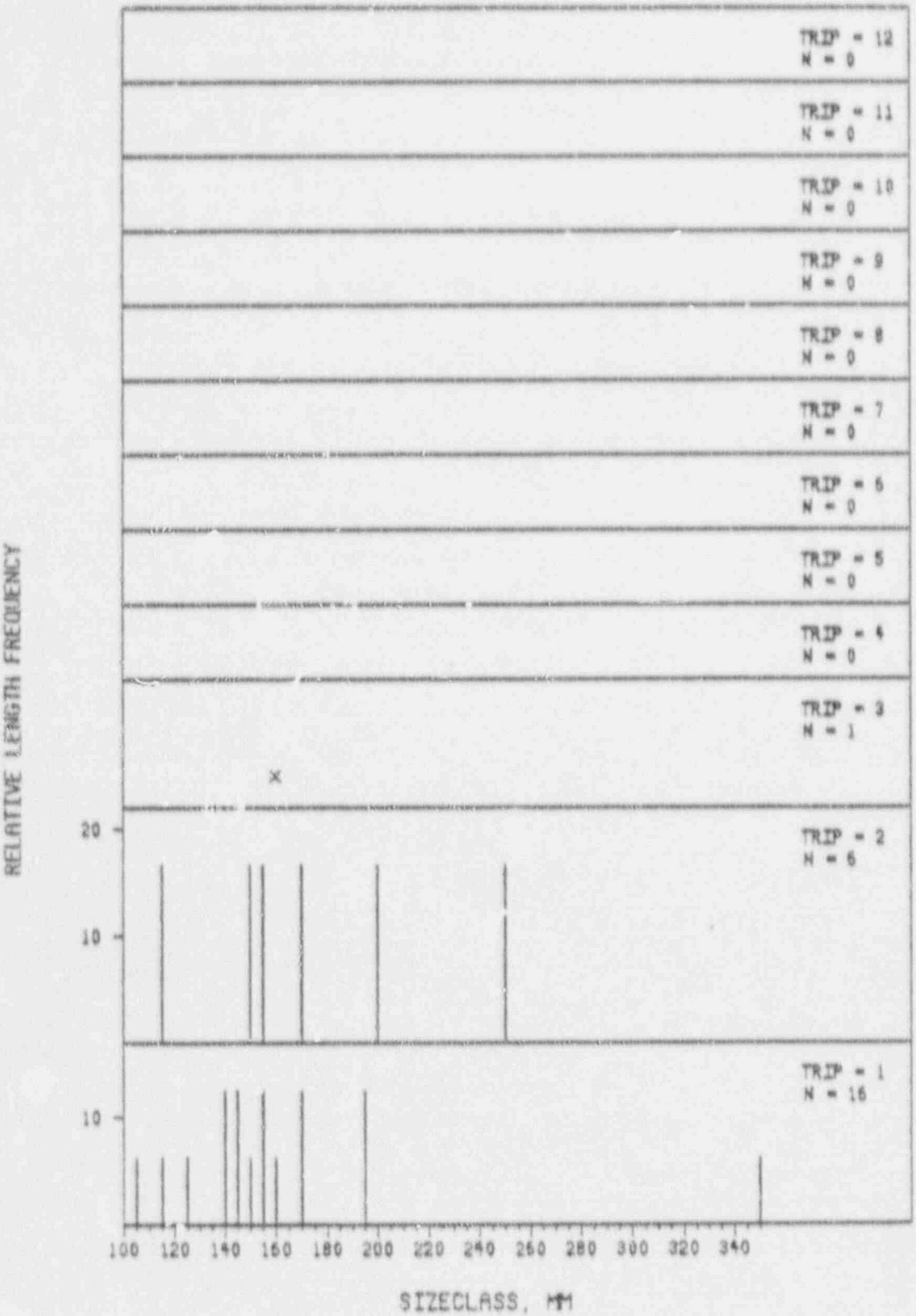
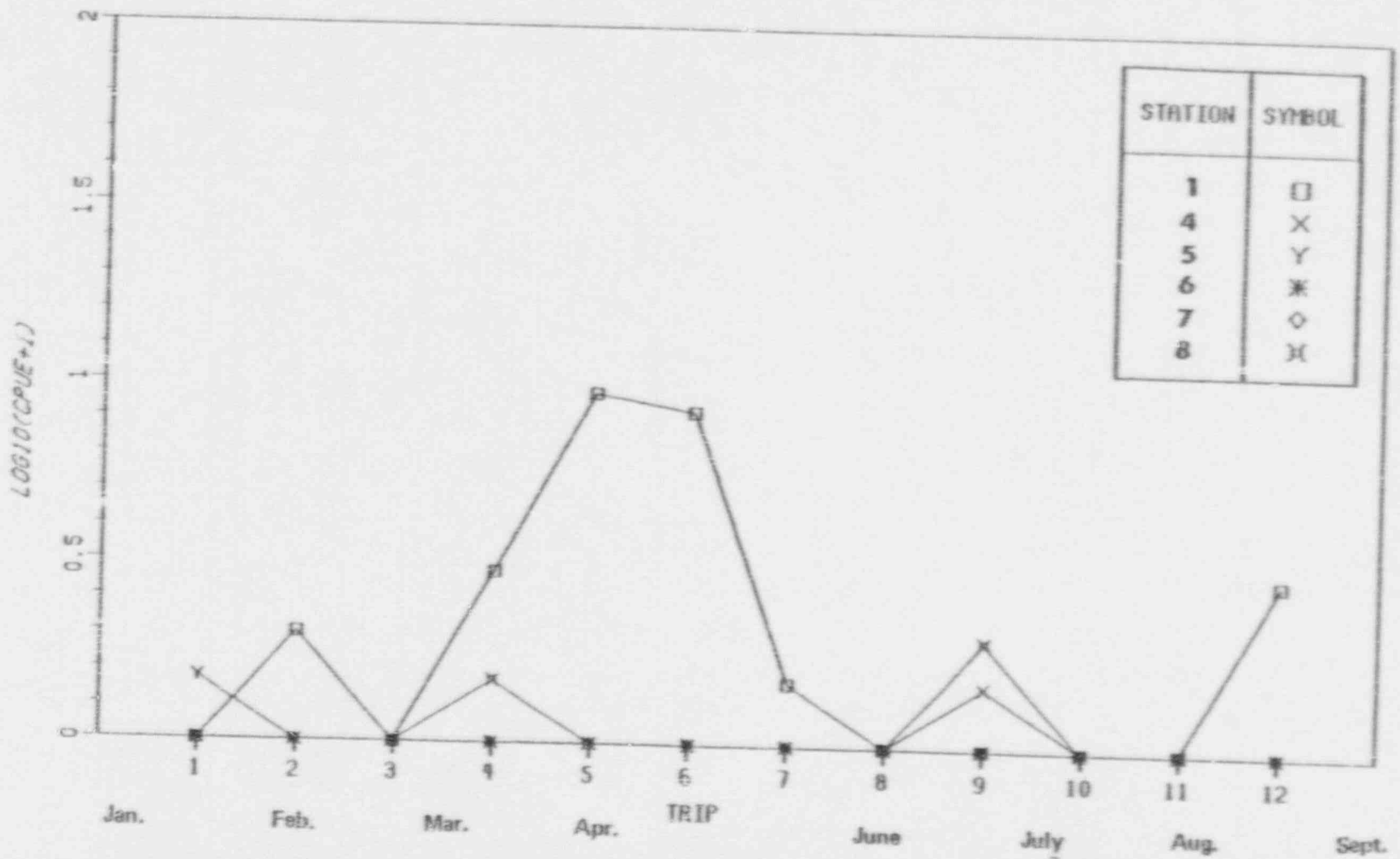


FIGURE 4.34. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN–AUG 1979, LARGE TRAWLS SPECIES = SPOTTED SEATROUT

FIGURE 4.35. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR GILL NETS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=SPOTTED SEATROUT



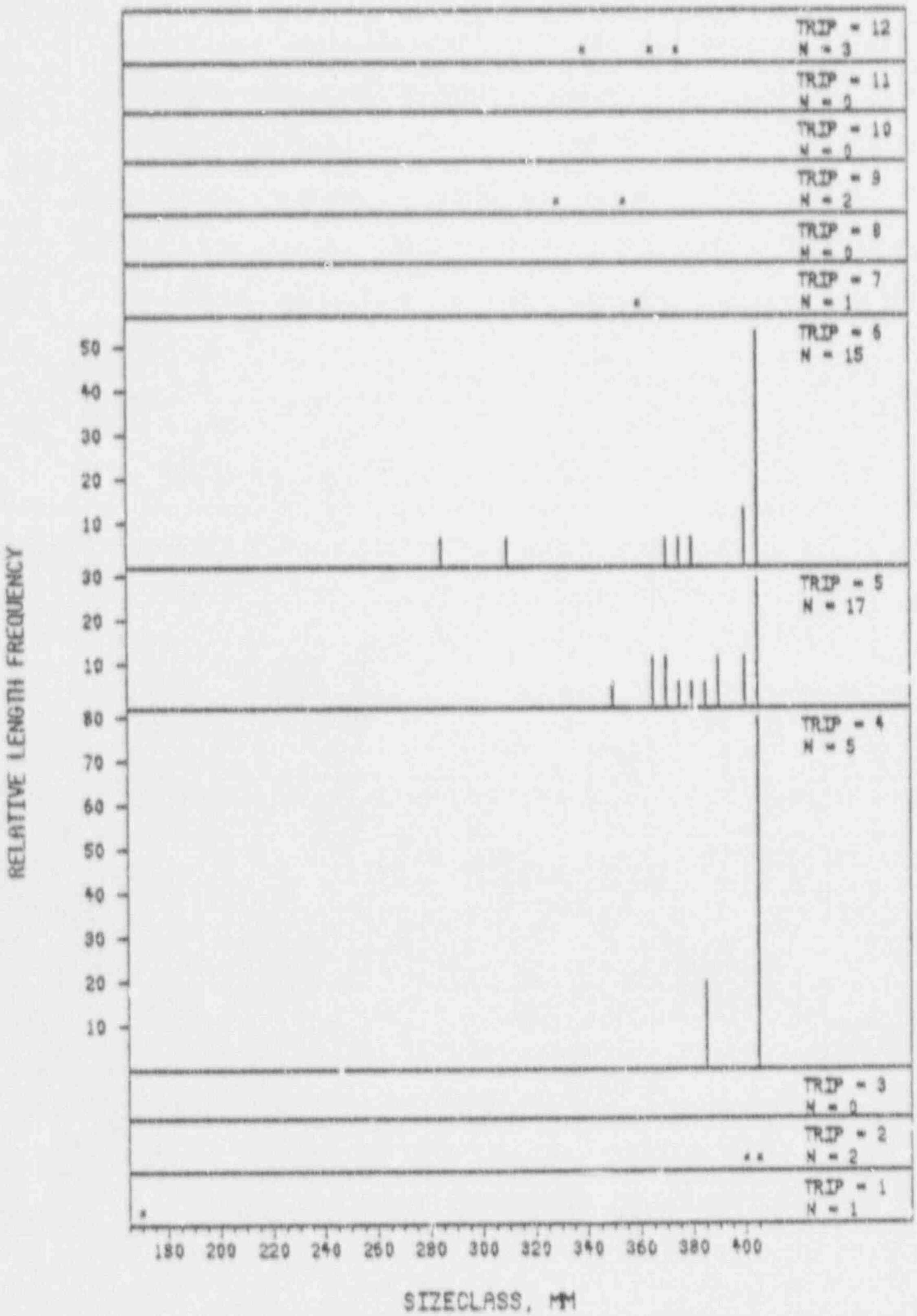


FIGURE4.36. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, GILL NETS SPECIES = SPOTTED SEATROUT

FIGURE 4.37. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=SOUTHERN FLOUNDER AGE=JUVENILE & ADULT

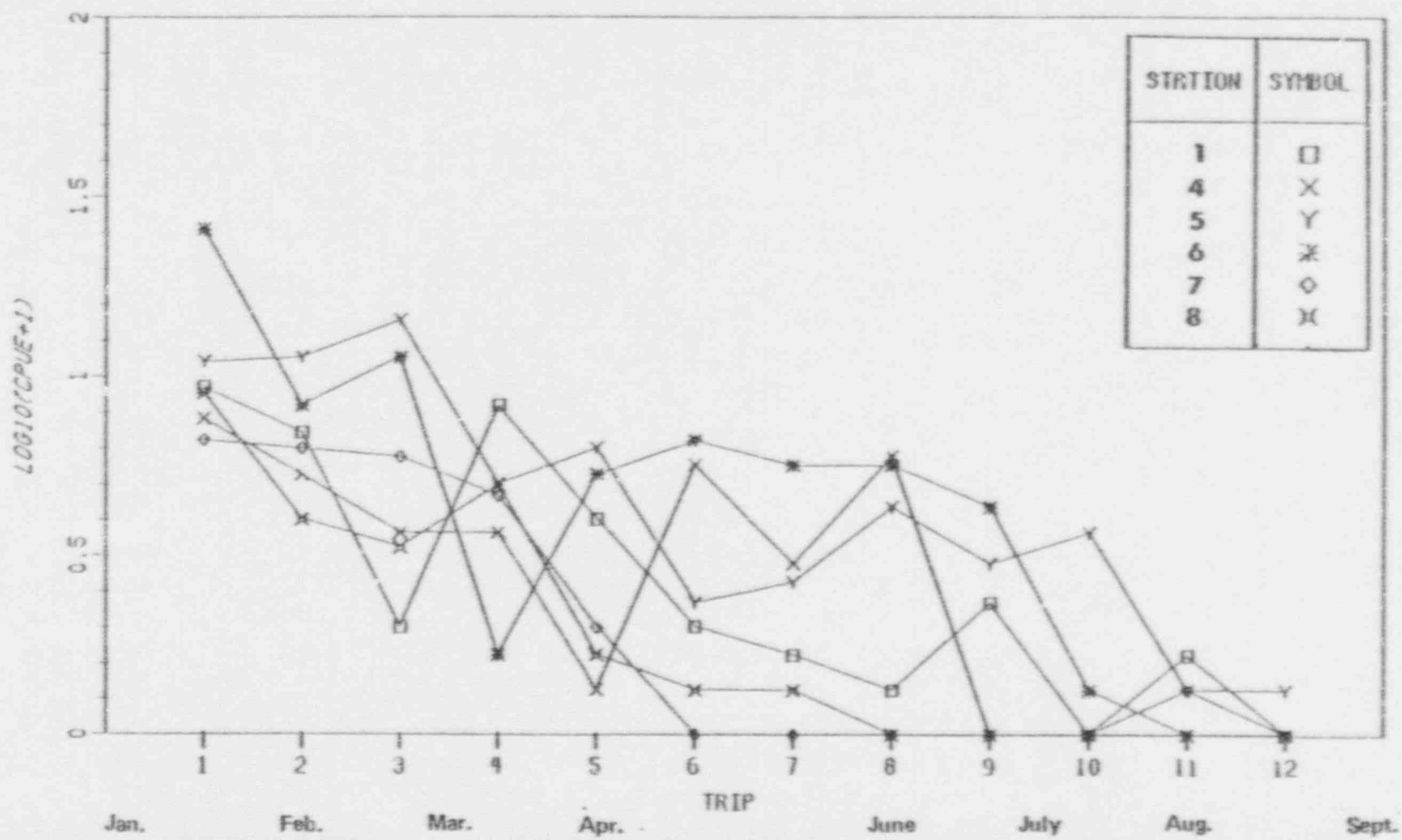
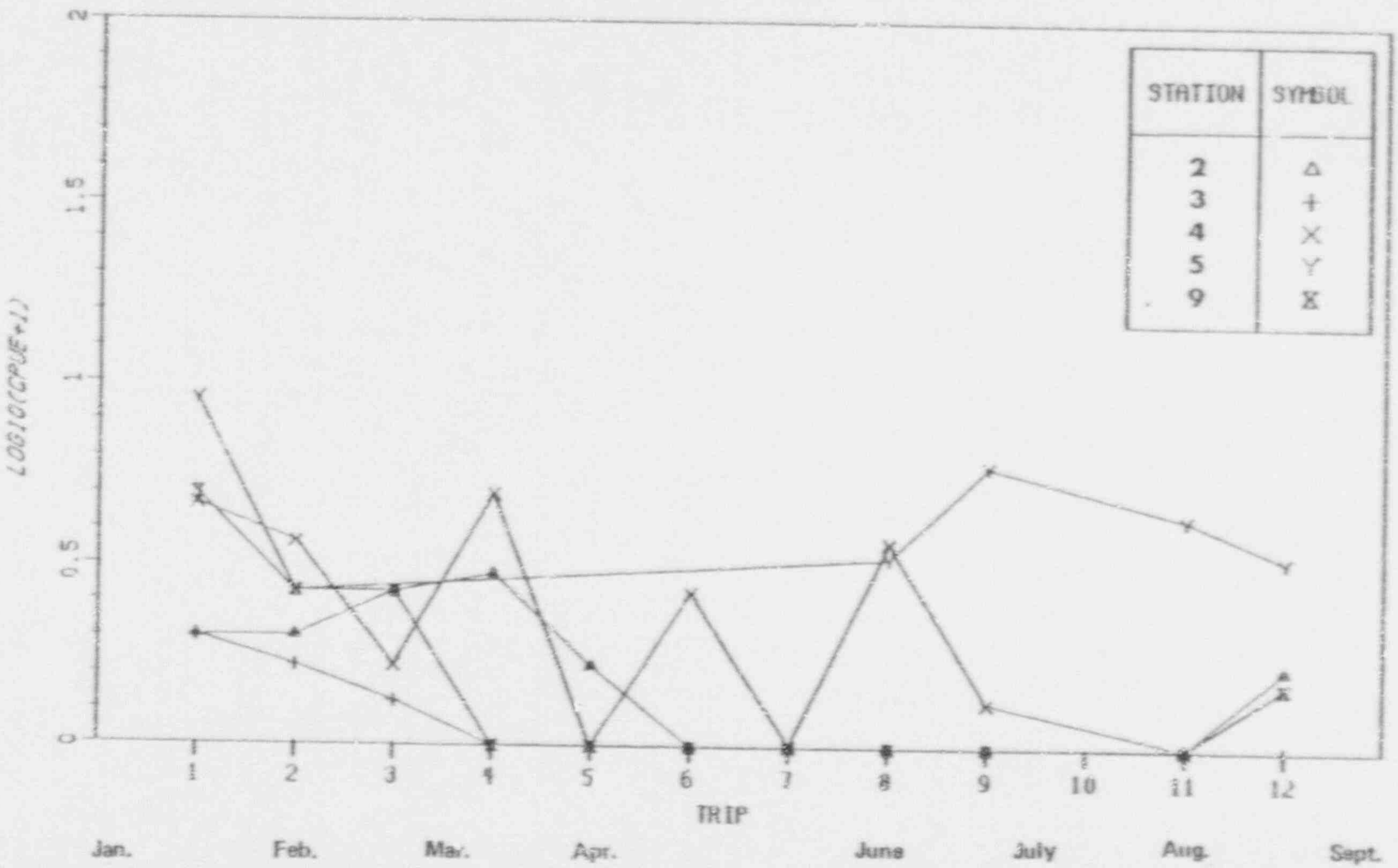


FIGURE 4.38. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979 SPECIES=SOUTHERN FLOUNDER AGE=JUVENILE & ADULT



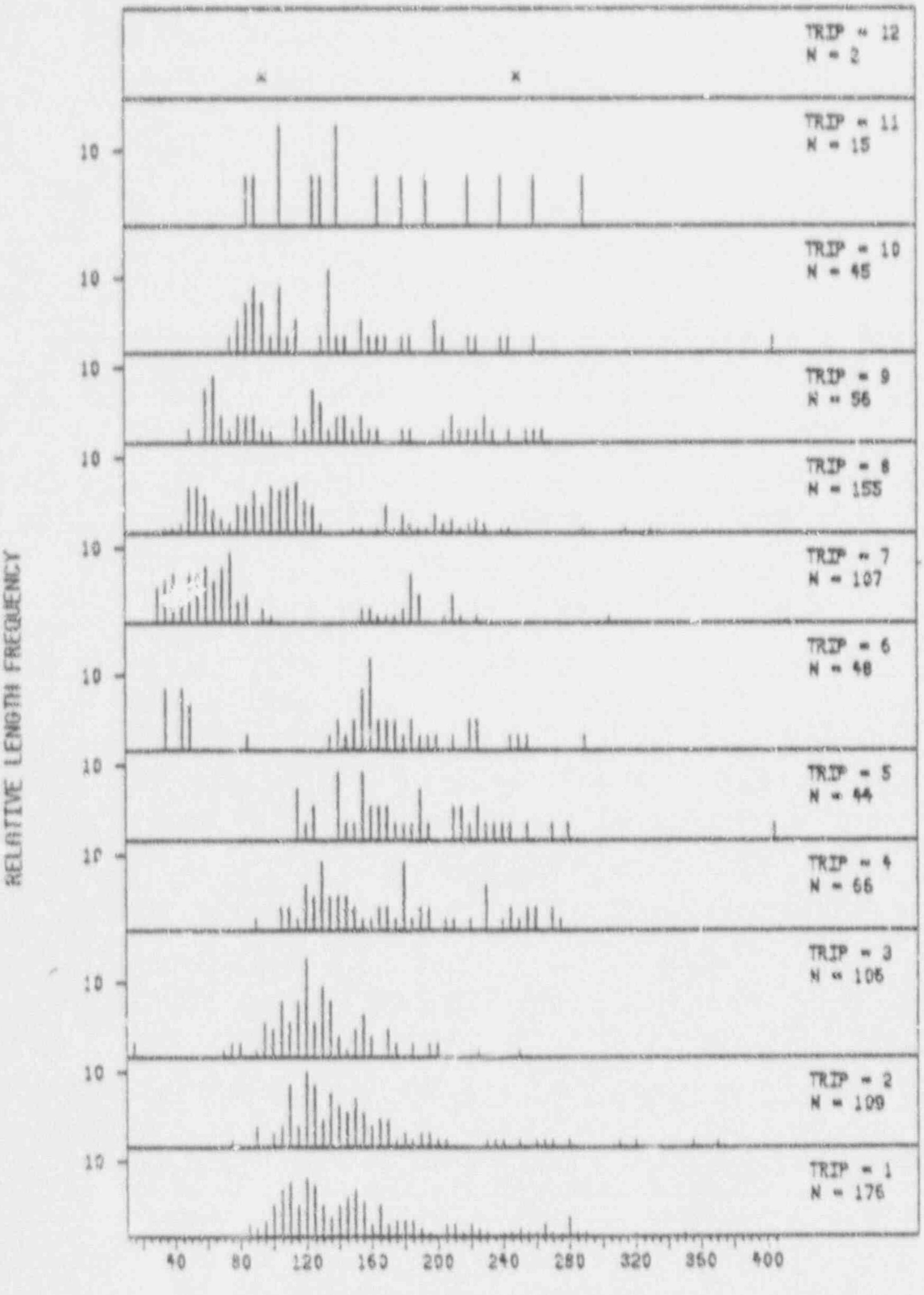


FIGURE 4.39. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN–AUG 1979, SMALL TRAWLS SPECIES = SOUTHERN FLOUNDER

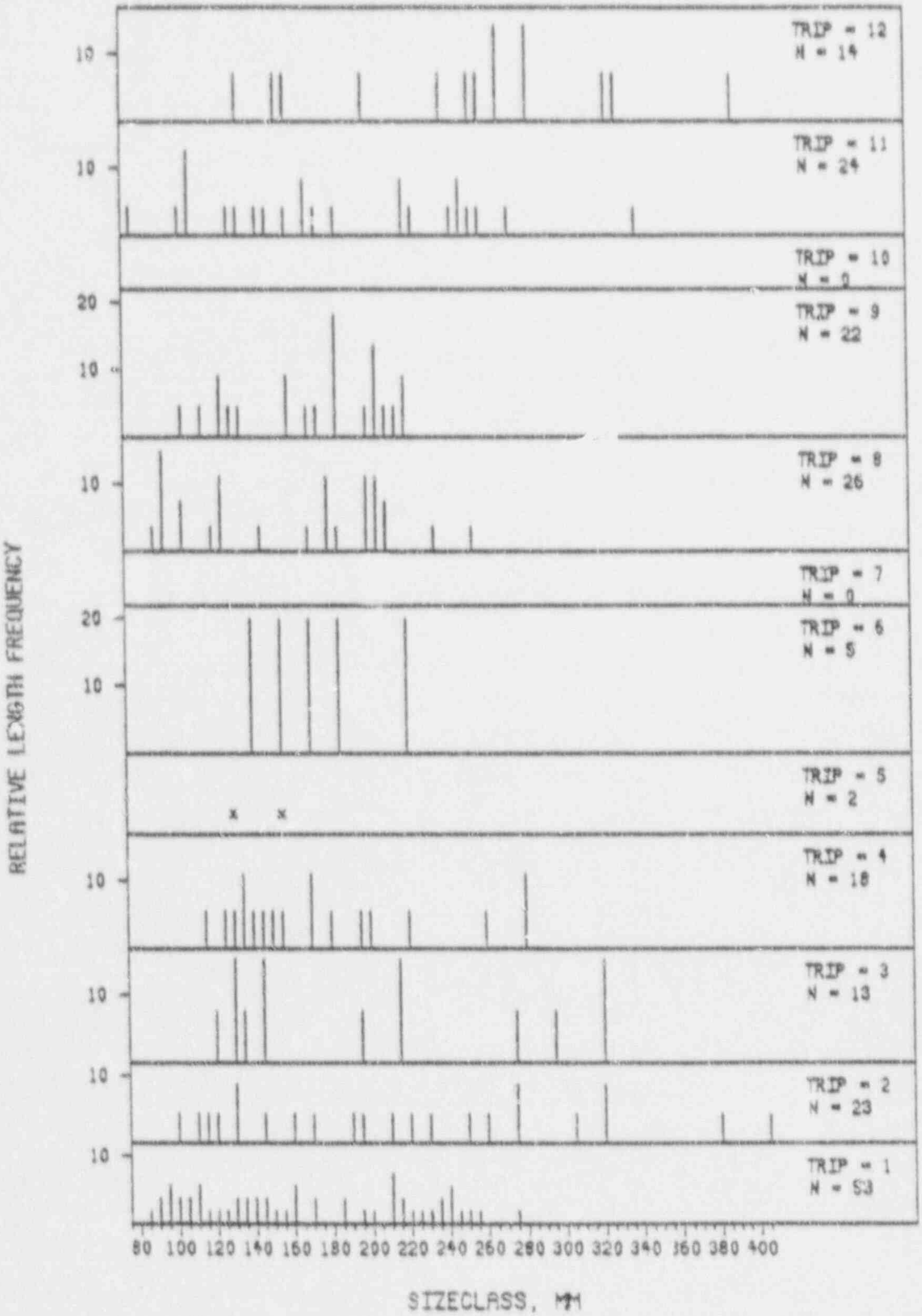


FIGURE 4.40 RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, LARGE TRAWLS SPECIES = SOUTHERN FLOUNDER

FIGURE 4.41 AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=SOUTHERN FLOUNDER AGE=YOUNG OF YEAR

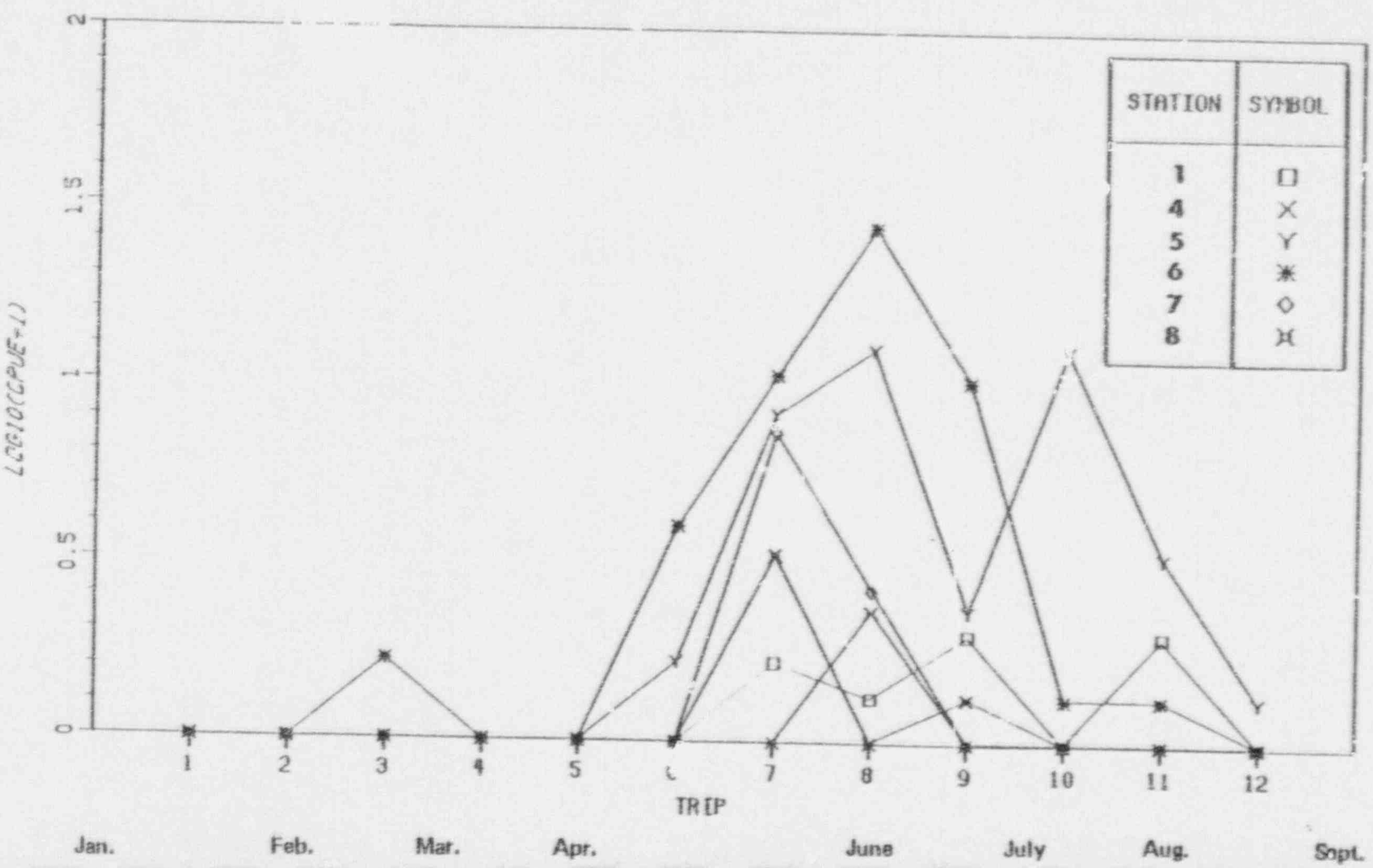


FIGURE 4. . AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=SOUTHERN FLOUNDER   AGE=YOUNG OF YEAR

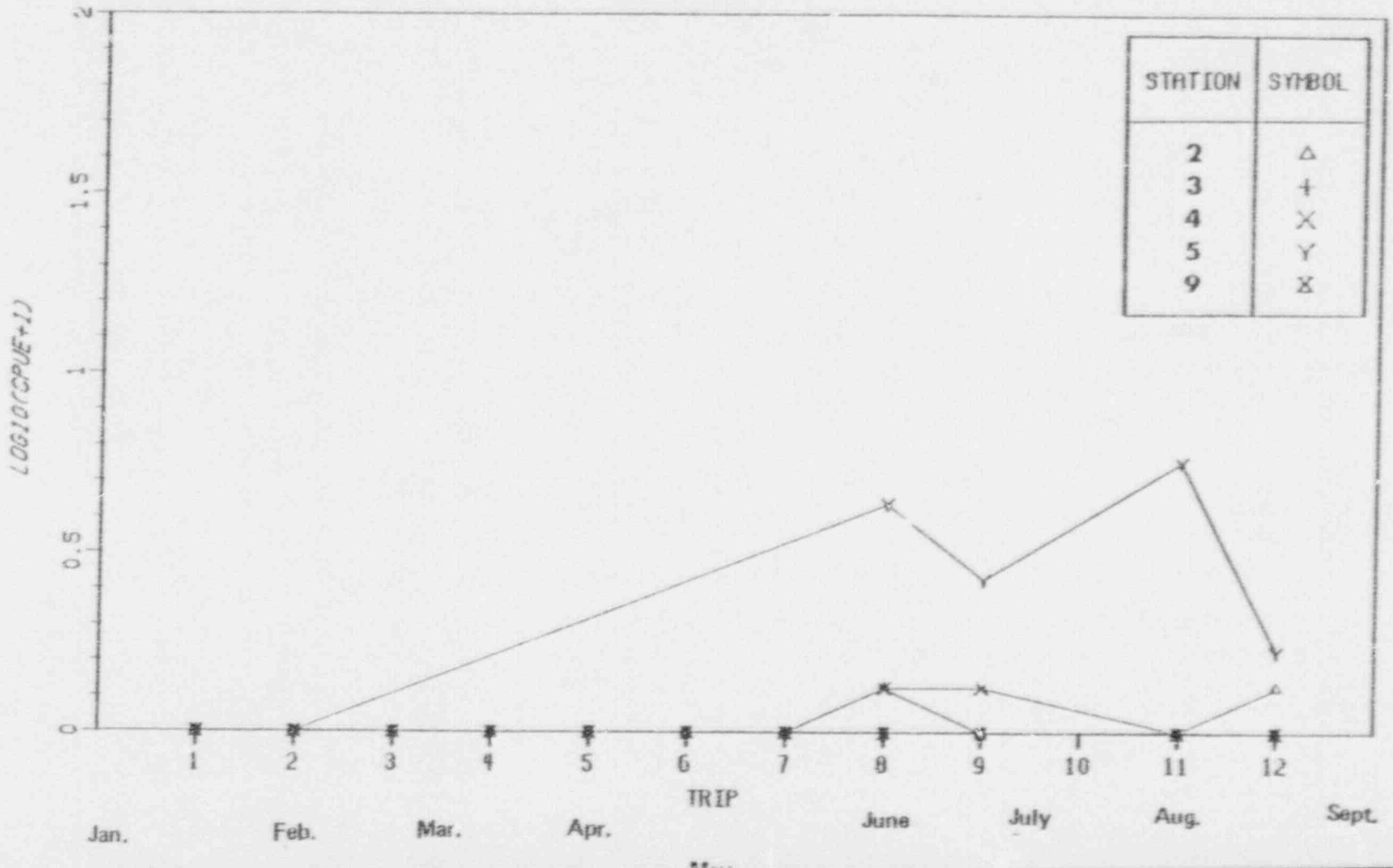
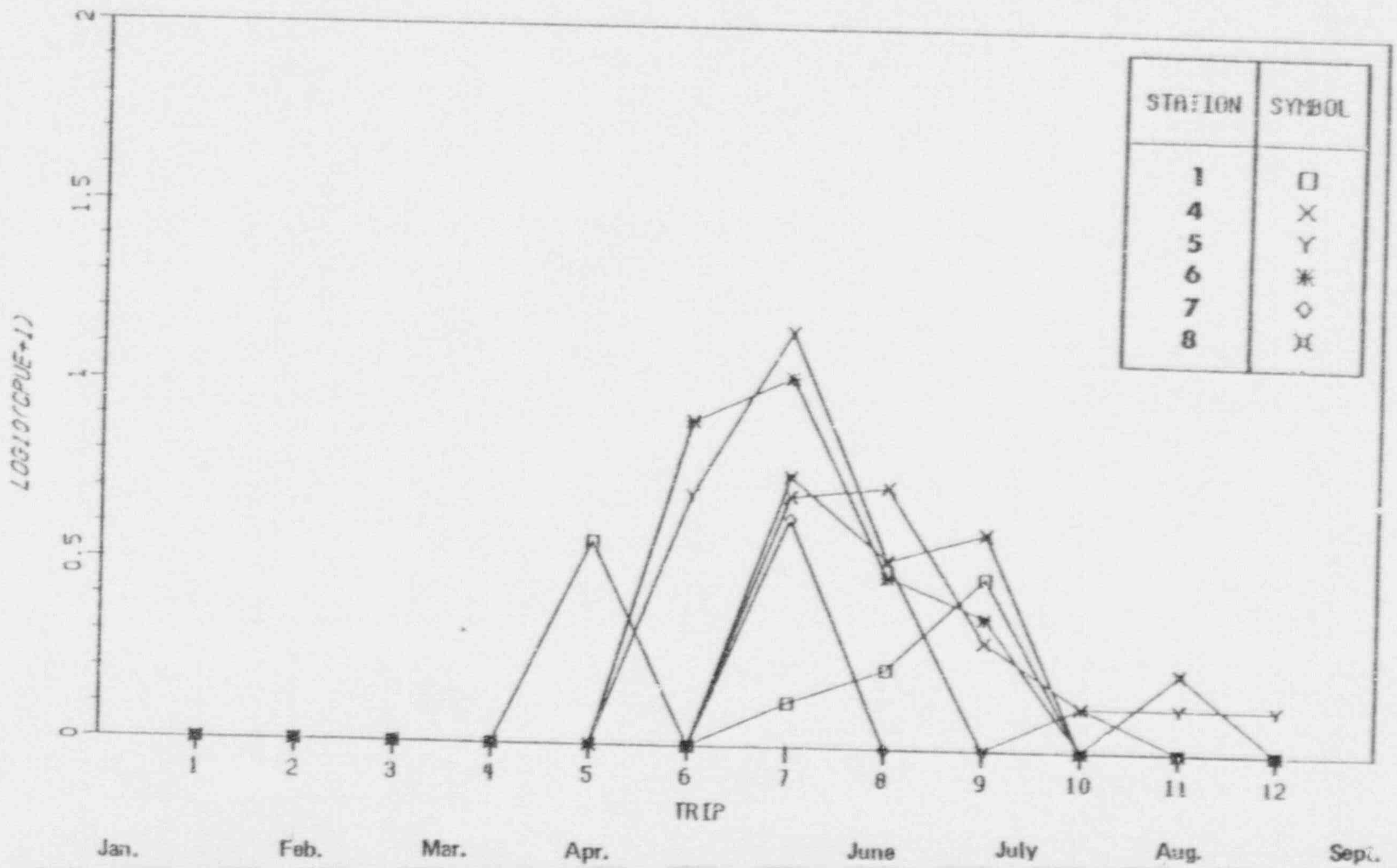


FIGURE 4.43. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=SUMMER FLOUNDER AGE=YOUNG OF YEAR



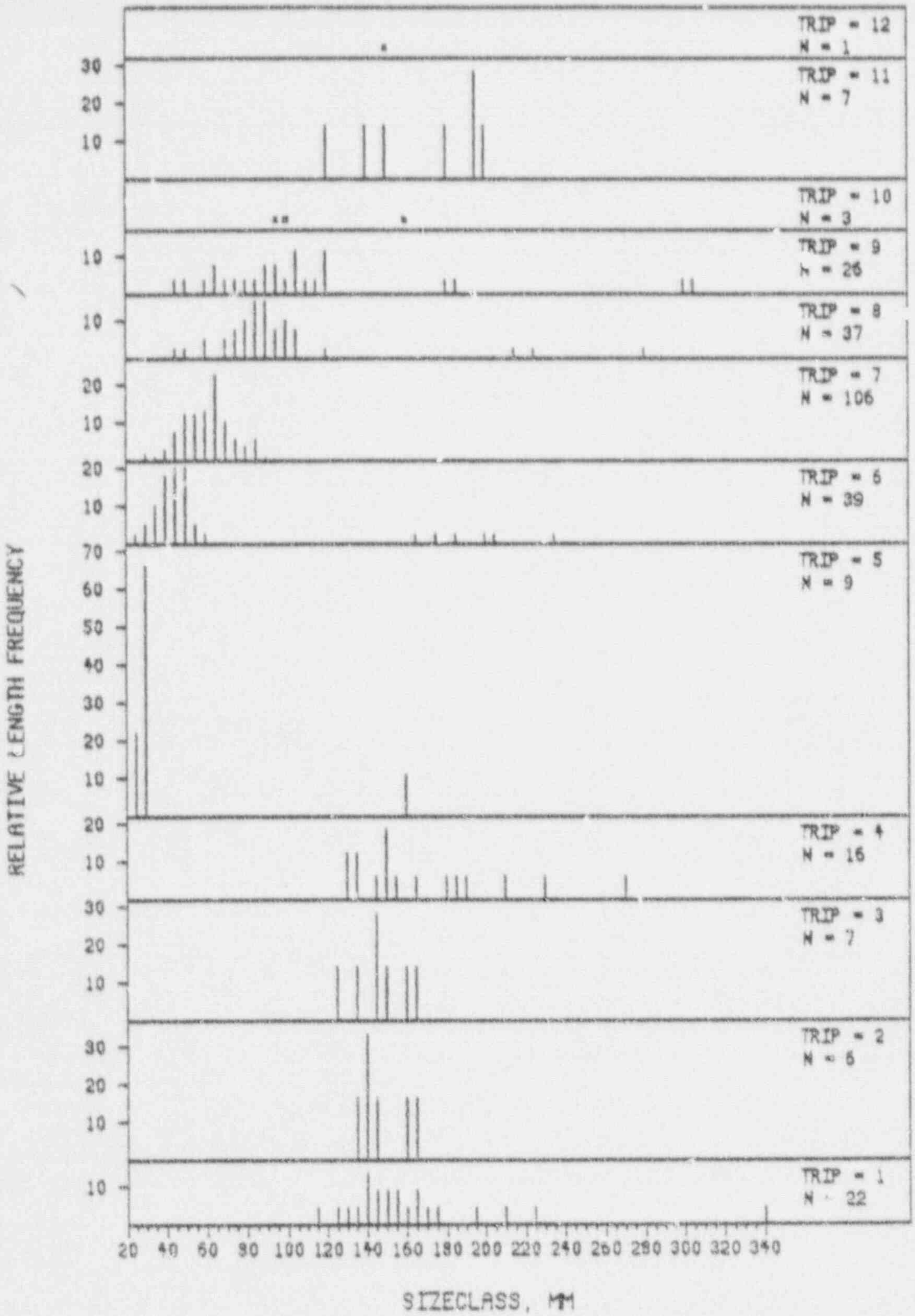


FIGURE 4.44 RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, SMALL TRAWLS SPECIES = SUMMER FLOUNDER

FIGURE 4.45. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=MULLET

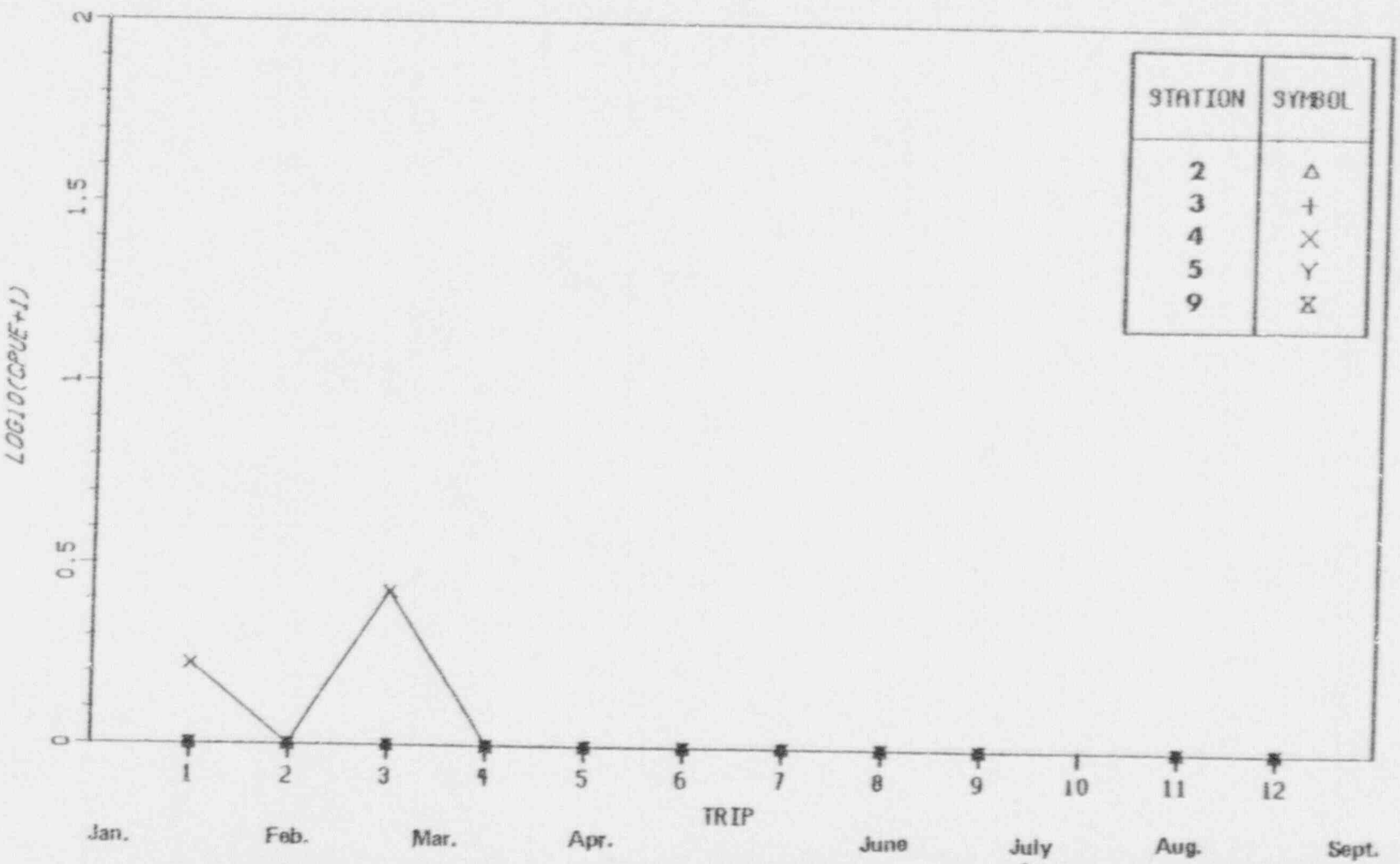
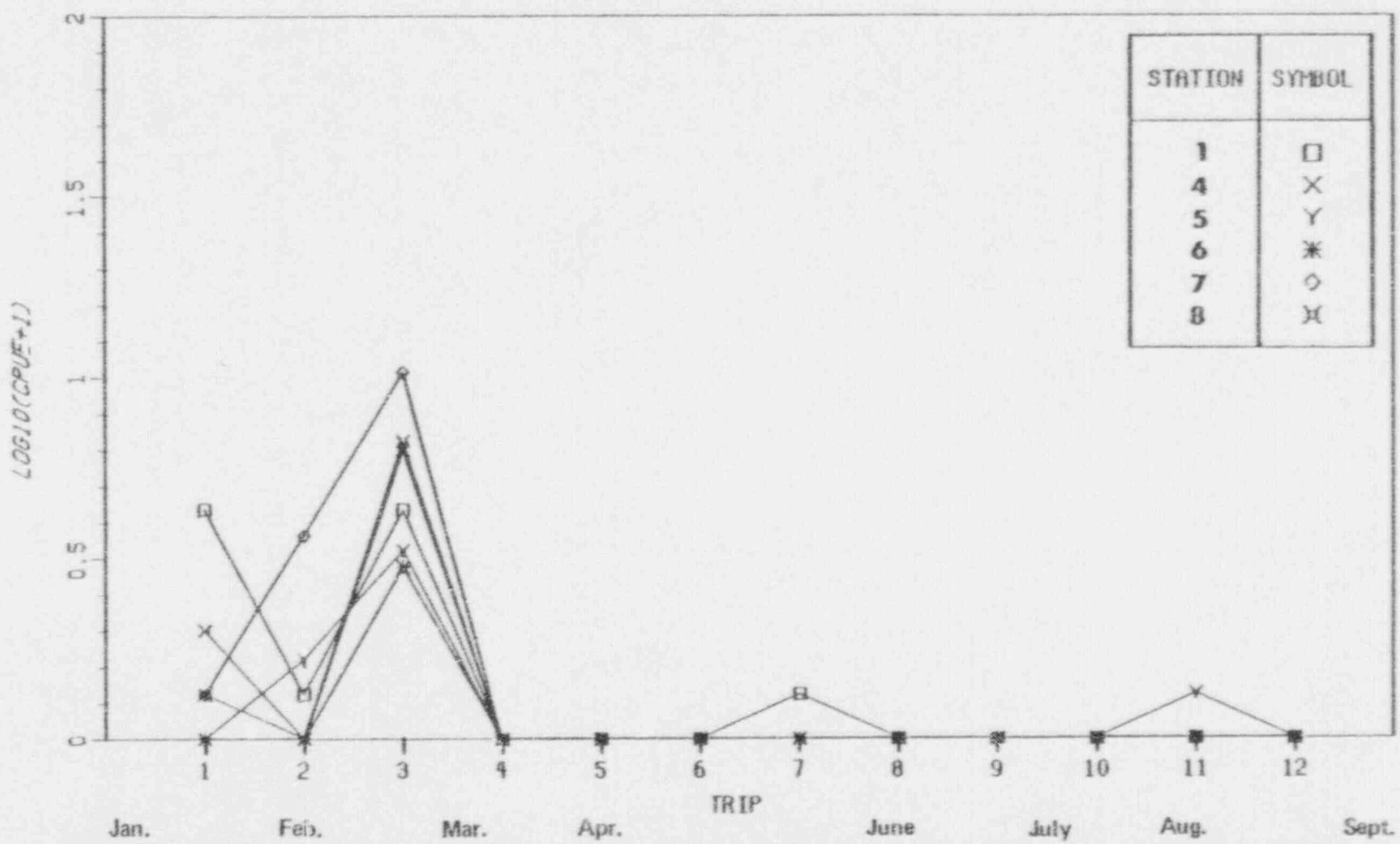


FIGURE 4.46. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR SMALL TRAWLS FOR NEKTON STUDY JAN .979 - AUG 1979

SPECIES=MULLET



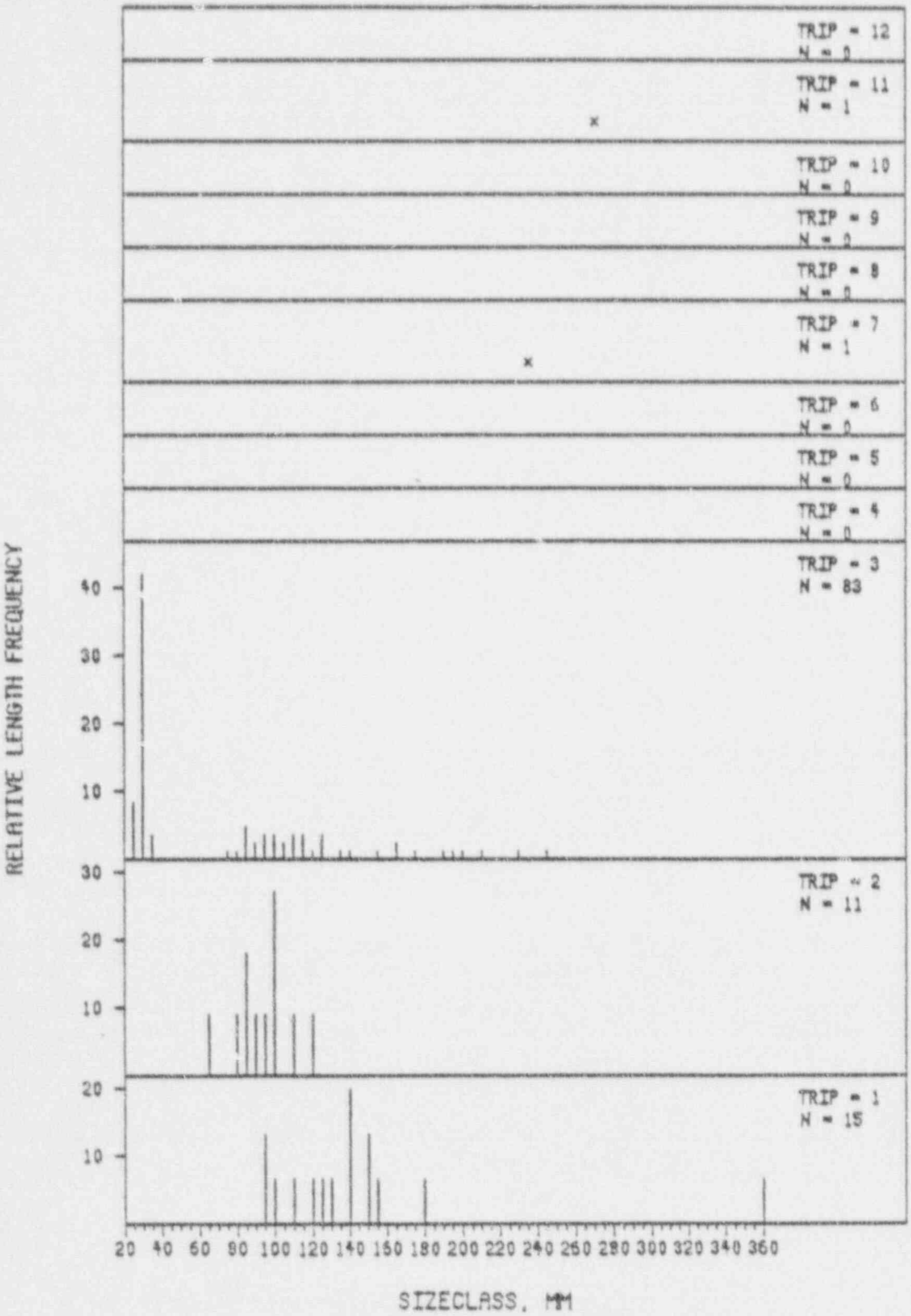


FIGURE 4.47. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, SMALL TRAWLS SPECIES = MULLET.

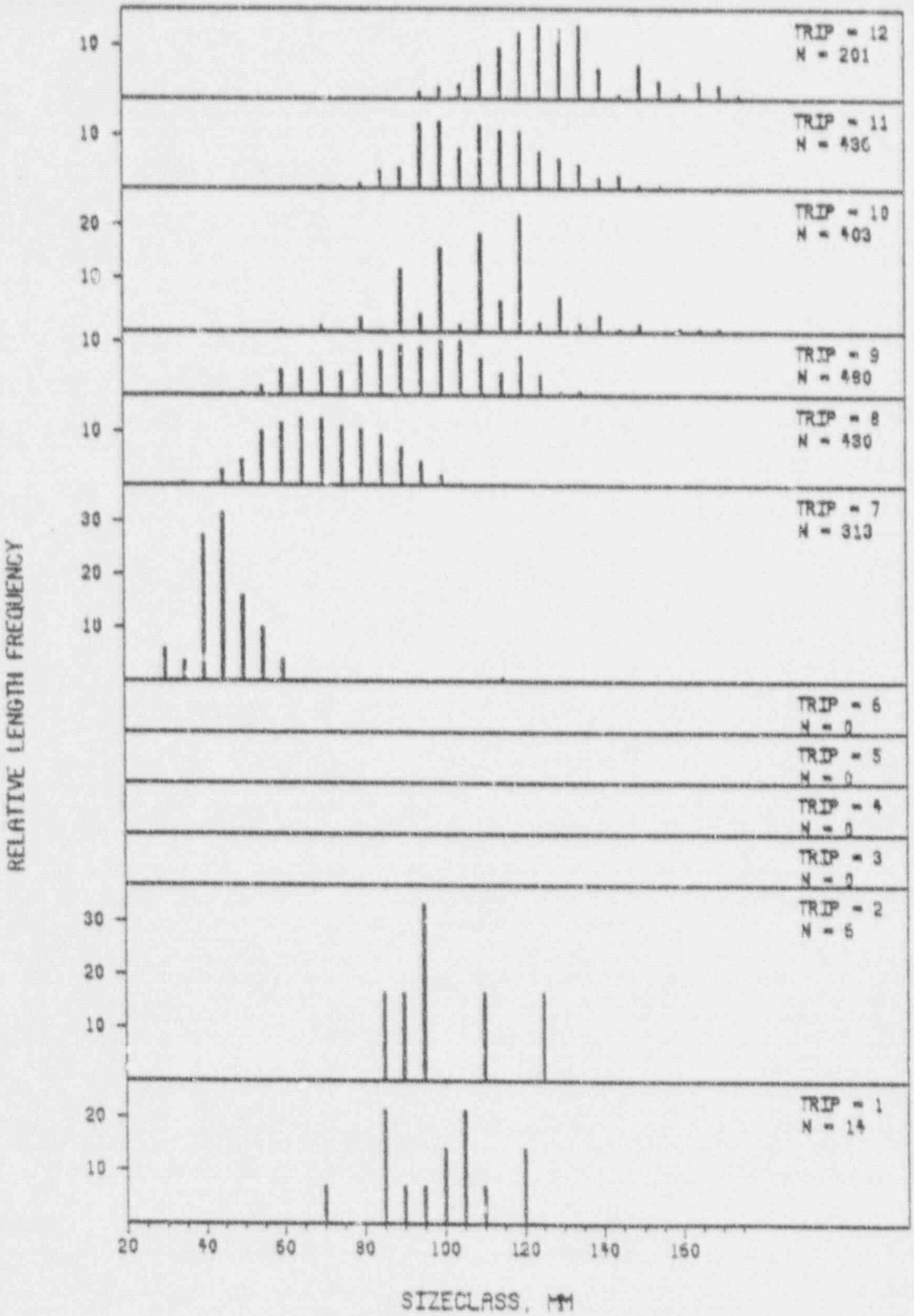


FIGURE 4.48. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN–AUG 1979, SMALL TRAWLS SPECIES = BROWN SHRIMP

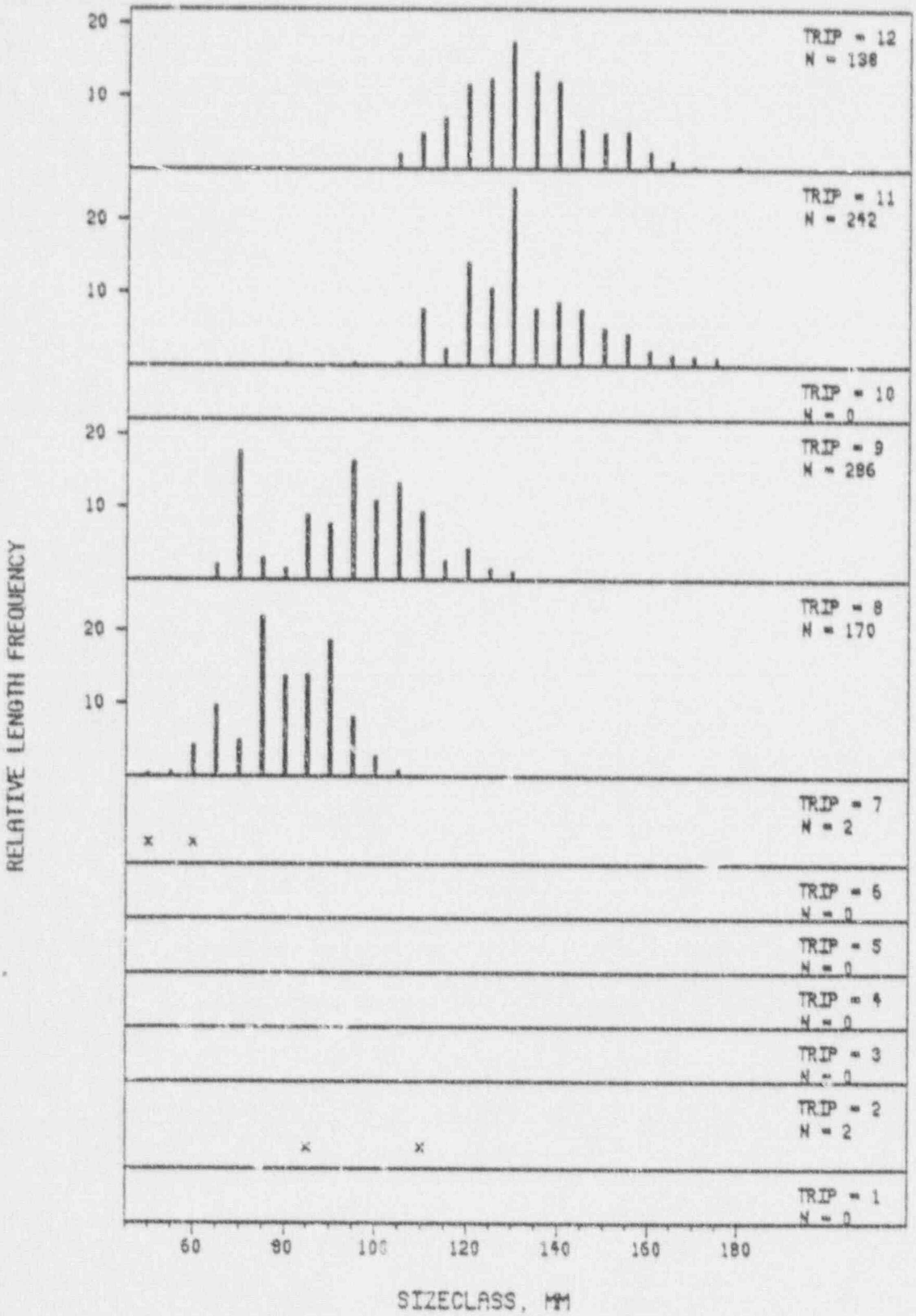


FIGURE 4.49. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, LARGE TRAWLS SPECIES = BROWN SHRIMP

FIGURE 4.50. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979 SPECIES=BROWN SHRIMP

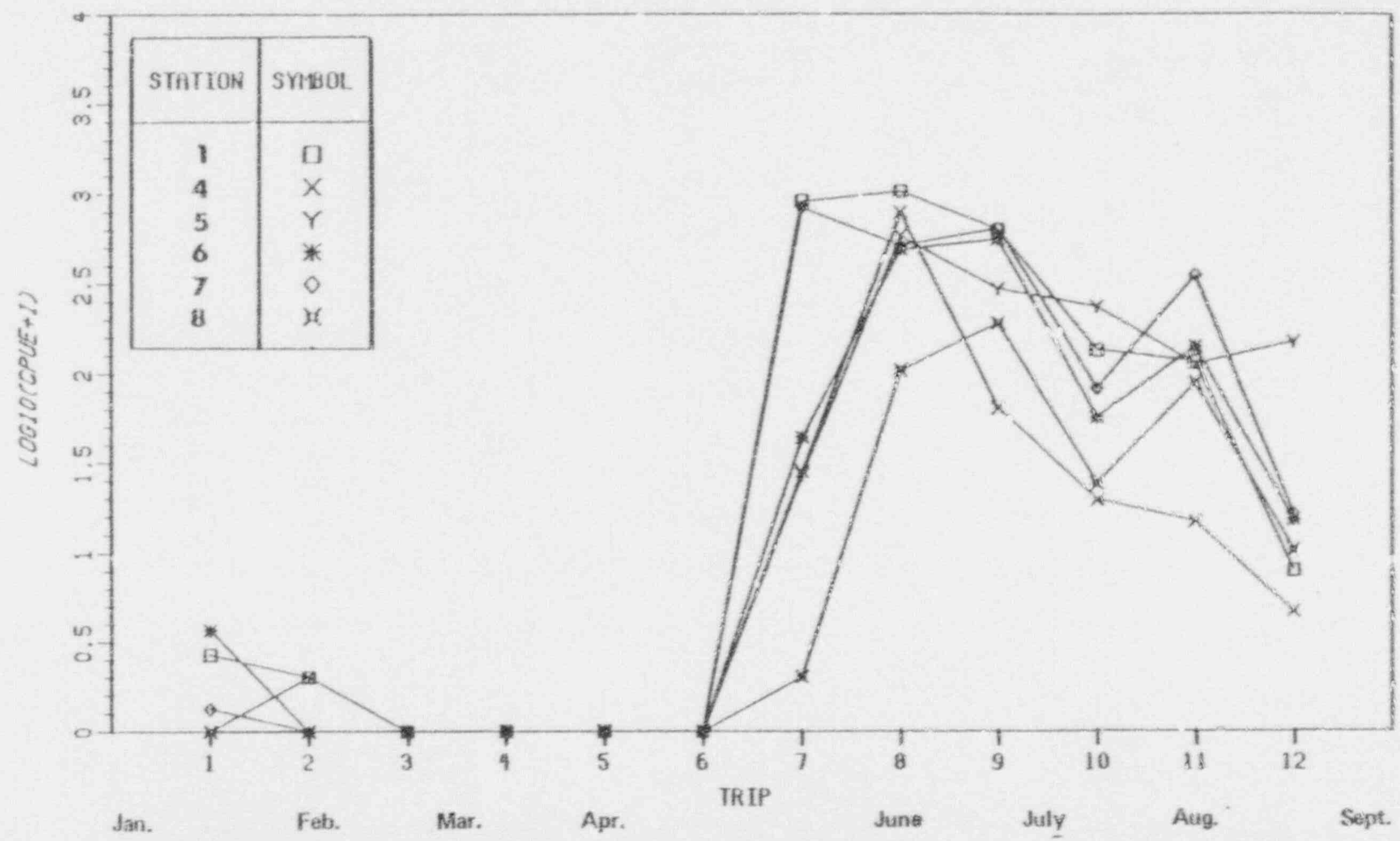


FIGURE 4.51. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=BROWN SHRIMP

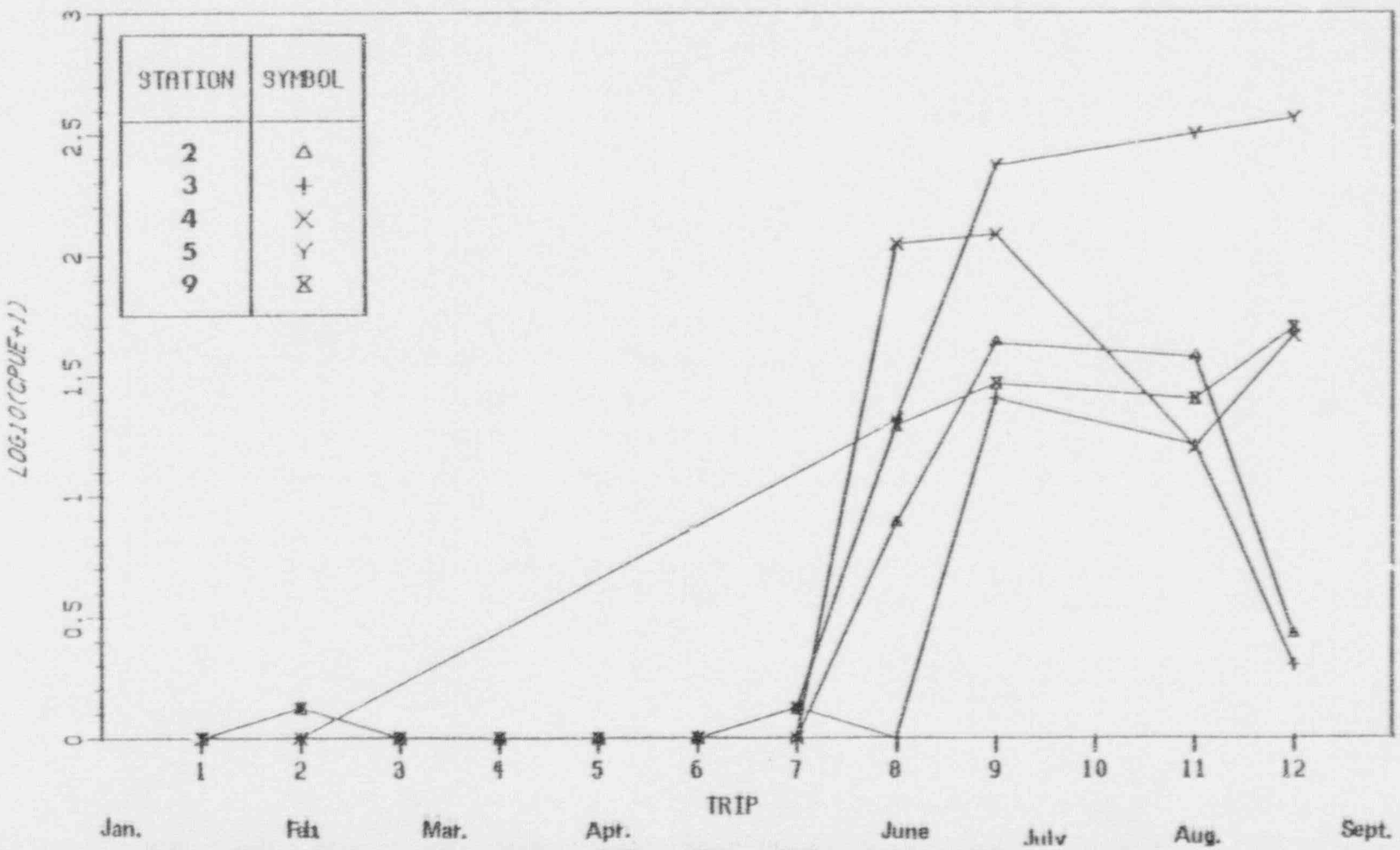


FIGURE 4.52. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=PINK SHRIMP

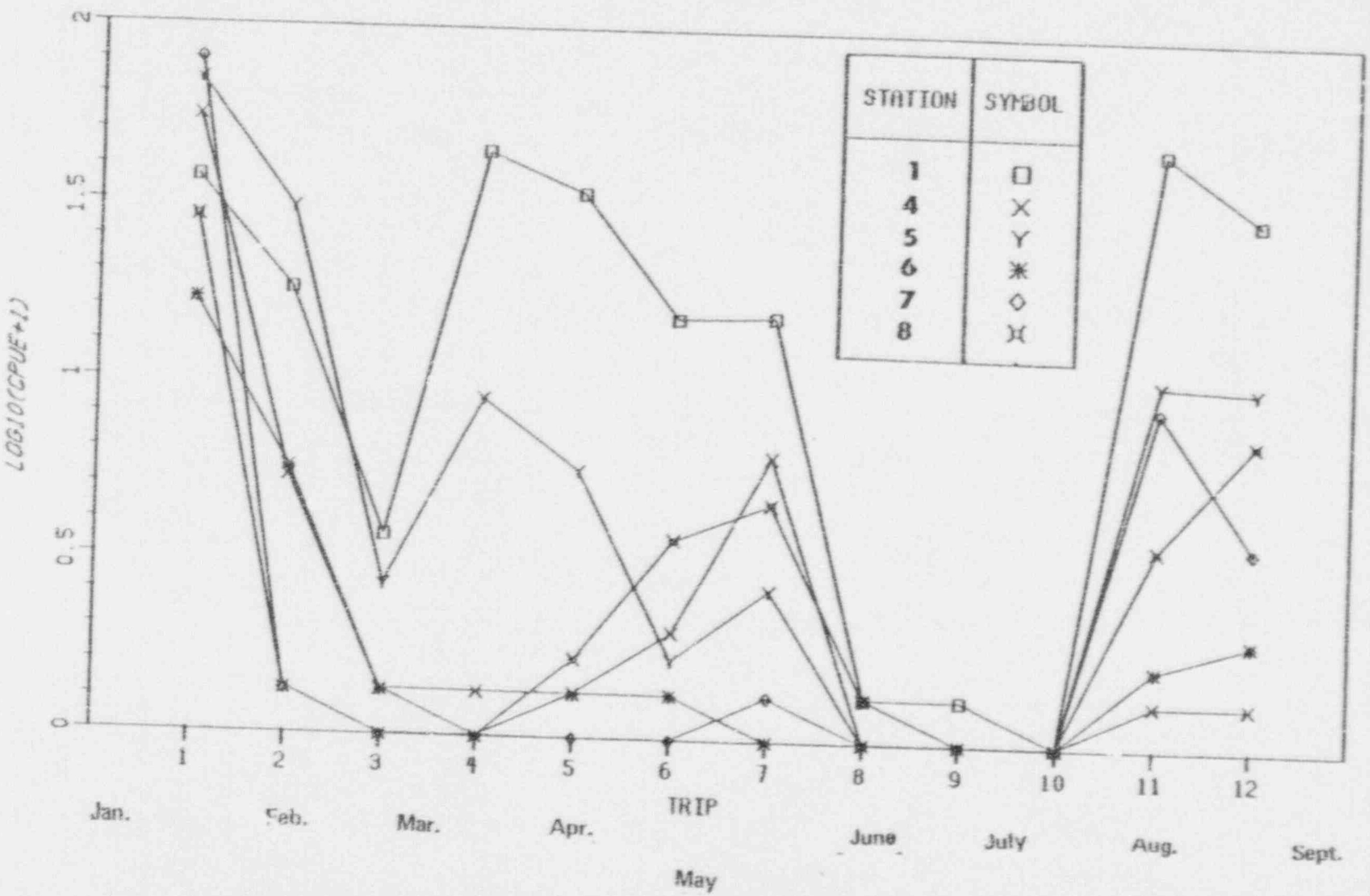
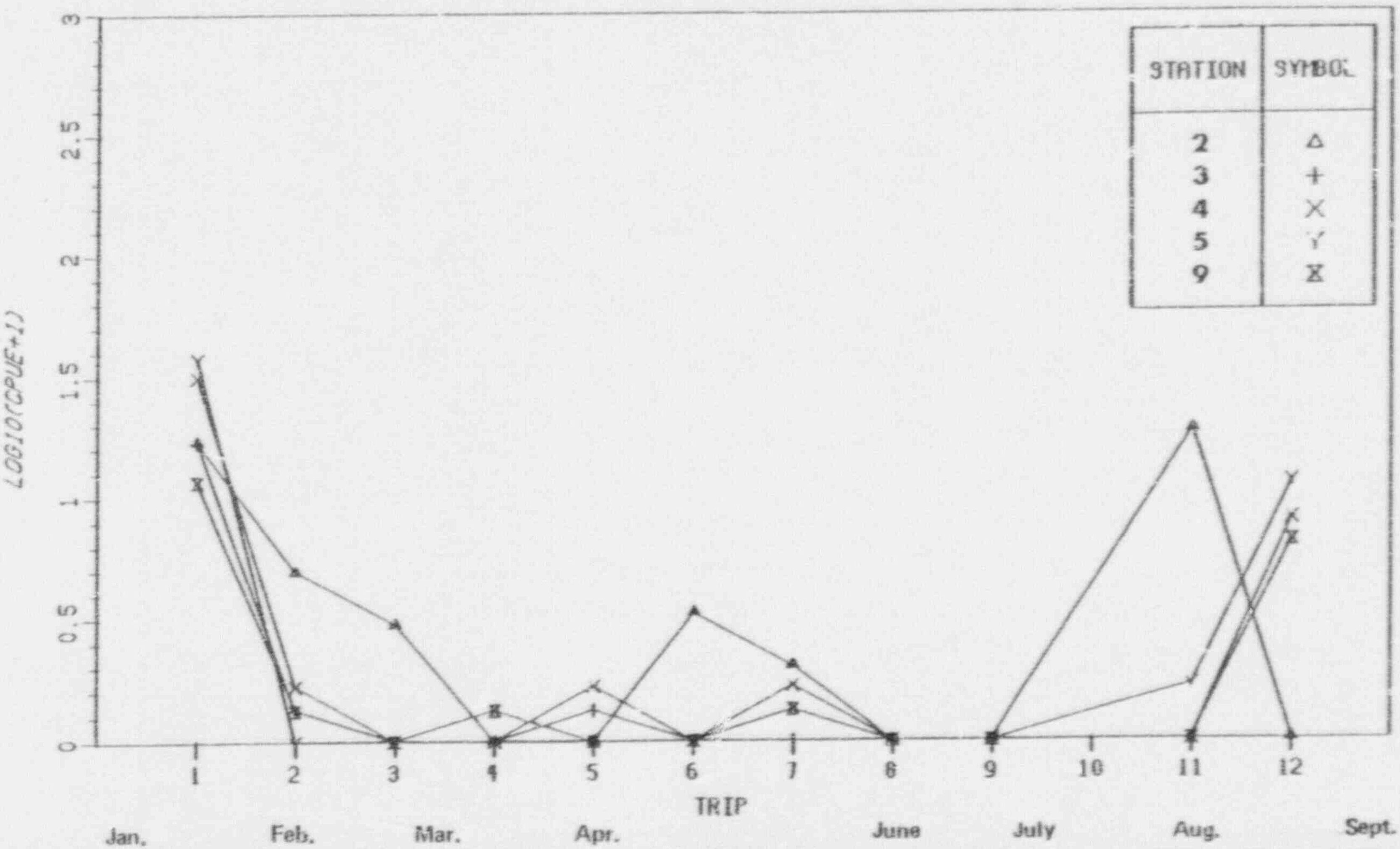


FIGURE 4.53. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979 SPECIES=PINK SHRIMP



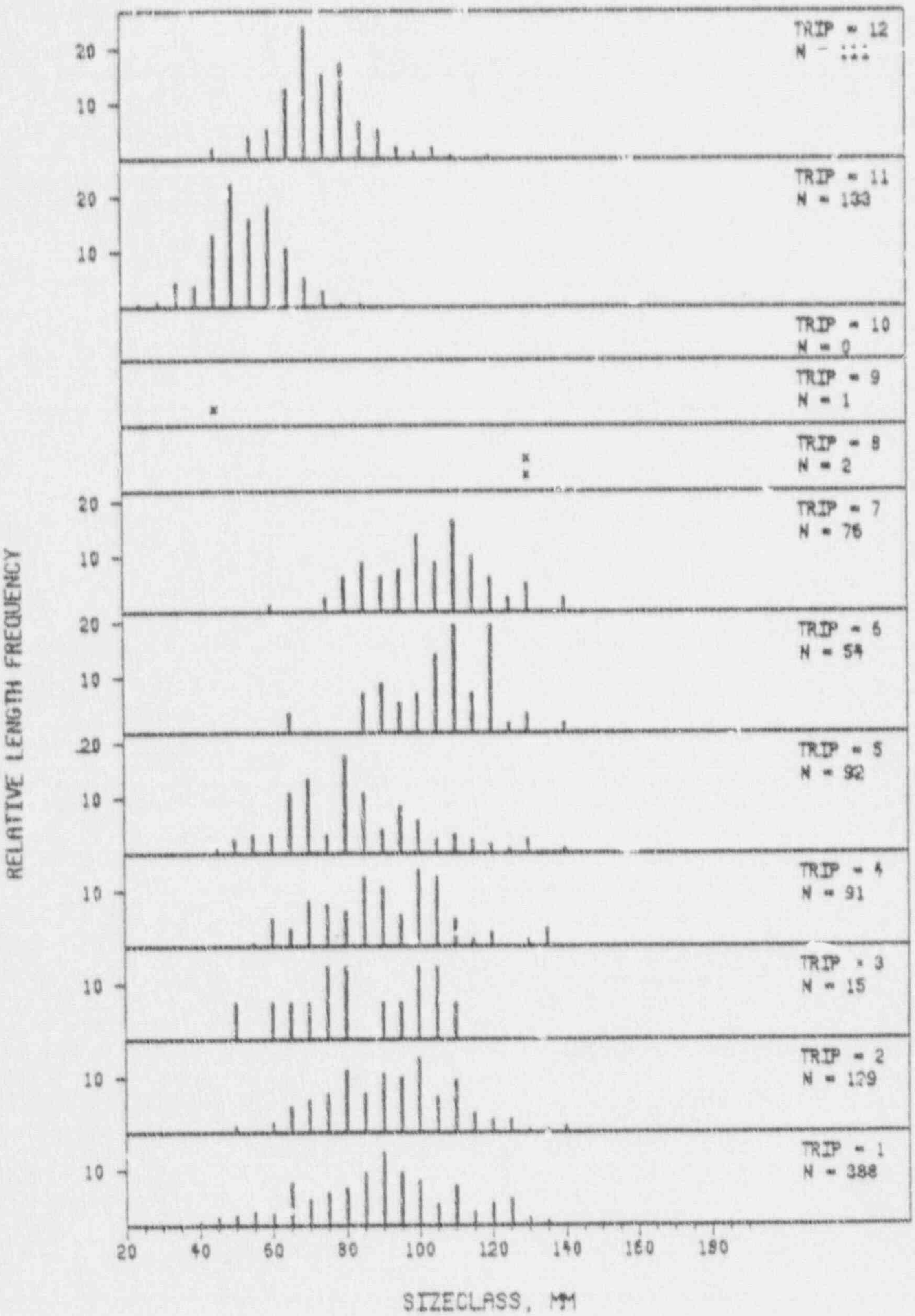


FIGURE 4.54. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, SMALL TRAWLS SPECIES = PINK SHRIMP

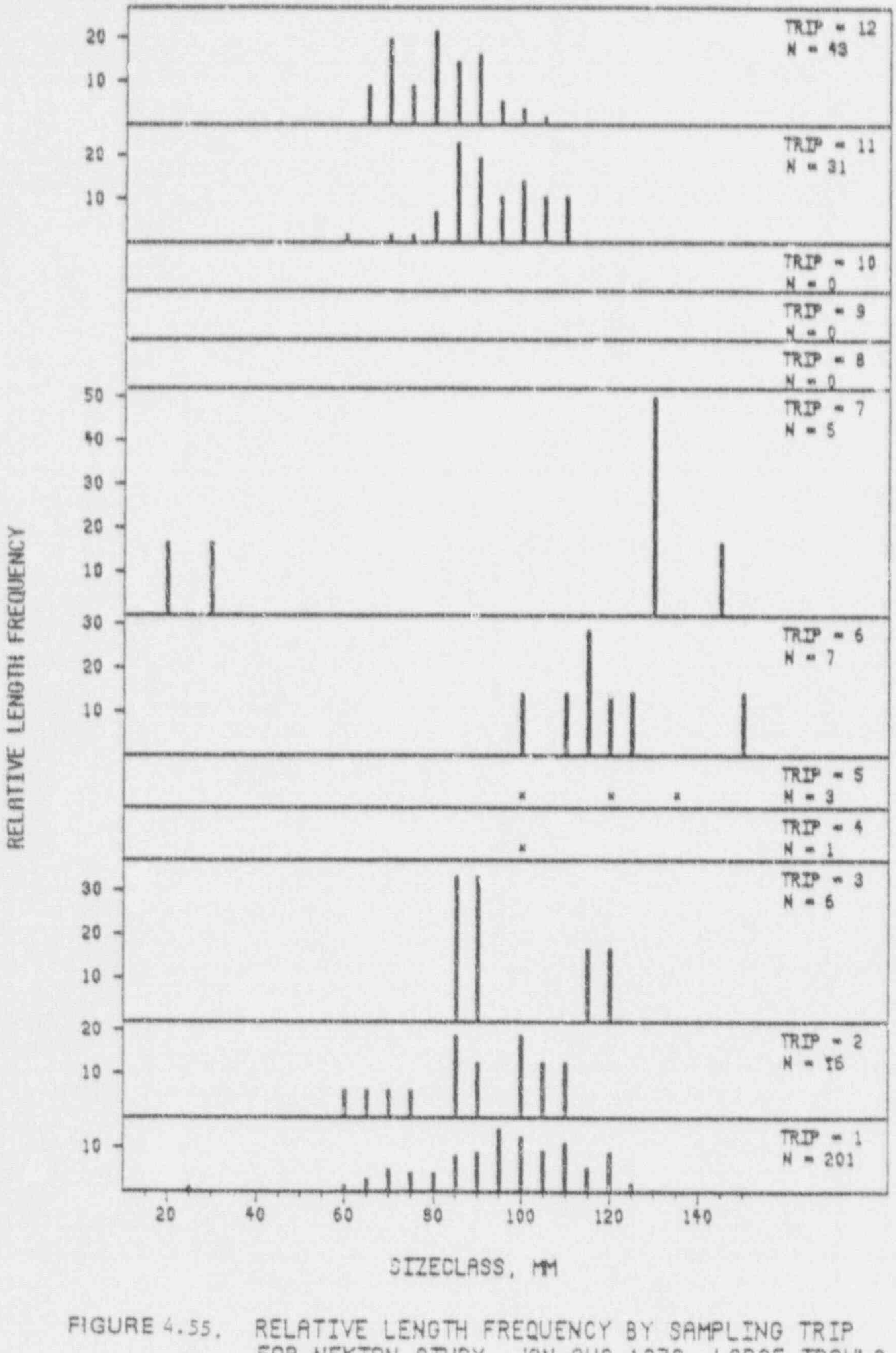


FIGURE 4.55. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN-AUG 1979, LARGE TRAWLS SPECIES = PINK SHRIMP

FIGURE 4.56, AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=WHITE SHRIMP

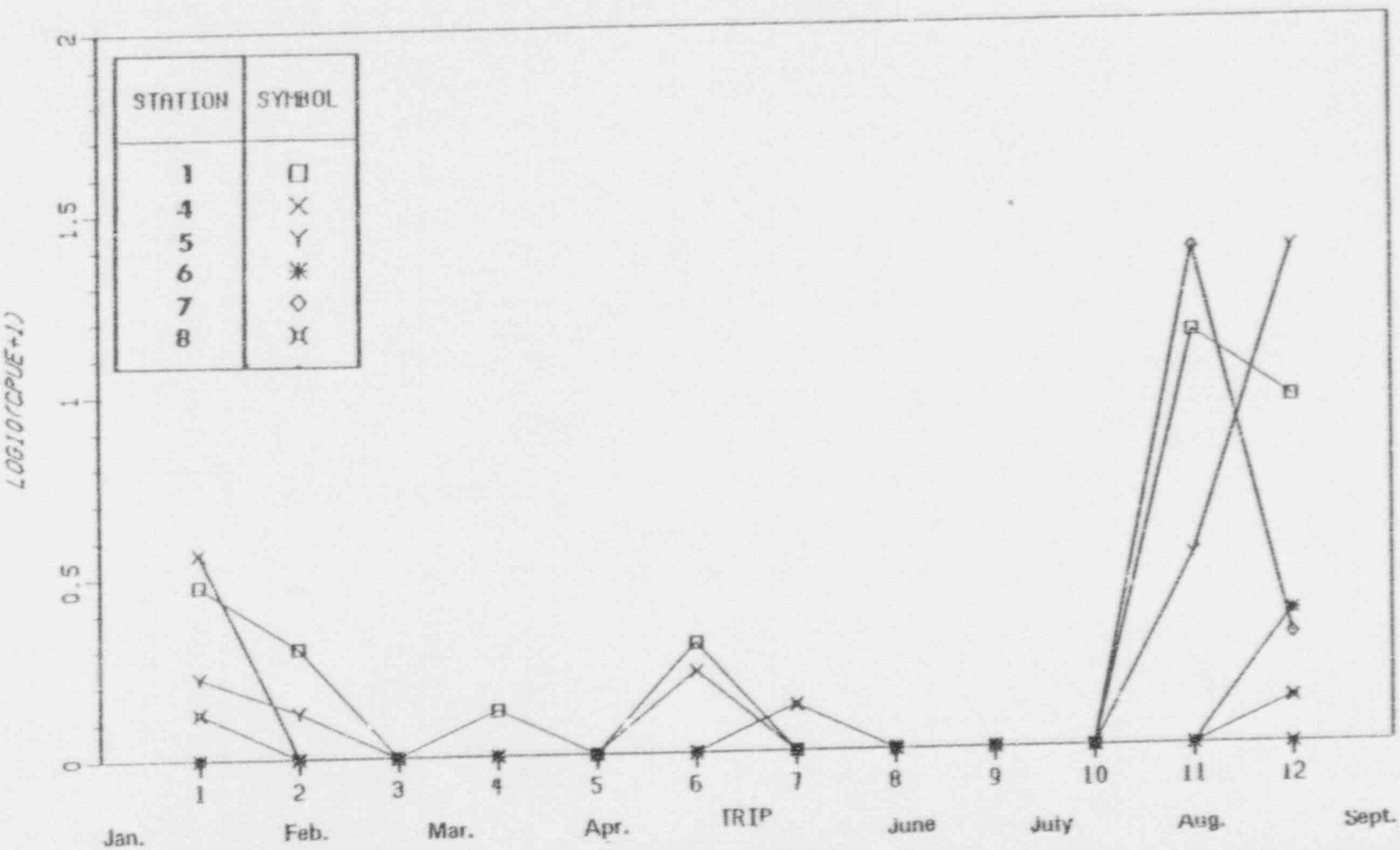
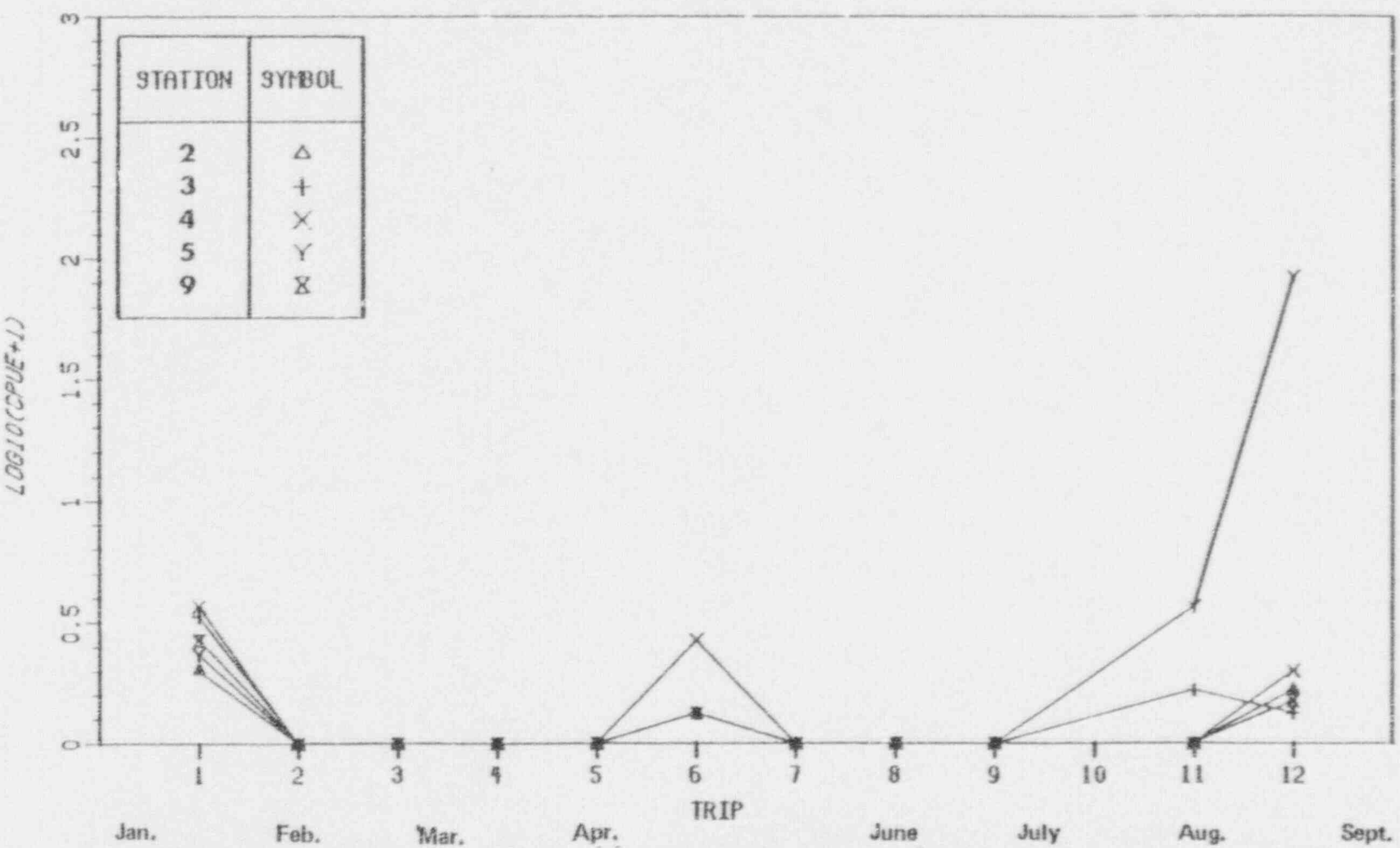


FIGURE 4.57. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=WHITE SHRIMP



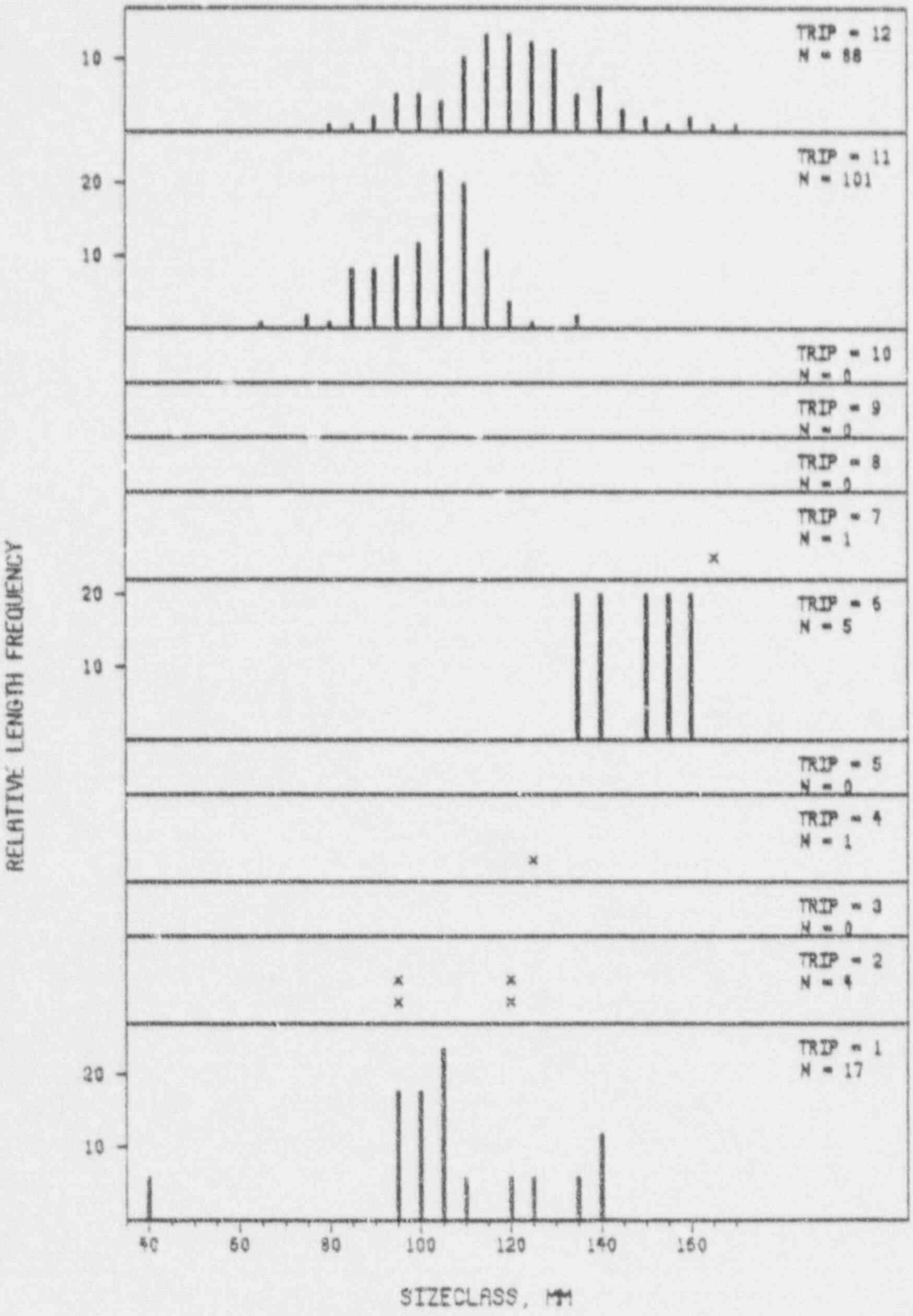


FIGURE 4.58. RELATIVE LENGTH FREQUENCY BY SAMPLING TRIP FOR NEKTON STUDY, JAN—AUG 1979, SMALL TRAWLS SPECIES = WHITE SHRIMP

FIGURE 4.59. AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR SMALL TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=BLUE CRABS

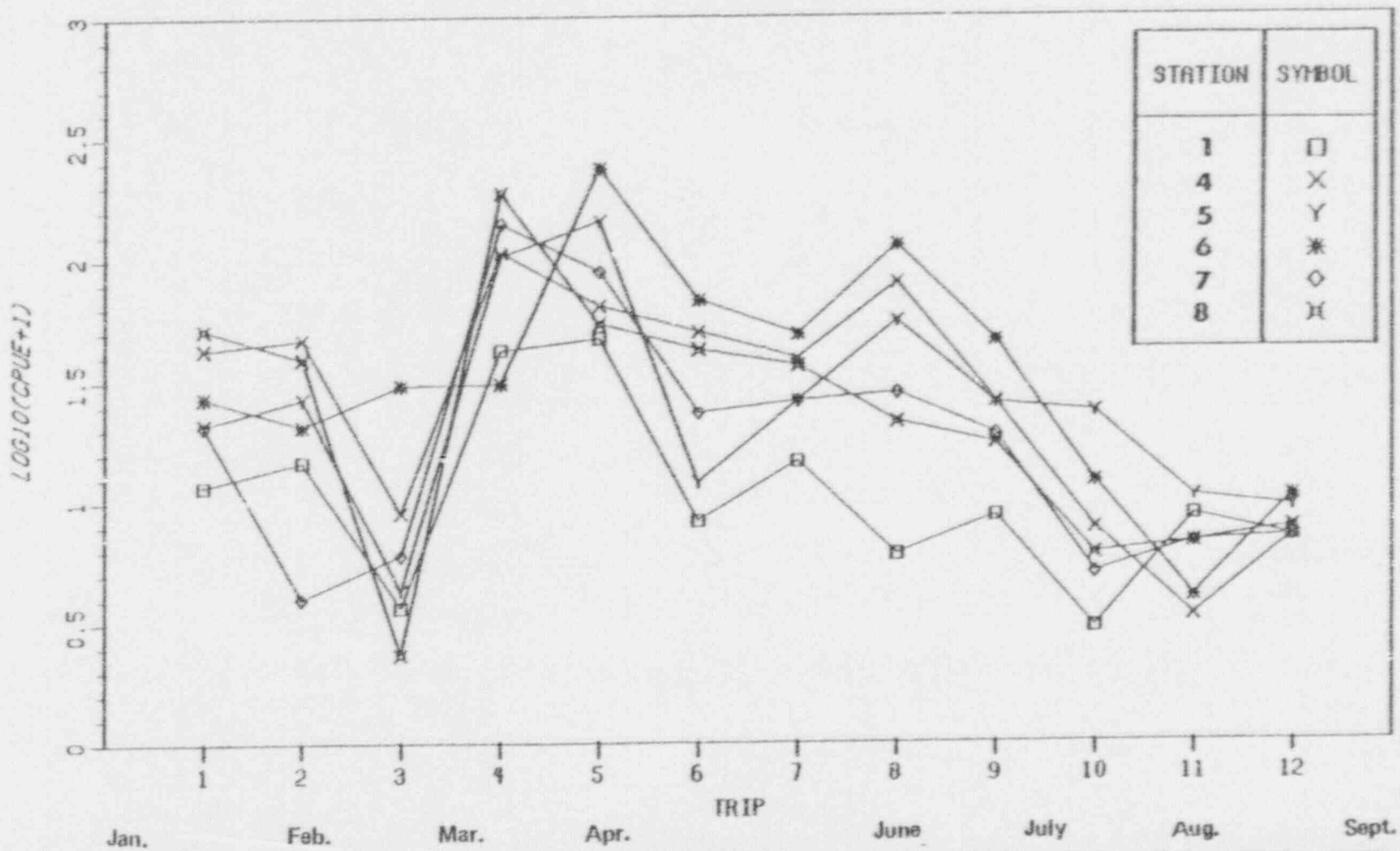
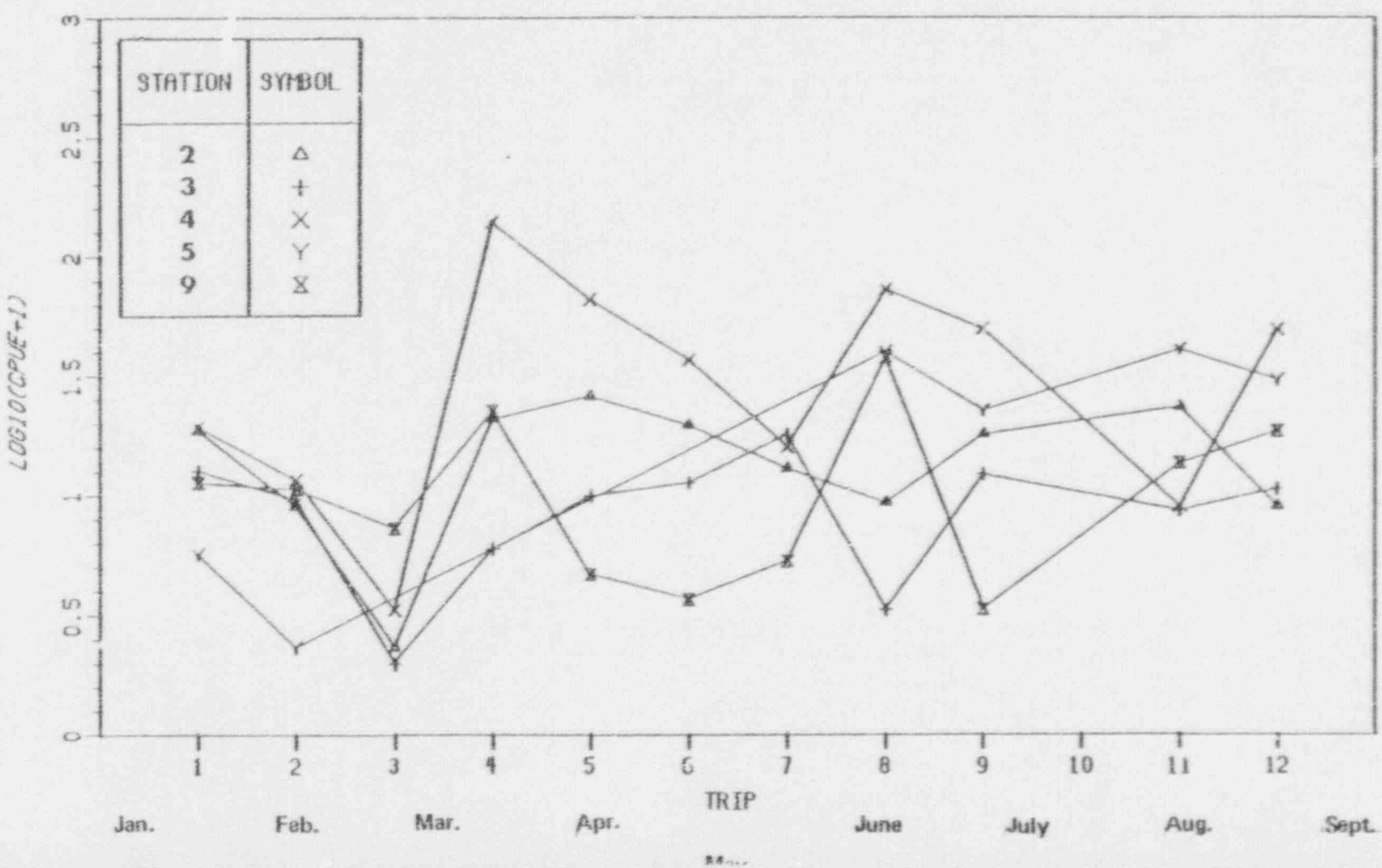


FIGURE 4.60 . AVERAGE CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR LARGE TRAWLS FOR NEKTON STUDY JAN 1979 - AUG 1979

SPECIES=BLUE CRABS



5.0 Impingement

5.1 Introduction

When organisms in the water withdrawn for cooling purposes are collected by or trapped on the traveling screens located in front of the intake pumps, they are said to be "impinged." At regular intervals throughout the day, usually every 2 to 4 hours, the traveling screens are rotated, and the organisms and debris are washed off with spray nozzles located behind the screens. The water, debris, and organisms flow down a trough into a spiral chute and empty into a basket floating in the intake canal. The basket can be raised and emptied into CP&L's 13.7 m (45 ft) nekton return boat, the Ms. SLUICE, and transported back to the estuary away from the influence of the intake canal. For sampling purposes the floating basket was emptied into a stainless steel basket located on the nekton return dock.

Impingement studies have been ongoing since the first pump was started in 1974. The first year (January 19, 1974 - January 18, 1975) all organisms impinged on the rotating screens were examined, with a few exceptions where subsampling was necessary because of the large sample size. Beginning February 1, 1975, impinged organisms were sampled for a 24-hour period once a week and subsampling became a standard sampling technique. This report primarily covers impingement between September 1978 and August 1979, with comparisons to previous years. More information on previous years' impingement can be found in CFS, Vol. XVII.

In an attempt to increase the survival of impinged organisms, a new nekton return system has been constructed. The organisms and debris are washed off the rotating screens in the same manner as mentioned above. They flow down the screen wash trough into a 55.2 cm (22 in) diameter pipe that empties into a 3.3 m^3 (864 gal) circular fiberglass tank on top of a concrete platform built in the intake canal. Excess water flows through screening around the top of the tank while the organisms remain in the tank. The significant feature of this new system is that the trough, pipe, and tank are essentially at the same level, eliminating much of the sudden drop that could have resulted in injury to the impinged organisms in the old system. A drain in the bottom of the tank can be opened, allowing organisms and debris to flow through a pipe and be emptied either into a stainless steel basket for examination or into a holding tank on the Ms. SLUICE for return to the estuary.

In an attempt to reduce impingement, a diversion device was installed at the mouth of the intake canal in January 1979. It consists of 38 pairs of 15.3 m (50 ft) pilings driven into the bottom across the mouth of the intake canal at its intersection with Walden Creek. A fence constructed of a series of 1.2 m (4 ft) wide panels is bolted to the pilings forming a barrier preventing most organisms from moving into the intake canal. The mesh of the galvanized steel screening in the panels is 13 mm (0.5 in). The entire device is constructed in a V shape pointed away from the plant so that tidal flushing will keep the screening relatively clean. In the event organisms are impinged on the structure, they should be washed off at the change of the tide. Impingement of fish here is not expected to be great, because the greatly increased cross-sectional area reduces the nontidal flow through the screening. Fish coming in contact with the screens can swim away. After installation it was realized that on extremely high tides, fish and crabs could move around the diversion device through the marsh and through a small tidal creek that intersects the intake canal. To prevent this, a 1.2 m (4 ft) high "crab fence" was constructed of 6.4 m (0.25 in) plastic mesh to keep fish and crabs from swimming around the diversion device. This fence extends from the diversion device to high ground along both sides of the intake canal.

5.2 Methods and Materials

5.2.1 Impingement Sampling

The impingement catch was examined weekly by CP&L fishery biologists with the number of examinations over a 24-hour period increased as the number of organisms being impinged increased. All organisms collected during the 24 hours were subject to examination although the time between examinations changed. Occasionally, a screen malfunction or other plant problems resulted in only one count (examination), but under normal operations 2, 3, or 4 examinations were made in a 24-hour period.

Subsampling was required if the catch for a particular examination period was too large to be examined in total. In such cases, the entire catch was weighed but only a portion examined. This technique was used in the majority of samples taken after February 1975. To refine the estimate of the catch, obviously large or one-of-a-kind items (terrapins, gar, sturgeons) were counted separately and not included in the subsample. The weight of the entire catch divided by the weight of the examined portion gave a multiplication or expansion factor that was used to obtain an estimate of the composition of the entire catch. Prior to September 1976, the calculation of the expansion factor and its application to the catch was done manually with a hand calculator, but since September 1976, this has been done by computer by simply entering the total and subsample weight on the impingement data sheet. The date, collection time, the number of hours fished (sample duration), and the number of intake pumps (1 to 4) operating on each of the two units were recorded. A water sample was collected just below the surface of the intake canal with a Van Dorn water sampler at the time of the sample collection. Water temperature was measured to the nearest degree centigrade, and salinity was measured to the nearest part per thousand (ppt).

An impingement examination consisted of separating the organisms from the trash, sorting, counting, recording a size range, and weighing as a total each species. Hard-to-measure species such as mantis shrimp, starfish, squid, and crabs were not measured but only counted and weighed. All weights were recorded to the nearest gram unless the total weight exceeded 3000 grams (6.6 lbs) or an individual specimen exceeded 1000 grams (2.2 lbs). In these cases the weight was measured in pounds and converted to grams. Total length to the nearest millimeter was recorded for fish and shrimp while carapace length was taken on terrapins, wingtip length on rays and skates, and usually an estimated length on live eels.

Starting in spring 1976, up to 100 specimens of 13 selected species (Table 5.1) were individually measured from each 24-hour study period for length frequency estimations. These species were chosen because of their dominance in the estuary and/or because they were commercially or recreationally important (see Section 5.1.2 of the IR). Whenever several obvious size groups of one species were present in the catch, they were treated separately and up to 100 specimens of each size group were measured. In this manner selection bias was largely avoided. Data sheets were coded in the field and submitted directly for keypunching.

To obtain monthly estimates of impingement, the total number of hours in a given month was divided by the number of hours sampled during that month. This expansion factor was then multiplied by the number and weight of all the organisms collected during that month. In this manner a month's catch was treated as a whole. The 12 monthly totals were then combined to obtain the annual estimate. For analysis, data were grouped into 12-month periods extending from September to August with the exception of Year I which was from January 1974 - August 1974; Year II was from September 1974 - August 1975; Year III from September 1975 - August 1976; Year IV from September 1976 - August 1977; Year V from September 1977 - August 1978; and Year VI from September 1978 - August 1979. This report deals with Years III-VI. Years I and II data can be found in CFS Volume XVII.

Since a varying number of samples was collected at different times during the day, it was decided to use only the morning sample (0600-1000) as an indication of the water salinity and temperature for that particular day or week.

5.2.2 Diversion Device Sampling

A weekly sampling program was started January 17, 1979, and continued through September 11, 1979, to determine the effectiveness of the diversion device. The sampling consisted of towing a 6.4 m (21 ft) wide semiballon otter trawl for 15 minutes at three stations in the intake canal. Station 4 was just outside the diversion device at the mouth of Walden Creek. The two other stations (5 and 6) were in the intake canal. Station 6 was just inside the diversion device and Station 5 was near the plant. These stations were sampled more intensively every three weeks as part of the nekton program (see Section 4). Surface and bottom temperature and salinity measurements were taken at each station before each trawl. The samples were analyzed in the field or placed in plastic bags and returned to the laboratory for analysis. All organisms were sorted to species, weighed, and counted. Minimum and maximum lengths were measured for all species except those species listed in Table 5.1. Up to 25 of each of these species were measured for total length (TL).

5.3 Impingement

5.3.1 Results

A total of 106 examinations conducted over 47 weeks was sampled from September 1978 to August 1979. Failure to sample during 5 weeks was due to wash down pump malfunction, a damaged pipe in the nekton return system, and in one case divers working on part of this system.

Water temperatures ranged from a low of 6.0°C (42.8°F) in January to a high of 29.0°C (84.2°F) in August. Salinities ranged from 31.0 ppt in November to zero ppt in January and again in March, showing the higher freshwater flows early in the year.

This year (VI) approximately 9,379,000 organisms weighing 50,277 kg (110,742 lbs) were impinged at BSEP, representing 146 taxonomic groups

(Table 5.2). Finfish accounted for 75% of the total number, shellfish 24%, and miscellaneous species 1%. A list of the estimated number and weight of all the species impinged can be found in Table 5.3.

In order to make analysis easier, the 146 taxa were grouped into the following 12 categories:

Group	Includes
Bay Anchovy	Bay Anchovy (*Anchoa mitchilli*)
Blue Crab	Crabs (*Callinectes sapidus*, *C. similis*, and *C. ornatus*)
Croaker	Atlantic Croaker (*Micropogonias undulatus*)
Flounder	Summer Flounder (*Paralichthys dentatus*)
	Southern Flounder (*P. lethostigma*)
	Gulf Flounder (*P. albigutta*)
Menhaden	Atlantic Menhaden (*Brevoortia tyrannus*)
Miscellaneous Species	All organisms not included in another species group (jellyfish, frogs, turtles, squid, etc.)
Mullet	Striped Mullet (*Mugil cephalus*)
	White Mullet (*M. curema*)
Other Finfish	All finfish not included in another group
Other Shellfish	Crustaceans such as Grass Shrimp, Mantis Shrimp, and Crabs other than Blue Crabs
Shrimp	Brown Shrimp (*Peneaus aztecus*)
	Pink Shrimp (*P. duorarum*)
	White Shrimp (*P. setiferus*)
Spot	Spot (*Leiostomus xanthurus*)
Trout	Weakfish (*Cynoscion regalis*)
	Spotted Seatrout (*C. nebulosus*)

The total number and weight of each of these species groups are presented by month in Table 5.4.

5.3.2 Discussion

5.3.2.1 Finfish

Bay Anchovy

Since BSEP began circulating water pump operation in 1974, the bay anchovy has been one of the more dominant organisms impinged. Gunther and Hall (1963) stated that the bay anchovy accounted for more biomass than any other fish of the south Atlantic and Gulf Coasts. For the years 1976-1979 (III-VI), it accounted for 33.2%, 16.6%, 15.2%, and 24.6%, respectively, of the total number impinged each year (Table 5.5). Although they were the highest percentage of organisms impinged this year, the number impinged was less than in the previous two years when the bay anchovy ranked second in the number impinged during both years.

Bay anchovies are impinged in the highest numbers during the winter months, November-February (Table 5.6), with an average of 76% being impinged during this time period over the last four years. Length frequency showed that the majority of bay anchovies impinged were adults (Figs. 5.1a-d). They are not impinged in large numbers during their spawning season, indicating that even though they are estuarine or nearshore ocean spawners, they must spawn in areas away from the immediate vicinity of the plant. This and their tremendous numbers indicate the plant should not impact their population through impingement.

Spot

Spot are among the dominant organisms impinged at BSEP due to their large numbers in the estuary (see Section 4 and CFS, Vol. XV). In the Years III-VI, they accounted for 3.9%, 5.2%, 3.4%, and 13.8%, respectively, (Table 5.5) of the total impingement. Even though spot accounted for a large number of individuals impinged at BSEP this year (second in abundance), their total weight of 2988 kg (6,587 lbs) declined by 65% (8493 kg - 18724 lbs) from Year IV and 41% (7340 kg - 16183 lbs) from Year V. The heaviest impingement of spot in Year VI in relation to total plant flow occurred in March (Table 5.7). Length-frequency figures (Figs. 5.2a-d) show that in March 1979 the majority of fish impinged were from 20-40 mm (0.8-1.6 in) TL, whereas in previous years the lengths ranged from about 75-130 mm (2.9-5.1 in) TL indicating that the young-of-the-year entered the system sooner. This was also the case for April and May where lengths were from 20 to 70 mm (0.8-2.8 in) TL smaller. A tidal creek that intersects the intake canal was not blocked off and could have allowed spot of the 20-40 mm TL range to circumvent the diversion device and enter the intake canal where they would have been unable to escape from the intake canal.

Croaker

Croaker were impinged more heavily in Year VI (Table 5.3) than in earlier years. Numbers impinged in Year VI were over 1,000,000. The weight of these organisms, however, was only slightly larger--1368.1 kg (3013.4 lbs) compared to 1313.8 kg (2893.3 lbs.)--last year and much lower than in Years III and IV--1979.1 kg (4359.3 lbs.) and 4185.7 kg (9219.6 lbs), respectively--reflecting their smaller size. The length-frequency graphs (Figs. 5.3a-d) showed that from March through May the croaker impinged were smaller (20-50 mm) than in previous years. They ranged from 20 mm (0.80 in) TL to 100 mm (3.9 in) TL in Year VI. This was during the time the diversion device was in the canal and it appears that the diversion device excluded larger croaker while the postlarvae were able to move through and juveniles move around (through the tidal creek) the diversion device into the intake canal. The length frequency figures also showed a large number of juvenile croaker from 45 to 210 mm TL were impinged during May and June of 1979 (after failure of the diversion device). This corresponds with the peak of abundance in the estuary (see Section 4). This is typically when the majority of croaker are impinged (Table 5.8), but this year as many as 75 percent more were impinged than in previous years.

Menhaden

Impingement rates for menhaden were much lower th' year than in Years IV and V. This is at least partially due to the milder winter of 1979. Menhaden are susceptible to impingement during periods of low temperatures and are therefore impinged in higher numbers during the colder months. In Years IV and V, menhaden were impinged in the highest numbers from December to March (Table 5.9) when temperatures ranged from 16.0°C to 4°C (61.0°F - 39.0°F). The average temperature from December through March in Years IV, V, and VI was 9.0°C (48.0°F), 8.0°C (46.0°F), and 9.0°C (49.0°F), respectively. Actual numbers impinged in Year VI decreased 94% compared to Year V and 91% compared to Year IV. Weights also decreased by 79% and 71% compared to Years V and IV, respectively.

The most significant reduction in numbers occurred from December through April. This was the time period the diversion device was effective. Length frequency results (Figs. 5.4a-d) showed that menhaden impinged during February, March, and April 1979 were slightly larger (10-20 mm larger) than in 1978 (Fig. 5.4c) and nekton studies showed that this was true throughout the estuary.

Trout

The number of trout impinged in Year VI was the lowest of the past four years. Very few trout were impinged in October and November, 515 and 128, respectively (Table 5.4). The number impinged increased to 1,550 in December and 1,352 in January. In previous years very few trout were impinged from February to May with the exception of Year V when around 26,700 trout were impinged in May. The majority of trout was impinged from June to August (Table 5.10) with an average of 75% of them caught during this time period over the past four years. Nekton studies this year showed that the peak of abundance for trout occurred in mid-July. As indicated by the length-frequency graphs, these trout were mostly juveniles ranging from 30 mm to 65 mm (Figs.

5.5a-d and 5.6a-d), corresponding to length-frequency results found in the estuary (see Section 4). The adults that were impinged were not caught during the spawning season.

Flounder

Flounder are not impinged in high numbers at BSEP. Only 31,443 were impinged in Year VI, which was the highest number of the past four years. Their weight was 58% lower than the previous year, indicating smaller flounder were impinged this year. Approximately 80% of the flounder were impinged from April to July, which is consistent with trends observed in the past four years (Table 5.11) and in the estuary this year. Length frequency showed that the majority of the flounder impinged during this time were less than 200 mm (7.9 in) TL and all of them were less than 400 mm (15.7 in) TL (Figs. 5.7a-d and 5.8a-d). No adults (over 400 mm TL) were impinged during this time period. Length frequency showed that flounder are impinged over a wide size range (40-400 mm TL) throughout the year, with no clear pattern observed. Flounder are hardy fish, more able to withstand impingement than many other species. With the new nekton return system and use of the diversion device, there should be no impact on the flounder population due to impingement.

Mullet

Mullet are not impinged in large numbers at BSEP. In Year VI the number of mullet impinged was down from the two previous years (Table 5.4) with only 28,693 impinged. About 78% of the mullet were impinged from December to April (Table 5.12). Length frequency graphs (Figs. 5.9a-d and 5.10a-d) showed that all of the mullet impinged during this time were less than 200 mm (7.9 in) TL. These would be juveniles because mullet do not reach sexual maturity until after they reach 200 mm SL (Anderson 1958). Although the diversion device was in effect from January through April, some of the smaller juveniles could have passed through or around the diversion device or were already in the canal before the diversion device was completed.

Other Finfish

This group is composed of 155 species impinged but not previously discussed. Few of these are of great economic value, but all play a part in the ecosystem of the estuary. Some are present at only certain times of the year, such as hake which are present only during the winter months. Others are "strays" brough north by the Gulf Stream and not normally found in the Cape Fear estuary, and still others are freshwater species that are present during periods of high freshwater flow. A list of these species can be found in Table 5.3.

5.3.2.2 Shellfish

Shrimp

The number and weight of shrimp impinged this year increased over the past two years. The milder winter this year helped to increase the local shrimp populations after the two previous abnormally cold winters. The drastic reduction of the white shrimp population brought on by the severe winters of Years IV and V was very evident in the impingement catches for those years with white shrimp representing over 60% of the total weight of shrimp impinged in Year IV, dropping to only 5%-6% in Years V and VI. Numbers of white shrimp impinged also decreased in Years V and VI from a high of 621,196 in Year III to a low of 23,144 in Year V (Table 5.3). Coinciding with the reduction of white shrimp, the number of pink shrimp increased in numbers from 52,225 and 31,312 in Years III and IV, respectively, to 254,094 and 230.927 in Years V and VI, respectively. Weights of pink shrimp impinged also increased to over 30% of the total shrimp catch from Years III and IV to Years V and VI.

Brown shrimp also showed increases in numbers and weights. Numbers increased from a low of 258,987 in Year IV to a high (for the four-year period) of 569,043 in Year VI, an increase of 45%. Weights increased by 51% from Year IV (1447.1 kg - 3190.3 lbs) to Year VI (2857.1 kg - 6298.8 lbs). Impingement of shrimp was typically higher during the summer months than in the winter (Table 5.13).

Brown shrimp first appear in impingement catches in May, followed by white and pink shrimp occurring in June and July. Lengths appeared to be consistent throughout this four-year period with shrimp first occurring in the catches at about 50 mm (Figs. 5.11a-d, 5.12a-d, and 5.13a-d). At the peak, shrimp average over 110 mm with white and brown shrimp being the larger of the species. Commercial landings for North Carolina were down 16% in Year IV and down 47% in Year V (NMFS). Commercial catches are up at least for the first six months of 1979. Shrimp exhibit high survival ability after being impinged and with the new nekton return system, survival should be increased (CFS, Vol. XVII).

The decline in shrimp abundance that occurred in the Cape Fear River also occurred along the east coast from North Carolina to Florida; it was not a result of plant operations. Extremely cold weather and high freshwater flows in the spring are the apparent causes for the shrimp population fluctuations.

Blue Crab

Blue crabs are one of the most abundant organisms impinged at BSEP. They have accounted for 8.0%, 1.9%, 4.5%, and 7.1% of the total numbers and for 23.8%, 5.1%, 9.4%, and 25.4% of the total weight impinged in the Years III-VI, respectively. Most crabs (65.5%) in Year III were impinged from September to February. However, in Years IV, V, and VI, the majority (87.0%, 75.0%, and 53.0%, respectively) were impinged from March to August (Table 5.14). This was probably due to the severely cold winters of Years IV and V. Blue crabs bury in the bottom during cold weather and remain there longer during the colder winters. Blue crabs are very hardy and survive impingement well. Survival studies show that 80%-85% of the crabs impinged can be returned to the estuary alive (CFS, Vol. XVII). With the diversion device in place and the new nekton return system in operation, virtually all impingement losses to the blue crab population can be eliminated.

Other Shellfish

Hardback shrimp, grass shrimp, mantis shrimp, calico crabs, and other swimming crabs of the genus Portunus comprise this group. None of these is impinged in large numbers. Hardback shrimp (Trachypeneus constrictus) are not commercially important in North Carolina. They are not present in impingement catches in high numbers during the winter but are common during the spring and summer. Grass shrimp (Palaemonetes spp.) and mantis shrimp (Squilla empusa) appear to be impinged in higher than usual numbers during periods following storms or higher freshwater flow. Calico crabs and portunid crabs are present in high numbers in the ocean and only move inside the estuary during periods of high salinity. They are susceptible to impingement during this time but are only impinged infrequently.

5.3.2.3 Miscellaneous Species

This group is composed of all other species or organisms impinged but not previously discussed. Brief squid (Lolliguncula brevis) is the dominant species in this group. They appear to be impinged primarily during periods of high salinity in the estuary. Terrapins (Malaclemys terrapin) are also in this group but are not impinged in high numbers. They exhibit close to 100% survival and nearly all are returned to the estuary. Other species in this group are jellyfish, frogs, and turtles.

5.4 Diversion Device

5.4.1 Results

A total of 180 trawls (efforts) was taken at three stations in the intake canal. These trawls collected 257,133 organisms representing 91 taxonomic groups from January 1979 to September 1979 (Table 5.15).

Spot were the most abundant organism comprising 43.2% of the total catch of organisms in the study. Croaker were second with 16.4% of the total catch. These were followed by bay anchovy (12.7%), grass shrimp (8.7%), brown shrimp (6.6%), blue crabs (2.9%), Atlantic menhaden (2.5%), and weakfish (1.7%). All other organisms combined, representing 83 more species, accounted for 5.3% of the total. Catch per unit effort (CPUE) for each of the species groups is presented by station in Table 5.16.

5.4.2 Discussion

The diversion device was considered to be in effective operation from mid-January through mid-May 1979. After this time it remained in place, but due to severe underwashing on the Walden Creek side and the loss of several panels that broke away from the pilings, it was considered ineffective. Since its presence may have influenced the impingement catch, sampling was continued through September 11, 1979. Spot, croaker, and menhaden are discussed in detail because of their importance in the estuary and abundance in impingement.

Spot

CPUE for young-of-the-year spot was highest at Station 6 at 771.7, followed by Station 5 at 701.2, and Station 4 at 267.7 (Table 5.16 and Fig. 5.14). Analysis of the data showed that significantly ($.001 \leq p$) more young-of-the-year spot were caught inside the diversion device at Stations 5 and 6 than outside at Station 4. The majority (79%) of young spot were caught in April and May with lengths ranging from 20 to 80 mm TL and over 50% were from 30 to 45 mm TL. Spot with a length of 40 mm TL or less could move through the screening of the diversion device. Many, if not all, of these spot of the 20-80 mm TL size range could have moved around the diversion device at high tide and through the tidal creek that intersects the intake canal. A crab fence constructed in May and June eliminated this means of entering the canal. Exclusion of predators and the inability of these spot to exit from the intake canal with an ebbing tide could partly explain the larger number of spot in the intake canal.

The exclusion of larger spot from the intake canal can be seen in the data. Analysis of mean lengths showed that larger young-of-the-year spot were caught at Stations 4 and 6 than at Station 5 (Fig. 5.15). Very few spot (less than 0.5% of total catch) over 150 mm were caught which was true for the entire estuary. Most young-of-the-year spot were caught in March, April, and May. These fish ranged in size from 20 to 80 mm (Fig. 5.16). Yearling (and a few adult) spot ranged from 80 to 290 mm TL with most from about 90-150 mm TL. Most spot caught in January were yearlings. These spot represented 99.8% of the catch of spot in January, 33.6% in February, 9.5% in March, and 1.8% in April. After May, they represented less than 1% of the total spot catch for June, July, August, and September.

Croaker

Young-of-the-year croaker ranged from 15 to 135 mm TL throughout the study period (Fig. 5.17). About 79% of the croaker caught from January to September were between 30 and 55 mm and 98.7% were less than 120 mm TL. This size range is very similar to the sizes impinged during this time. Analysis of mean lengths (Fig. 5.18) showed larger croaker were caught at Station 4 than at Stations 5 and 6, while the diversion device was in effect. After the device failed, larger croaker were more prevalent at Stations 6 and 5, indicating movement towards the plant after the diversion device was ineffective. From March to May of this year, the croaker impinged were smaller (about 60-100 mm TL smaller) than 1978 and less than 2% were over 120 mm. This is partly due to the earlier recruitment of young croaker this year.

Analysis of the data showed that significantly more ($.001 \leq p$) young-of-the-year croaker were caught after the diversion device was ineffective which was during the time of peak abundance in the estuary. Most (58%) were caught in May and June. This is also true for larger croaker with slightly more caught in June than in May.

Menhaden

Menhaden caught in the trawls during the time the diversion device was in effect were primarily yearlings 90-100 mm TL (Fig. 5.20). Significantly ($.001 \leq p$) more were caught in February than in January, March, and April (abundance was highest for this size group from January to April). Juvenile and adult menhaden catches were highest at Station 4 and were only slightly lower at Station 5. Catches at Station 6 were significantly lower than Stations 4 and 5 (Fig. 5.19). Ninety percent of the menhaden caught during the study were caught from January to April, and it appears as though the menhaden were able to move around the diversion device during high tide. Nekton studies showed that this group of menhaden moved out of the estuary in May, which is when they began disappearing from the trawl samples. This year class disappeared from impingement catch in June (Fig. 5.4d). Menhaden catches in the trawls after April were very small and consisted of a wide range of sizes (Fig. 5.20).

5.5 Conclusions

Total weight of organisms impinged this year (VI) was down from the two previous years (IV and V). This year's weight was 45% lower than Year IV and 62% lower than Year V. Even though Year VI's total weight was higher than Year III (by 28%), this was expected because only one unit was in operation during Year III, thus less cooling water was needed. The number of organisms impinged was also less this year than in Years IV and V, 35% and 54% less, respectively. Numbers impinged in Year VI were 47% higher than Year III for the same reason explained above. Weights for menhaden, miscellaneous species, mullet, other finfish, spot, and trout were less in Year VI than in Years IV and V. Bay anchovy and flounder were impinged less this year than last year and croaker were impinged in less weight this year than in Year IV. Weights for blue crabs and other shellfish were higher this year than in the Years III, IV, and V. The weight of shrimp increased over Years IV and V, but did not reach the weight impinged in Year III (see Table 5.3 for weights impinged Years III-VI).

The diversion device was in effect from mid-January to around the middle of May 1979. Total weight of impinged organisms for this time period this year was 82% less than in Year V and 69% less than in Year IV. This indicates that the diversion device may have decreased impingement by excluding larger fish. Even though this winter was milder than the previous two winters, the marked decrease in the impingement weight must be attributed, at least in part, to the diversion device. The effectiveness of the diversion device appears especially evident for species normally impinged in higher numbers during the winter months.

From January to May in Year IV, 5334.1 kg* (11759.7 lbs) of spot were impinged. In Year V, this increased to 6292.5 kg (13872.6 lbs). This year (VI), with the diversion device in place, impingement of spot fell to only 1962.7 kg (4327.0 lbs). This was a decrease of 65% from Year IV and 69% from Year V. The number of spot impinged in Year VI with the diversion device in place increased 729% over Year III, 129% over Year IV, and 122% over Year V. However, length frequency (Fig. 5.2d) shows that the spot impinged this year (VI) were smaller than in Years III, IV, and V. These small spot appeared in impingement catches earlier this year than in previous years. Diversion device studies showed that while the diversion was in effect, spot of significantly greater mean length (Fig. 5.15) were caught outside and just inside the diversion device at Stations 4 and 6 than at the plant (Station 5). Also, spot at Station 4 were slightly larger (2-5 mm) than at Station 6 and 5-10 mm larger than Station 5 (Fig. 5.16). This tends to support the theory that the diversion device does exclude larger fish.

The weights of croaker also decreased for the time the diversion device was in effect. Weights for Year VI decreased 441% from Year III, 777% from Year IV, and 0.1% from Year V. Numbers impinged in Year VI from January to May increased 439% over Year III, 273% over Year IV, and

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*This total does not include fish impinged in February of 1977 because no data were collected that month.

287% over Year V. However, as with spot, impingement length-frequency data showed that these croaker (Year VI) were smaller than in previous years.

Diversion device length-frequency for croaker also showed that while the diversion device was effective (January to mid-May), mean lengths for croaker were larger at Station 4 than at Stations 6 and 5 (Fig. 5.18). These fish were from 510 mm larger. After failure of the diversion device, catches of croaker increased inside the diversion device and mean lengths of the croaker also increased. These trends can also be seen in the impingement catches with smaller individuals being impinged in Year VI than in previous years during the time period the diversion device was in effect. After failure of the diversion device, numbers impinged increased along with slight increases in lengths. Weights of impinged croaker were much lower in Year VI than in Years III and IV, also indicating smaller croaker were being impinged.

The decrease in impingement during January to May is especially evident with menhaden. The total weight impinged during this time period in Years IV and V was 46515.1 kg (102547.2 lbs)* and 61065.7 kg (134625.4 lbs), respectively, while the total for this period in Year VI was only 4237.5 kg (9341.9 lbs). These were decreases of 91% and 93%, respectively. Numbers of menhaden impinged per million cubic meters of water entrained (Table 5.9) also decreased this year, with the most significant reduction occurring from December to April. This decrease occurred despite the fact that menhaden impinged this year (VI) were larger than in previous years. Nekton studies showed that this was the case throughout the lower estuary. This and the reductions seen in impingement can be partly attributed to the milder winter. Diversion device studies showed that more menhaden were caught at Stations 4 and 5 than at Station 6. Menhaden were able to move around the diversion device and it appears that once they were inside they moved directly to the plant. Mean lengths were not significantly different at the three different stations.

Bay anchovies are impinged in the highest numbers from November to February over a wide range of lengths (20-100 mm) TL. The diversion device would have a lesser effect on them because of their smaller size. The majority of bay anchovies could pass through the mesh of the diversion device screening. Even so, it is thought that the diversion device would divert some by the mere fact of its presence at the mouth of the intake canal.

Diversion device data for other species not previously discussed, but caught in the trawl samples, are lacking. Because of the low numbers caught (except for grass shrimp which showed very high catches in February) analysis would not be valid. Grass shrimp, however, because of their small size would probably not be deviated by the diversion device.

If the problems associated with leaving the diversion device in year-round (biofouling and underwashing of the screens) can be solved and movement around the diversion device is eliminated by construction of the "crab fence," impingement should be reduced substantially. With the diversion device in effective use, the only organisms susceptible to impingement will be those that can move through the mesh in the screening. This cannot be eliminated, but impingement catches resulting from these organisms would be substantially lower than past years. Year-round use of the diversion device and/or return to the estuary of the reduced number of impinged organisms by the improved nekton system should ensure that the plant's effect upon the estuarine system is minimal.

5.6 References

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Table 5.1 LIST OF SPECIES USED IN LENGTH FREQUENCY ANALYSIS

Anchoa mitchilli - Bay anchovy

Brevoortia tyrannus - Atlantic menhaden

Cynoscion nebulosus - Spotted seatrout

C. regalis - Weakfish

Leiostomus xanthurus - Spot

Micropogonias undulatus - Atlantic croaker

Mugil cephalus - Striped mullet

M. curema - White mullet

Paralichthys dentatus - Summer flounder

P. lethostigma - Southern flounder

Penaeus aztecus - Brown shrimp

P. duorarum - Pink shrimp

P. setiferus - White shrimp

TABLE 5.2
A COMPARISON OF IMPINGEMENT RATES
SEPTEMBER 1975 - AUGUST 1979

	SEPT. 1975-AUG. 1976	SEPT. 1976-AUG. 1977	SEPT. 1977-AUG. 1978	SEPT. 1978-AUG. 1979
NUMBER OF ORGANISMS	4,970,559	14,465,201	20,290,670	9,379,226
WEIGHT (KG)	36,160	91,786	132,989	50,277
NUMBER OF SHELLFISH	1,608,933	1,313,431	1,972,270	2,209,812
WEIGHT OF SHELLFISH	14,268	9,005	16,205	18,979
NUMBER OF FINFISH	3,329,539	13,089,438	18,166,796	7,061,401
WEIGHT OF FINFISH	20,561	81,939	108,986	30,741
NUMBER OF MISC. SPECIES	32,087	62,332	151,604	108,013
WEIGHT OF MISC. SPECIES	1,331	841	7,798	557
TOTAL NUMBER OF TAXA	140	125	136	146
TOTAL TAXA OF FINFISH	121	108	120	129
SPECIES WITH LESS THAN 100 SPECIMENS	45	29	30	34
SPECIES WITH LESS THAN 1000 SPECIMENS	79	63	63	76
SPECIES REPRESENTING MORE THAN 2 PERCENT OF THE TOTAL CATCH	10	6	4	11

Table 5.3

SPECIES LIST OF ORGANISMS IMPINGED AT BSEP

FROM SEPTEMBER 1975 - AUGUST 1979

SPECIES	SEP 75 - AUG 76 NUMBER	SEP 75 - AUG 76 WT. (KG)	SEP 76 - AUG 77 NUMBER	SEP 76 - AUG 77 WT. (KG)	SEP 77 - AUG 78 NUMBER	SEP 77 - AUG 78 WT. (KG)	SEP 78 - AUG 79 NUMBER	SEP 78 - AUG 79 WT. (KG)
ALEWIFE ALOSA PSEUDOHARENGUS	3382	10.5	2271	20.9	0	0.0	0	0.0
AMERICAN EEL ANGUILLA ROSTRATA	161	24.8	137	5.9	442	18.1	502	55.2
AMERICAN SHAD ALOSA SAPIDISSIMA	7456	33.5	4462	29.3	6684	66.9	7291	41.9
ATLANTIC BUMPER CHLOROSCOMBRUS CHRYSURUS	21730	96.2	32560	133.5	50366	239.3	15997	74.8
ATLANTIC CUTLASSFISH TRICHIURUS LEPTURUS	2412	31.0	248	5.1	193	0.8	131	1.0
ATLANTIC MENHADEN BREVOORTIA TYRANNUS	316411	9990.0	7587988	54884.4	11899284	75304.1	710712	15655.6
ATLANTIC MIDSHIPMAN PORICHTHYS POROSISSIMUS	18	1.5	0	0.0	0	0.0	185	5.4
ATLANTIC NEEDLEFISH STRONGYLURA MARINA	1235	5.1	1268	17.4	1903	7.4	1436	6.8
ATLANTIC SHARPNOSE SHARK RHIZOPRINODON TERRAENOVAE	26	4.0	83	10.8	150	15.3	227	28.8
ATLANTIC SILVERSIDE MENIDIA MENIDIA	14304	44.2	86075	250.8	304371	1157.6	31044	121.0
ATLANTIC SPADEFISH CHAETODIPTERUS FABER	282	0.5	617	2.6	3112	9.2	4491	13.4
ATLANTIC STINGRAY DASYATIS SABINA	133	17.8	515	136.2	716	199.6	184	42.8
ATLANTIC STURGEON ACIPENSER OXYRHYNCHUS	30	9.8	21	14.9	201	77.3	12	3.0
ATLANTIC THREAD HERRING OPISTHONEMA OGLINUM	2569	13.7	169	1.2	312	1.6	138	1.1
BALLYHOO HEMIRAMPHUS BRASILIENSIS	0	0.0	0	0.0	0	0.0	462	0.2
BANDED DRUM LARIMUS FASCIATUS	258	21.3	1412	1.5	130	0.4	468	3.8
BAY ANCHOVY ANCHOA MITCHILLI	1648709	2509.7	2406617	3415.3	3088203	5586.5	2306849	4133.2
BAY WHIFF CITHARICHTHYS SPILOPTERUS	3422	44.3	2412	27.3	4248	39.3	7406	62.9
BIGEYE PRIACANTHUS ARENATUS	0	0.0	0	0.0	0	0.0	9	0.2
BIGHEAD SEAROBIN PRIONOTUS TRIBULUS	39264	82.2	111340	318.3	112431	261.7	164548	344.5
BLACK DRUM POGONIAS CROMIS	0	0.0	0	0.0	28	21.1	246	24.6
BLACK GROUPER MYCTEROPERCA BONACI	18	1.9	16	1.5	120	1.9	0	0.0
BLACK SEA BASS CENTROPRISTIS STRIATA	87	2.4	0	0.0	74	1.3	50	1.4
BLACKCHEEK TONGUEFISH SYMPHURUS PLAGIUSA	78336	317.1	62411	291.3	254568	1063.7	129561	548.8
BLUE CRABS CALLINECTES SPP.	397317	8592.2	272493	4695.4	906076	12551.6	666963	12755.6

Table 5.3 (cont'd.)

SPECIES LIST OF ORGANISMS IMPINGED AT BSEP

FROM SEPTEMBER 1975 - AUGUST 1979

SPECIES	SEP 75 - AUG 76 NUMBER	SEP 75 - AUG 76 WT. (KG)	SEP 76 - AUG 77 NUMBER	SEP 76 - AUG 77 WT. (KG)	SEP 77 - AUG 78 NUMBER	SEP 77 - AUG 78 WT. (KG)	SEP 78 - AUG 79 NUMBER	SEP 78 - AUG 79 WT. (KG)
BLUE RUNNER CARANX CRYSOS	0	0.6	0	0.0	57	1.6	0	0.0
BLUEBACK HERRING ALOSA AESTIVALIS	106881	321.7	125113	631.0	109752	747.2	412923	400.8
BLUEFISH POMATOMUS SALTATRIX	3019	42.0	9902	106.9	17873	259.8	7356	113.5
BLUEGILL LEPOMIS MACROCHIRUS	807	6.6	60	0.2	7098	75.9	921	3.6
BLUESPOTTED SUNFISH ENNEACANTHUS GLORIOSUS	0	0.0	0	0.0	48	0.1	56	0.1
BLUNTNOSE STINGRAY DASYATIS SAYI	0	0.0	0	0.0	14	6.4	9	3.3
BRIEF SQUID LOLLIGUNCULA BREVIS	26593	189.5	60100	333.6	42148	184.2	106979	412.5
BROWN BAR CRABS PORTUNUS SPP	950	6.2	16806	47.6	5107	12.4	8486	13.5
BROWN BULLHEAD ICTALURUS NEBULOSUS	6	1.2	0	0.0	0	0.0	0	0.0
BROWN SHRIMP PENAEUS AZTECUS	438103	1884.8	258987	1447.1	313381	1792.0	569043	2857.1
BUTTERFISH PEPRILUS TRIACANTHUS	1672	3.0	38832	124.5	1041	2.0	1320	7.8
CALICO CRABS OVALIPES SPP	0	0.0	0	0.0	20	0.2	1085	0.7
CHAIN PIPEFISH SYNGNATHUS LOUISIANAE	1217	3.6	848	1.9	2247	7.5	2019	8.6
CLEARNOSE SKATE RAJA EGLANTERIA	0	0.0	8	4.7	6	10.2	19	11.8
COBIA RACHYCENTRON CANADUM	238	2.8	356	0.4	364	0.3	189	0.3
COMMON SQUID LOLIGO PEALII	80	0.4	0	0.0	0	0.0	0	0.0
COMMON STARFISH ASTERIAS FORBESI	627	0.9	83	0.1	0	0.0	0	0.0
CONGER EEL CONGER OCEANICUS	0	0.0	8	0.6	303	44.6	223	10.4
COWNOSE RAY RHINOPTERA BONASUS	0	0.0	0	0.0	8	10.8	0	0.0
CRESTED BLENNY HYPLEUROCHILUS GEMINATUS	0	0.0	0	0.0	0	0.0	15	0.1
CRESTED CUSK-EEL OPHIDION WELSHI	5690	75.4	7712	109.9	14486	215.3	6450	72.4
CREVALLE JACK CARANX HIPPOS	20844	22.6	11866	14.5	5479	17.4	8123	17.4
CROAKER MICROPOGONIAS UNDULATUS	192105	1979.1	420612	4185.7	291229	1313.8	1085429	1368.1
CUSK-EEL OPHIDIIDAE	0	0.0	0	0.0	0	0.0	9714	96.2

Table 5.3 (cont'd.)

SPECIES LIST OF ORGANISMS IMPINGED AT RSEP

FROM SEPTEMBER 1975 - AUGUST 1979

SPECIES	SEP 75 - AUG 76 NUMBER	SEP 75 - AUG 76 WT. (KG)	SEP 76 - AUG 77 NUMBER	SEP 76 - AUG 77 WT. (KG)	SEP 77 - AUG 78 NUMBER	SEP 77 - AUG 78 WT. (KG)	SEP 78 - AUG 79 NUMBER	SEP 78 - AUG 79 WT. (KG)
DARTER GOBY GOBIONELLUS BOLEOSOMA	30	0.0	0	0.0	0	0.0	935	1.7
DIAMONDBACK TERRAPIN MALACLEMYS TERRAPIN	521	151.9	1801	506.6	1136	316.0	618	135.3
DOG SNAPPER LUTJANUS JOCU	0	0.0	0	0.0	8	0.2	0	0.0
FAT SLEEPER DORMITATOR MACULATUS	233	1.7	0	0.0	140	2.1	47	0.1
FEATHER BLENNY HYPSOBLENNIUS HENTZI	1093	4.1	785	3.1	1710	6.7	2931	16.6
FLIER CENTRARCHUS MACROPTERUS	0	0.0	0	0.0	309	6.1	0	0.0
FLORIDA POMPANO TRACHINOTUS CAROLINUS	6	0.5	804	3.5	0	0.0	6	1.4
FLYINGFISH CYPSELURUS SPP	16	2.8	0	0.0	0	0.0	0	0.0
FRECKLED BLENNY HYPSOBLENNIUS IONTHAS	3180	8.5	2176	6.6	2355	7.3	2116	6.7
FRESHWATER GOBY GOBIONELLUS SHUFELDTI	54	0.1	113	0.3	0	0.0	0	0.0
FRESHWATER PRAWN MACROBRACHIUM SPP.	59	0.6	0	0.0	75	0.5	105	0.7
FRINGED FLOUNDER ETROPUS CROSSOTUS	4145	30.2	7102	36.2	14378	73.8	93236	360.1
GAG MYCTEROPERCA MICROLEPIS	56	2.9	47	1.2	539	20.4	31	1.8
GIZZARD SHAD DOROSOMA CEPEDIANUM	17501	120.8	365991	1023.5	28324	328.7	11724	74.1
GOLDEN SHINER NOTEMIGONUS CHRYSOLEUCAS	37	0.1	0	0.0	3464	20.4	35	0.4
GRASS SHRIMP PALAEMONETES SPP	40356	16.1	152391	63.8	249268	103.3	258493	112.1
GRAY SNAPPER LUTJANUS GRISEUS	1255	10.7	845	3.7	5234	27.1	2155	12.7
GREAT BARRACUDA SPHYRAENA BARRACUDA	15	0.0	0	0.0	0	0.0	0	0.0
GREEN GOBY MICROGOBIUS THALASSINUS	31	0.0	0	0.0	0	0.0	0	0.0
GREEN TREEFROG HYLA CINEREA	0	0.0	47	0.0	0	0.0	0	0.0
GUAGUANCHE SPHYRAENA GUACHANCHO	30	0.0	228	0.2	74	0.1	79	0.1
GULF FLOUNDER PARALICHTHYS ALBIGUTTA	0	0.0	15	0.4	0	0.0	8	0.1
HAKE GADIDAE	0	0.0	0	0.0	0	0.0	1141	3.6
HALFBEAK HYPORHAMPHUS UNIFASCIATUS	166	0.1	1518	2.3	1140	0.7	2595	1.2

Table 5.3 (cont'd.)

SPECIES LIST OF ORGANISMS IMPINGED AT BSEP

FROM SEPTEMBER 1975 - AUGUST 1979

SPECIES	SEP 75 - AUG 76 NUMBER	SEP 75 - AUG 76 WT. (KG)	SEP 76 - AUG 77 NUMBER	SEP 76 - AUG 77 WT. (KG)	SEP 77 - AUG 78 NUMBER	SEP 77 - AUG 78 WT. (KG)	SEP 78 - AUG 79 NUMBER	SEP 78 - AUG 79 WT. (KG)
HARVESTFISH PEPRILUS ALEPIDOTUS	613	6.6	359	2.8	2347	14.9	5952	46.8
HICKORY SHAD ALOSA MEDIOCRIS	0	0.0	6	1.9	399	4.9	38	0.6
HOGCHOKER TRINECTES MACULATUS	16487	91.5	18866	105.1	62077	367.1	11353	73.1
HORSE-EYE JACK CARANX LATUS	0	0.0	0	0.0	86	3.5	0	0.0
INSHORE LIZARDFISH SYNODUS FOETENS	483	6.0	1551	46.9	2561	73.7	2262	100.5
IRISH POMPANO (MOJARRA) DIAPTERUS OLISTHOSTOMUS	787	5.4	831	2.5	241	0.9	807	8.5
JACKS CARANGIDAE	0	0.0	0	0.0	0	0.0	62	2.5
JELLY BOMB OR CABBAGE HEAD STOMOLOPHUS MELEAGRIS	4283	983.6	0	0.0	108200	7297.4	0	0.0
KING MACKEREL SCOMBEROMORUS CAVALLA	0	0.0	0	0.0	0	0.0	109	0.2
KINGFISH MENTICIRRHUS SPP	0	0.0	0	0.0	0	0.0	35	0.1
LADYFISH ELOPS SAURUS	144	5.7	39	3.6	211	11.7	164	14.1
LANE SNAPPER LUTJANUS SYNAGRIS	0	0.0	31	0.1	143	0.9	0	0.0
LARGEMOUTH BASS MICROPTERUS SALMOIDES	43	1.6	0	0.0	1041	2.6	27	0.0
LEATHERJACKET OLIGOPLITES SAURUS	6	0.0	0	0.0	0	0.0	0	0.0
LEOPARD SEAROBIN PRIONOTUS SCITULUS	384	1.0	246	1.2	1828	6.9	1078	6.3
LINED SEAHORSE HIPPOCAMPUS ERECTUS	0	0.0	76	0.1	8	0.0	17221	74.4
LOGGERHEAD SEA TURTLE CARETTA CARETTA	0	0.0	0	0.0	1	237.5	0	0.0
LONGNOSE GAR LEPISOSTEUS OSSEUS	14	5.1	0	0.0	17	6.2	50	0.0
LOOKDOWN SELENE VOMER	16094	51.5	4282	16.3	20476	198.6	26562	77.9
MANTIS SHRIMP SQUILLA EMPUSA	18662	169.1	17809	187.0	37112	388.3	83381	1367.9
MICROGOBIUS SPP. MICROGOBIUS SPP.	0	0.0	0	0.0	0	0.0	74	0.1
MIXED HAKE UROPHYCIS SPP.	508	1.4	353	0.6	0	0.0	185	0.4
MIXED MULLET MUGIL SPP.	1063	11.5	0	0.0	8	0.0	0	0.0
MOJARRA EUCINOSTOMUS SPP	3030	11.3	171	0.8	0	0.0	233	5.5

Table 5.3 (cont'd.)

SPECIES LIST OF ORGANISMS IMPINGED AT BSEP

FROM SEPTEMBER 1975 - AUGUST 1979

SPECIES	SEP 75 - AUG 76 NUMBER	SEP 75 - AUG 76 WT. (KG)	SEP 76 - AUG 77 NUMBER	SEP 76 - AUG 77 WT. (KG)	SEP 77 - AUG 78 NUMBER	SEP 77 - AUG 78 WT. (KG)	SEP 78 - AUG 79 NUMBER	SEP 78 - AUG 79 WT. (KG)
MOONFISH SELENE SETAPINNIS	73	0.1	63	0.1	139	0.2	269	0.3
MUD SHRIMP UPOGEBIA AFFINIS	25	0.0	587	1.1	519	1.0	2570	[illegible].9
MUMMICHOG FUNDULUS HETEROCLITUS	3685	11.3	2095	4.9	4229	13.1	1441	4.4
NAKED GOBY GOBIOSOMA BOSCI	64	0.0	188	0.4	348	0.5	495	1.1
NASSAU GROUPER EPINEPHELUS STRIATUS	6	0.0	0	0.0	0	0.0	0	0.0
NORTHERN KINGFISH MENTICIRRHUS SAXATILIS	0	0.0	0	0.0	0	0.0	391	0.9
NORTHERN PIPEFISH SYNGNATHUS FUSCUS	467	0.9	1160	1.8	837	2.1	730	1.6
NORTHERN PUFFER SPHOEROIDES MACULATUS	403	0.5	1483	2.5	430	3.9	665	1.1
NORTHERN SEAROBIN PRIONOTUS CAROLINUS	110	0.2	294	0.7	29	0.0	301	0.9
NORTHERN SENNET (BARRACUDA) SPHYRAENA BOREALIS	226	0.1	0	0.0	0	0.0	238	0.3
NORTHERN STARGAZER ASTROSCOPUS GUTTATUS	72	0.1	1104	1.9	0	0.0	0	0.0
OCELLATED FLOUNDER ANCYLOPSETTA QUADROCELLATA	1032	5.1	2609	20.8	3145	[illegible]1.7	1849	12.1
OPOSSUM PIPEFISH OOSTETHUS LINEATUS	0	0.0	15	0.0	0	0.0	70	0.0
ORANGE FILEFISH ALUTERUS SCHOEPFI	266	0.4	326	0.3	16	0.0	370	0.3
OYSTER TOADFISH OPSANUS TAU	5010	90.4	11162	197.9	17204	340.3	16418	247.3
PALESPOTTED SNAKE EEL OPHICHTHUS OCELLATUS	0	0.0	0	0.0	0	0.0	9	0.0
PARALICHTHYS SPP PARALICHTHYS SPP	0	0.0	246	1.0	1262	10.2	0	0.0
PERMIT TRACHINOTUS FALCATUS	12	0.0	23	0.0	49	0.8	311	0.7
PIGFISH ORTHOPRISTIS CHRYSOPTERA	4069	15.3	1841	5.3	2762	6.2	453	8.0
PINFISH LAGODON RHOMBOIDES	31750	241.1	73567	582.4	122372	949.4	6919	84.8
PINK SHRIMP PENAEUS DUORARUM	52226	114.3	31312	80.8	254094	1042.0	230927	1364.6
PINK WORMFISH MICRODESMUS LONGIPINNIS	0	0.0	7	0.1	0	0.0	0	0.0
PIPEFISH SPP SYNGNATHUS SPP	0	0.0	0	0.0	32	0.0	0	0.0
PIRATE PERCH APHREDODERUS SAYANUS	10	0.0	0	0.0	0	0.0	0	0.0

Table 5.3 (cont'd.)

SPECIES LIST OF ORGANISMS IMPINGED AT BSEP

FROM SEPTEMBER 1975 - AUGUST 1979

SPECIES	SEP 75 - AUG 76 NUMBER	SEP 75 - AUG 76 WT. (KG)	SEP 76 - AUG 77 NUMBER	SEP 76 - AUG 77 WT. (KG)	SEP 77 - AUG 78 NUMBER	SEP 77 - AUG 78 WT. (KG)	SEP 78 - AUG 79 NUMBER	SEP 78 - AUG 79 WT. (KG)
PLANEHEAD FILEFISH MONACANTHUS HISPIDUS	9134	10.2	29128	22.5	3104	6.0	11400	9.3
PUMPKINSEED LEPOMIS GIBBOSUS	0	0.0	295	1.5	5553	66.5	0	0.0
RED DRUM SCIAENOPS OCELLATA	173	0.4	121	41.8	5732	21.3	454	1.2
RED GROUPER EPINEPHELUS MORIO	0	0.0	9	0.	63	5.2	0	0.0
REDEAR SUNFISH LEPOMIS MICROLOPHUS	0	0.0	0	0.0	165	5.7	9	0.0
REMORA REMORA REMORA	0	0.0	0	0.0	0	0.0	30	2.3
ROCK SEA BASS CENTROPRISTIS PHILADELPHICA	74	2.2	215	[illegible]	57	2.7	7	0.1
ROCK SHRIMP SICYONIA SPP	12	0.0	192	0.3	120	0.2	367	0.6
ROUGH SILVERSIDE MEMBRAS MARTINICA	14450	35.3	48649	138.6	38097	123.7	235743	615.4
SAILFIN MOLLY POECILIA LATIPINNA	6	0.0	0	0.0	0	0.0	0	6.0
SAND PERCH DIPLECTRUM FORMOSUM	6	0.0	23	0.2	84	2.6	0	0.0
SAND SHRIMP CRANGON SEPTEMSPINOSA	0	0.0	0	0.0	43	0.0	130	0.1
SARGASSUMFISH HISTRIO HISTRIO	0	0.0	68	1.1	0	0.0	0	0.0
SEA CATFISH ARIUS FELIS	45	3.4	0	0.0	0	0.0	0	0.0
SEA HARE APLYSIA SPP	8	4.9	0	0.0	0	0.0	43	8.0
SEA ROBIN SPP TRIGLIDAE	0	0.0	0	0.0	0	0.0	24436	37.4
SHARKSUCKER ECHENEIS NAUCRATES	6	0.6	8	0.2	0	0.0	0	0.0
SHARPTAIL GOBY GOBIONELLUS HASTATUS	428	2.4	372	1.2	953	3.2	702	2.5
SHEEPSHEAD ARCHOSARGUS PROBATOCEPHALUS	202	10.2	0	0.0	1190	16.1	157	5.6
SHEEPSHEAD MINNOW CYPRINODON VARIEGATUS	77	0.1	30	0.0	0	0.0	0	0.0
SHRIMP EEL OPHICHTHUS GOMESI	153[illegible]	68.7	703	32.7	1060	38.7	5084	184.2
SILVER JENNY EUCINOSTOMUS GULA	31	0.2	23	0.1	667	5.3	969	11.7
SILVER PERCH BAIRDIELLA CHRYSURA	19284	118.5	34689	673.7	27580	313.0	8236	45.6
SILVER SEATROUT CYNOSCION NOTHUS	12	0.1	0	0.0	0	0.0	0	0.0

Table 5.3 (cont'd.)

SPECIES LIST OF ORGANISMS IMPINGED AT BSEP

FROM SEPTEMBER 1975 - AUGUST 1979

SPECIES	SEP 75 - AUG 76 NUMBER	SEP 75 - AUG 76 WT. (KG)	SEP 76 - AUG 77 NUMBER	SEP 76 - AUG 77 WT. (KG)	SEP 77 - AUG 78 NUMBER	SEP 77 - AUG 78 WT. (KG)	SEP 78 - AUG 79 NUMBER	SEP 78 - AUG 79 WT. (KG)
SKILLETFISH (CLINGFISH) GOBIESOX STRUMOSUS	2059	4.3	4301	7.6	5773	13.8	[illegible]	[illegible]
SMOOTH BUTTERFLY RAY GYMNURA MICRURA	18	3.7	38	8.2	34	6.0	[illegible]	[illegible]
SMOOTH PUFFER LAGOCEPHALUS LAEVIGATUS	38	0.2	76	0.1	0	0.0	[illegible]	[illegible]
SNAPPING SHRIMP ALPHEUS SPP	3196	3.3	6187	7.7	10933	12.0	[illegible]	32.3
SNAPPING TURTLE CHELYDRA SERPENTINA	0	0.0	0	0.0	0	0.0	6	0.9
SOUTHERN FLOUNDER PARALICHTHYS LETHOSTIGMA	7156	440.5	6793	549.8	21233	939.9	21083	550.7
SOUTHERN HAKE UROPHYCIS FLORIDANUS	261	1.2	1928	18.7	199	3.4	5606	31.2
SOUTHERN KINGFISH MENTICIRRHUS AMERICANUS	689	1.4	1494	18.2	1787	[illegible]	561	8.3
SOUTHERN STARGAZER ASTROSCOPUS Y-GRAECUM	377	3.6	156	5.2	488	0.9	2546	6.0
SOUTHERN STINGRAY DASYATIS AMERICANA	16	4.6	0	0.0	0	0.0	8	2.6
SPANISH MACKEREL SCOMBEROMORUS MACULATUS	141	2.8	0	0.0	608	3.3	62	1.3
SPECKLED WORM EEL MYROPHIS PUNCTATUS	16	0.5	166	4.0	1679	55.6	3945	124.7
SPECKLED WORM EEL(LEPTOCEPHALUS) MYROPHIS PUNCTATUS	0	0.0	0	0.0	0	0.0	7	0.0
SPIDER CRABS LIBINIA SPP.	43	0.0	109	0.8	0	0.0	0	0.0
SPINYCHEEK SLEEPER ELEOTRIS PISONIS	78	1.3	0	0.0	207	1.4	184	1.6
SPOT LEIOSTOMUS XANTHURUS	195801	1815.5	754548	7339.5	692767	8492.7	1290095	2988.1
SPOTFIN MOJARRA EUCINOSTOMUS ARGENTEUS	1035	6.0	376	1.8	6983	57.4	1628	13.5
SPOTTED HAKE UROPHYCIS REGIUS	11268	58.5	278321	3228.5	356000	3814.0	25503	386.7
SPOTTED SEATROUT CYNOSCION NEBULOSUS	6092	111.0	11452	185.4	6759	174.6	2757	53.0
SPOTTED TRUNKFISH LACTOPHRYS BICAUDALIS	0	0.0	0	0.0	29	0.2	0	0.0
STAR DRUM STELLIFER LANCEOLATUS	112037	257.9	250067	628.6	98839	414.8	27943	122.4
STONE CRAB MENIPPE MERCENARIA	1410	3.3	1759	8.7	0	0.0	0	0.0
STRIPED ANCHOVY ANCHOA HEPSETUS	[illegible]	47.2	23175	110.6	60759	[illegible]	34887	102.3
STRIPED BLENNY CHASMODES BOSQUIANUS	137	0.5	760	2.4	1895	4.9	760	2.8

Table 5.3 (cont'd.)

SPECIES LIST OF ORGANISMS IMPINGED AT BSEP

FROM SEPTEMBER 1975 - AUGUST 1979

SPECIES	SEP 75 - AUG 76 NUMBER	SEP 75 - AUG 76 WT. (KG)	SEP 76 - AUG 77 NUMBER	SEP 76 - AUG 77 WT. (KG)	SEP 77 - AUG 78 NUMBER	SEP 77 - AUG 78 WT. (KG)	SEP 78 - AUG 79 NUMBER	SEP 78 - AUG 79 WT. (KG)
STRIPED BURRFISH CHILOMYCTERUS SCHOEPFI	658	6.4	458	14.4	512	11.6	1398	12.0
STRIPED KILLIFISH FUNDULUS MAJALIS	0	0.0	0	0.0	31	0.1	14	0.0
STRIPED MULLET MUGIL CEPHALUS	5185	147.5	20005	465.8	22944	632.1	25603	97.6
STRIPED SEAROBIN PRIONOTUS EVOLANS	179	2.2	47	0.5	0	0.0	0	0.0
SUMMER FLOUNDER PARALICHTHYS DENTATUS	1117	36.2	4133	172.4	8225	332.6	10355	195.7
TARPON MEGALOPS ATLANTICA	0	0.0	0	0.0	63	4.1	0	0.0
TARPON LARVAE MEGALOPS LEPTOCEPHALUS	0	0.0	0	0.0	0	0.0	159	0.1
TAUTOG TAUTOGA ONITIS	0	0.0	16	8.6	0	0.0	0	0.0
THREADFIN SHAD DOROSOMA PETENENSE	60784	277.1	15759	100.5	5066	23.0	899	6.5
THREESPINE STICKLEBACK GASTEROSTEUS ACULEATUS	0	0.0	0	0.0	0	0.0	7	0.0
TIDEWATER SILVERSIDE MENIDIA BERYLLINA	120	2.1	0	0.0	0	0.0	15	0.0
TONGUEFISH SYMPHURUS SPP	0	0.0	0	0.0	0	0.0	45604	178.6
TRACHYPENAEUS CONSTRICTUS TRACHYPENAEUS CONSTRICTUS	35431	24.0	86699	59.6	172541	97.0	334894	240.3
TRIPLETAIL LOBOTES SURINAMENSIS	31	0.7	39	0.1	8	0.2	8	0.5
UNIDENTIFIED HERRING UNID. CLUPEID	0	0.0	0	0.0	23	0.0	0	0.0
WARMOUTH LEPOMIS GULOSUS	55	0.3	0	0.0	191	0.9	119	0.5
WEAKFISH CYNOSCION REGALIS	272792	564.1	134988	1096.0	284819	3329.1	126463	276.4
WHITE CATFISH ICTALURUS CATUS	0	0.0	15	7.9	174	40.3	0	0.0
WHITE MULLET MUGIL CUREMA	3722	29.7	16395	47.4	9129	187.9	3090	31.5
WHITE SHRIMP PENAEUS SETIFERUS	621196	3453.7	468401	2406.3	23144	205.2	24288	229.3
WINDOWPANE SCOPHTHALMUS AQUOSUS	833	15.0	21849	166.3	15779	103.0	4537	66.0
YELLOW BULLHEAD ICTALURUS NATALIS	0	0.0	0	0.0	0	0.0	7	0.2

Table 5.4

EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	SEPTEMBER 1975 NUMBER	SEPTEMBER 1975 WT. (KG)	SEPTEMBER 1976 NUMBER	SEPTEMBER 1976 WT. (KG)
BAY ANCHOVY	18315	17.6	30015	33.5
BLUE CRAB	39098	1778.0	22185	1077.0
CROAKER	1156	18.5	518	18.2
FLOUNDER	236	22.1	608	56.5
MENHADEN	7031	226.5	3998	242.2
MISC. SPECIES	7962	76.9	3840	48.2
MULLET	369	6.4	1620	10.7
OTHER FINFISH	44949	216.9	67320	356.4
OTHER SHELLFISH	9886	64.3	14400	14.6
SHRIMP	132776	849.0	188888	1170.3
SPOT	762	6.9	2430	67.8
TROUT	21782	49.9	5108	18.4
TOTAL	284322	3333.0	340930	3113.8

SPECIES	SEPTEMBER 1977 NUMBER	SEPTEMBER 1977 WT. (KG)	SEPTEMBER 1978 NUMBER	SEPTEMBER 1978 WT. (KG)
BAY ANCHOVY	13590	15.6	10913	12.2
BLUE CRAB	22260	702.8	42413	1420.9
CROAKER	230	2.6	270	4.2
FLOUNDER	1670	107.3	468	36.5
MENHADEN	2400	153.5	7320	527.4
MISC. SPECIES	1620	14.8	5385	60.6
MULLET	110	4.4	293	6.5
OTHER FINFISH	48820	270.1	50078	201.4
OTHER SHELLFISH	13930	21.5	9105	9.9
SHRIMP	30170	167.8	28193	152.8
SPOT	840	9.6	450	15.0
TROUT	1260	4.3	1965	7.0
TOTAL	136900	1474.3	156873	2454.4

Table 5.6 (cont'd.)

EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	OCTOBER 1975 NUMBER	OCTOBER 1975 WT. (KG)	OCTOBER 1976 NUMBER	OCTOBER 1976 WT. (KG)
BAY ANCHOVY	48277	57.4	46606	55.5
BLUE CRAB	135429	3282.5	6829	186.5
CROAKER	1106	57.9	39	0.7
FLOUNDER	1323	99.6	86	22.5
MENHADEN	3679	99.4	352	22.5
MISC. SPECIES	145	41.4	24278	94.9
MULLET	310	9.5	298	16.0
OTHER FINFISH	75578	309.4	399151	1104.2
OTHER SHELLFISH	4392	41.7	22007	22.1
SHRIMP	166553	1060.0	55903	528.6
SPOT	1519	71.9	650	21.5
TROUT	20284	56.5	728	3.9
TOTAL	458595	5187.2	556927	2083.9

SPECIES	OCTOBER 1977 NUMBER	OCTOBER 1977 WT. (KG)	OCTOBER 1978 NUMBER	OCTOBER 1978 WT. (KG)
BAY ANCHOVY	44772	48.6	27726	35.7
BLUE CRAB	19367	505.2	34751	957.1
CROAKER	23	0.8	248	6.0
FLOUNDER	395	37.8	490	47.8
MENHADEN	2085	71.4	29444	1730.4
MISC. SPECIES	10184	49.6	7477	51.2
MULLET	279	5.8	794	12.5
OTHER FINFISH	52948	286.7	26238	227.4
OTHER SHELLFISH	26102	19.2	38087	40.3
SHRIMP	38332	317.0	19294	120.5
SPOT	535	5.3	781	27.2
TROUT	1403	6.1	515	16.8
TOTAL	196425	1353.5	185845	3274.9

Table 5.4 (cont'd.)

EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	NOVEMBER 1975 NUMBER	NOVEMBER 1975 WT. (KG)	NOVEMBER 1976 NUMBER	NOVEMBER 1976 WT. (KG)
BAY ANCHOVY	154145	183.0	187590	222.3
BLUE CRAB	18970	460.9	4230	23.0
CROAKER	631	25.3	1560	4.4
FLOUNDER	36	2.6		
MENHADEN	976	11.3	2370	67.9
MISC. SPECIES	1755	18.1	1350	14.4
MULLET	2142	31.2	270	13.3
OTHER FINFISH	17816	90.8	115440	312.5
OTHER SHELLFISH	5343	3.8	22020	117.1
SHRIMP	58838	358.7	183060	589.9
SPOT	179	11.1	7920	94.4
TROUT	1107	7.5	6630	44.4
TOTAL	261938	1204.3	532440	1503.6

SPECIES	NOVEMBER 1977 NUMBER	NOVEMBER 1977 WT. (KG)	NOVEMBER 1978 NUMBER	NOVEMBER 1978 WT. (KG)
BAY ANCHOVY	249709	459.5	20663	31.0
BLUE CRAB	48154	493.6	20888	228.5
CROAKER	1160	14.9	83	3.2
FLOUNDER	1566	75.7	263	27.4
MENHADEN	65806	915.8	43350	2161.0
MISC. SPECIES	2194	16.5	6818	25.0
MULLET	554	20.5	773	19.1
OTHER FINFISH	130737	897.1	49635	314.8
OTHER SHELLFISH	42183	240.4	36115	48.6
SHRIMP	80823	337.4	7305	66.8
SPOT	57766	800.2	[illegible]	21.9
TROUT	31154	165.1	128	11.9
TOTAL	711806	4436.7	188321	2959.2

Table 5.4 (cont'd.)

EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	DECEMBER 1975 NUMBER	DECEMBER 1975 WT. (KG)	DECEMBER 1976 NUMBER	DECEMBER 1976 WT. (KG)
BAY ANCHOVY	182283	283.9	269390	396.8
BLUE CRAB	12509	107.2	744	2.0
CROAKER	9119	285.0	14539	348.4
FLOUNDER	31	6.5	419	32.3
MENHADEN	1920	61.2	193921	2384.8
MISC. SPECIES	377	1.9	202	0.9
MULLET	2161	46.2	2170	137.2
OTHER FINFISH	148794	443.6	235290	751.3
OTHER SHELLFISH	2315	3.2	10633	45.2
SHRIMP	71066	334.8	43912	146.9
SPOT	2180	54.2	78182	1380.8
TROUT	1358	15.8	10323	123.0
TOTAL	434113	1643.5	859725	5740.6

SPECIES	DECEMBER 1977 NUMBER	DECEMBER 1977 WT. (KG)	DECEMBER 1978 NUMBER	DECEMBER 1978 WT. (KG)
BAY ANCHOVY	1430449	2329.1	1015343	1658.9
BLUE CRAB	85447	423.1	136361	540.8
CROAKER	616	5.5	1984	15.4
FLOUNDER	1353	83.3	1418	105.3
MENHADEN	1160520	6456.0	157224	2261.8
MISC. SPECIES	[illegible]	12.0	19608	81.8
MULLET	10702	243.0	5603	53.6
OTHER FINFISH	276004	1121.6	477896	2028.9
OTHER SHELLFISH	[illegible]	54.1	224921	746.4
SHRIMP	37027	147.9	75121	547.0
SPOT	40242	1016.2	20685	368.1
TROUT	15774	239.8	1550	20.5
TOTAL	3134111	12131.6	2137714	8458.5

Table 5.4 (cont'd.)

EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	JANUARY 1976 NUMBER	JANUARY 1976 WT. (KG)	JANUARY 1977 NUMBER	JANUARY 1977 WT. (KG)
BAY ANCHOVY	519647	679.0	534622	626.6
BLUE CRAB	1240	2.0		
CROAKER	54907	351.3	55547	1381.3
FLOUNDER	1562	39.3		
MENHADEN	53357	1441.4	1574074	12283.7
MULLET	918	55.7	9415	198.1
OTHER FINFISH	98344	484.2	217570	840.1
OTHER SHELLFISH	9102	4.0	4863	2.3
SHRIMP	26288	97.7	874	2.3
SPOT	23572	306.8	74833	1588.7
TROUT	2902	54.6	14849	331.7
TOTAL	791839	3516.0	2491647	17254.[illegible]

SPECIES	JANUARY 1978 NUMBER	JANUARY 1978 WT. (KG)	JANUARY 1979 NUMBER	JANUARY 1979 WT. (KG)
BAY ANCHOVY	478281	874.6	473060	863.0
BLUE CRAB	50940	110.3	74164	206.6
CROAKER	56934	73.8	18048	25.5
FLOUNDER	1309	43.6	2114	65.6
MENHADEN	6892152	43567.2	118178	2075.9
MISC. SPECIES			254	6.4
MULLET	9572	129.6	874	8.8
OTHER FINFISH	212668	1050.3	506131	747.9
OTHER SHELLFISH	53283	76.2	165763	799.1
SHRIMP	68786	196.2	103782	667.0
SPOT	265211	3914.1	65497	996.4
TROUT	29918	1013.3	1352	19.4
TOTAL	8139044	51049.2	1529217	5483.6

Table 5.4 (cont'd.)

EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	FEBRUARY 1976 NUMBER	FEBRUARY 1976 WT. (KG)	FEBRUARY 1977 NUMBER	FEBRUARY 1977 WT. (KG)
BAY ANCHOVY	94414	155.2		
BLUE CRAB	52975	276.9		
CROAKER	28926	562.7		
FLOUNDER	671	29.2		
MENHADEN	85006	1675.1		
MISC. SPECIES	25	6.9		
MULLET	602	24.3		
OTHER FINFISH	49436	343.6		
OTHER SHELLFISH	20880	27.5		
SHRIMP	18989	80.0		
SPOT	85899	928.5		
TROUT	1812	35.0		
TOTAL	439635	4144.9		

SPECIES	FEBRUARY 1978 NUMBER	FEBRUARY 1978 WT. (KG)	FEBRUARY 1979 NUMBER	FEBRUARY 1979 WT. (KG)
BAY ANCHOVY	33768	54.3	152761	224.1
BLUE CRAB	168	1.5	1659	4.3
CROAKER	2184	7.4	1281	2.3
FLOUNDER	1204	45.8	217	12.0
MENHADEN	332836	1713.9	17759	359.5
MULLET	5488	212.4	819	9.9
OTHER FINFISH	123928	625.5	18578	92.2
OTHER SHELLFISH	112840	44.8	22855	9.9
SHRIMP			588	3.1
SPOT	7056	69.2	1253	26.2
TROUT	1092	20.1	266	6.8
TOTAL	620564	2793.5	218036	750.3

Table 5.4 (cont'd.)

EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	MARCH NUMBER	1976 WT. (KG)	MARCH NUMBER	1977 WT. (KG)
BAY ANCHOVY	206894	325.8	891426	1326.3
BLUE CRAB	51189	671.5	136232	.23.3
CROAKER	15012	357.9	44586	1290.6
FLOUNDER	372	20.2	1334	95.6
MENHADEN	3805	209.3	3752796	22102.5
MISC. SPECIES	178	20.8	181	74.5
MULLET	326	4.7	7018	93.1
OTHER FINFISH	32558	231.6	324330	3295.3
OTHER SHELLFISH	9006	17.2	127358	58.1
SHRIMP	8331	43.8	1247	5.7
SPOT	9773	107.1	214540	2505.1
TROUT	163	4.3	9404	300.9
TOTAL	331607	2014.2	5510452	31271.0

SPECIES	MARCH NUMBER	1978 WT. (KG)	MARCH NUMBER	1979 WT. (KG)
BAY ANCHOVY	436214	814.0	57957	73.4
BLUE CRAB	121832	262.4	97028	535.2
CROAKER	3666	19.5	11122	2.5
FLOUNDER	2685	184.6	383	23.0
MENHADEN	1858865	8572.4	12235	284.7
MULLET	2592	194.1	14309	0.5
OTHER FINFISH	470960	3253.8	12723	68.8
OTHER SHELLFISH	28333	11.7	98494	37.0
SHRIMP			308	1.4
SPOT	46159	440.1	535492	169.2
TROUT	3191	102.7	15	0.5
TOTAL	2974497	13855.3	84006	1196.2

Table 5.4 (cont'd.)

EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	APRIL 1976 NUMBER	APRIL 1976 WT. (KG)	APRIL 1977 NUMBER	APRIL 1977 WT. (KG)
BAY ANCHOVY	134040	248.5	[illegible]440	481.0
BLUE CRAB	[illegible]640	148.5	[illegible]5635	466.3
CROAKER	1935	37.0	51158	669.8
FLOUNDER	105	2.1	149[illegible]	153.9
MENHADEN	2400	39.2	1176908	7163.6
MISC. SPECIES	5565	950.8	1995	112.1
MULLET	90	0.1	653	0.4
OTHER FINFISH	8070	45.2	152565	1884.5
OTHER SHELLFISH	1620	1.3	17715	10.8
SHRIMP	2340	22.0	480	3.4
SPOT	1065	16.5	103620	1050.5
TROUT	75	1.9	6900	216.4
TOTAL	165945	1513.1	1834562	12212.7

SPECIES	APRIL 1978 NUMBER	APRIL 1978 WT. (KG)	APRIL 1979 NUMBER	APRIL 1979 WT. (KG)
BAY ANCHOVY	83230	189.8	36360	62.1
BLUE CRAB	103100	1285.3	61418	608.5
CROAKER	3110	[illegible]0.6	3555	7.2
FLOUNDER	3910	[illegible]5.2	2295	31.4
MENHADEN	915050	3812.2	4320	53.4
MISC. SPECIES	116850	7372.7	105	12.0
MULLET	190	0.1	803	0.5
OTHER FINFISH	44150	1489.9	17498	121.9
OTHER SHELLFISH	3300	4.0	9308	5.8
SHRIMP	90	0.5	158	0.8
SPOT	22930	412.4	14888	28.5
TROUT	7540	339.0		
TOTAL	1353450	15161.7		

Table 5.4 (cont'd.)

EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	MAY NUMBER	1976 WT. (KG)	MAY NUMBER	1977 WT. (KG)
BAY ANCHOVY	51414	84.5	62275	121.5
BLUE CRAB	10215	258.5	25571	854.6
CROAKER	14896	30.1	16109	22.1
FLOUNDER	62	10.3	1023	37.8
MENHADEN	17174	202.6	535497	4965.3
MISC. SPECIES	7704	70.9	12141	288.1
MULLET	574	0.2	6509	2.9
OTHER FINFISH	12555	50.7	96483	344.6
OTHER SHELLFISH	2217	5.2	13110	11.7
SHRIMP	35077	87.4	18657	25.0
SPOT	8029	26.1	67906	189.8
TROUT	62	0.1	275	7.4
TOTAL	159979	826.6	855556	6870.8

SPECIES	MAY NUMBER	1978 WT. (KG)	MAY NUMBER	1979 WT. (KG)
BAY ANCHOVY	177002	500.2	190933	473.4
BLUE CRAB	89465	2406.6	68695	1817.5
CROAKER	95267	631.6	590044	711.2
FLOUNDER	4989	150.3	10916	72.1
MENHADEN	493692	3400.0	[illegible]	1464.0
MISC. SPECIES	363	89.0	[illegible]	14.9
MULLET	273	0.1	[illegible]	2.1
OTHER FINFISH	159185	2030.3	[illegible]	718.3
OTHER SHELLFISH	32892	17.1	[illegible]	20.1
SHRIMP	465	4.1	42058	117.8
SPOT	115746	1456.7	445832	742.3
TROUT	26742	931.2	80	4.7
TOTAL	1197101	11617.2	1701950	6158.4

Table 5.4 (cont'd.)

EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	JUNE NUMBER	1976 WT. (KG)	JUNE NUMBER	1977 WT. (KG)
BAY ANCHOVY	182364	361.2	63178	118.7
BLUE CRAB	26652	548.2	38562	1408.8
CROAKER	37674	102.6	233704	431.1
FLOUNDER	828	46.1	4040	54.0
MENHADEN	39468	1609.7	277306	3295.0
MISC. SPECIES	2280	20.3	5237	82.9
MULLET	180	0.4	3509	5.5
OTHER FINFISH	41148	148.3	59264	376.3
OTHER SHELLFISH	8028	12.8	5063	5.5
SHRIMP	260166	1097.6	200683	1089.1
SPOT	29424	96.6	189815	398.0
TROUT	125454	200.6	87597	213.8
TOTAL	753666	4244.4	1177958	7477.7

SPECIES	JUNE NUMBER	1978 WT. (KG)	JUNE NUMBER	1979 WT. (KG)
BAY ANCHOVY	48825	106.4	209535	466.3
BLUE CRAB	48960	1970.5	85407	3930.5
CROAKER	67783	150.5	432636	474.4
FLOUNDER	1448	30.3	10001	162.9
MENHADEN	33618	1142.1	114982	945.1
MISC. SPECIES	1519	55.9	775	38.0
MULLET	142	0.4	1112	3.3
OTHER FINFISH	39347	280.2	83590	393.0
OTHER SHELLFISH	5396	3.0	23070	14.0
SHRIMP	85356	365.9	397629	1952.1
SPOT	17106	75.4	170129	366.5
TROUT	43018	94.6	48265	59.6
TOTAL	392518	4275.2	1577151	8805.7

Table 5.4 (cont'd.)
EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	JULY NUMBER	1976 WT. (KG)	JULY NUMBER	1977 WT. (KG)
BAY ANCHOVY	45031	87.1	16120	26.6
BLUE CRAB	10293	320.4	3255	209.6
CROAKER	23624	115.9	2108	11.0
FLOUNDER	2370	141.7	1147	189.1
MENHADEN	74247	3385.1	69347	2280.7
MISC. SPECIES	959	29.5	7192	61.9
MULLET	606	2.5	7688	23.5
OTHER FINFISH	58937	190.6	15624	133.1
OTHER SHELLFISH	9457	12.8	23653	47.9
SHRIMP	172999	699.0	29791	177.6
SPOT	17818	94.	9486	35.5
TROUT	83842	170.3	4278	17.1
TOTAL	500183	5249.8	189689	3215.6

SPECIES	JULY NUMBER	1978 WT. (KG)	JULY NUMBER	1979 WT. (KG)
BAY ANCHOVY	76704	178.1	51469	120.0
BLUE CRAB	108760	2122.6	23436	1267.9
CROAKER	56000	324.7	16793	52.8
FLOUNDER	7368	207.8	1780	80.1
MENHADEN	127997	4561.8	25509	1249.6
MISC. SPECIES	9007	96.3	52833	160.6
MULLET	1746	5.2	390	1.9
OTHER FINFISH	110212	586.0	40203	188.5
OTHER SHELLFISH	85410	45.7	31806	19.0
SHRIMP	205916	1265.2	62540	530.2
SPOT	41771	237.4	21895	90.0
TROUT	104911	488.2	41079	74.8
TOTAL	935802	10120.0	379733	3835.4

Table 5.4 (cont'd.)
EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	AUGUST NUMBER	1976 WT. (KG)	AUGUST NUMBER	1977 WT. (KG)
BAY ANCHOVY	11885	26.5	4955	4.5
BLUE CRAB	30107	737.6	9250	344.3
CROAKER	3119	34.9	744	8.1
FLOUNDER	676	56.9	1035	82.1
MENHADEN	27348	1029.2	1419	76.2
MISC. SPECIES	5134	93.5	5914	58.3
MULLET	1693	7.7	1250	12.7
OTHER FINFISH	91190	371.9	42584	197.8
OTHER SHELLFISH	17844	28.8	21415	40.1
SHRIMP	158100	722.9	25204	196.7
SPOT	15581	94.9	1166	7.4
TROUT	20045	78.3	345	4.4
TOTAL	382722	3283.1	115281	1032.1

SPECIES	AUGUST NUMBER	1978 WT. (KG)	AUGUST NUMBER	1979 WT. (KG)
BAY ANCHOVY	15659	16.3	50129	83.1
BLUE CRAB	207623	2268.7	20743	1237.8
CROAKER	4266	41.9	9365	63.4
FLOUNDER	2825	100.9	1078	82.1
MENHADEN	14183	937.8	38679	2542.8
MISC. SPECIES	9719	90.9	14497	104.5
MULLET	430	3.5	1577	10.5
OTHER FINFISH	121842	791.1	68359	288.1
OTHER SHELLFISH	46256	77.1	24975	22.2
SHRIMP	43652	237.5	37280	291.8
SPOT	6405	56.1	12893	136.7
TROUT	25575	99.1	33983	105.3
TOTAL	498435	4720.9	313556	4968.3

Table 5.4 (cont'd.)

EXPANDED MONTHLY IMPINGEMENT DATA

SEPTEMBER 1975 - AUGUST 1979

SPECIES	TOTALS SEPTEMBER 1975 TO AUGUST 1976 NUMBER	WT. (KG)	TOTALS SEPTEMBER 1976 TO AUGUST 1977 NUMBER	WT. (KG)
BAY ANCHOVY	1648709	2509.7	2406617	3415.3
BLUE CRAB	397317	8592.2	272493	4695.4
CROAKER	192105	1979.1	420612	4185.7
FLOUNDER	8272	476.6	11185	723.8
MENHADEN	316411	9990.0	7587988	54884.4
MISC. SPECIES	32084	1331.0	62330	841.2
MULLET	9971	188.9	36400	513.4
OTHER FINFISH	679375	2926.8	1725621	9596.1
OTHER SHELLFISH	100090	222.6	282237	375.4
SHRIMP	1111523	5452.9	758699	3934.0
SPOT	195801	1815.5	754548	7339.5
TROUT	278886	674.8	146437	1281.4
TOTAL	4970544	36160.1	14465167	91785.6

SPECIES	TOTALS SEPTEMBER 1977 TO AUGUST 1978 NUMBER	WT. (KG)	TOTALS SEPTEMBER 1978 TO AUGUST 1979 NUMBER	WT. (KG)
BAY ANCHOVY	3088203	5586.5	2306849	4133.2
BLUE CRAB	906076	12551.6	666963	12755.6
CROAKER	291229	1313.8	1085429	1368.1
FLOUNDER	30722	1282.6	31443	746.2
MENHADEN	11899204	75304.1	710712	15655.6
MISC. SPECIES	151604	7797.7	108011	557.0
MULLET	32078	820.1	28693	129.2
OTHER FINFISH	1841001	12682.6	1478916	5391.2
OTHER SHELLFISH	475574	614.8	718587	1772.3
SHRIMP	590617	3039.5	824256	4451.3
SPOT	692767	8492.7	1290095	2988.1
TROUT	291578	3503.5	129218	329.3
TOTAL	20290653	132989.5	9379172	50277.1

TABLE 5.5

THE TEN MOST ABUNDANT SPECIES AND PERCENTAGE OF THE TOTAL IMPINGEMENT CATCH

SEPTEMBER 1975 - AUGUST 1979

SEPT. 1975-AUG. 1976		SEPT. 1976-AUG. 1977		SEPT. 1977-AUG. 1978		SEPT. 1978-AUG. 1979	
BAY ANCHOVY	33.2	ATLANTIC MENHADEN	52.5	ATLANTIC MENHADEN	58.6	BAY ANCHOVY	24.6
WHITE SHRIMP	12.5	BAY ANCHOVY	16.6	BAY ANCHOVY	15.2	SPOT	13.8
BROWN SHRIMP	8.8	SPOT	5.2	BLUE CRABS	4.5	CROAKER	11.6
BLUE CRABS	8.0	WHITE SHRIMP	3.2	SPOT	3.4	ATLANTIC MENHADEN	7.6
ATLANTIC MENHADEN	6.4	CROAKER	2.9	SPOTTED HAKE	1.8	BLUE CRABS	7.1
WEAKFISH	5.5	GIZZARD SHAD	2.5	BROWN SHRIMP	1.5	BROWN SHRIMP	6.1
SPOT	3.9	SPOTTED HAKE	1.9	ATLANTIC SILVERSIDE	1.5	BLUEBACK HERRING	4.4
CROAKER	3.9	BLUE CRABS	1.9	CROAKER	1.4	TRACHYPENAEUS CONSTRICTU	3.6
STAR DRUM	2.3	BROWN SHRIMP	1.8	WEAKFISH	1.4	GRASS SHRIMP	2.8
BLUEBACK HERRING	2.2	STAR DRUM	1.7	BLACKCHEEK TONGUEFISH	1.3	ROUGH SILVERSIDE	2.5
PERCENT OF TOTAL	86.7	PERCENT OF TOTAL	90.2	PERCENT OF TOTAL	90.6	PERCENT OF TOTAL	84.1

Table 5.6 NUMBER OF BAY ANCHOVY
IMPINGED PER MILLION CUBIC METERS OF WATER
ENTRAINED DURING EACH MONTH SEPTEMBER 1975 - AUGUST 1979

	SEP 75-AUG 76	SEP 76-AUG 77	SEP 77-AUG 78	SEP 78-AUG 79
SEPTEMBER	290.1	331.6	118.7	88.8
OCTOBER	535.9	499.5	498.4	166.1
NOVEMBER	1658.8	4224.5	2734.5	156.3
DECEMBER	2002.5	4242.9	12507.7	6109.2
JANUARY	6613.7	6713.2	3335.4	3888.5
FEBRUARY	1260.1		297.4	2018.1
MARCH	2848.3	8153.9	2645.7	959.8
APRIL	2276.6	2470.2	524.6	489.8
MAY	969.5	442.6	1073.3	1435.9
JUNE	2127.7	493.1	364.7	1472.4
JULY	511.2	96.7	437.4	362.3
AUGUST	130.9	30.4	88.1	283.1

Table 5.7 NUMBER OF SPOT
IMPINGED PER MILLION CUBIC METERS OF WATER
ENTRAINED DURING EACH MONTH SEPTEMBER 1975 - AUGUST 1979

	SEP 75-AUG 76	SEP 76-AUG 77	SEP 77-AUG 78	SEP 78-AUG 79
SEPTEMBER	12.1	26.8	7.3	3.7
OCTOBER	16.9	7.0	6.0	4.7
NOVEMBER	1.9	178.4	632.6	2.3
DECEMBER	23.9	1231.4	789.1	124.5
JANUARY	300.0	980.7	1989.0	538.4
FEBRUARY	1146.4		62.1	16.6
MARCH	134.5	1962.4	280.0	8868.5
APRIL	18.1	866.4	144.5	200.5
MAY	151.4	402.6	707.9	3353.0
JUNE	343.3	1481.6	127.8	1195.5
JULY	202.3	56.9	238.2	129.1
AUGUST	171.6	7.2	36.0	72.6

Table 5.8 NUMBER OF CROAKER
IMPINGED PER MILLION CUBIC METERS OF WATER
ENTRAINED DURING EACH MONTH SEPTEMBER 1975 - AUGUST 1979

	SEP 75-AUG 76	SEP 76-AUG 77	SEP 77-AUG 78	SEP 78-AUG 79
SEPTEMBER	[illegible]	3.7	2.0	2.2
OCTOBER	[illegible]	0.4	0.3	1.5
NOVEMBER	[illegible]	35.1	12.7	0.6
DECEMBER	[illegible]	229.0	5.4	11.9
JANUARY	[illegible]	[illegible]	397.0	146.4
FEBRUARY	[illegible]	[illegible]	19.2	16.9
MARCH	[illegible]	[illegible]	22.2	184.2
APRIL	[illegible]	[illegible]	19.6	47.9
MAY	280.9	[illegible]	577.7	4437.5
JUNE	439.6	[illegible]	506.3	3040.1
JULY	268.2	12.7	319.3	99.0
AUGUST	34.4	4.6	24.0	52.9

Table 5.9 NUMBER OF MENHADEN
IMPINGED PER MILLION CUBIC METERS OF WATER
ENTRAINED DURING EACH MONTH SEPTEMBER 1975 - AUGUST 1979

	SEP 75-AUG 76	SEP 76-AUG 77	SEP 77-AUG 78	SEP 78-AUG 79
SEPTEMBER	111.4	44.2	21.0	59.6
OCTOBER	40.9	3.8	23.2	176.4
NOVEMBER	10.5	53.4	720.6	328.0
DECEMBER	21.1	3054.3	10147.5	946.0
JANUARY	679.1	19582.4	48064.5	971.4
FEBRUARY	1134.5		2931.3	234.6
MARCH	52.4	34326.9	11274.4	202.6
APRIL	40.6	9840.3	5767.2	58.2
MAY	323.9	3805.5	2993.7	1065.8
JUNE	460.5	2164.5	251.1	806.0
JULY	842.9	416.2	729.9	150.4
AUGUST	301.2	8.7	79.8	216.4

Table 5.10 NUMBER OF TROUT
IMPINGED PER MILLION CUBIC METERS OF WATER
ENTRAINED DURING EACH MONTH SEPTEMBER 1975 - AUGUST 1979

	SEP 75-AUG 76	SEP 76-AUG 77	SEP 77-AUG 78	SEP 78-AUG 79
SEPTEMBER	345.0	56.4	11.0	16.0
OCTOBER	225.6	7.8	15.6	3.1
NOVEMBER	11.9	149.3	341.2	1.0
DECEMBER	14.9	162.6	137.9	9.3
JANUARY	36.9	184.7	208.6	11.1
FEBRUARY	24.2		9.6	3.5
MARCH	2.2	86.0	19.4	0.2
APRIL	1.3	57.7	47.5	0.0
MAY	1.2	2.0	162.2	0.5
JUNE	1463.7	683.7	321.3	339.3
JULY	951.8	25.7	598.2	242.1
AUGUST	220.8	2.1	143.9	191.9

Table 5.11 NUMBER OF FLOUNDER
IMPINGED PER MILLION CUBIC METERS OF WATER
ENTRAINED DURING EACH MONTH SEPTEMBER 1975 - AUGUST 1979

	SEP 75-AUG 76	SEP 76-AUG 77	SEP 77-AUG 78	SEP 78-AUG 79
SEPTEMBER	3.7	6.7	14.6	4.0
OCTOBER	14.7	0.9	4.4	2.9
NOVEMBER	0.4	0.0	17.1	2.0
DECEMBER	0.3	6.6	11.8	8.5
JANUARY	19.9	0.0	9.1	17.4
FEBRUARY	9.0		10.6	2.9
MARCH	5.1	12.2	16.3	6.3
APRIL	1.8	12.5	24.6	30.9
MAY	1.2	7.3	30.3	82.1
JUNE	9.7	31.5	10.8	70.3
JULY	26.9	6.9	42.0	10.5
AUGUST	7.4	6.3	15.9	5.1

Table 5.12 NUMBER OF MULLET
IMPINGED PER MILLION CUBIC METERS OF WATER
ENTRAINED DURING EACH MONTH SEPTEMBER 1975 - AUGUST 1979

	SEP 75-AUG 76	SEP 76-AUG 77	SEP 77-AUG 78	SEP 78-AUG 79
SEPTEMBER	4.8	17.9	1.0	2.4
OCTOBER	3.4	3.2	3.1	4.8
NOVEMBER	23.1	6.1	6.1	5.8
DECEMBER	23.7	34.2	93.6	33.7
JANUARY	11.7	67.4	66.8	7.2
FEBRUARY	8.0		48.3	10.8
MARCH	4.5	64.2	15.7	237.0
APRIL	1.5	5.5	1.2	10.6
MAY	10.8	46.3	1.7	10.1
JUNE	2.1	27.4	1.1	7.8
JULY	6.9	46.1	10.0	2.3
AUGUST	18.6	7.7	2.4	6.9

Table 5.13 NUMBER OF SHRIMP
IMPINGED PER MILLION CUBIC METERS OF WATER
ENTRAINED DURING EACH MONTH SEPTEMBER 1975 - AUGUST 1979

	SEP 75-AUG 76	SEP 76-AUG 77	SEP 77-AUG 78	SEP 78-AUG 79
SEPTEMBER	2103.1	2086.9	263.5	229.5
OCTOBER	1852.3	706.3	426.7	115.6
NOVEMBER	633.2	4122.5	885.1	55.3
DECEMBER	780.7	691.6	323.8	452.0
JANUARY	334.6	10.9	479.7	853.1
FEBRUARY	253.4		0.0	7.8
MARCH	114.7	11.4	0.0	5.1
APRIL	39.8	4.0	0.6	2.1
MAY	661.5	132.6	2.8	692.3
JUNE	3035.5	1566.4	637.5	2794.1
JULY	1963.9	178.8	1174.2	368.6
AUGUST	1741.3	154.6	245.7	210.5

Table 5.14 NUMBER OF BLUE CRAB IMPINGED PER MILLION CUBIC METERS OF WATER ENTRAINED DURING EACH MONTH SEPTEMBER 1975 - AUGUST 1979

	SEP 75-AUG 76	SEP 76-AUG 77	SEP 77-AUG 78	SEP 78-AUG 79
SEPTEMBER	619.3	245.1	194.4	345.2
OCTOBER	1506.1	73.2	215.6	208.2
NOVEMBER	204.1	95.3	527.3	156.0
DECEMBER	137.4	11.7	747.1	820.5
JANUARY	15.8	0.0	355.2	609.6
FEBRUARY	707.0		1.5	21.9
MARCH	704.7	1246.1	738.9	1606.9
APRIL	146.9	214.3	649.8	827.3
MAY	192.6	181.7	542.5	516.6
JUNE	311.0	301.0	365.7	600.1
JULY	116.8	19.5	620.2	138.1
AUGUST	331.6	56.7	1158.6	117.1

Table 5.15. DIVERSION DEVICE STUDY SPECIES TOTAL NUMBER AND PERCENT TOTAL, JANUARY-SEPTEMBER, 1979.

SPECIES TAXONOMIC NAME	SPECIES COMMON NAME	NUMBER	%
ALOSA AESTIVALIS	BLUEBACK HERRING	3	0.00
ALOSA MEDIOCRIS	HICKORY SHAD	1	0.00
ALOSA SAPIDISSIMA	AMERICAN SHAD	16	0.01
ALOSA SPECIES	SHAD SPECIES	1	0.00
ALPHEUS SPP	SNAPPING SHRIMP	50	0.02
ANCHOA HEPSETUS	STRIPED ANCHOVY	276	0.11
ANCHOA MITCHILLI	BAY ANCHOVY	32731	12.73
ANCHOA SPP	ANCHOVY SPP	2	0.00
ANCYLOPSETTA QUADROCELLATA	OCELLATED FLOUNDER	5	0.00
ANGUILLA ROSTRATA	AMERICAN EEL	32	0.01
ARCHOSARGUS PROBATOCEPHALUS	SHEEPSHEAD	3	0.00
ASTROSCOPUS Y-GRAECUM	SOUTHERN STARGAZER	3	0.00
BAIRDIELLA CHRYSURA	SILVER PERCH	59	0.02
BREVOORTIA TYRANNUS	ATLANTIC MENHADEN	6495	2.53
CALLINECTES SPP.	BLUE CRABS	7558	2.94
CARANX HIPPOS	CREVALLE JACK	2	0.00
CENTROPRISTIS PHILADELPHICA	ROCK SEA BASS	1	0.00
CHAETODIPTERUS FABER	ATLANTIC SPADEFISH	8	0.00
CHASMODES BOSQUIANUS	STRIPED BLENNY	1	0.00
CHILOMYCTERUS SCHOEPFI	STRIPED BURRFISH	1	0.00
CHLOROSCOMBRUS CHRYSURUS	ATLANTIC BUMPER	10	0.00
CITHARICHTHYS SPILOPTERUS	BAY WHIFF	138	0.05
CRANGON SEPTEMSPINOSA	SAND SHRIMP	15	0.01
CYNOSCION NEBULOSUS	SPOTTED SEATROUT	80	0.03
CYNOSCION REGALIS	WEAKFISH	4359	1.70
DASYATIS SABINA	ATLANTIC STINGRAY	6	0.00
DOROSOMA CEPEDIANUM	GIZZARD SHAD	10	0.00
ETROPUS CROSSOTUS	FRINGED FLOUNDER	60	0.02
FUNDULUS HETEROCLITUS	MUMMICHOG	1	0.00
GOBIESOX STRUMOSUS	SKILLETFISH (CLINGFISH)	6	0.00
GOBIONELLUS BOLEOSOMA	DARTER GOBY	26	0.01
GOBIONELLUS HASTATUS	SHARPTAIL GOBY	34	0.01
GOBIONELLUS SHUFELDTI	FRESHWATER GOBY	1	0.00
GOBIOSOMA BOSCI	NAKED GOBY	6	0.00
GOBIOSOMA GINSBURGI	SEABOARD GOBY	4	0.00
HYPSOBLENNIUS IONTHAS	FRECKLED BLENNY	1	0.00
ICTALURUS CATUS	WHITE CATFISH	1	0.00
LAGODON RHOMBOIDES	PINFISH	25	0.01
LARIMUS FASCIATUS	BANDED DRUM	1	0.00
LEIOSTOMUS XANTHURUS	SPOT	110943	43.15
LEPOMIS MACROCHIRUS	BLUEGILL	1	0.00
LOLLIGUNCULA BREVIS	BRIEF SQUID	939	0.37
MALACLEMYS TERRAPIN	DIAMONDBACK TERRAPIN	4	0.00
MEMBRAS MARTINICA	ROUGH SILVERSIDE	1	0.00
MENIDIA MENIDIA	ATLANTIC SILVERSIDE	174	0.07
MENTICIRRHUS AMERICANUS	SOUTHERN KINGFISH	1	0.00
MENTICIRRHUS SAXATILIS	NORTHERN KINGFISH	9	0.00
MENTICIRRHUS SPP	KINGFISH	8	0.00
MICROGOBIUS THALASSINUS	GREEN GOBY	2	0.00
MICROPOGONIAS UNDULATUS	CROAKER	42139	16.39
MONACANTHUS HISPIDUS	PLANEHEAD FILEFISH	7	0.00
MUGIL CEPHALUS	STRIPED MULLET	45	0.02

Table 5.15. (cont'd) DIVERSION DEVICE STUDY SPECIES TOTAL NUMBER AND PERCENT TOTAL, JANUARY-SEPTEMBER, 1979.

SPECIES TAXONOMIC NAME	SPECIES COMMON NAME	NUMBER	%
MUGIL CUREMA	WHITE MULLET	2	0.00
MYROPHIS PUNCTATUS	SPECKLED WORM EEL	3	0.00
OPHICHTHUS GOMESI	SHRIMP EEL	3	0.00
OPHIDIIDAE	CUSK-EEL	63	0.02
OPHIDION WELSHI	CRESTED CUSK-EEL	103	0.04
OPSANUS TAU	OYSTER TOADFISH	69	0.03
PALAEMONETES SPP	GRASS SHRIMP	22430	8.72
PARALICHTHYS DENTATUS	SUMMER FLOUNDER	301	0.12
PARALICHTHYS LETHOSTIGMA	SOUTHERN FLOUNDER	1300	0.51
PARALICHTHYS SPP	PARALICHTHYS SPP	1	0.00
PENAEUS AZTECUS	BROWN SHRIMP	17074	6.64
PENAEUS DUORARUM	PINK SHRIMP	1352	0.53
PENAEUS SETIFERUS	WHITE SHRIMP	277	0.11
PEPRILUS ALEPIDOTUS	HARVESTFISH	9	0.00
PEPRILUS TRIACANTHUS	BUTTERFISH	9	0.00
PETROMYZON MARINUS	SEA LAMPREY	1	0.00
POGONIAS CROMIS	BLACK DRUM	5	0.00
POMATOMUS SALTATRIX	BLUEFISH	7	0.00
PRIONOTUS SCITULUS	LEOPARD SEAROBIN	4	0.00
PRIONOTUS TRIBULUS	BIGHEAD SEAROBIN	527	0.20
RHIZOPRIONODON TERRAENOVAE	ATLANTIC SHARPNOSE SHAR	5	0.00
SCIAENOPS OCELLATA	RED DRUM	3	0.00
SCOPHTHALMUS AQUOSUS	WINDOWPANE	22	0.01
SELENE VOMER	LOOKDOWN	82	0.03
SICYONIA SPP	ROCK SHRIMP	1	0.00
SPHOEROIDES MACULATUS	NORTHERN PUFFER	4	0.00
SQUILLA EMPUSA	MANTIS SHRIMP	390	0.15
STELLIFER LANCEOLATUS	STAR DRUM	66	0.03
SYMPHURUS PLAGIUSA	BLACKCHEEK TONGUEFISH	3041	1.18
SYMPHURUS SPP	TONGUEFISH	46	0.02
SYNGNATHUS LOUISIANAE	CHAIN PIPEFISH	2	0.00
SYNODUS FOETENS	INSHORE LIZARDFISH	24	0.01
TRACHYPENAEUS CONSTRICTUS	TRACHYPENAEUS CONSTRICT	1586	0.62
TRIGLIDAE	SEA ROBIN SPP	1	0.00
TRINECTES MACULATUS	HOGCHOKER	256	0.10
UPOGEBIA AFFINIS	MUD SHRIMP	5	0.00
UROPHYCIS FLORIDANUS	SOUTHERN HAKE	436	0.17
UROPHYCIS REGIUS	SPOTTED HAKE	1317	0.51
UROPHYCIS SPP.	MIXED HAKE	1	0.00
	TOTAL	257133	100.00

Table 5.16 Catch per unit effort by species and station for diversion device study--January 1979 - September 1979[1]

Species	Age	Station 4	Station 5	Station 6
Bay Anchovy		175.0	205.7	164.8
Menhaden	Young[2]	0.1	0.5	0.1
	Adult[3]	56.5	38.3	1.1
Spotted Seatrout		0.1	1.1	0.0
Weakfish	Young	20.7	38.8	12.0
	Adult	0.3	0.7	0.2
Spot	Young	267.7	701.2	771.7
	Adult	23.8	72.2	10.1
Croaker	Young	211.7	279.4	207.5
	Adult	0.7	2.4	0.8
Mullet		0.4	0.3	0.1
Summer Flounder	Young	0.6	2.4	1.6
	Adult	0.1	0.2	0.2
Southern Flounder	Young	0.2	3.8	3.1
	Adult	3.2	5.7	5.9
White Shrimp		0.8	2.9	1.0
Pink Shrimp		6.6	11.8	4.1
Brown Shrimp		67.9	114.3	102.4
Blue Crabs		42.6	32.5	50.8
Total Organisms		989.5	1895.0	1401.0

[1] 60 efforts per station

[2] young-of-the-year

[3] juveniles and adults

Figure 5.1a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=ANCHOA MITCHILLI YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

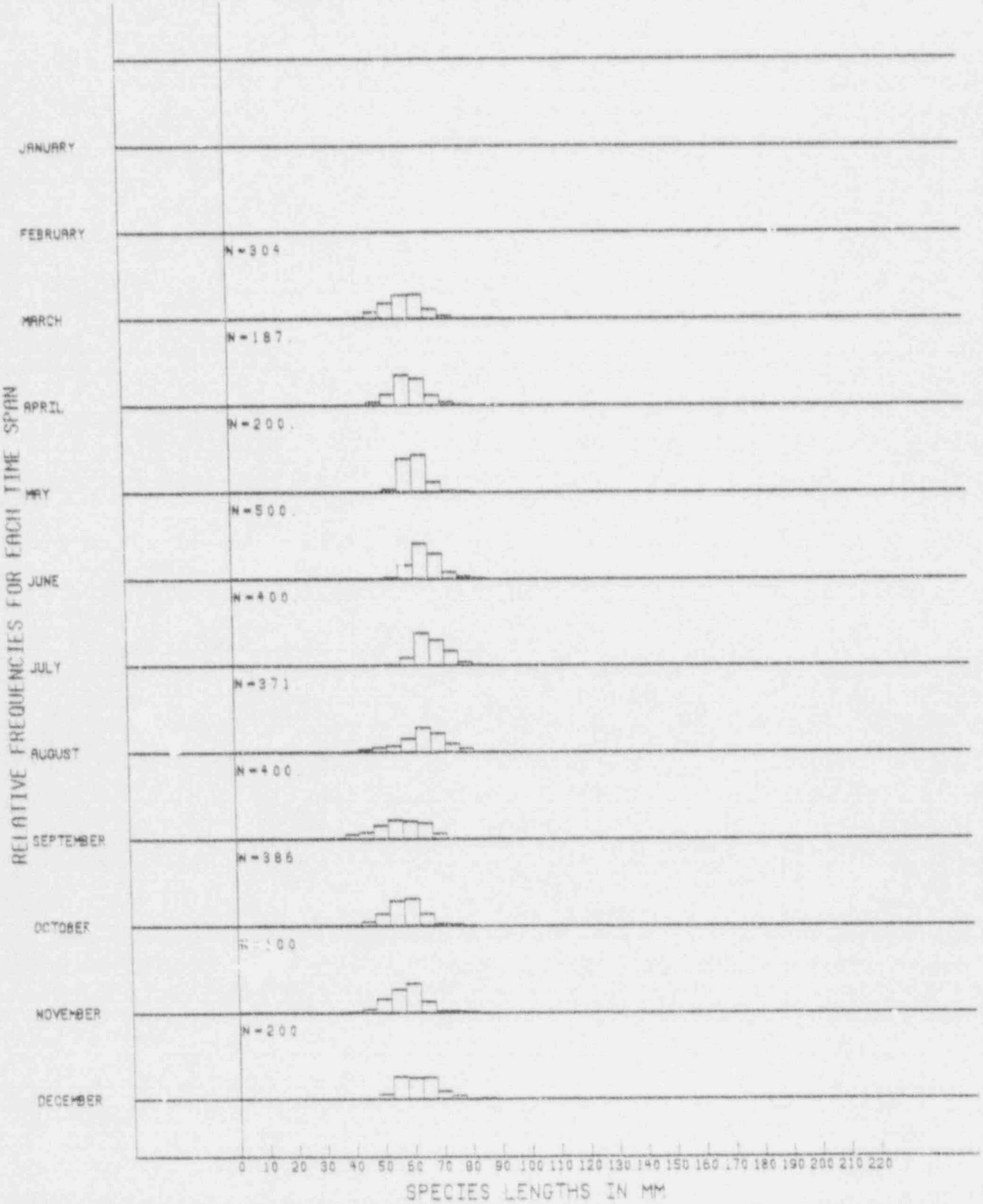

Figure 5.1b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=ANCHOA MITCHILLI YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

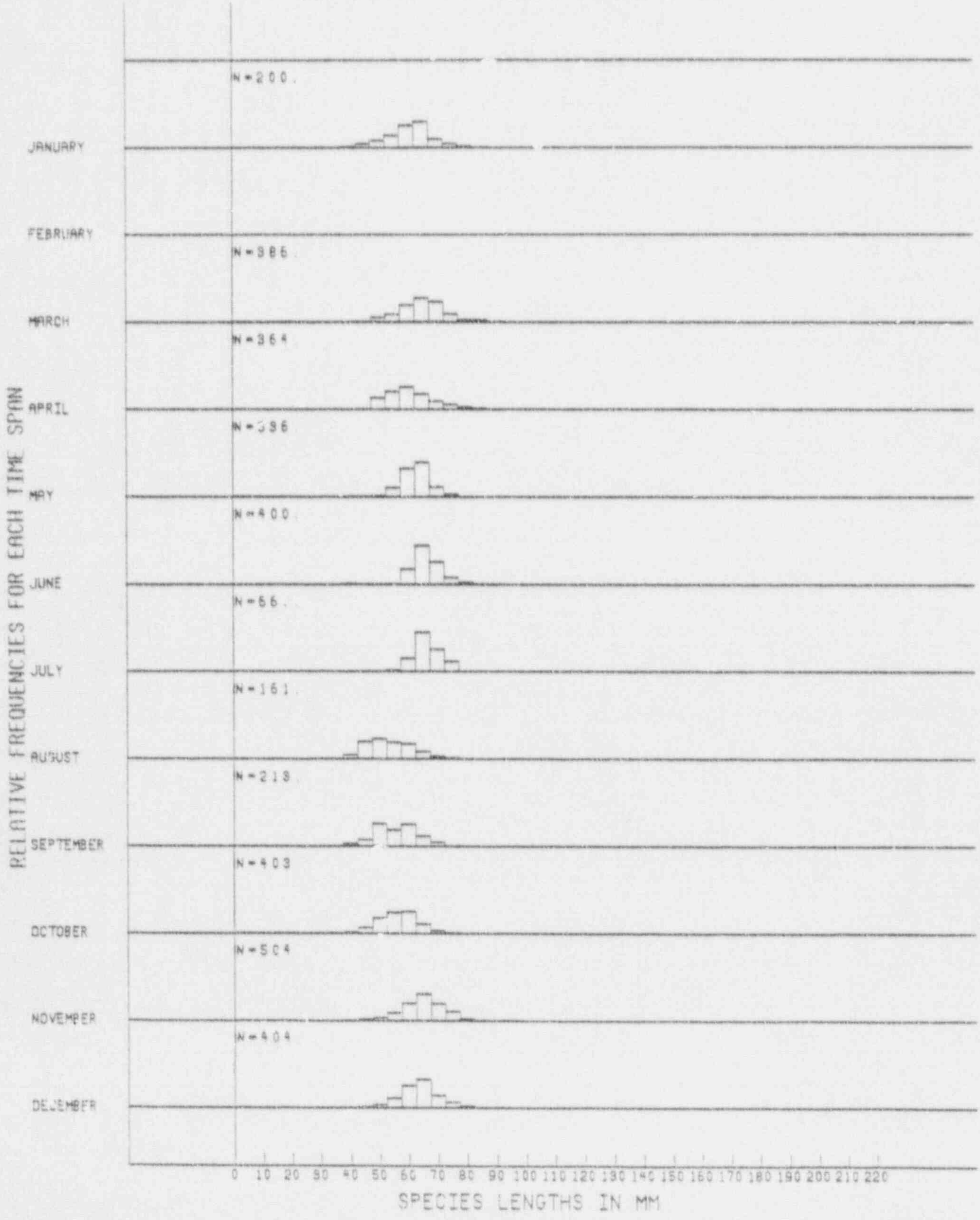

Figure 5.1c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS USING ONE MONTH INTERVALS OVER TIME

SCIENTIFIC NAME=ANCHOA MITCHILLI YEAR=1978

PLOT OF Y * X CONNECTING LINES USED

PLOT OF W * V SYMBOL USED IS N

PLOT OF W * Q SYMBOL USED IS =

PLOT OF W * U SYMBOL IS VALUE OF Z2

PLOT OF W * S SYMBOL IS VALUE OF Z1

PLOT OF W * T SYMBOL IS VALUE OF Z0

PLOT OF W * R SYMBOL IS VALUE OF ZA

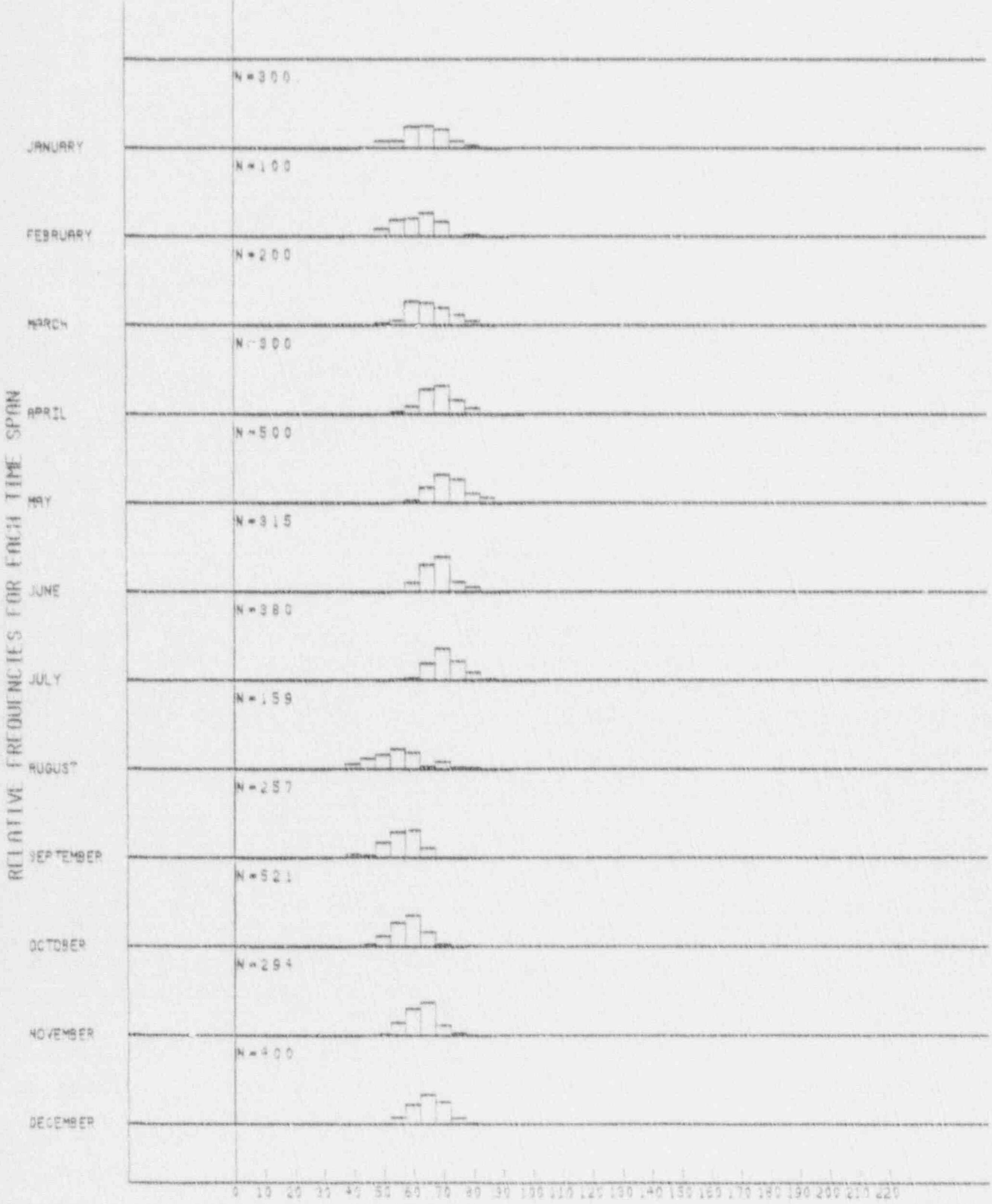

Figure 5.1d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=ANCHOA MITCHILLI YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

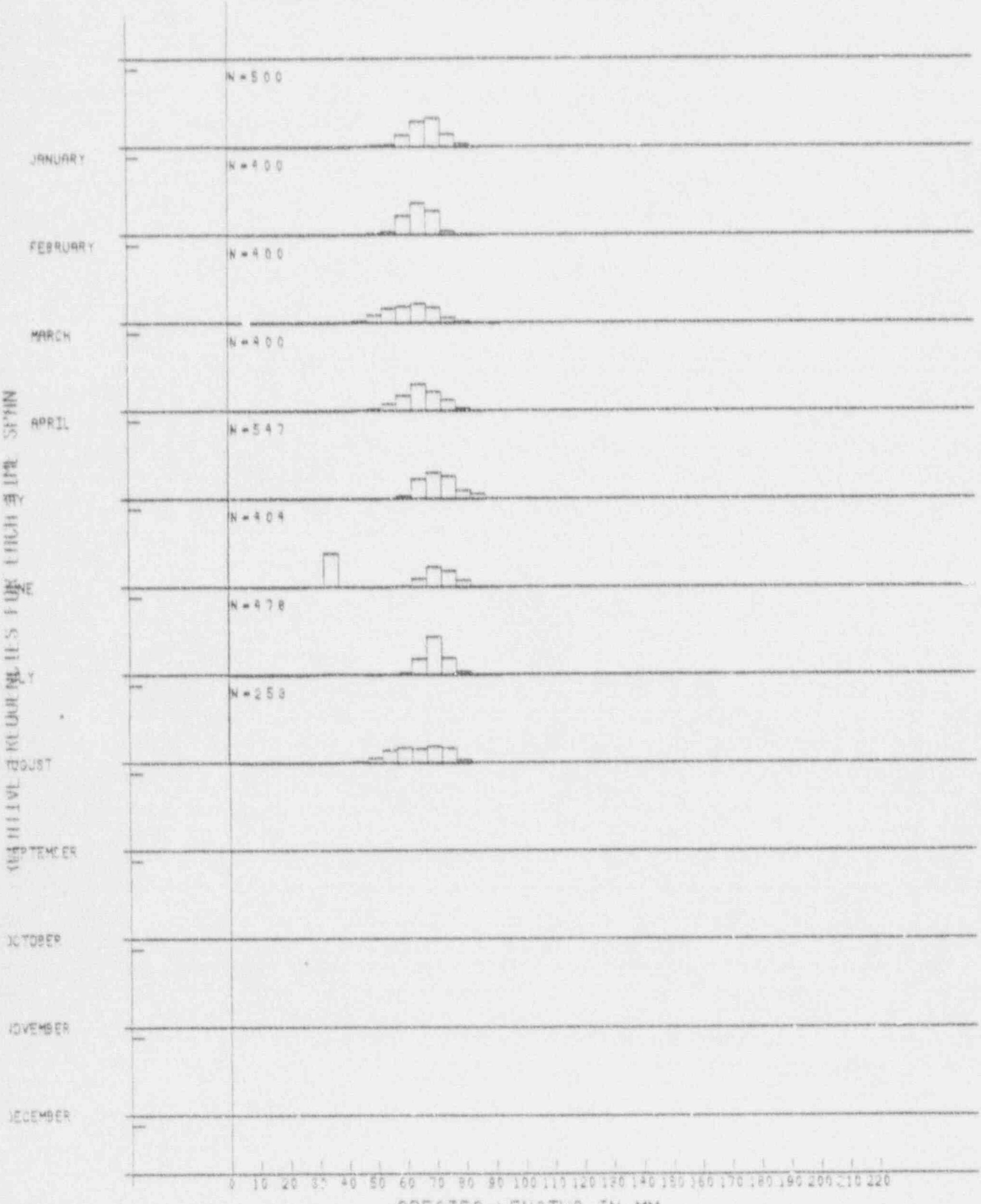

Figure 5.2a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=LEIOSTOMUS XANTHURUS YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

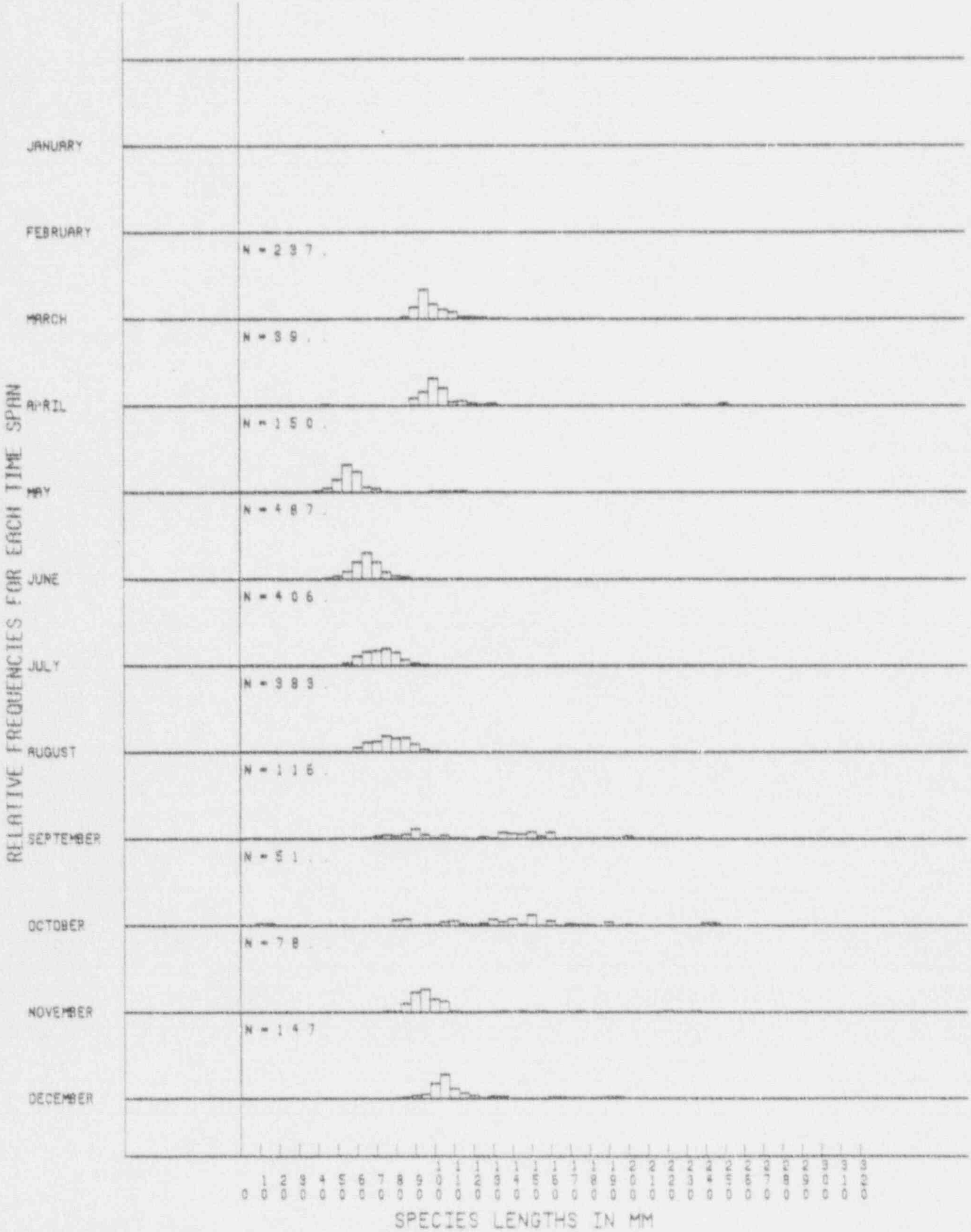

Figure 5.2b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=LEIOSTOMUS XANTHURUS YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

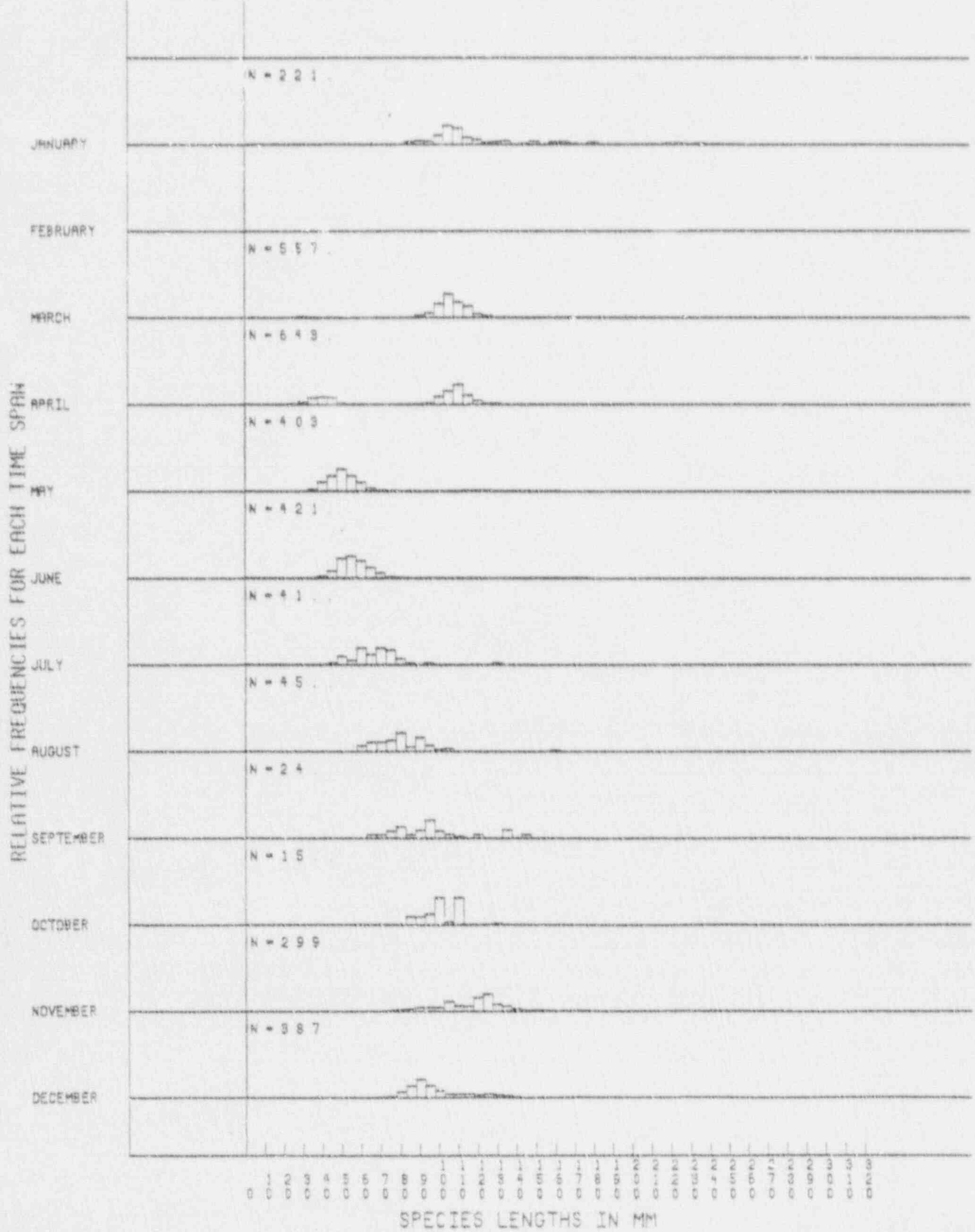

Figure 5.2c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=LEIOSTOMUS XANTHURUS YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

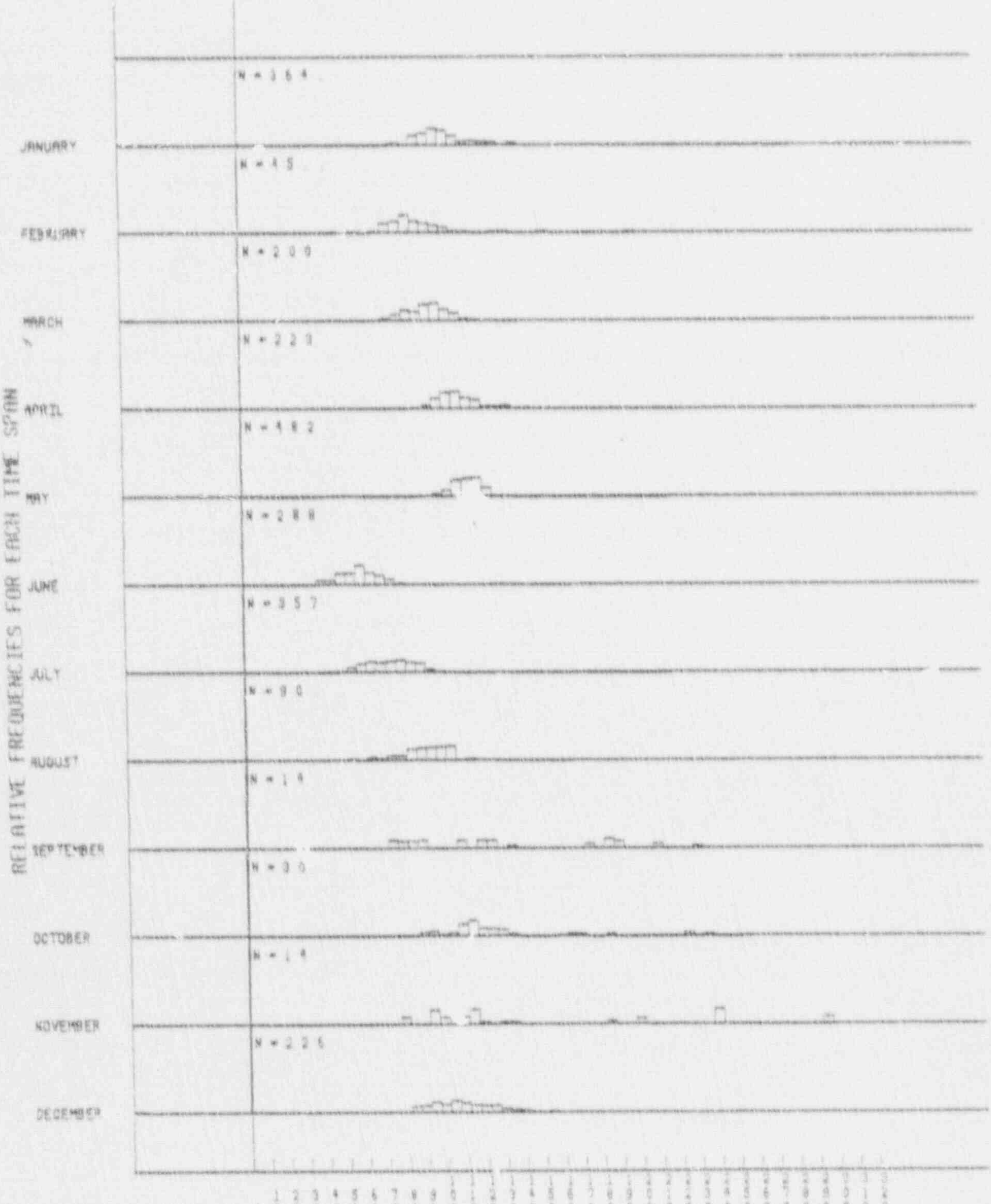

Figure 5.2d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=LEIOSTOMUS XANTHURUS YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

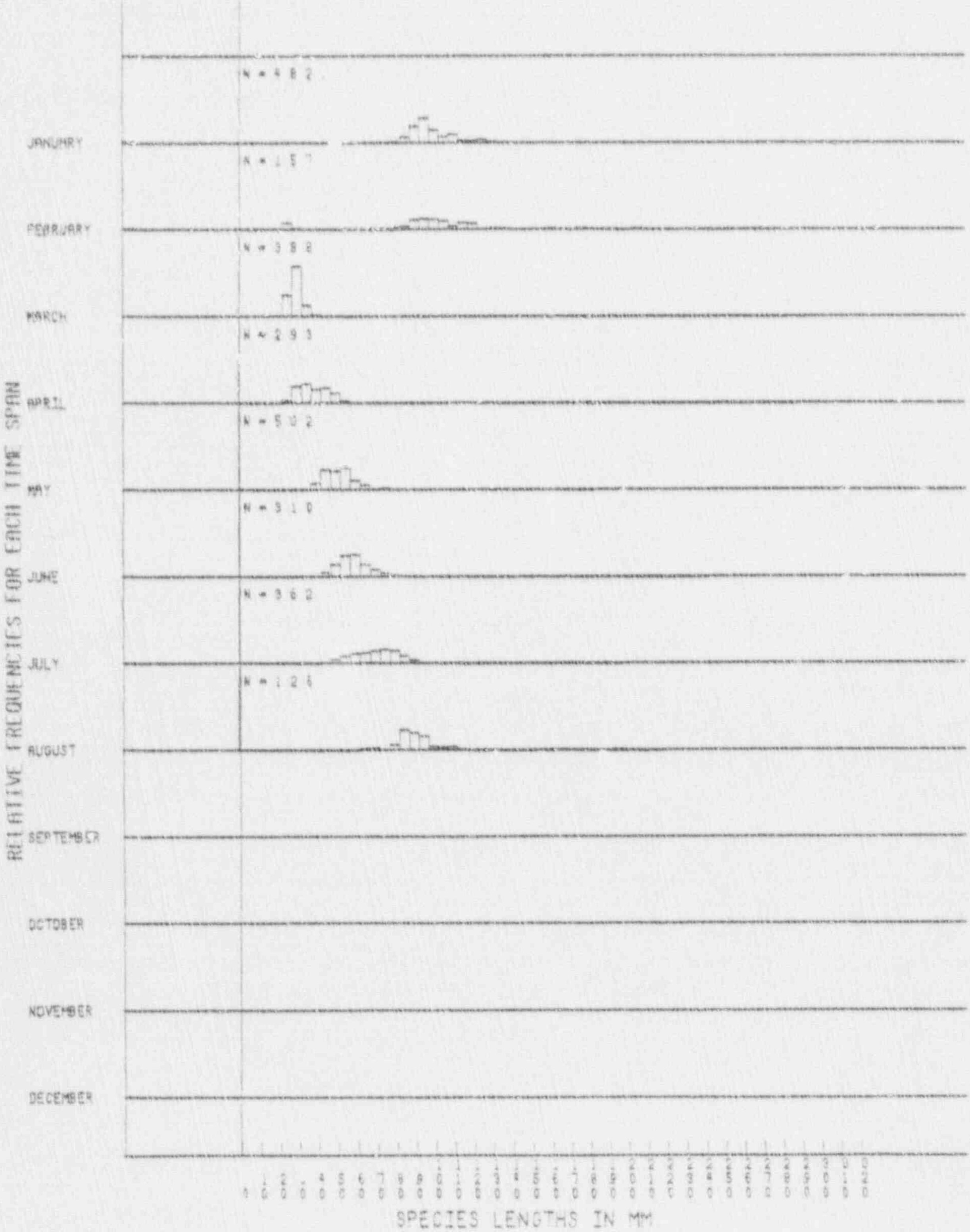

Figure 5.3a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MICROPOGONIAS UNDULATUS YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS *
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

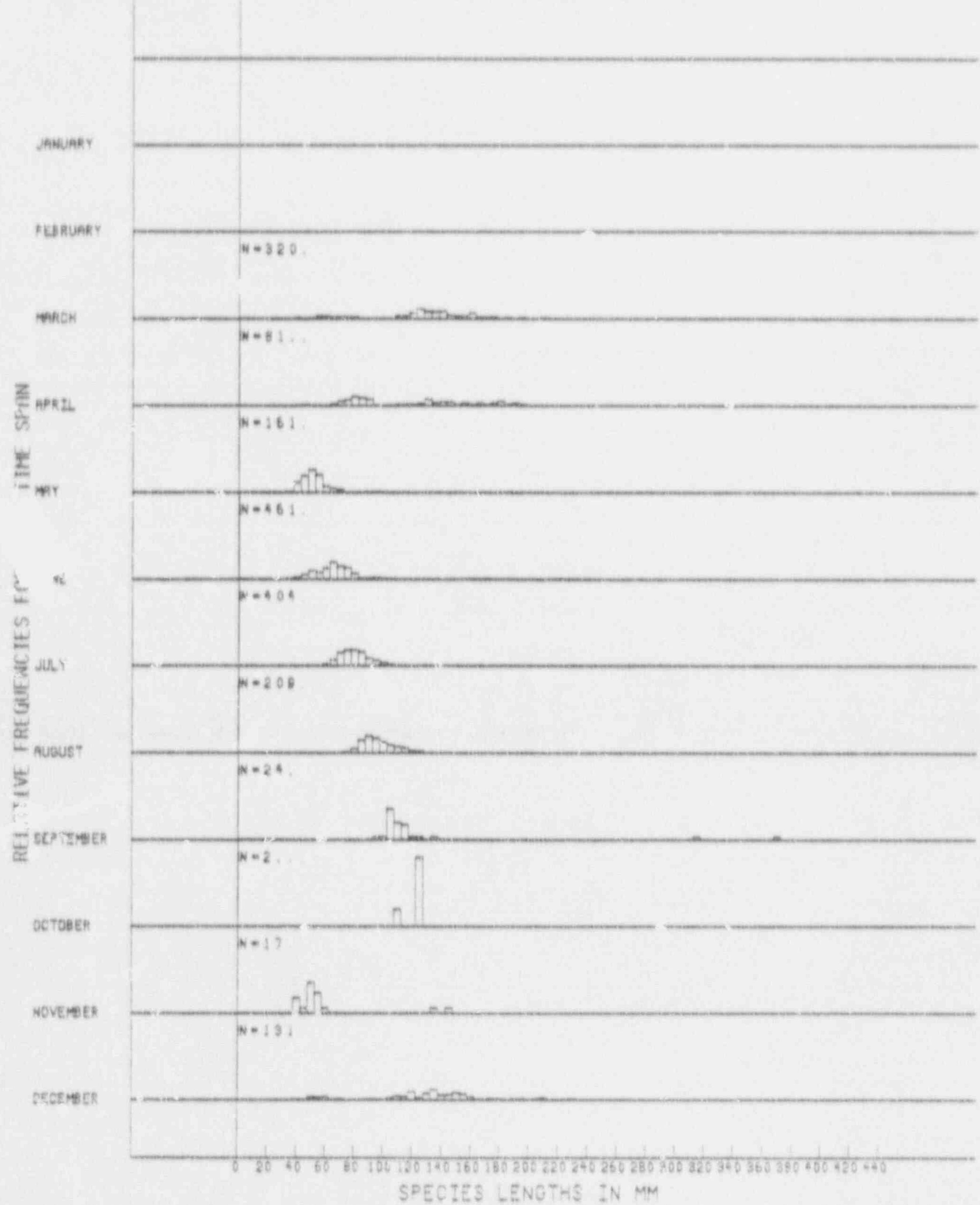

Figure 5.3b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MICROPOGONIAS UNDULATUS YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

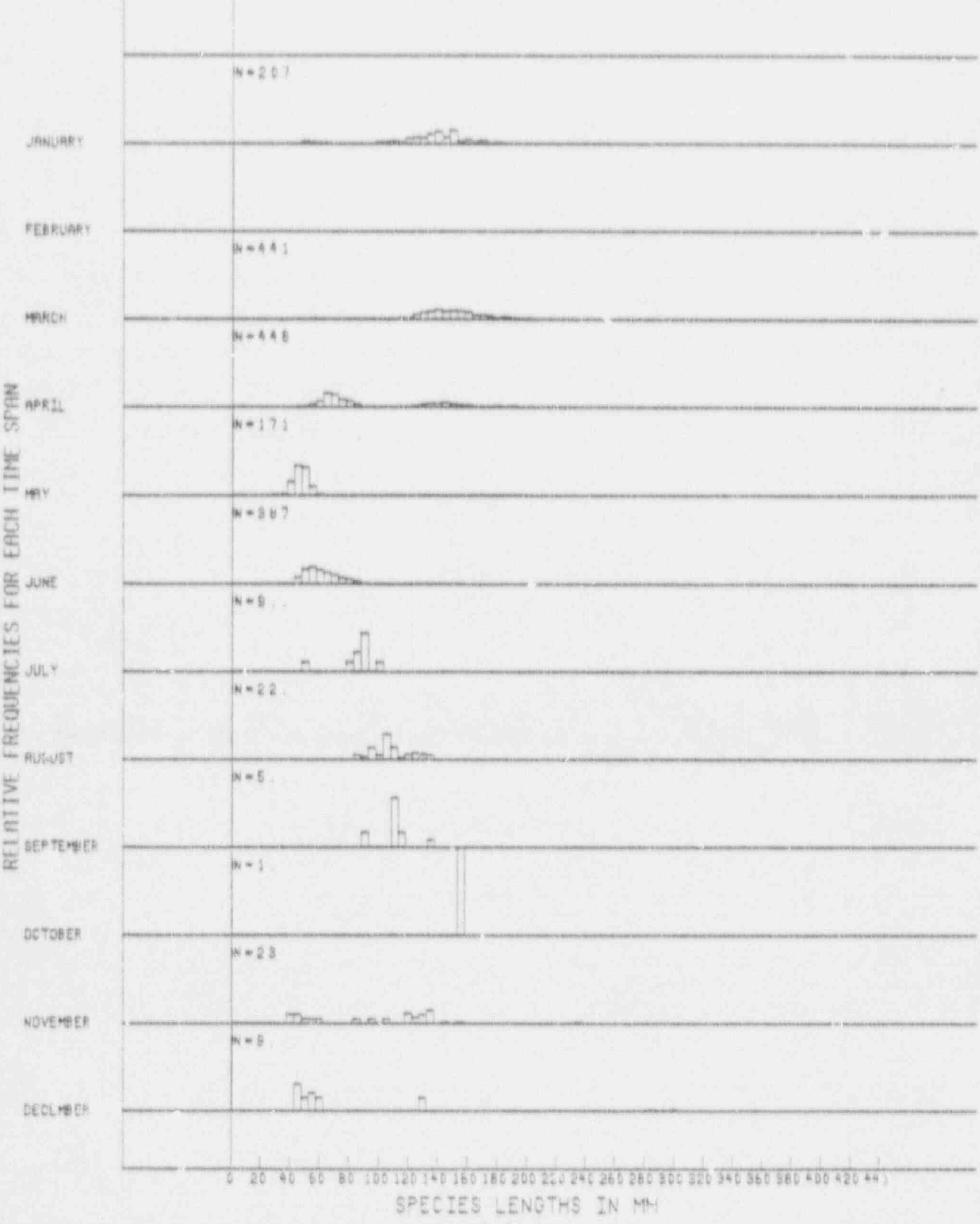

Figure 5.3c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MICROPOGONIAS UNDULATUS YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

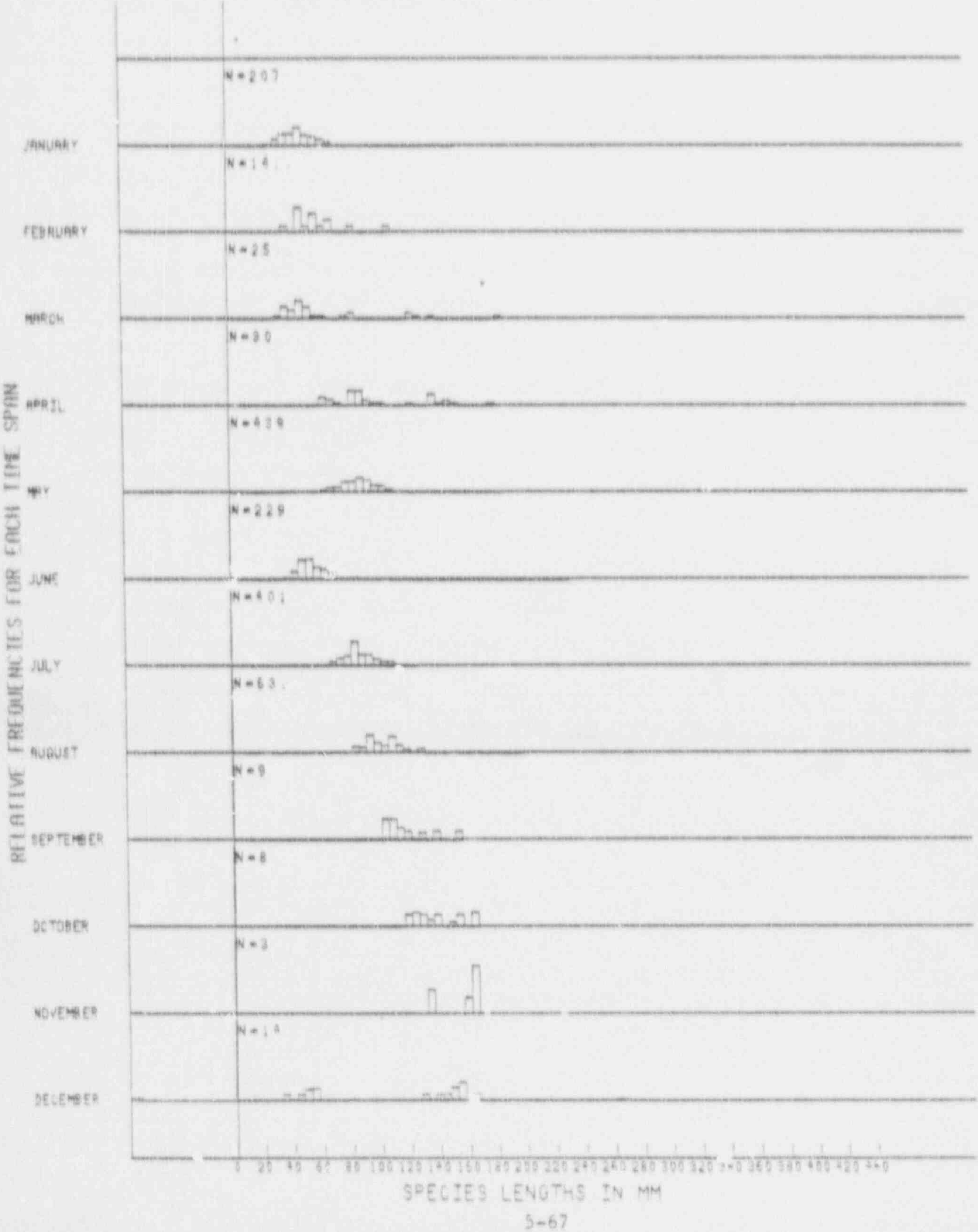

Figure 5.3d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MICROPOGONIAS UNDULATUS YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

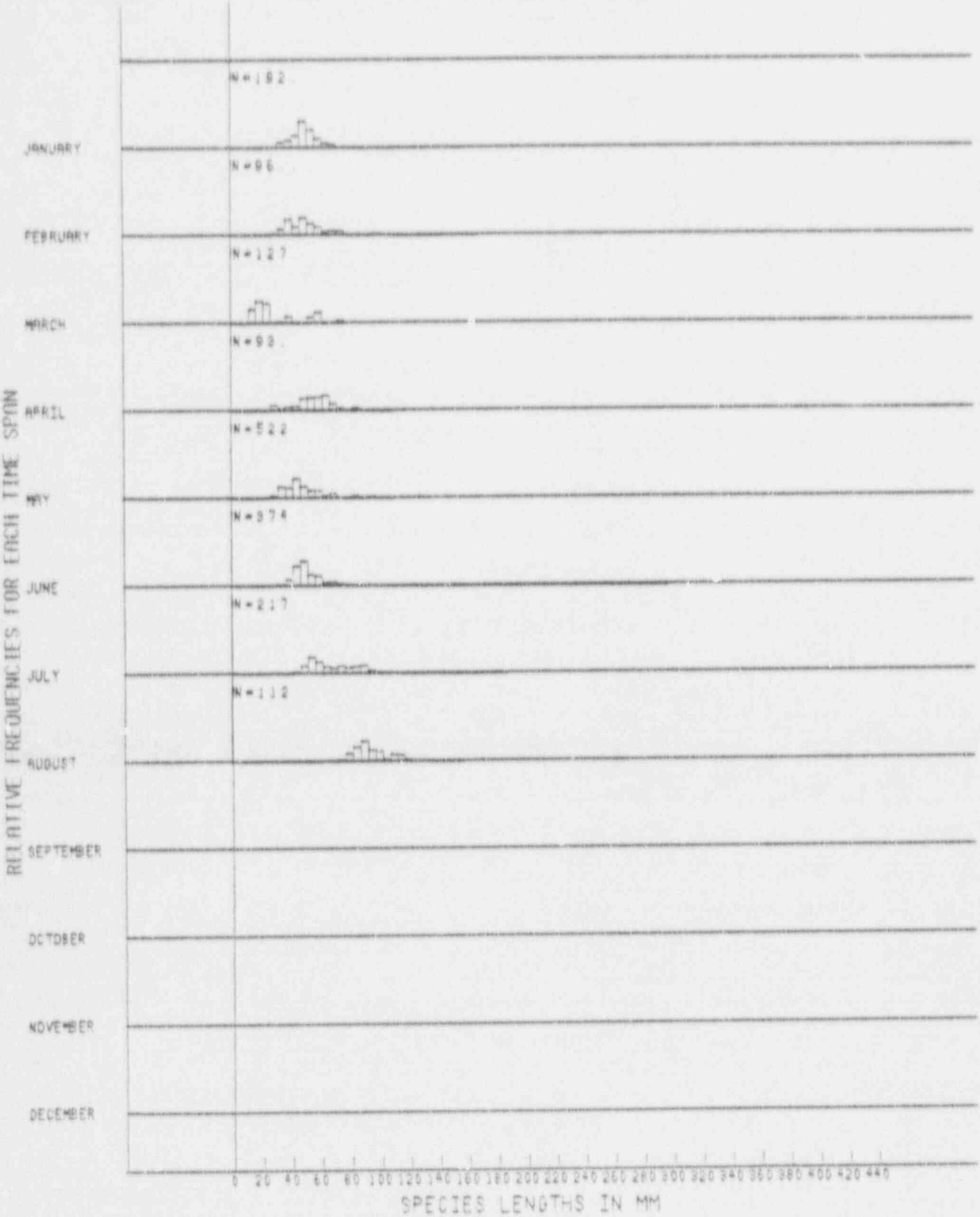

Figure 5.4a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=BREVOORTIA TYRANNUS YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

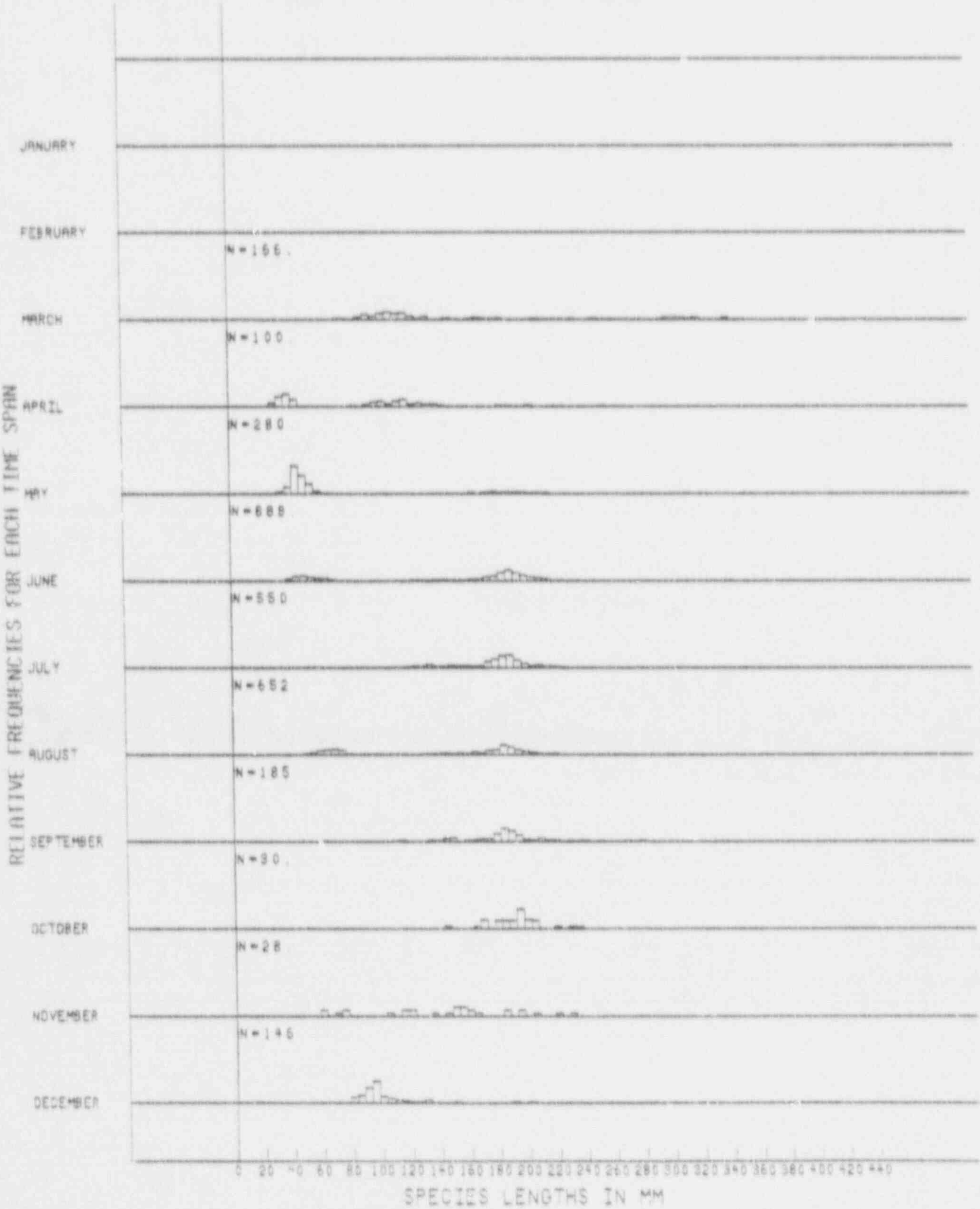

Figure 5.4b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=BREVOORTIA TYRANNUS YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

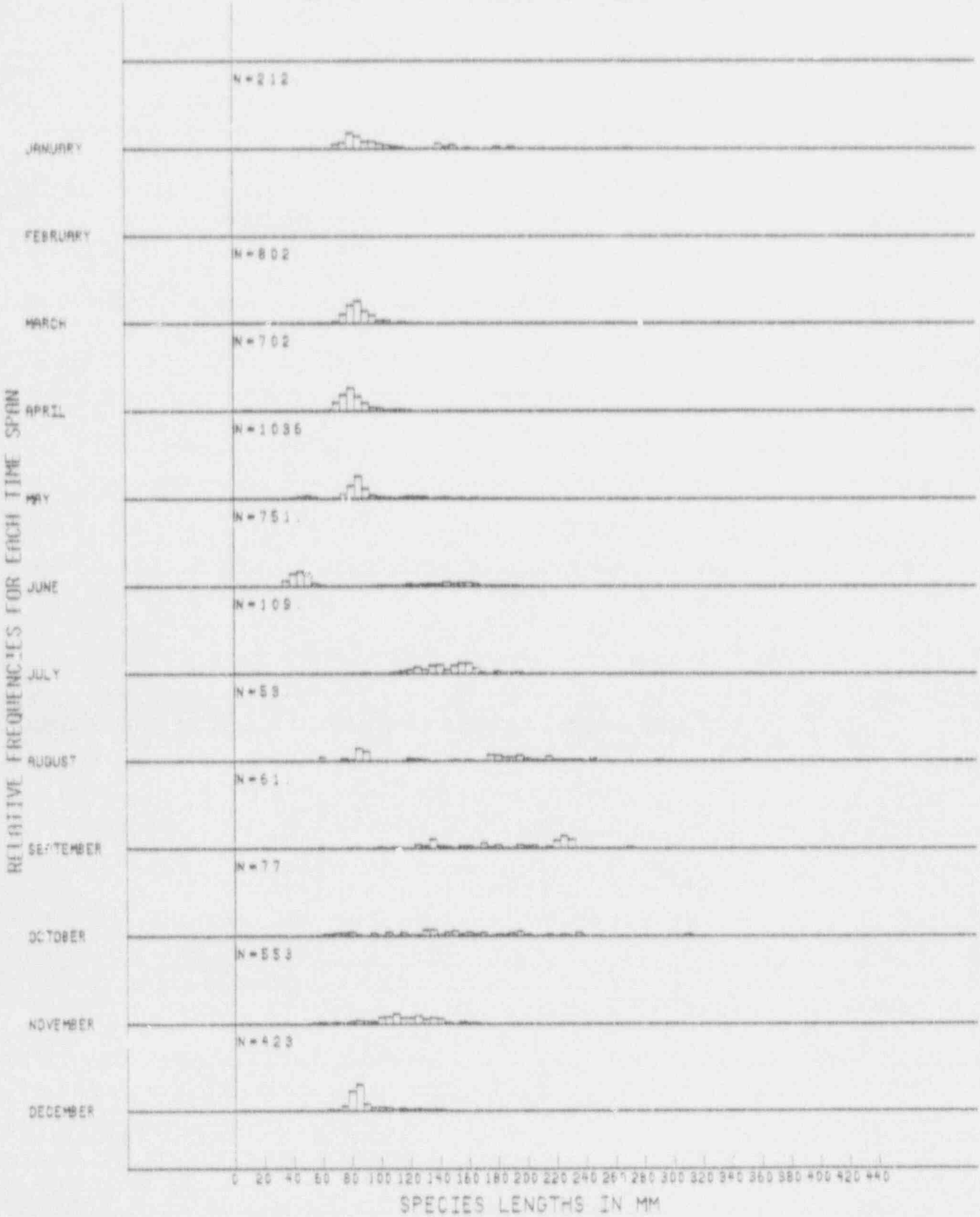

Figure 5.4c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=BREVOORTIA TYRANNUS YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

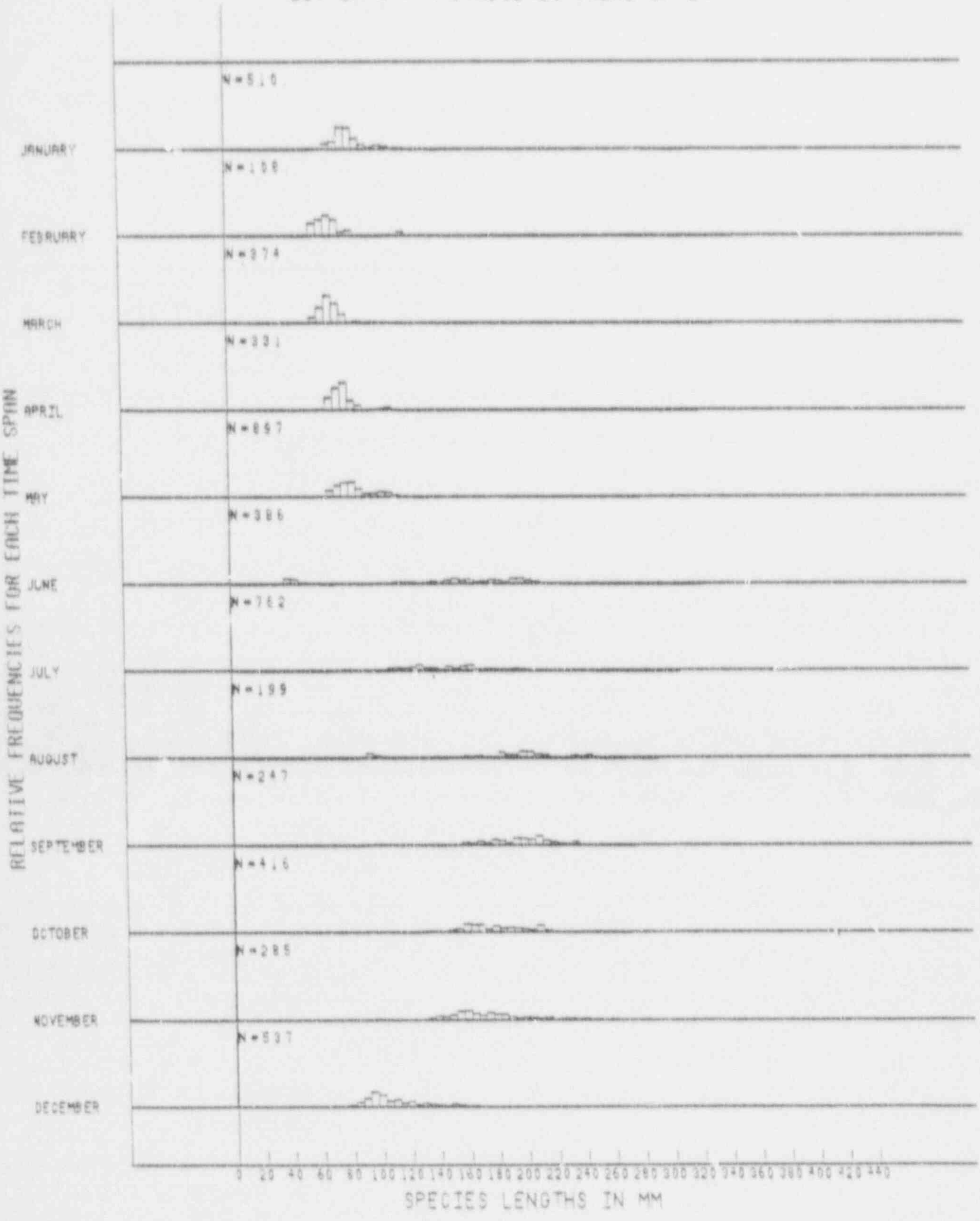

Figure 5.4d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=BREVOORTIA TYRANNUS YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

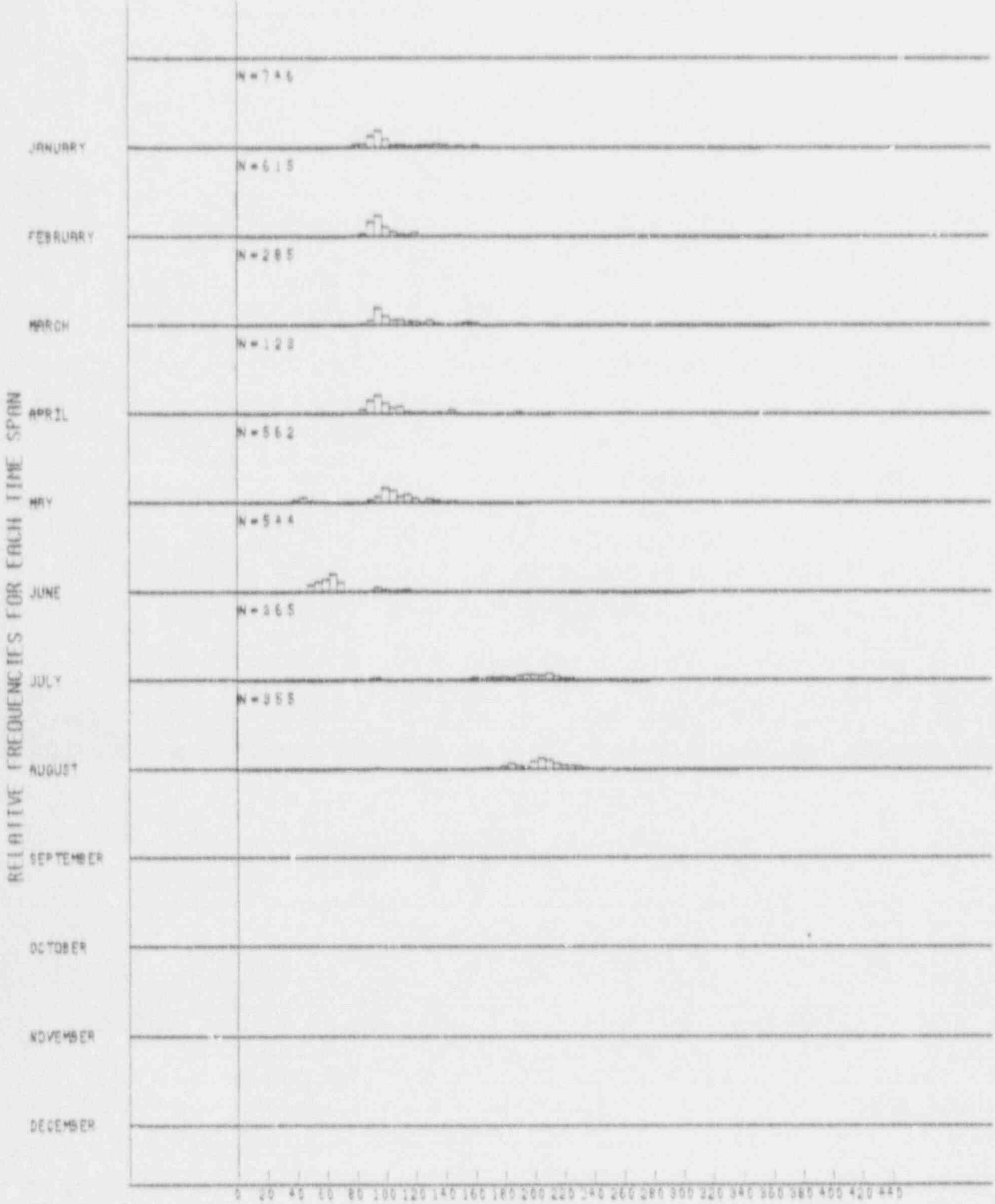

Figure 5.5a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=CYNOSCION NEBULOSUS YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

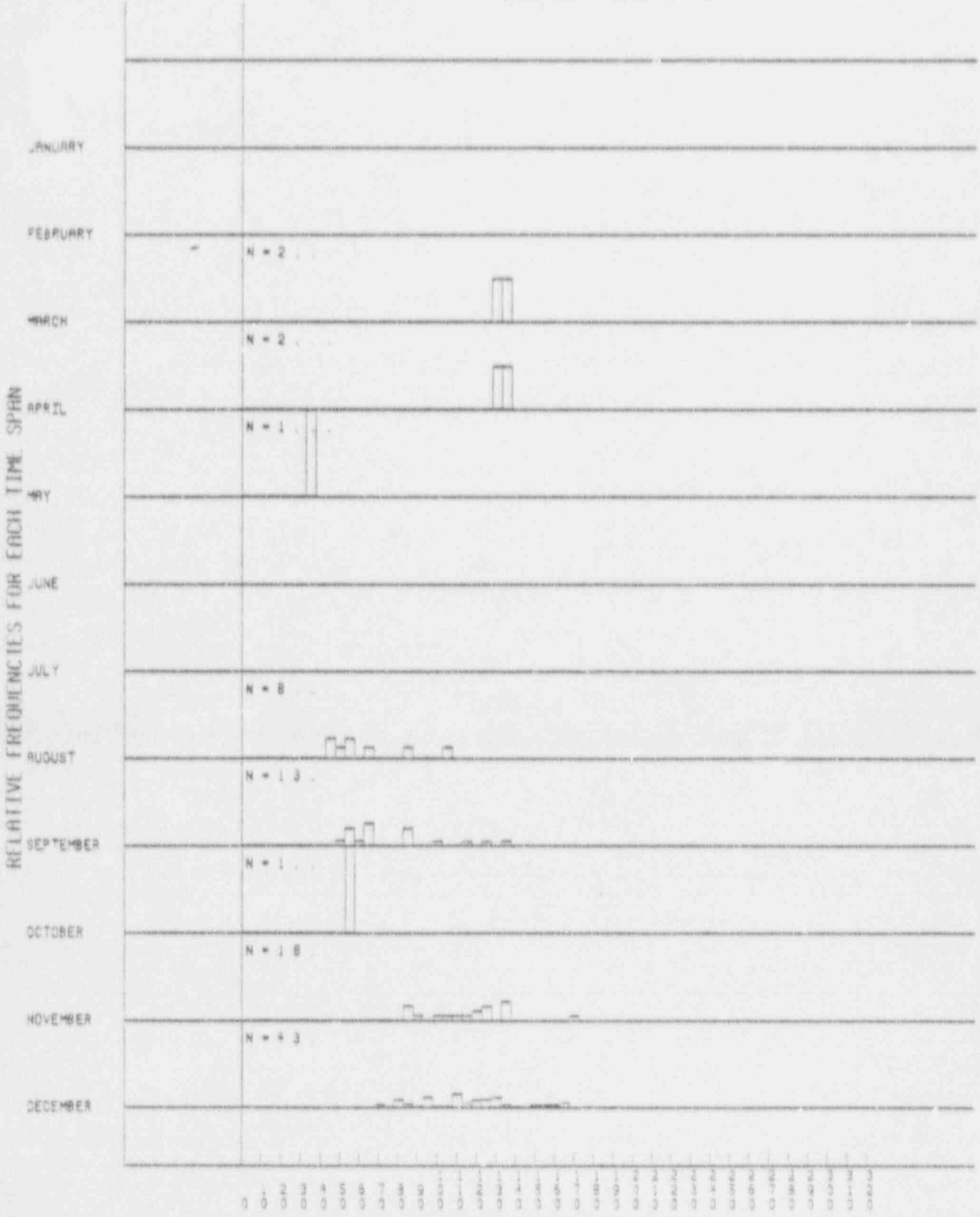

Figure 5.5b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=CYNOSCION NEBULOSUS YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

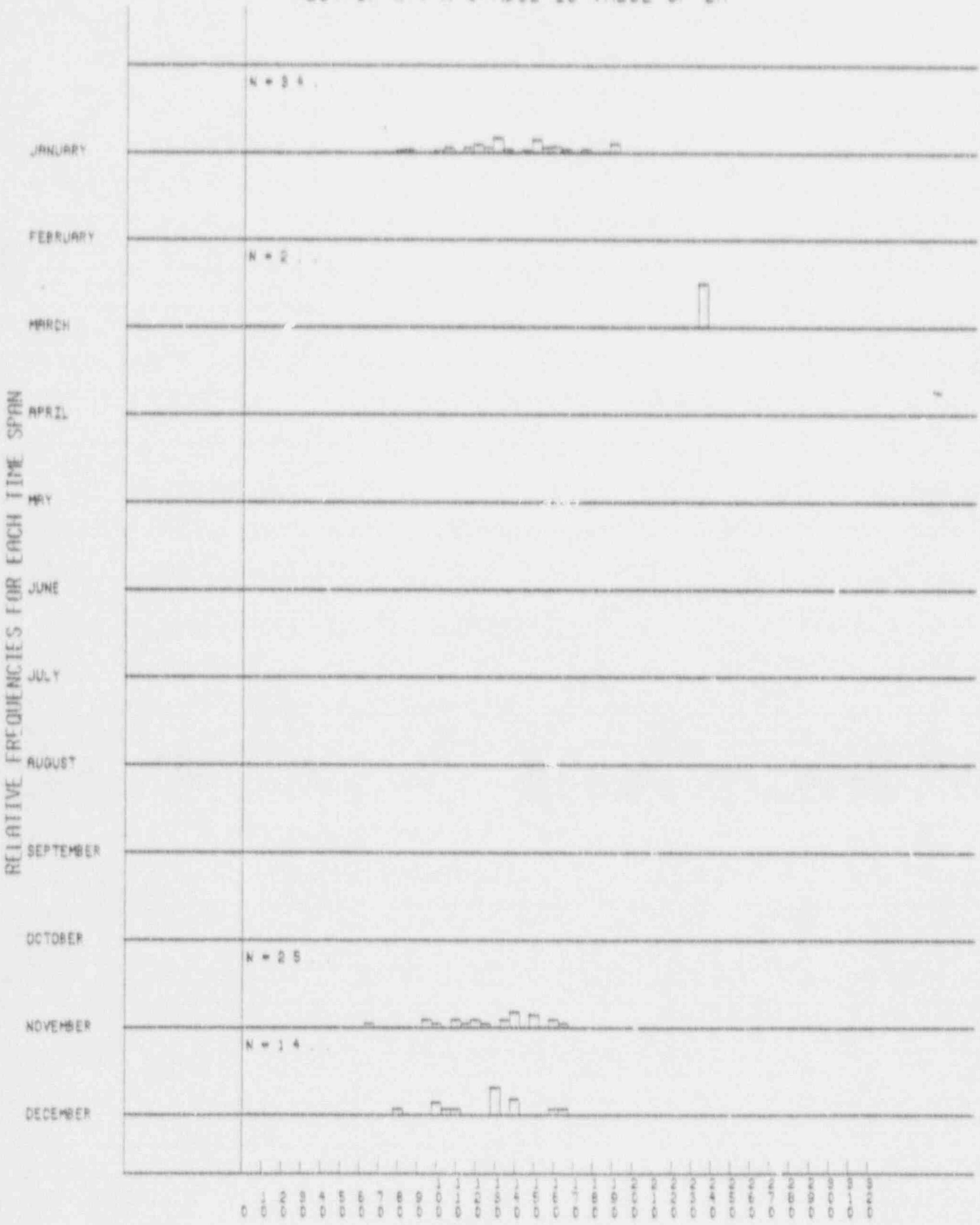

Figure 5.5c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=CYNOSCION NEBULOSUS YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

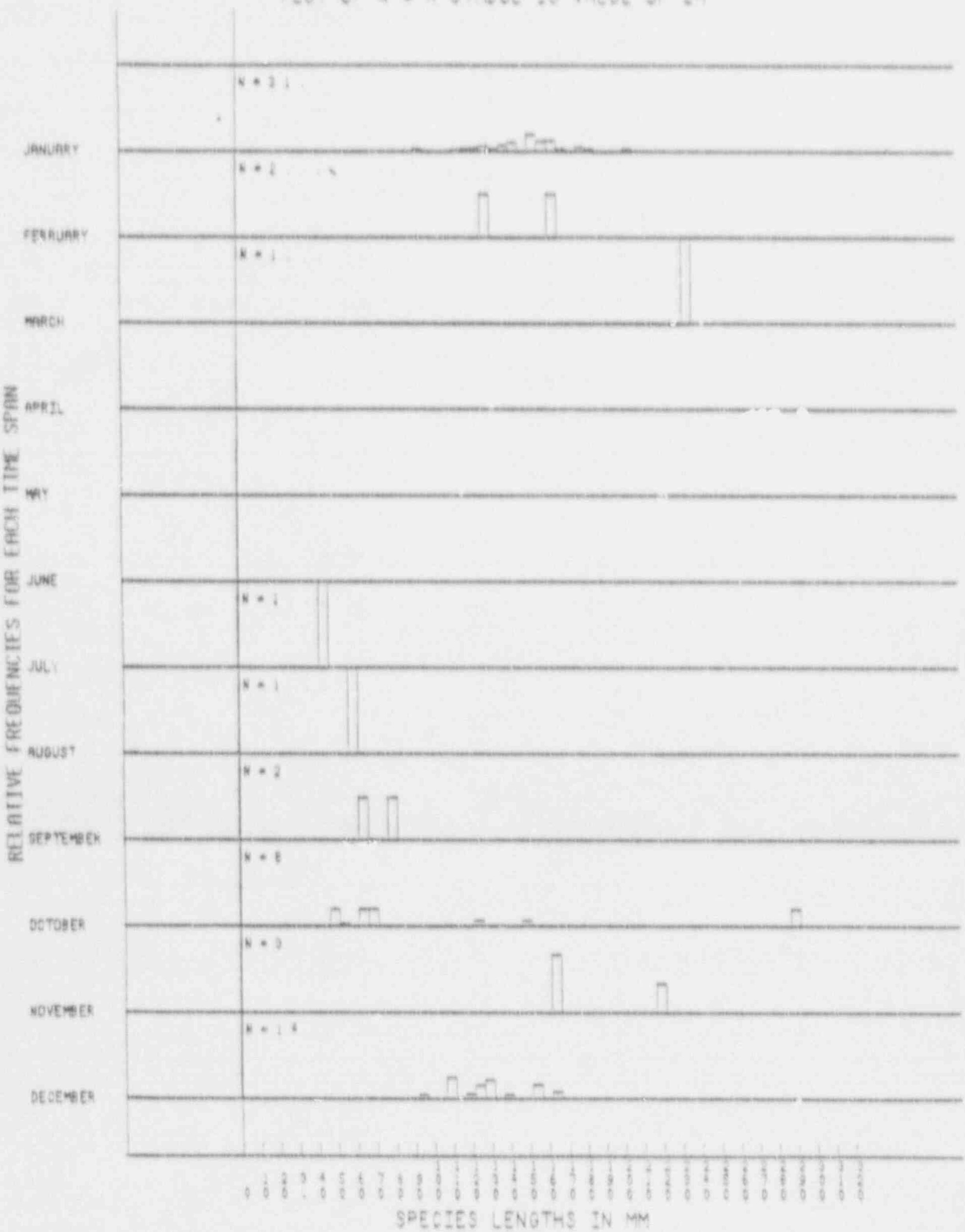

Figure 5.5d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=CYNOSCION NEBULOSUS YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

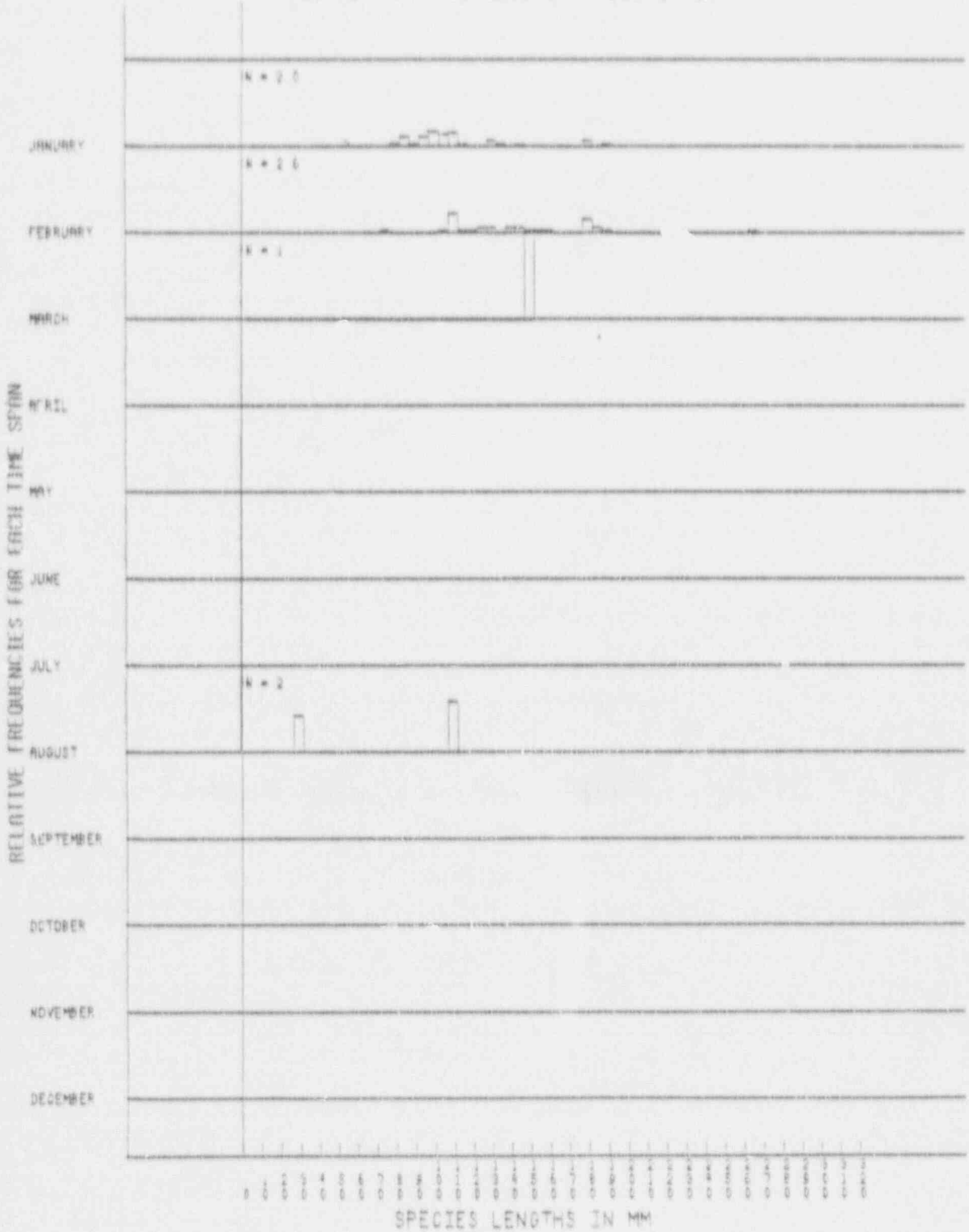

Figure 5.6a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=CYNOSCION REGALIS YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

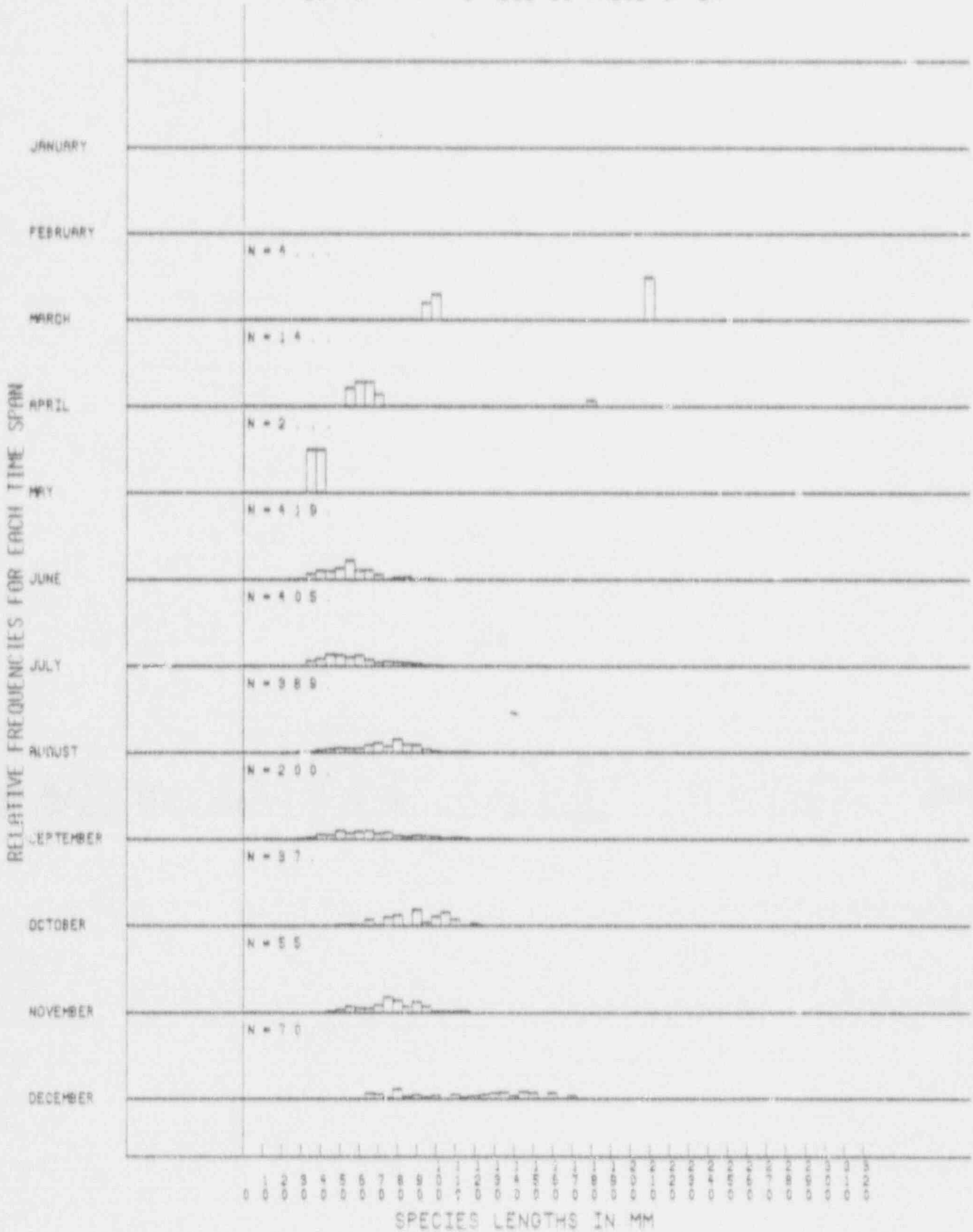

Figure 5.6b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=CYNOSCION REGALIS YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT * U SYMBOL IS VALUE OF Z2
PLOT OF SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

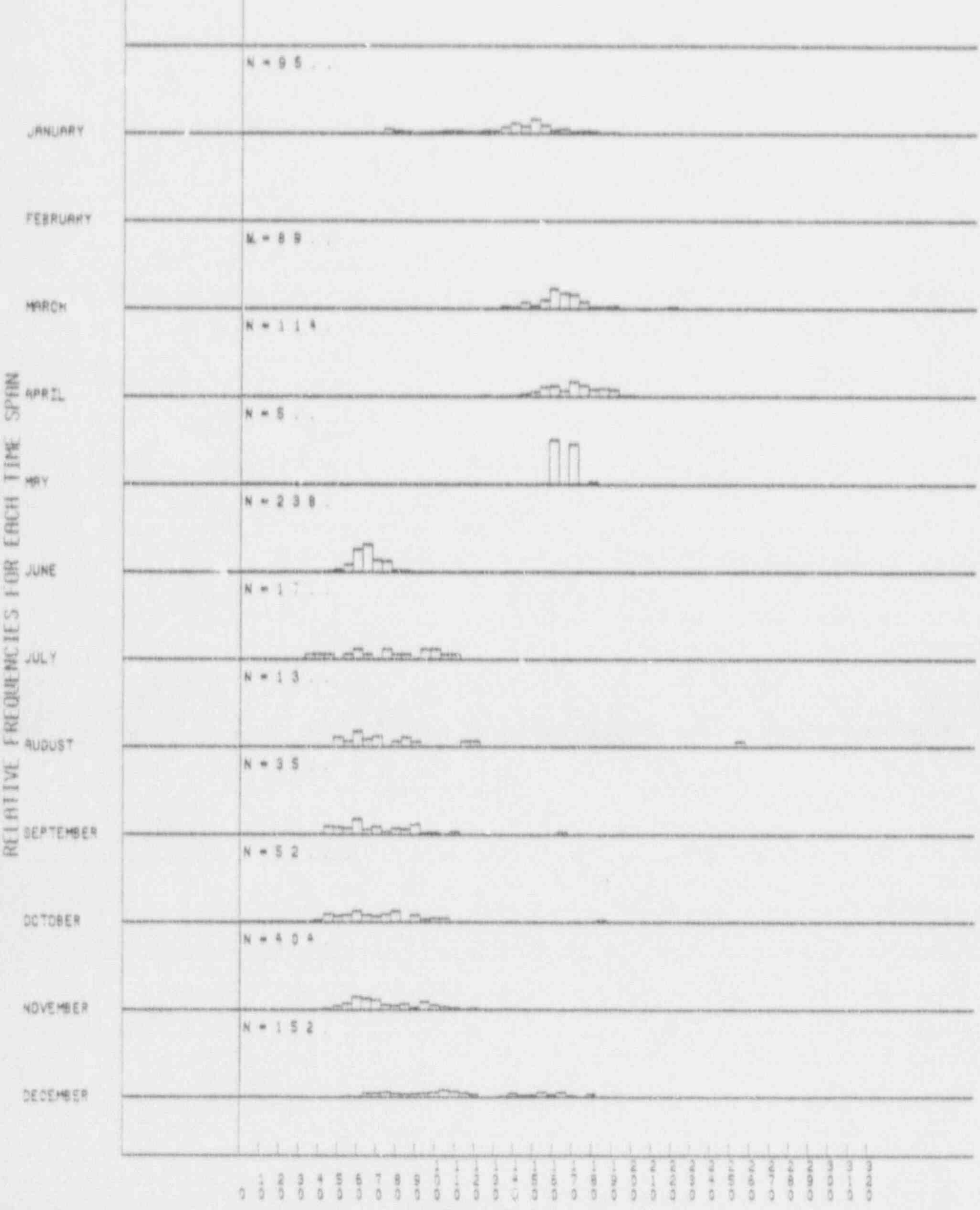

Figure 5.6c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=CYNOSCION REGALIS YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

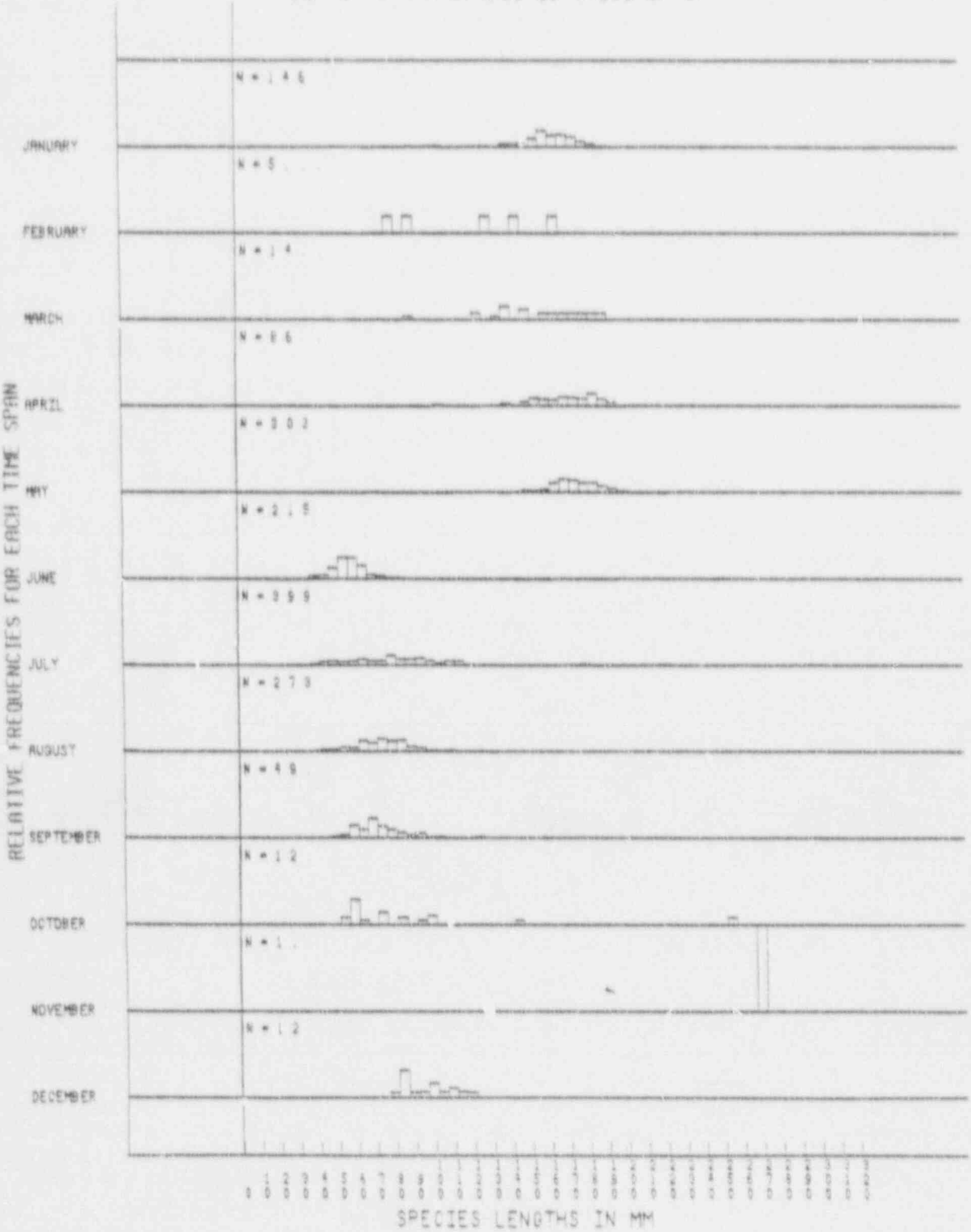

Figure 5.6d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=CYNOSCION REGALIS   YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * D SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

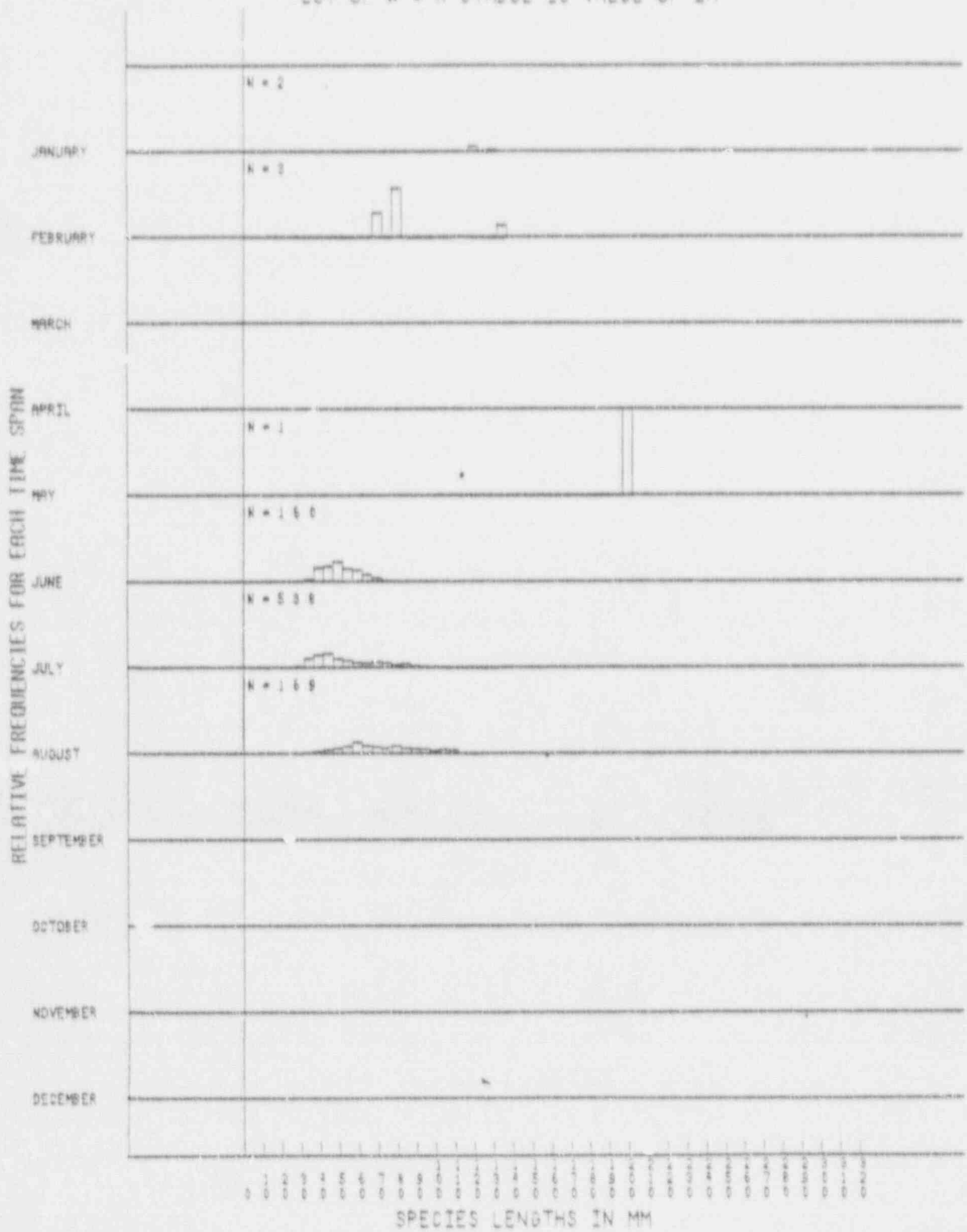

Figure 5.7a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PARALICHTHYS DENTATUS YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

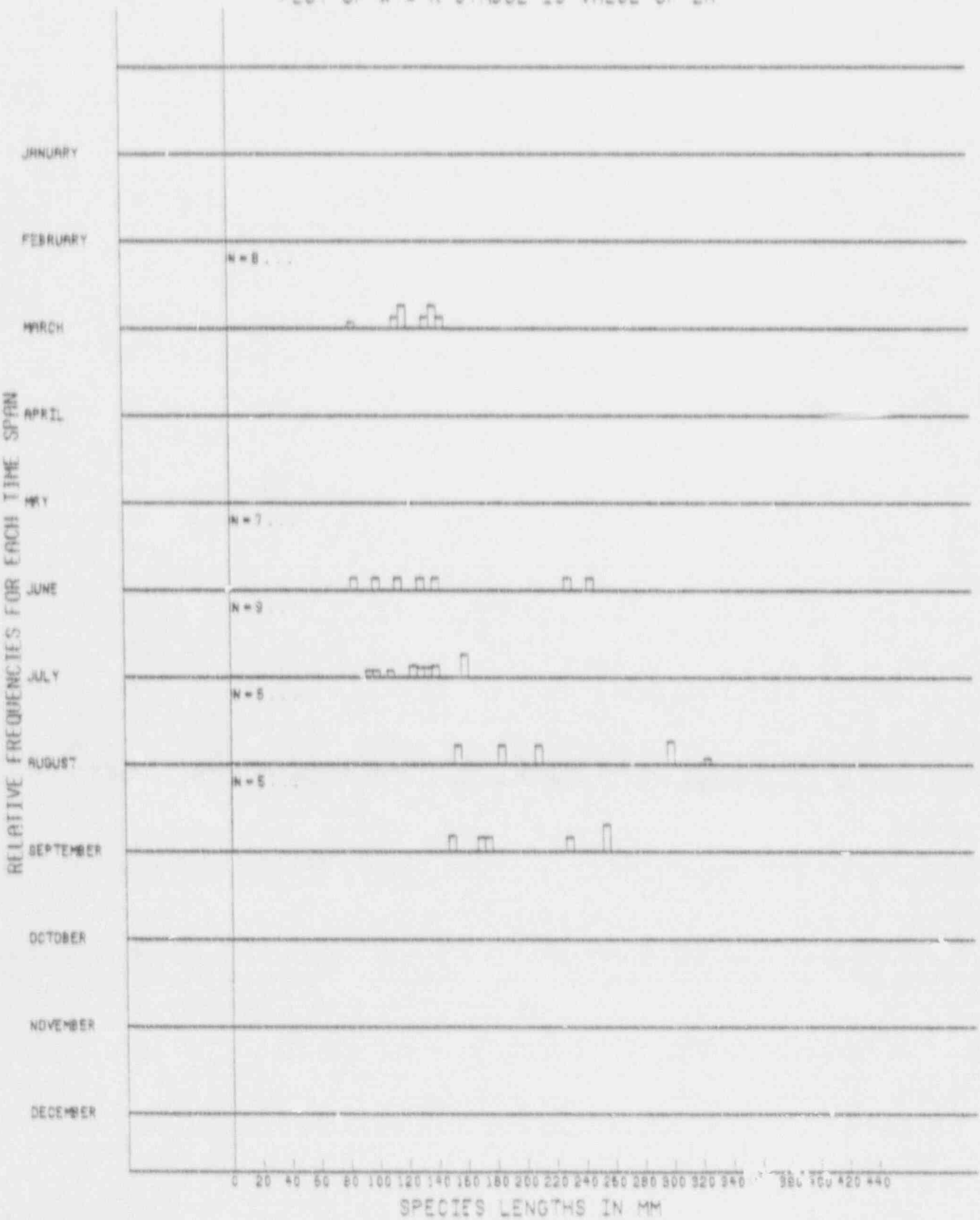

Figure 5.7b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PARALICHTHYS DENTATUS YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

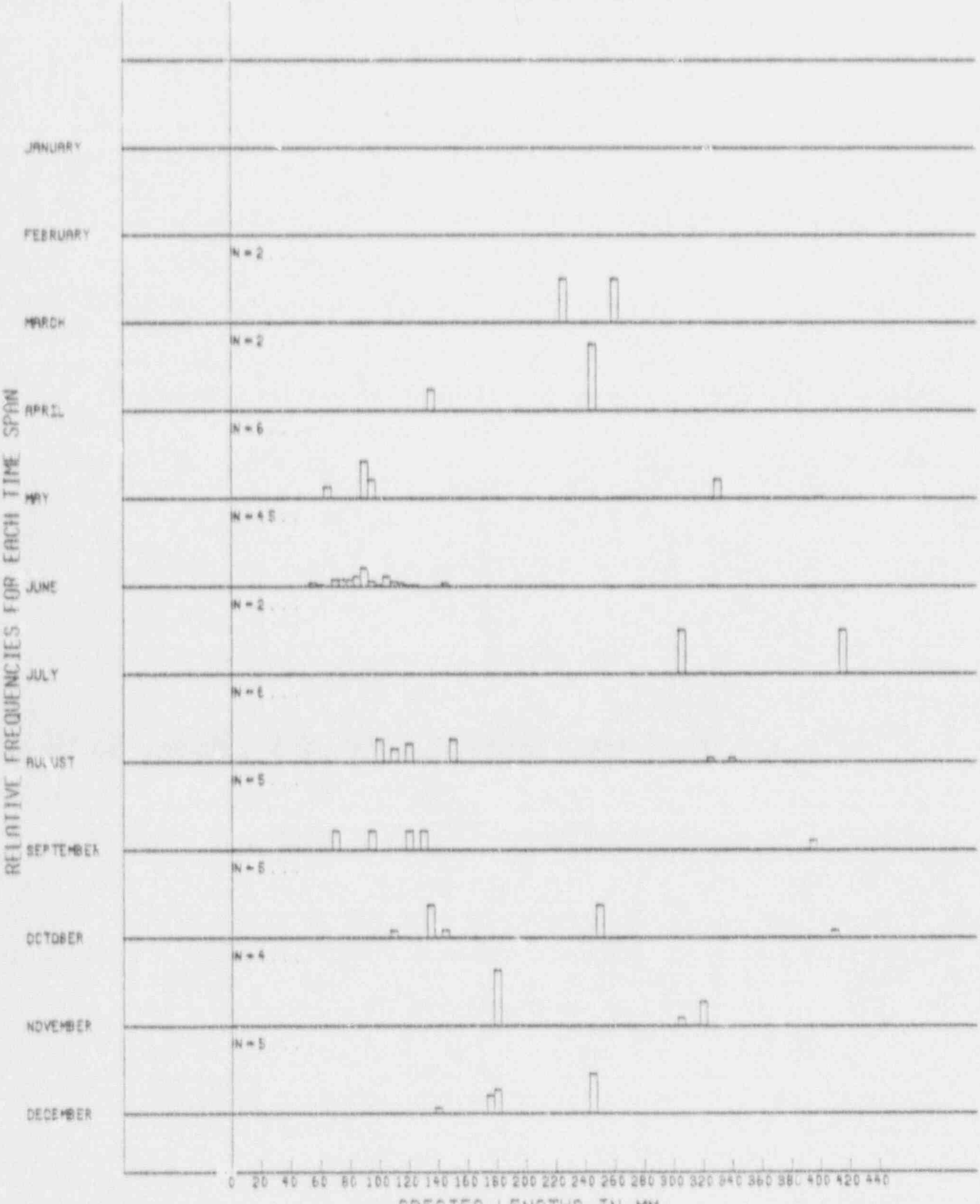

Figure 5.7c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PARALICHTHYS DENTATUS YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * P SYMBOL IS VALUE OF ZA

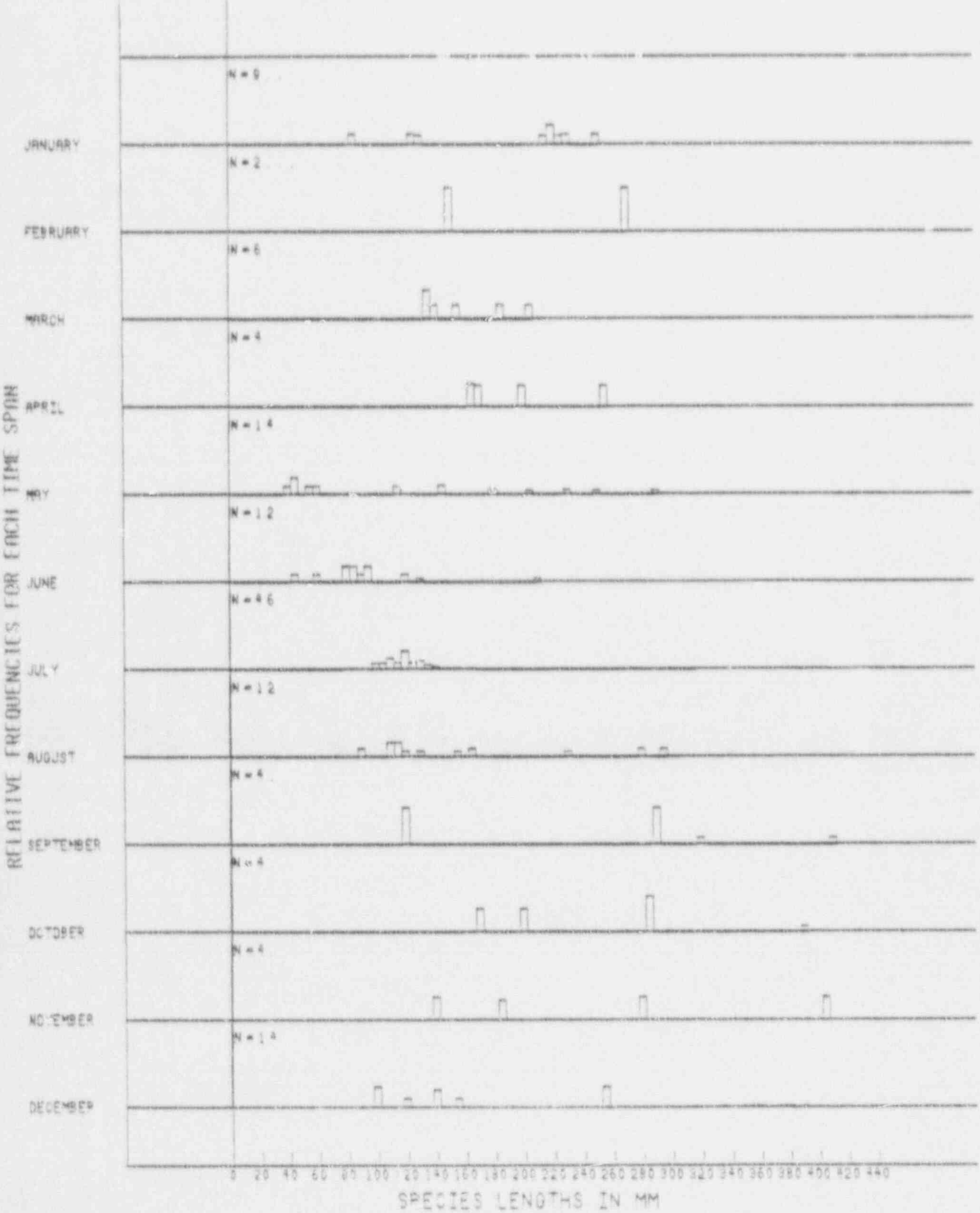

Figure 5.7d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PARALICHTHYS DENTATUS YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

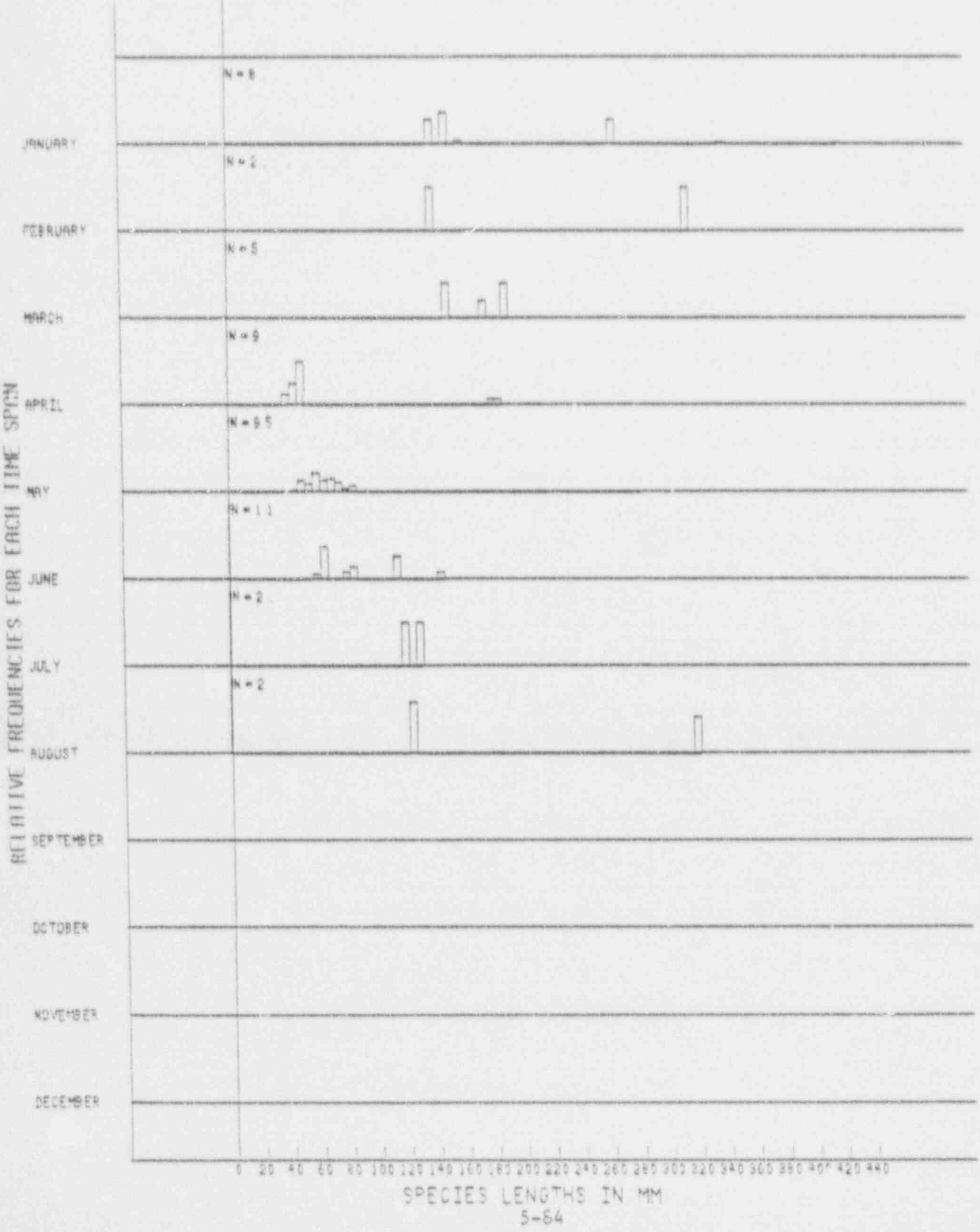

Figure 5.8a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PARALICHTHYS LETHOSTIGMA YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

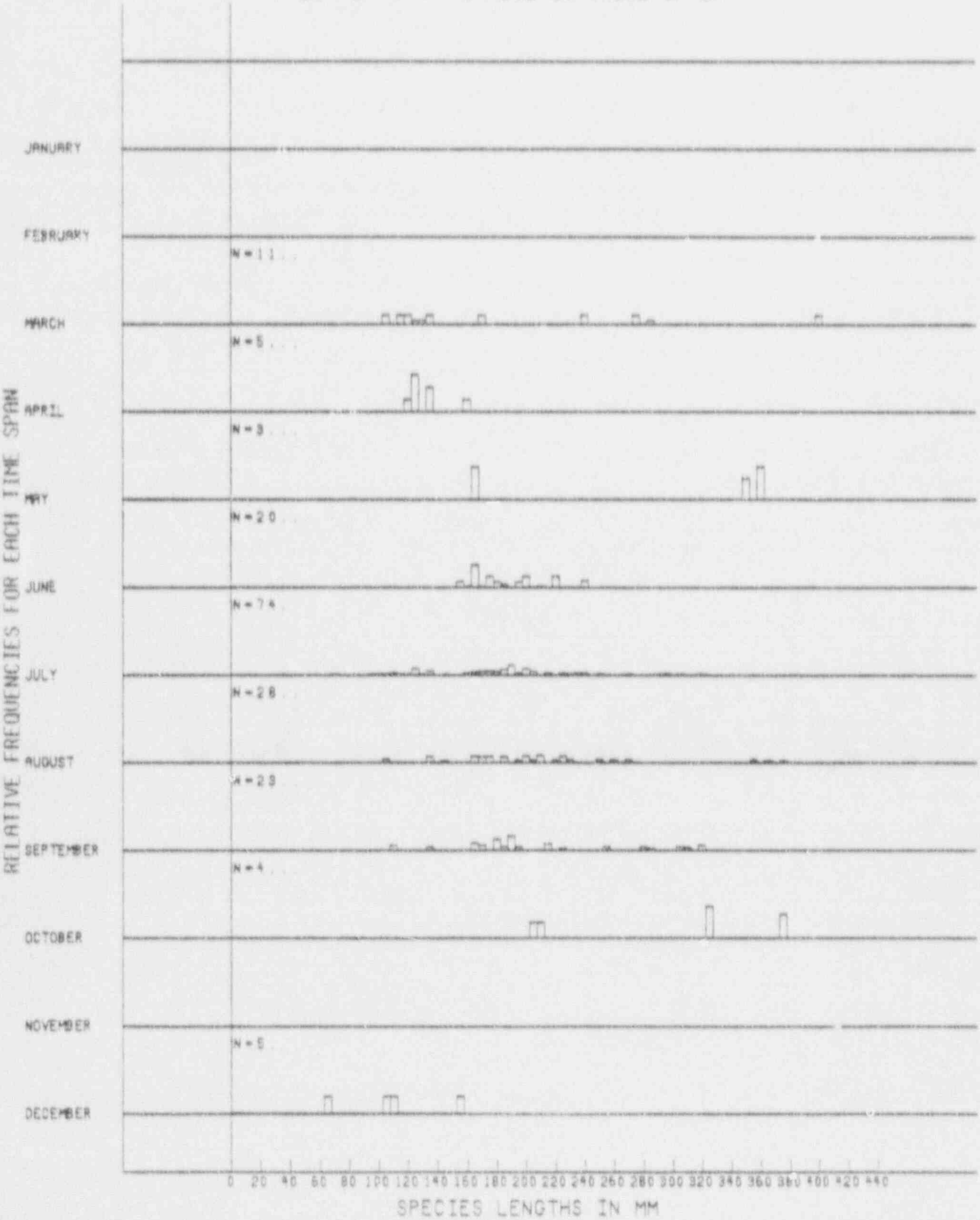

Figure 5.8b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PARALICHTHYS LETHOSTIGMA YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

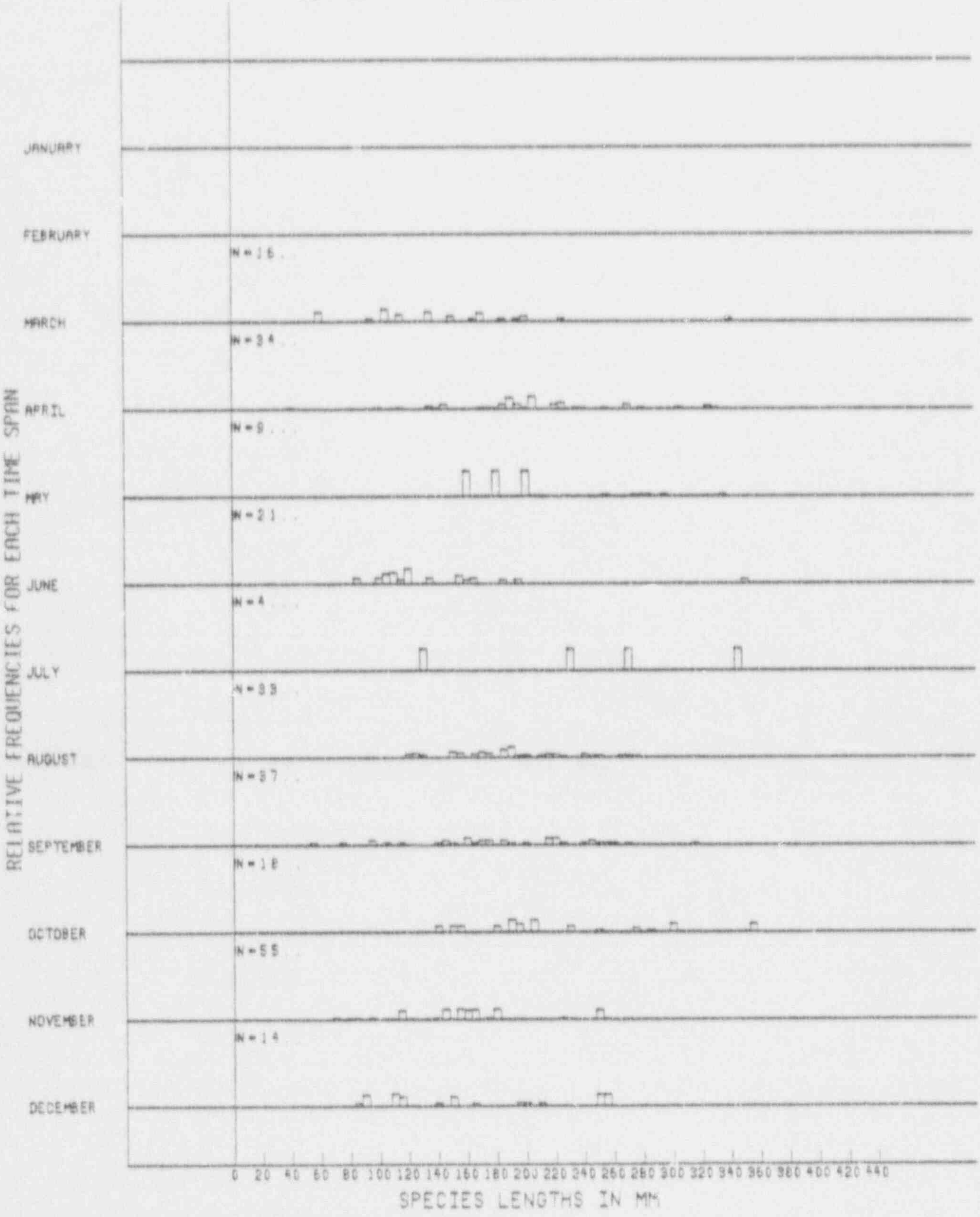

Figure 5.8c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PARALICHTHYS LETHOSTIGMA YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS *
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

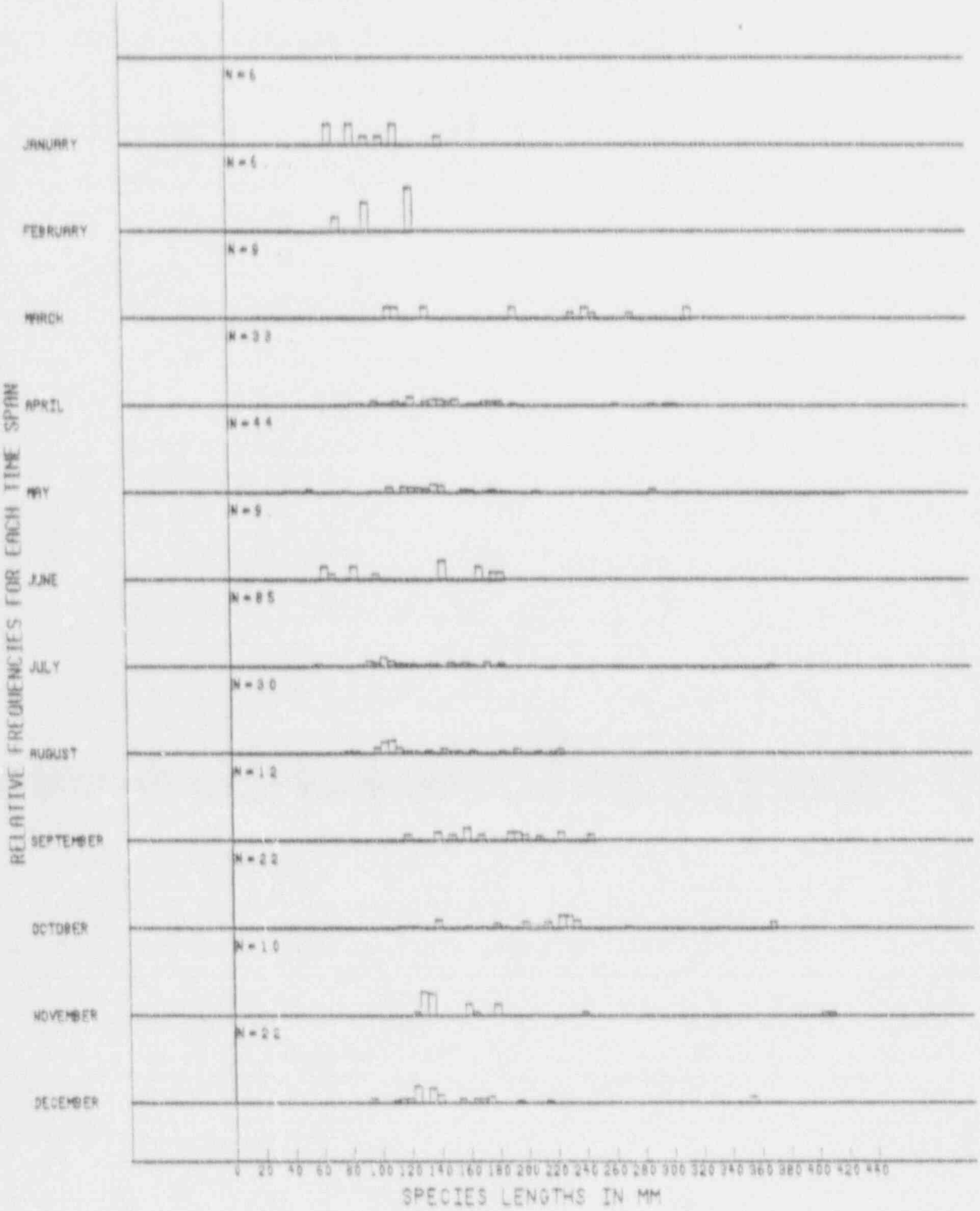

Figure 5.8d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PARALICHTHYS LETHOSTIGMA YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

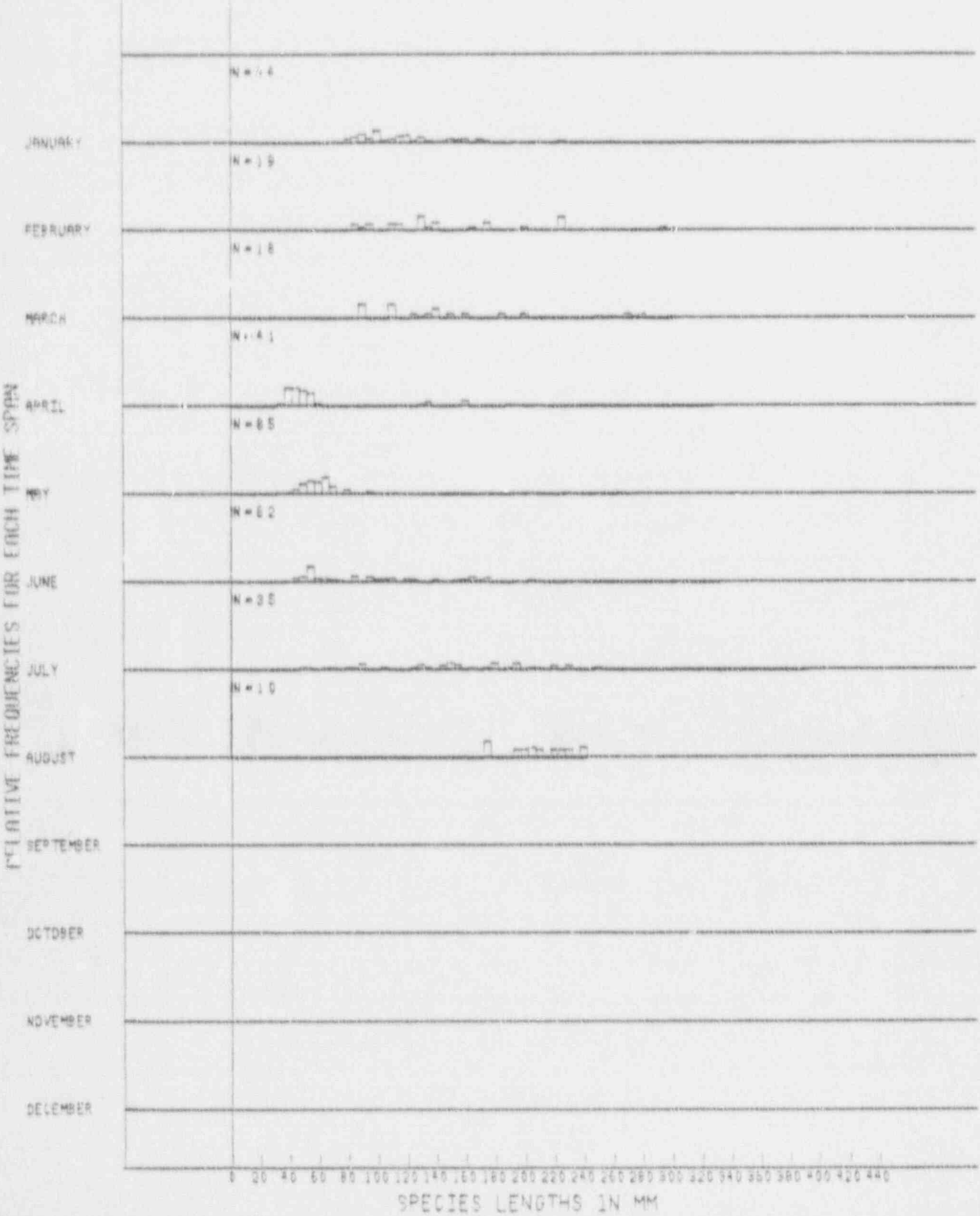

Figure 5.9a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MUGIL CEPHALUS YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

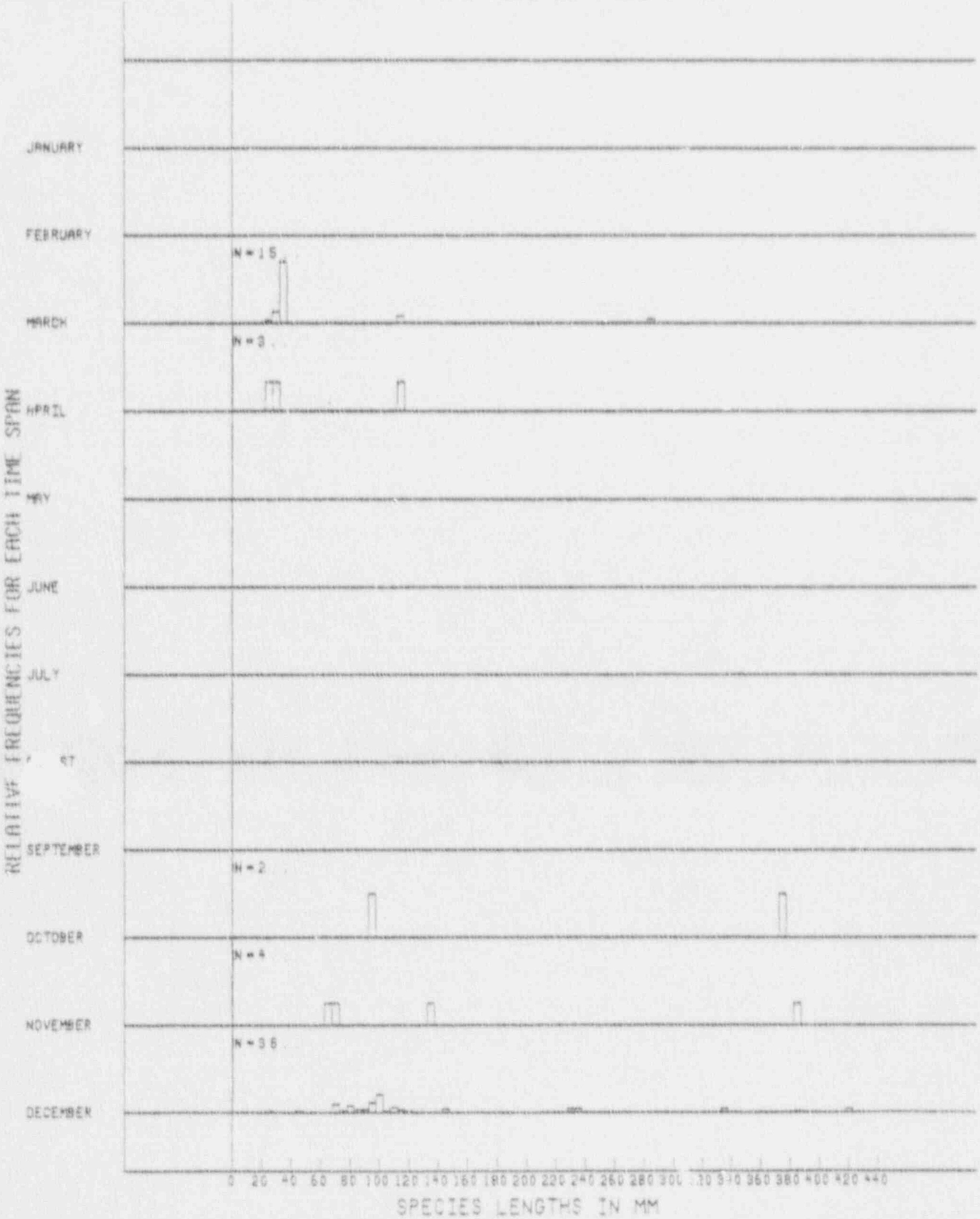

Figure 5.9b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MUGIL CEPHALUS YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS *
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

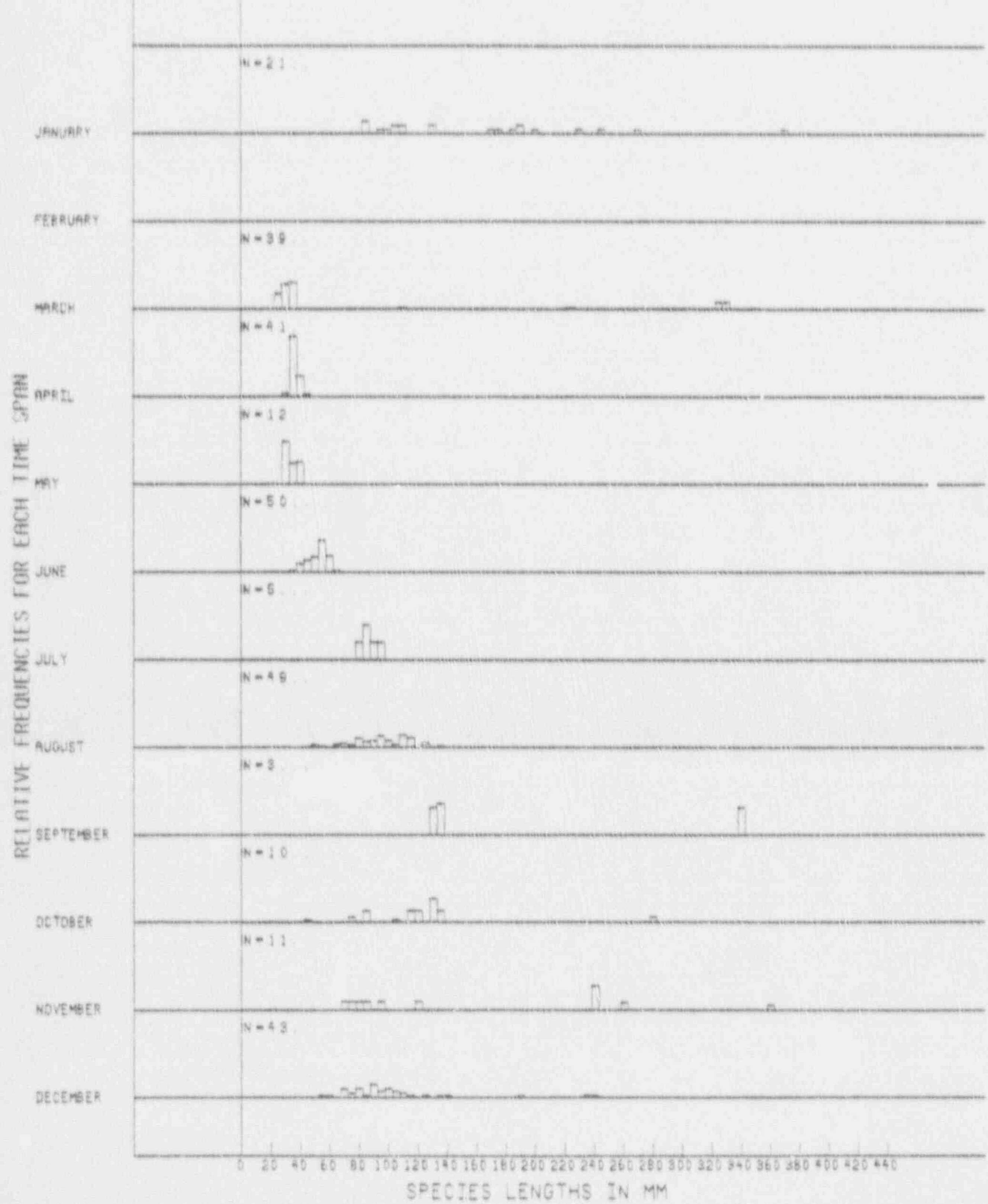

Figure 5.9c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MUGIL CEPHALUS YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS *
PLOT OF W * J SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

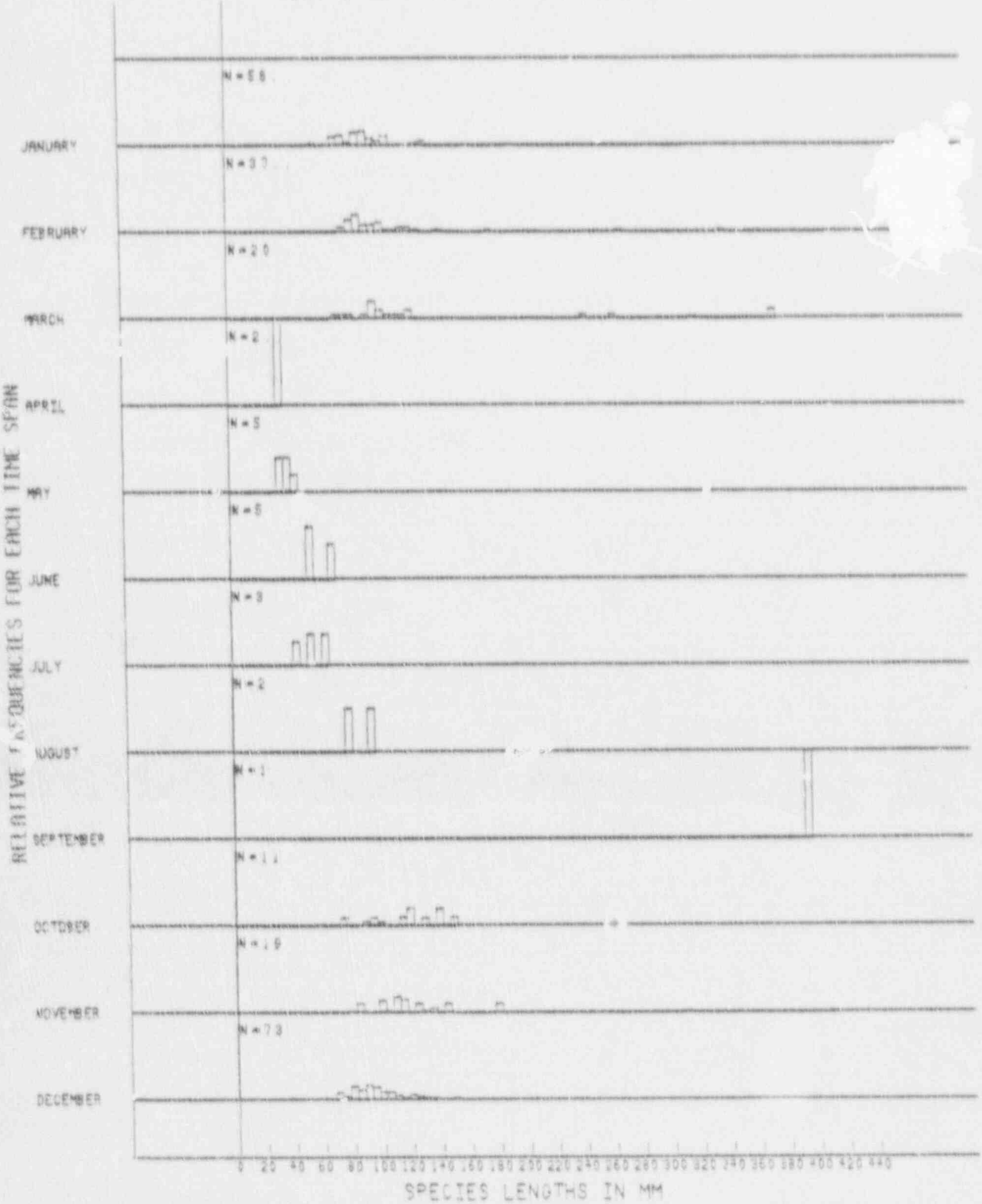

Figure 5.9d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MUGIL CEPHALUS YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

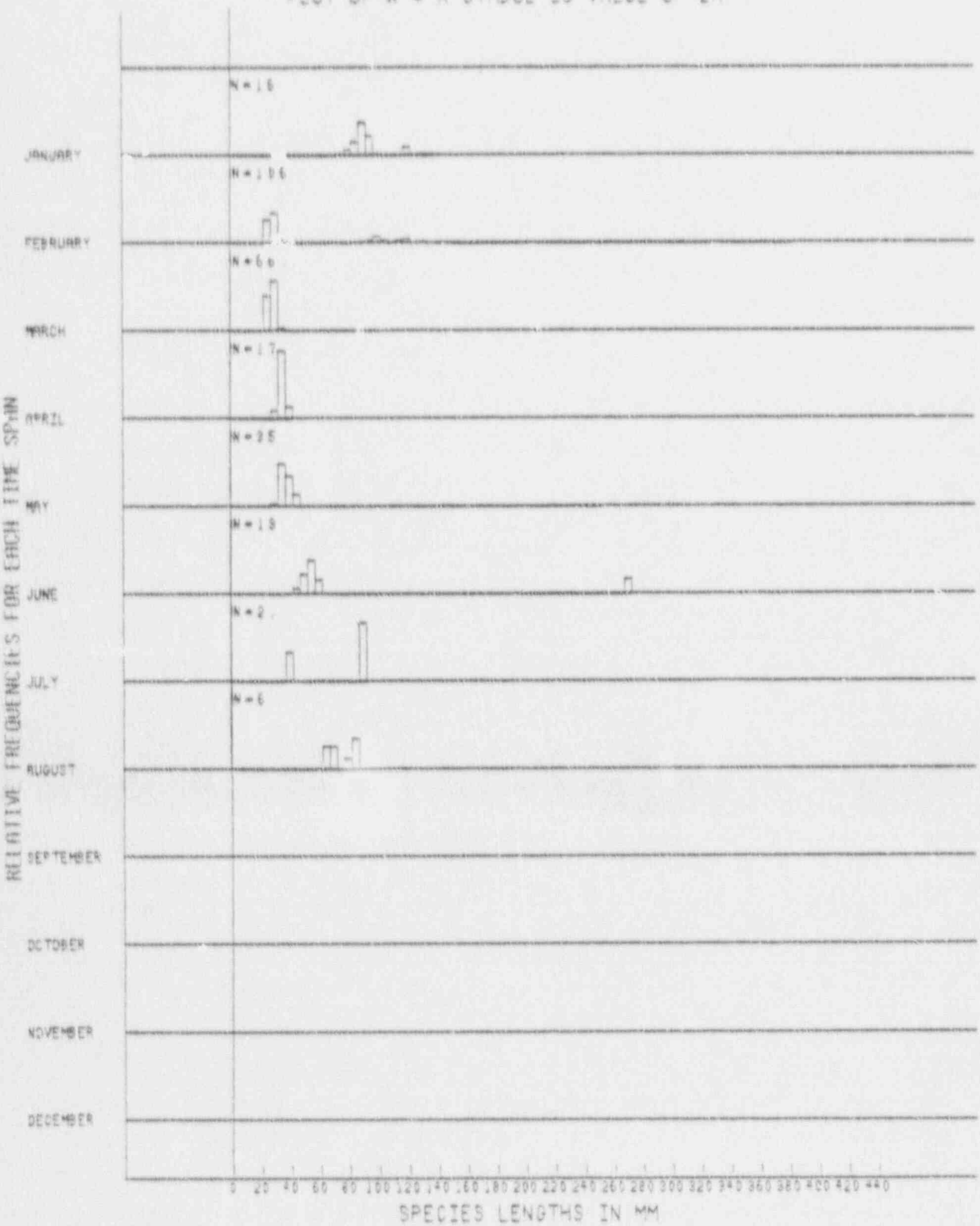

Figure 5.10a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MUGIL CUREMA YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
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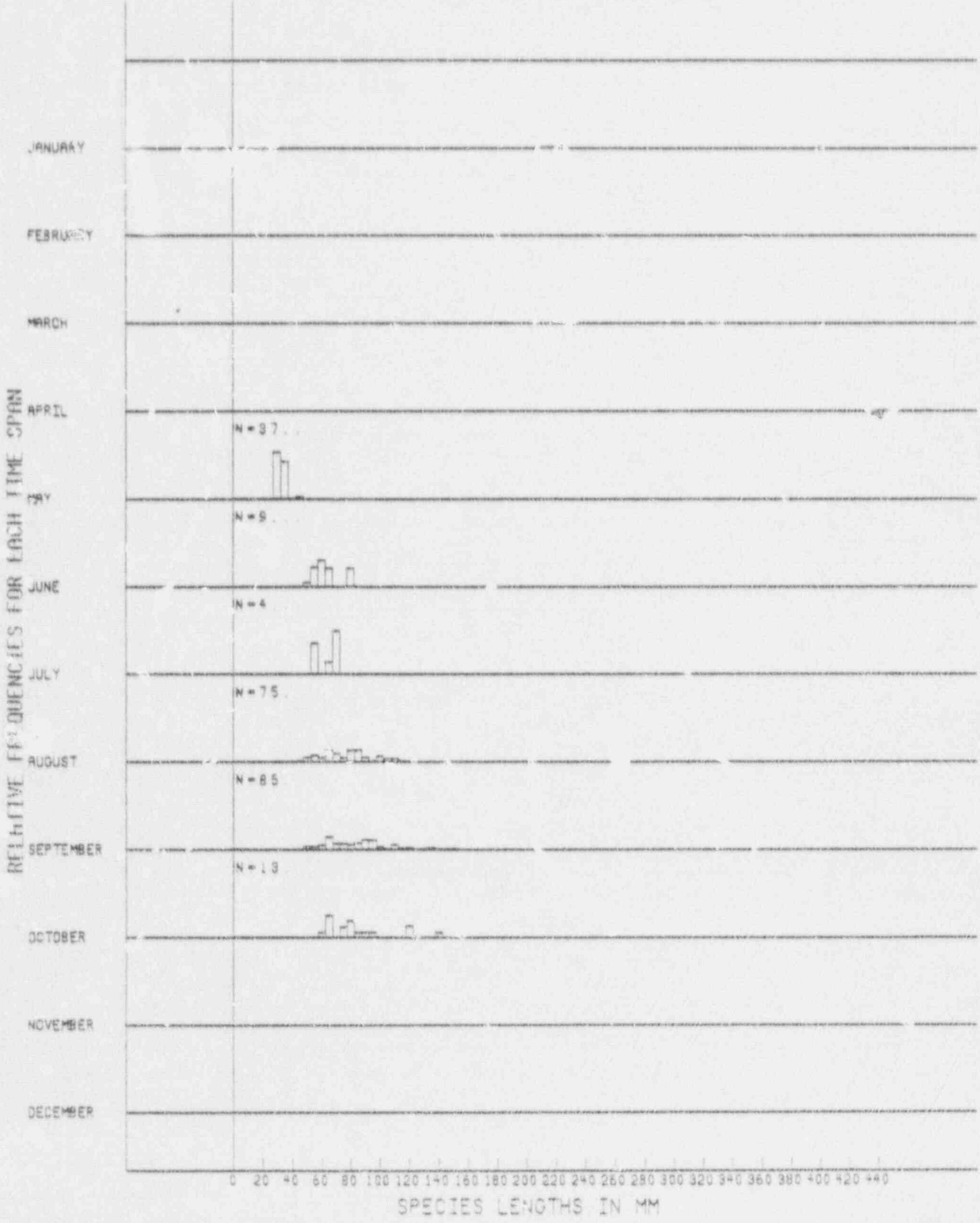

Figure 5.10b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MUGIL CUREMA YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

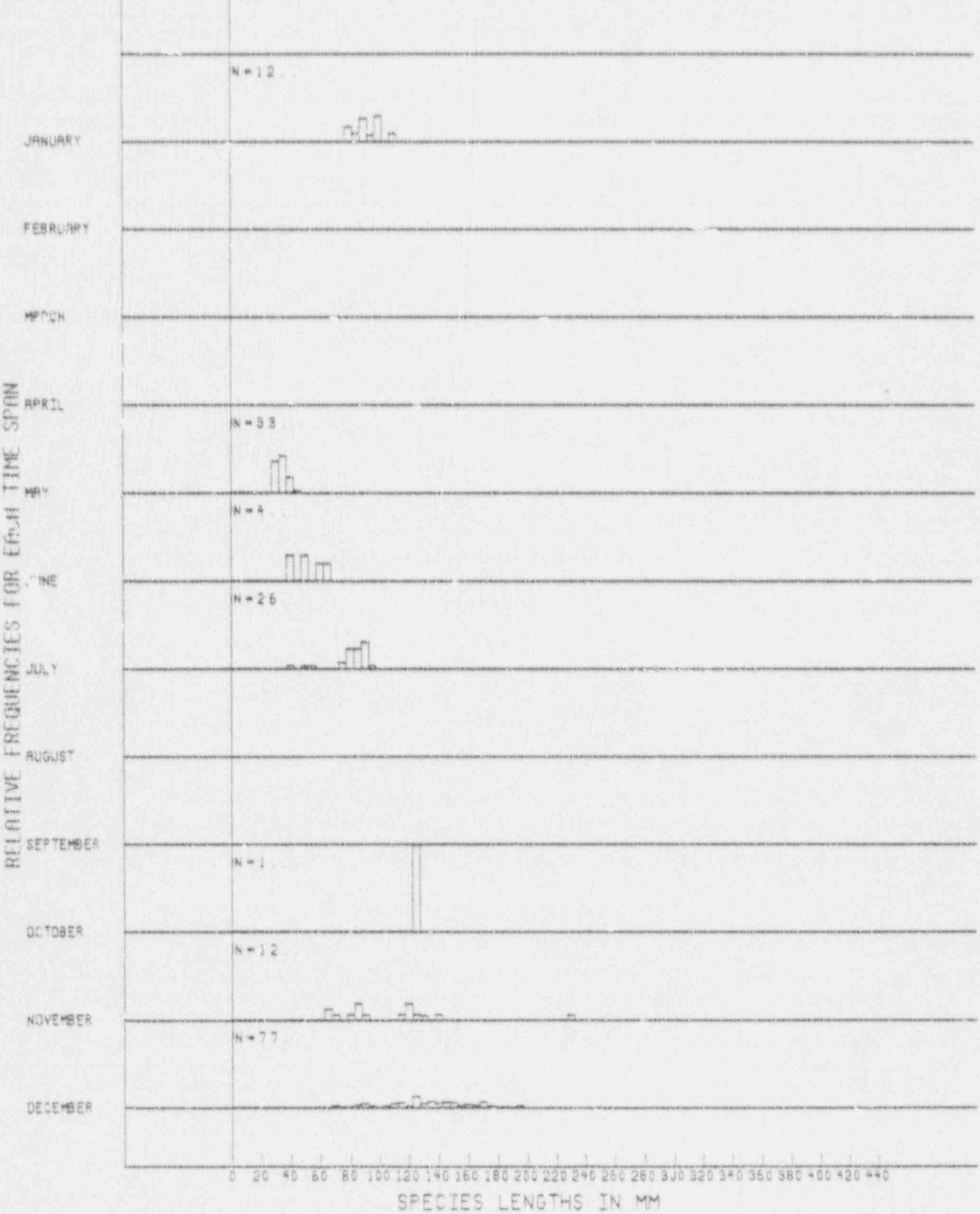

Figure 5.10c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MUGIL CUREMA YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

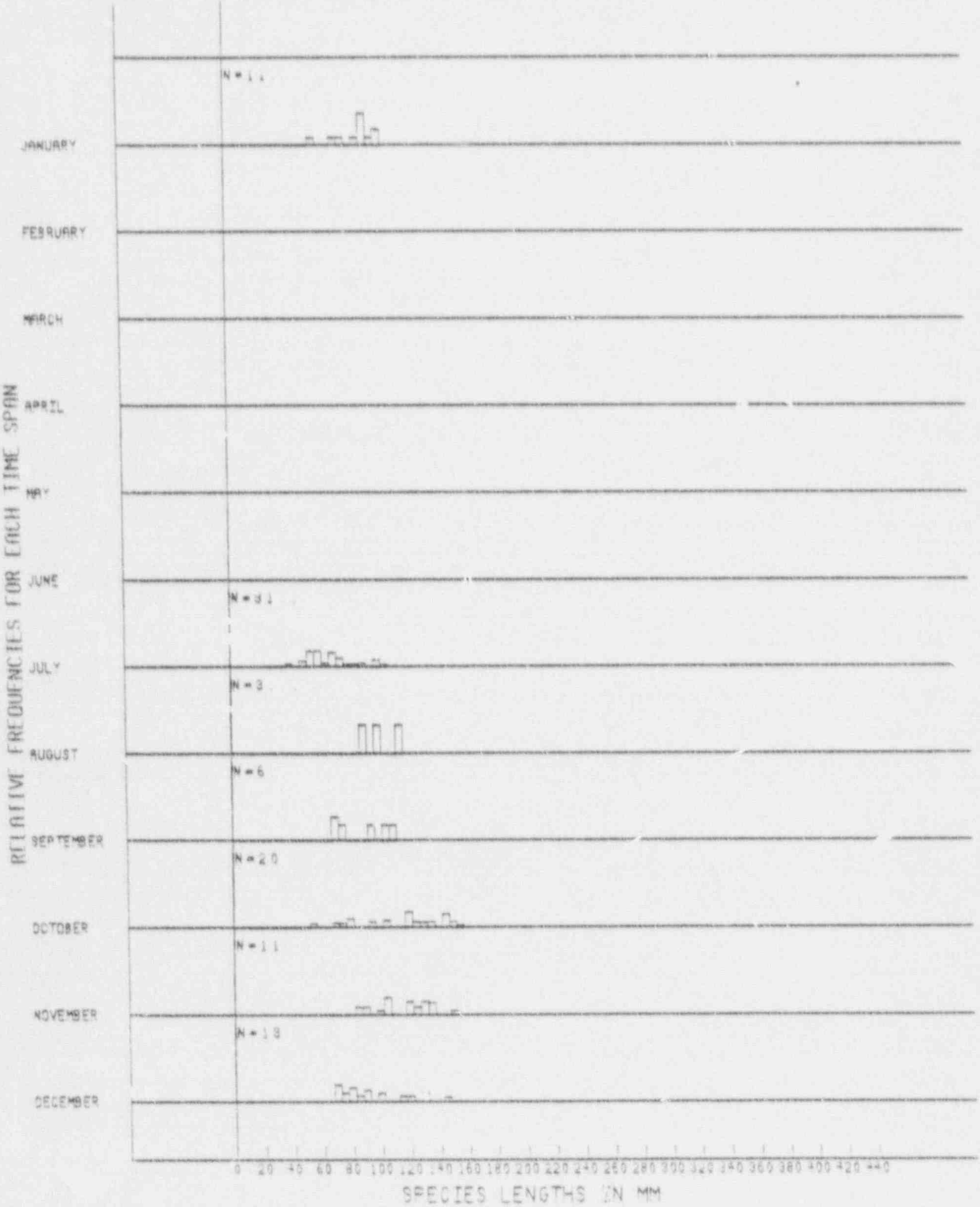

Figure 5.10d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=MUGIL CUREMA YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZR

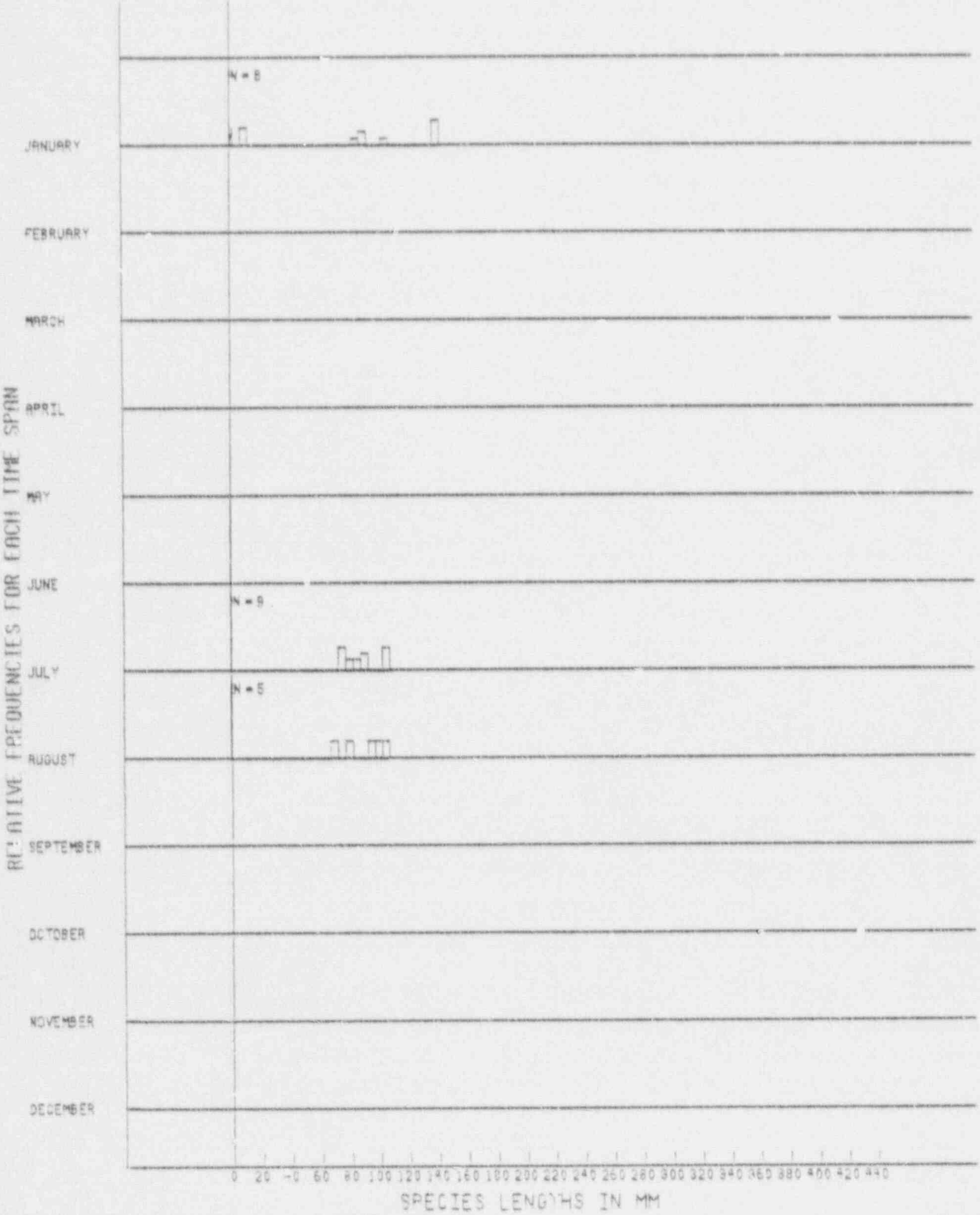

Figure 5.11a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS AZTECUS YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

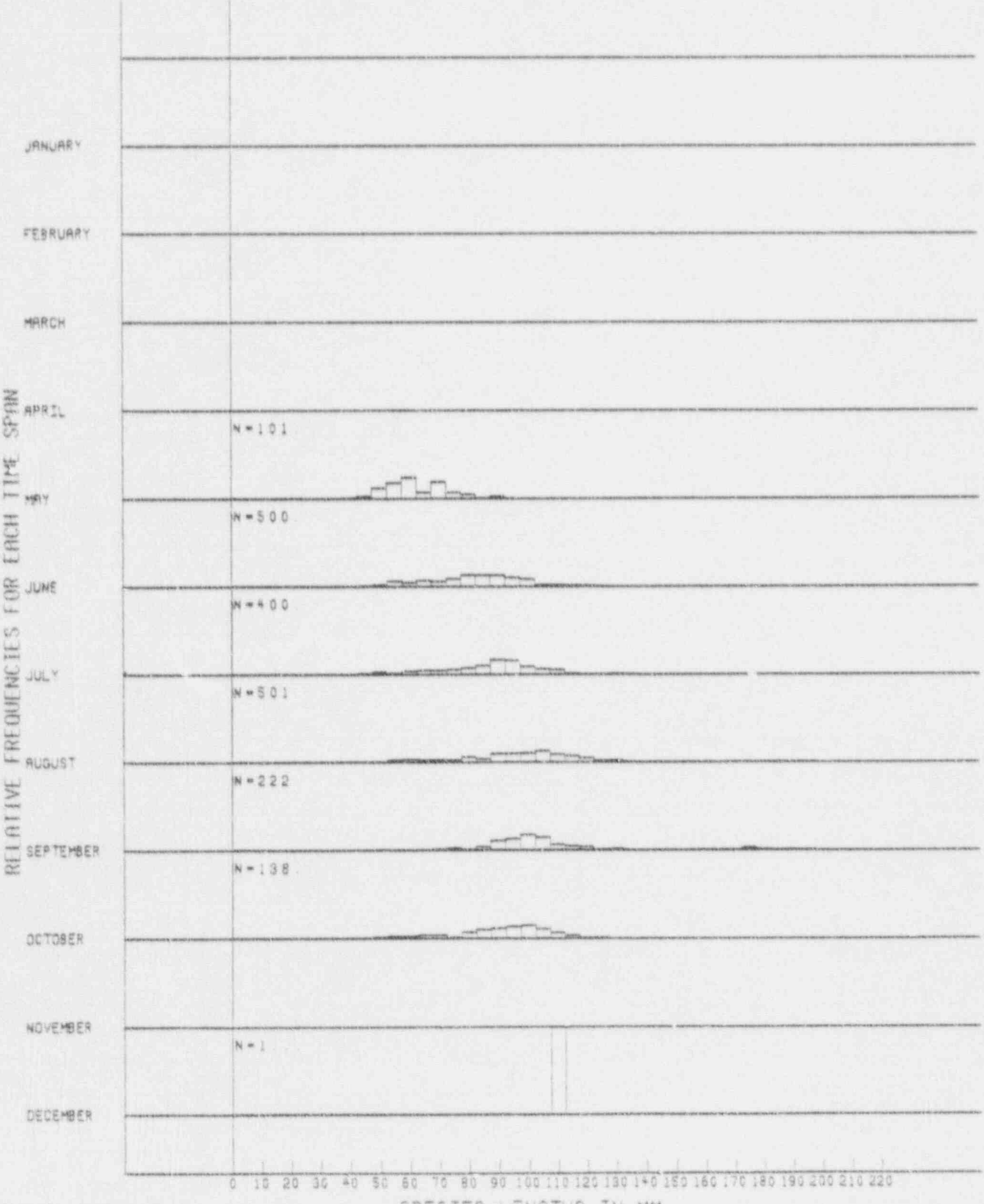

Figure 5.11b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS AZTECUS YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
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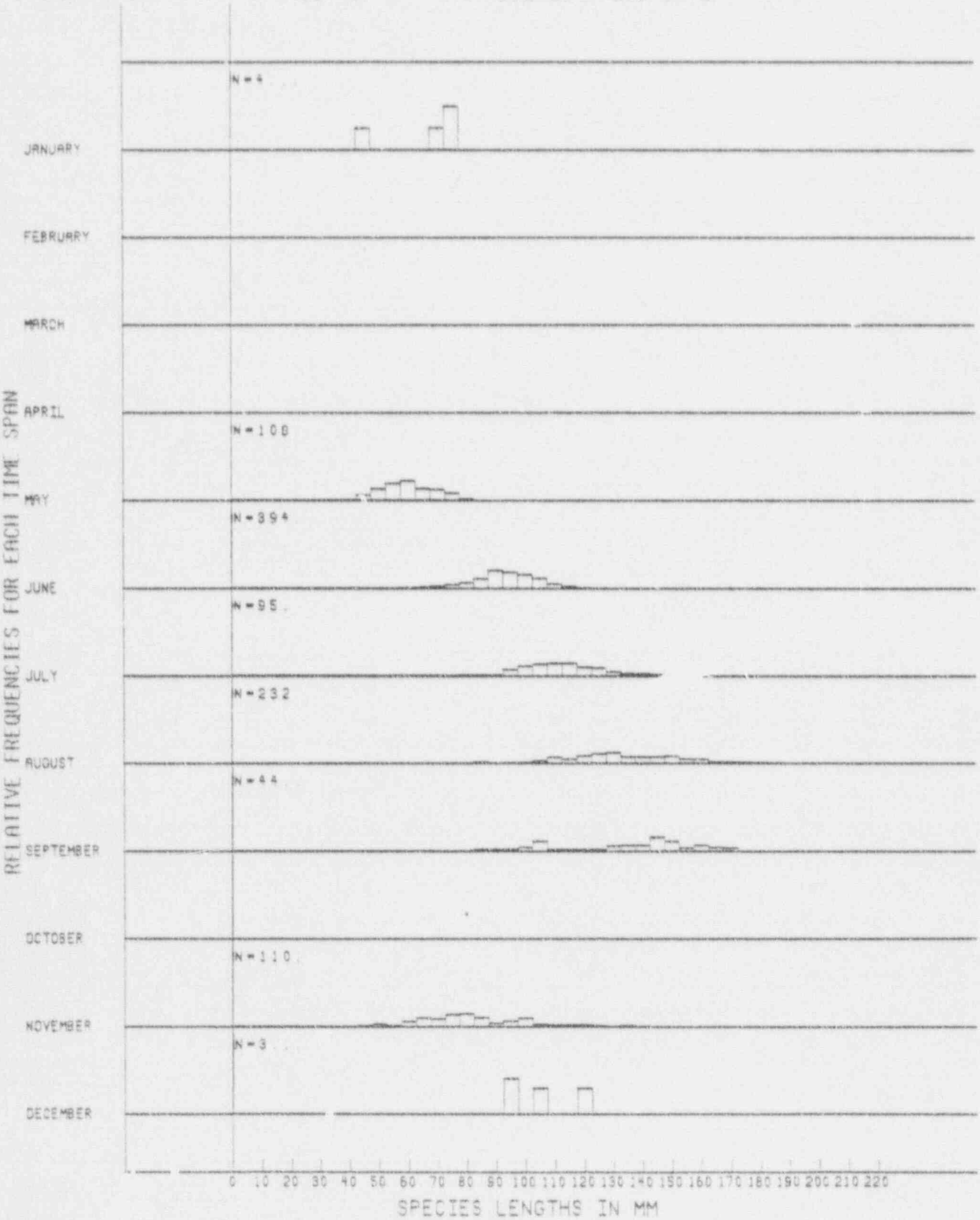

Figure 5.11c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS AZTECUS YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

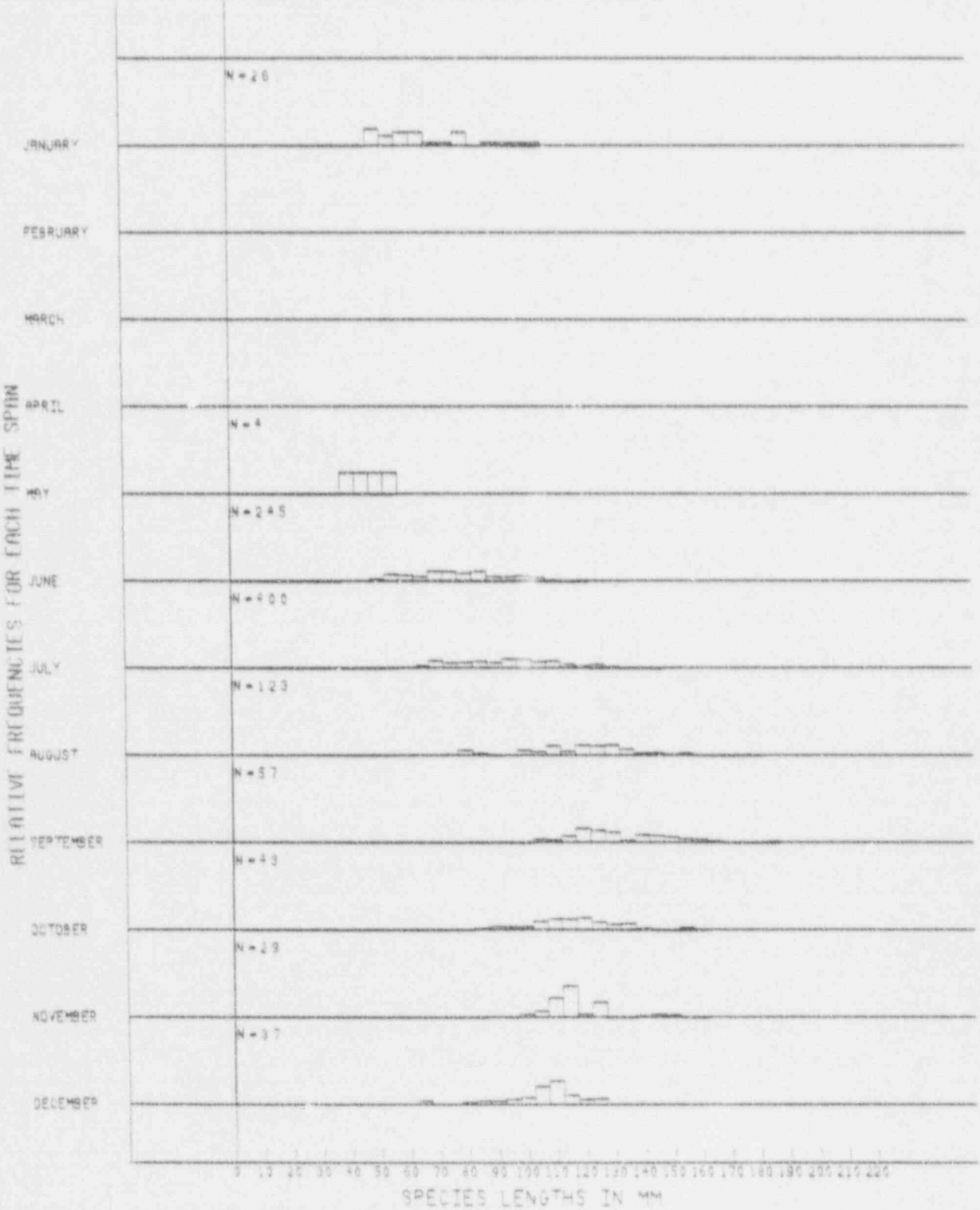

Figure 5.11d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS AZTECUS YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

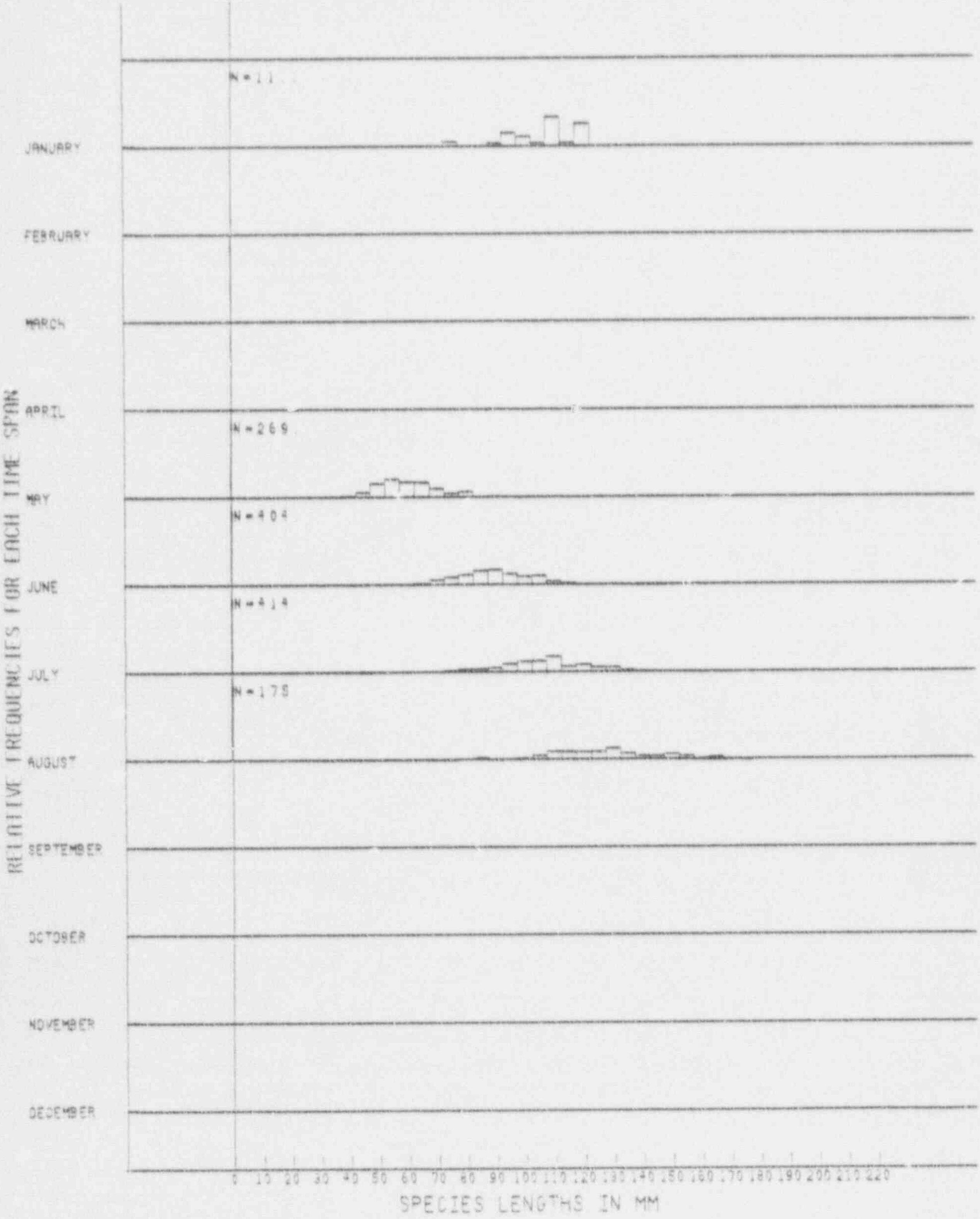

Figure 5.12a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS DUORARUM YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

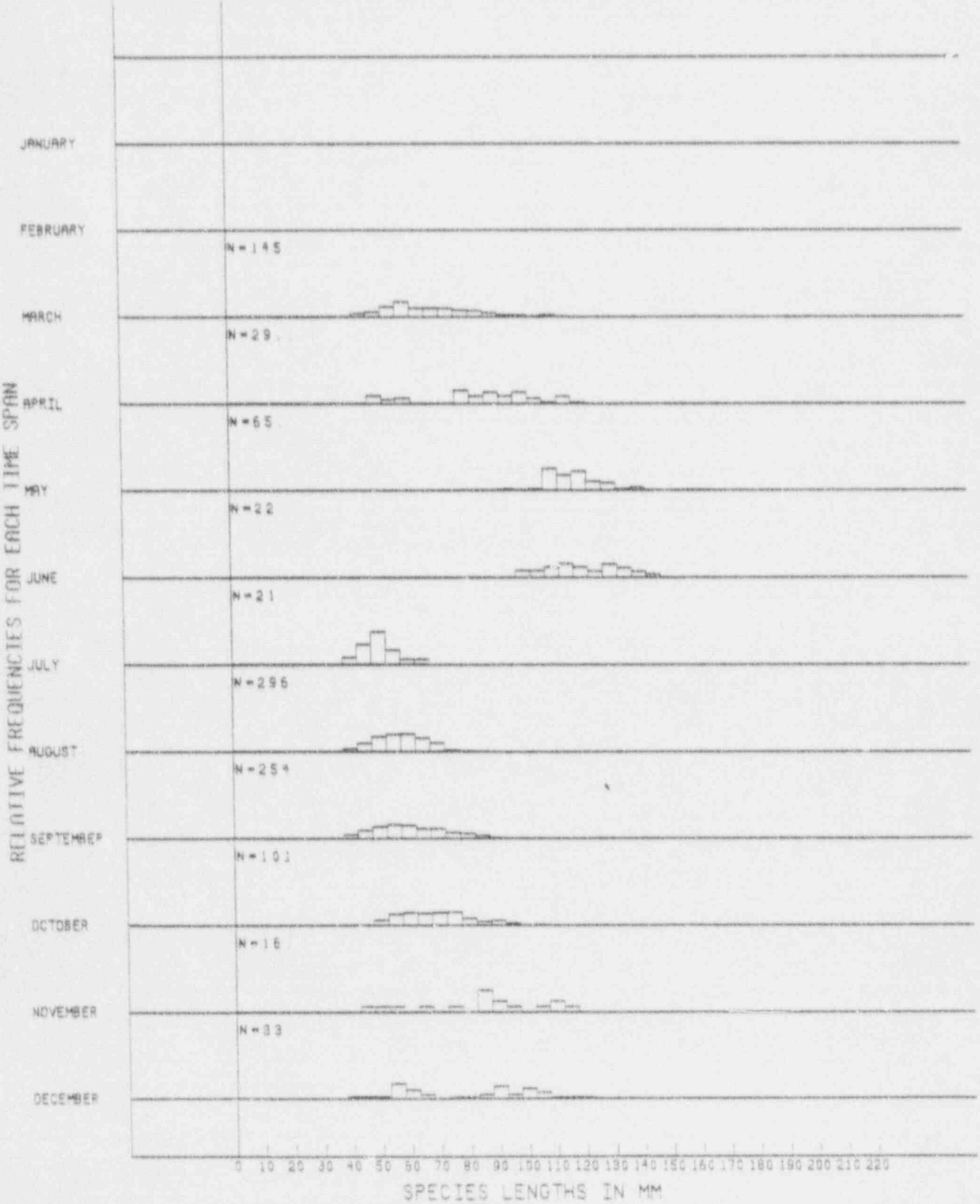

Figure 5.12h RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS DUORARUM YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

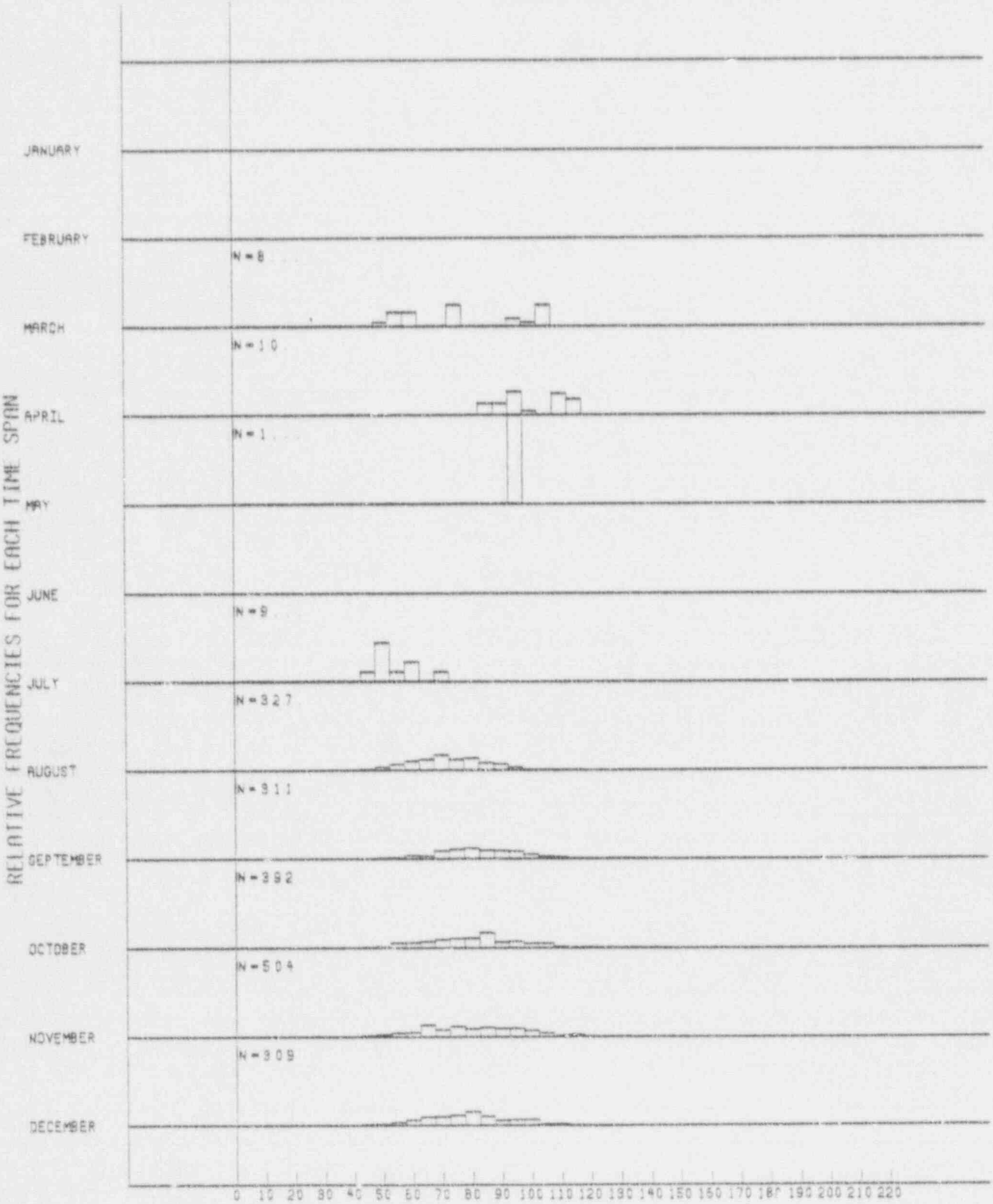

Figure 5.12c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS DUORARUM YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

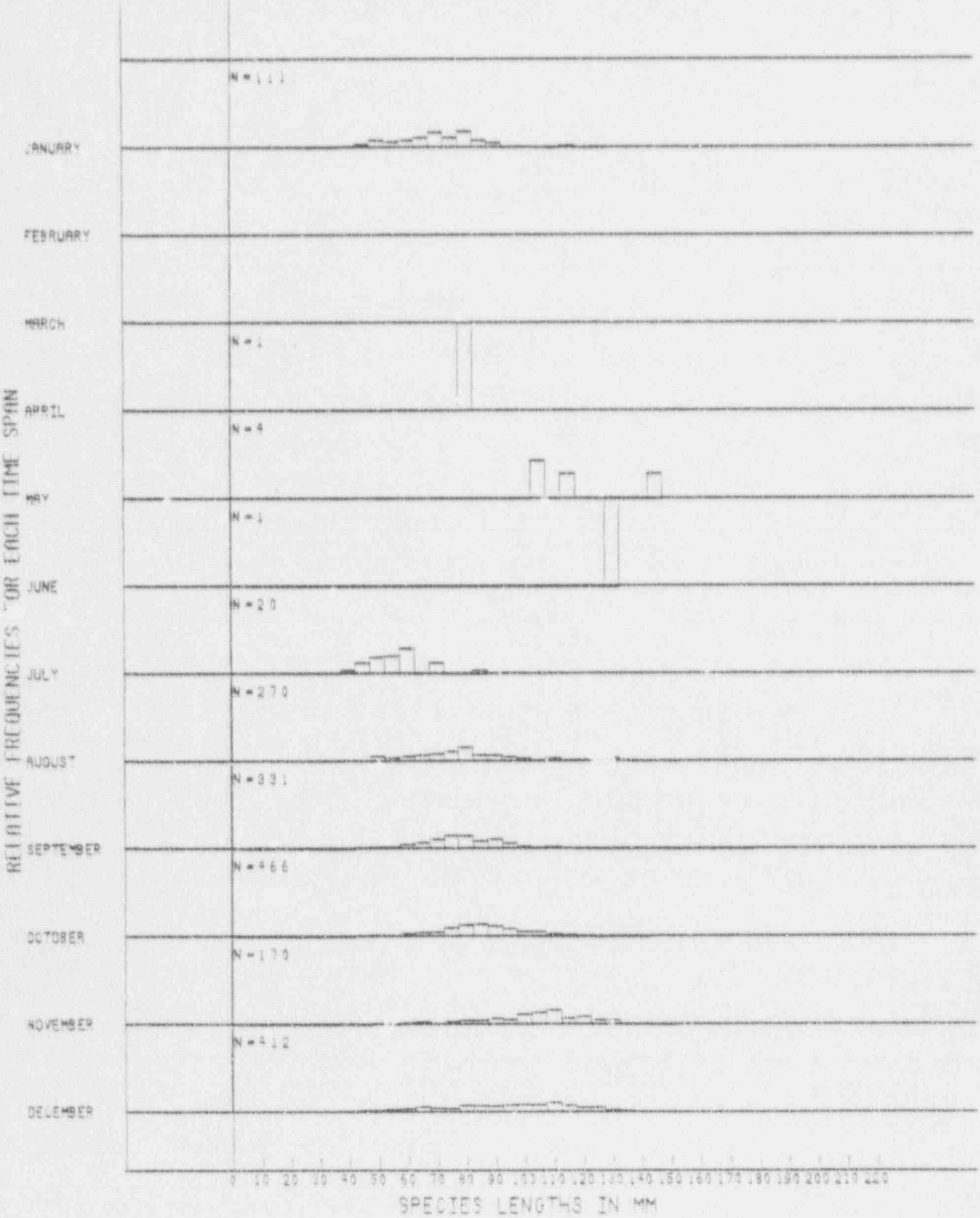

Figure 5.12d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS DUORARUM YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

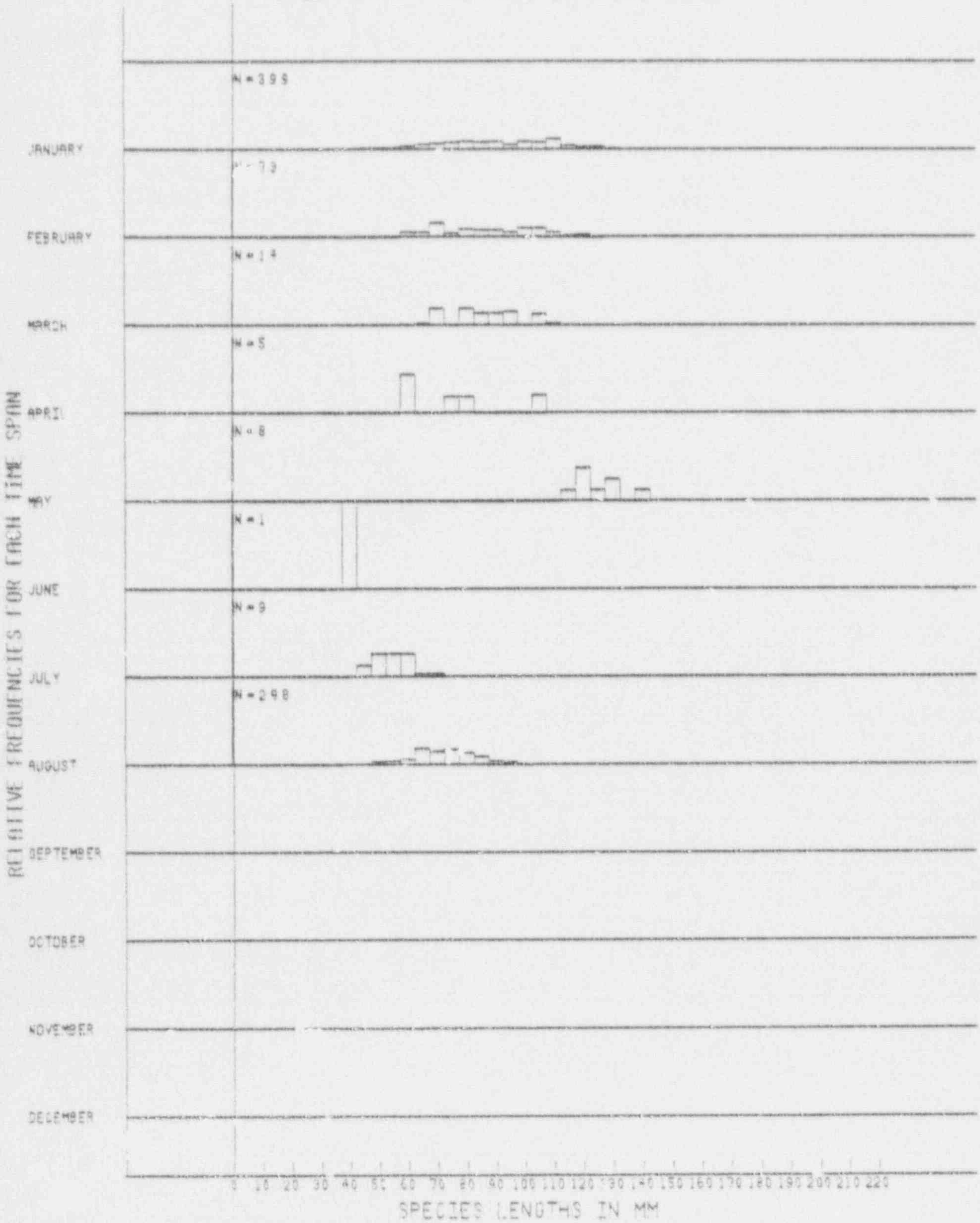

Figure 5.13a RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS SETIFERUS YEAR=1976
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

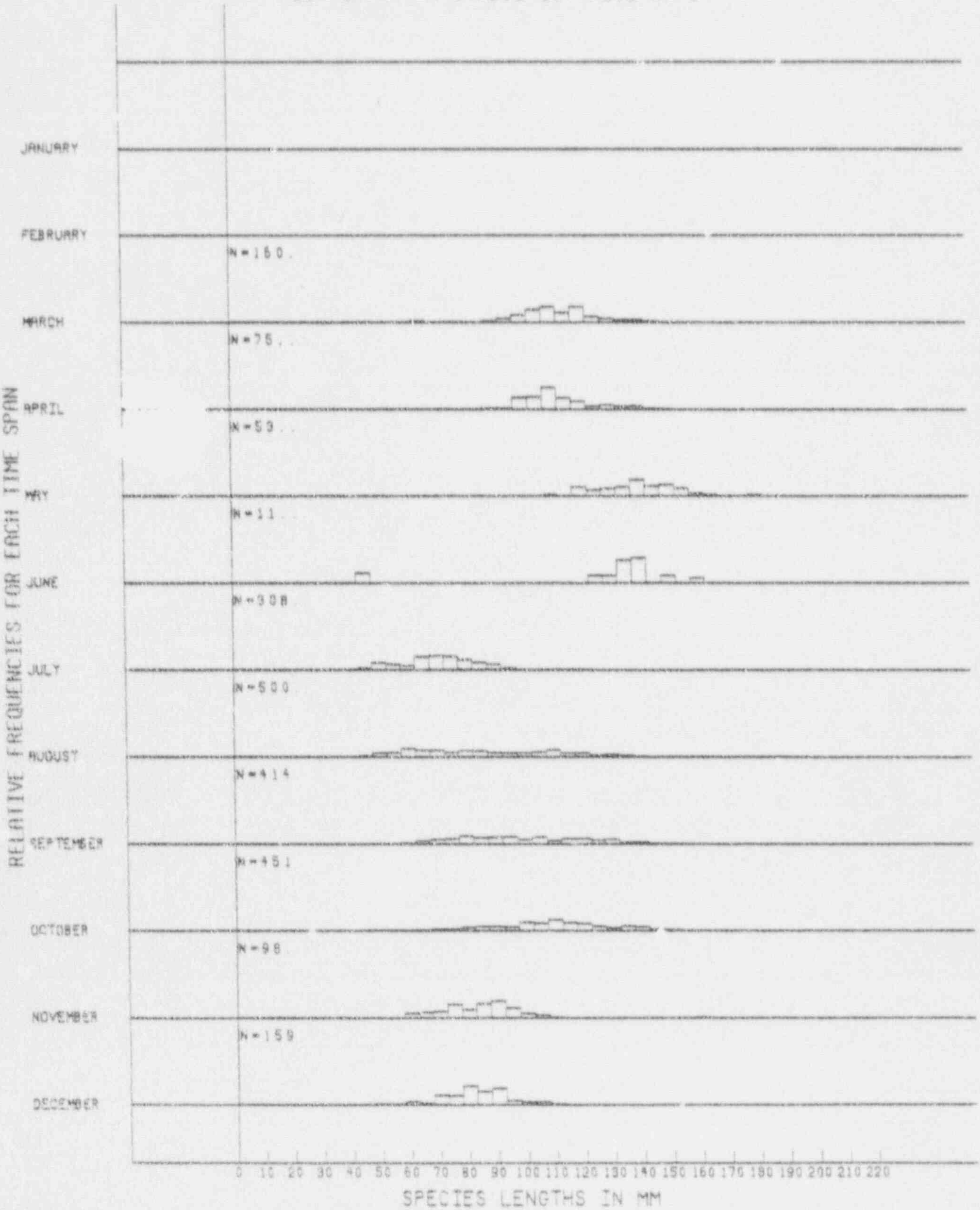

Figure 5.13b RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS SETIFERUS YEAR=1977
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
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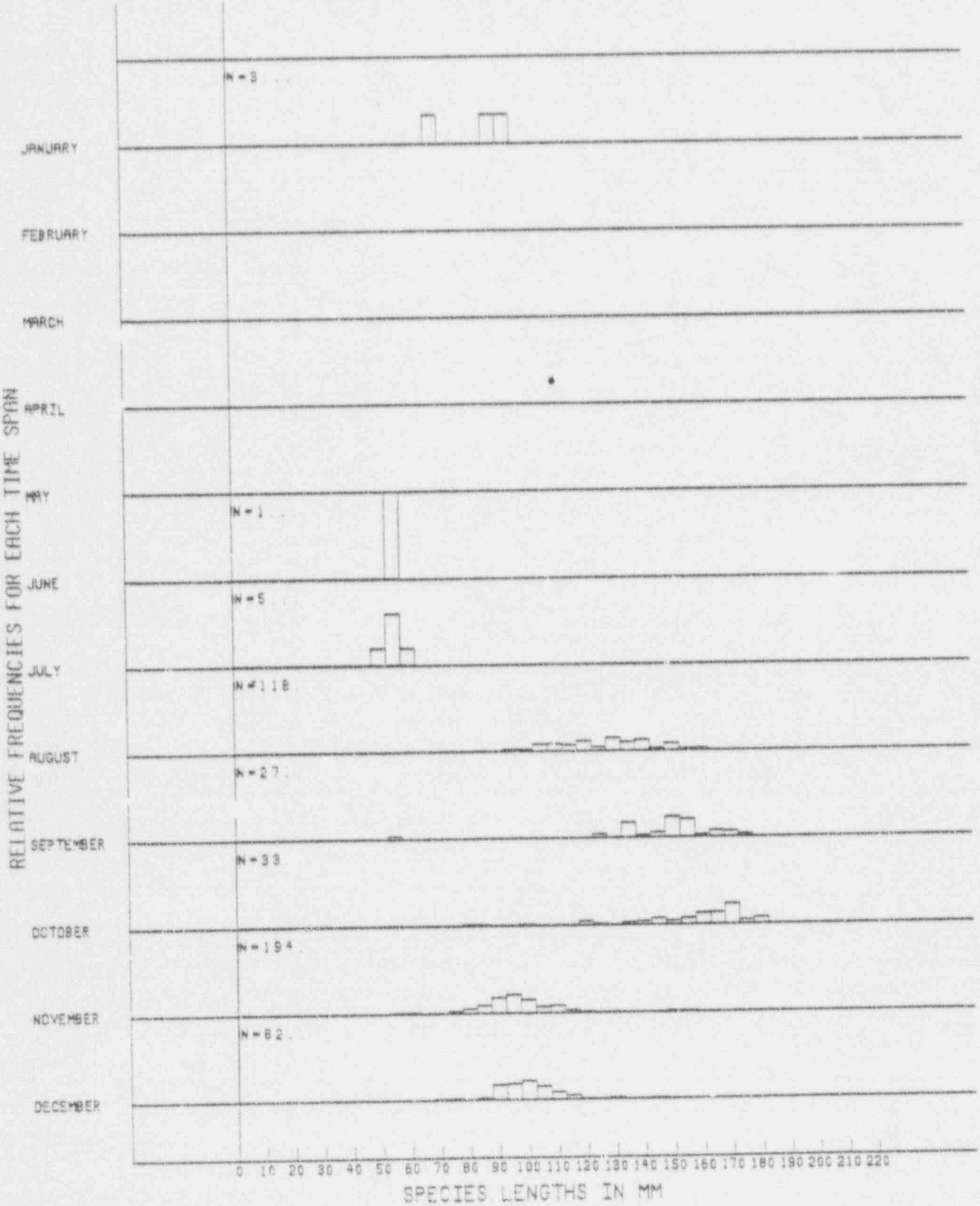

Figure 5.13c RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS SETIFERUS YEAR=1978
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
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PLOT OF W * T SYMBOL IS VALUE OF Z0
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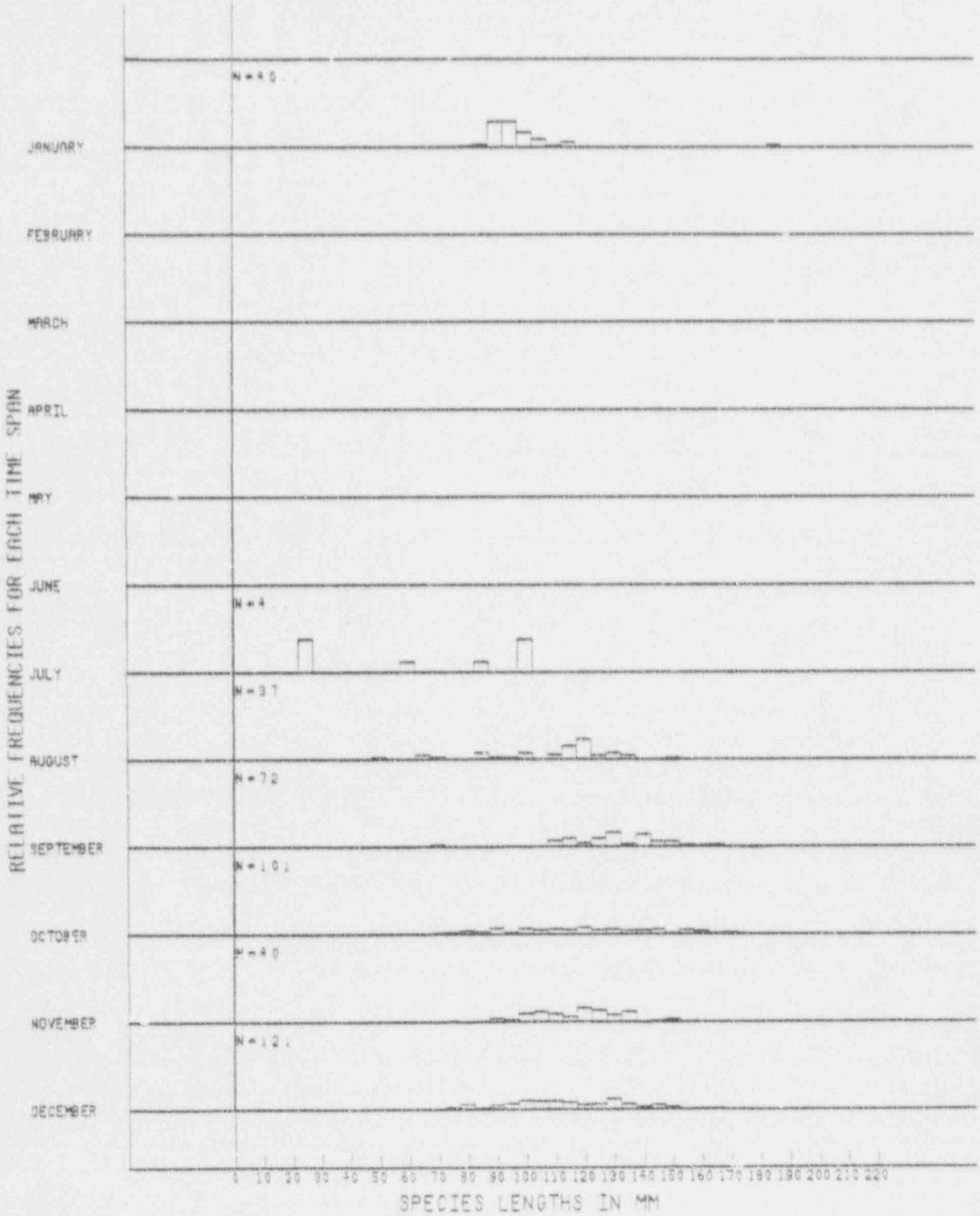


Figure 5.13d RELATIVE FREQUENCY PLOTS FOR SPECIES LENGTHS
USING ONE MONTH INTERVALS OVER TIME
SCIENTIFIC NAME=PENAEUS SETIFERUS YEAR=1979
PLOT OF Y * X CONNECTING LINES USED
PLOT OF W * V SYMBOL USED IS N
PLOT OF W * Q SYMBOL USED IS =
PLOT OF W * U SYMBOL IS VALUE OF Z2
PLOT OF W * S SYMBOL IS VALUE OF Z1
PLOT OF W * T SYMBOL IS VALUE OF Z0
PLOT OF W * R SYMBOL IS VALUE OF ZA

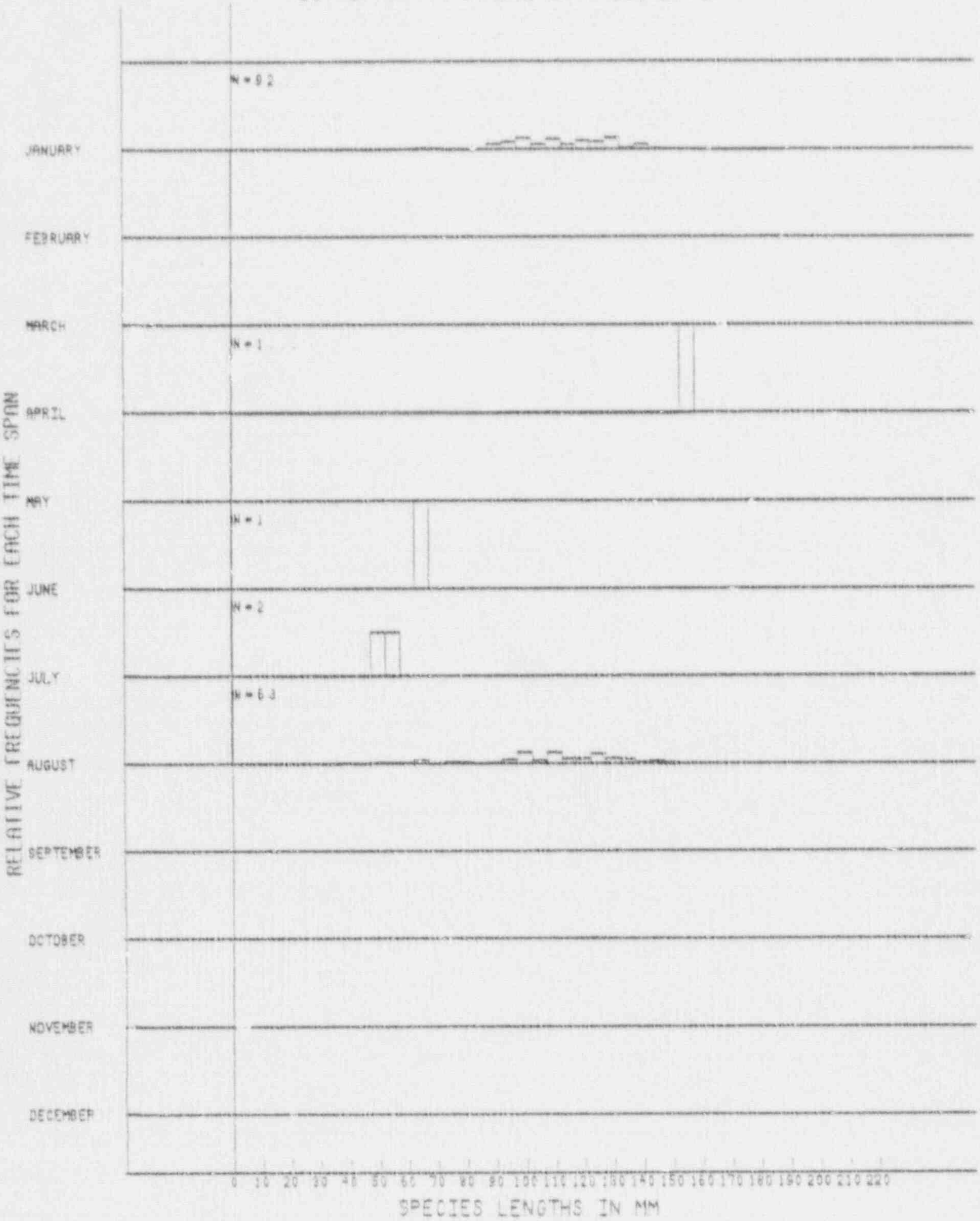


FIGURE 5.14. CATCH PER UNIT EFFORT (CPUE) BY STATION

FOR DIVERSION DEVICE STUDY JAN 1979 - SEPT 1979

SPECIES=SPOT AGE=YOUNG OF YEAR

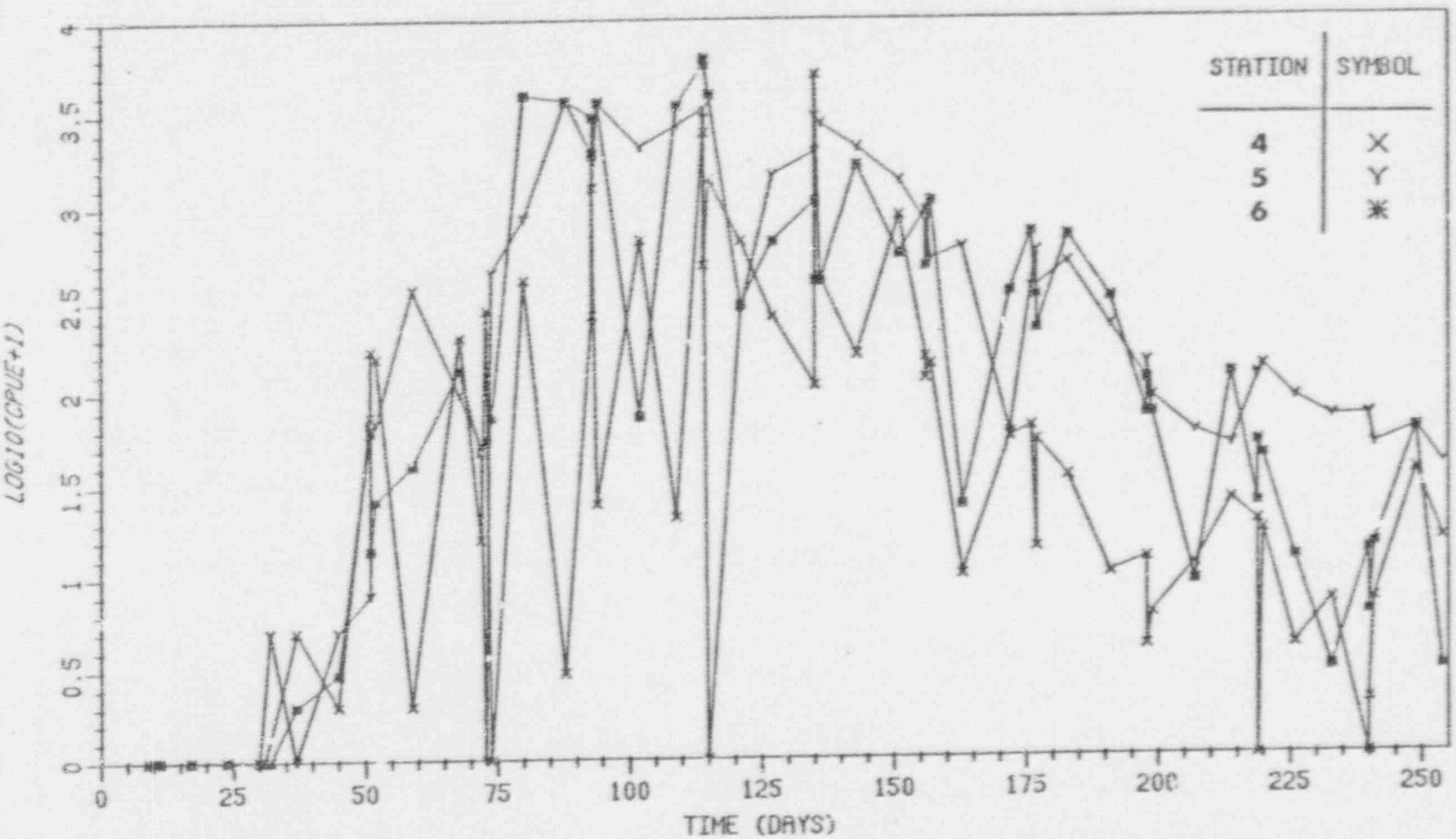
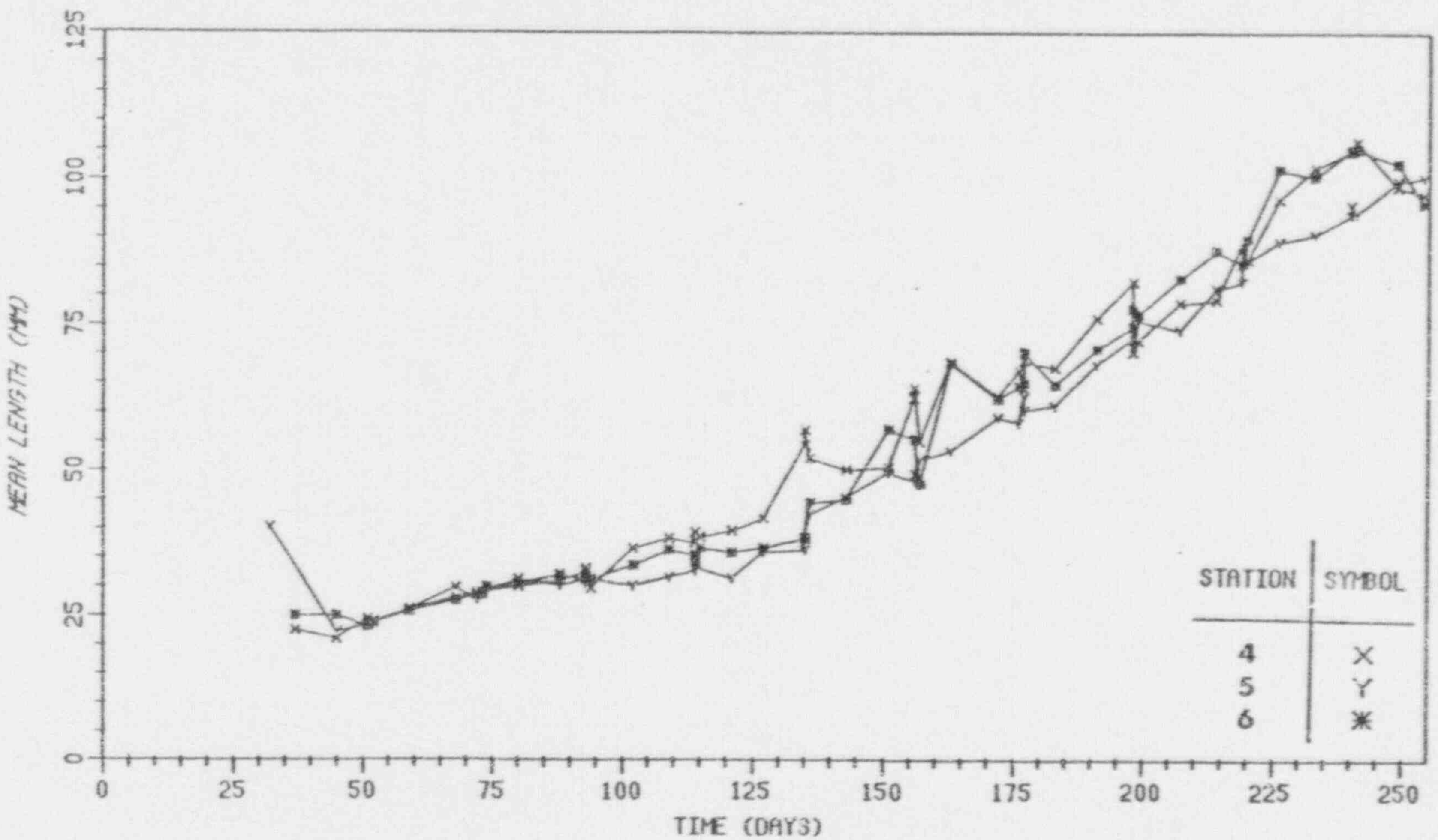


FIGURE 5.15. MEAN LENGTH (MM) BY STATION

FOR DIVERSION DEVICE STUDY JAN 1979 - SEPT 1979

SPECIES=SPOT AGE=YOUNG OF YEAR



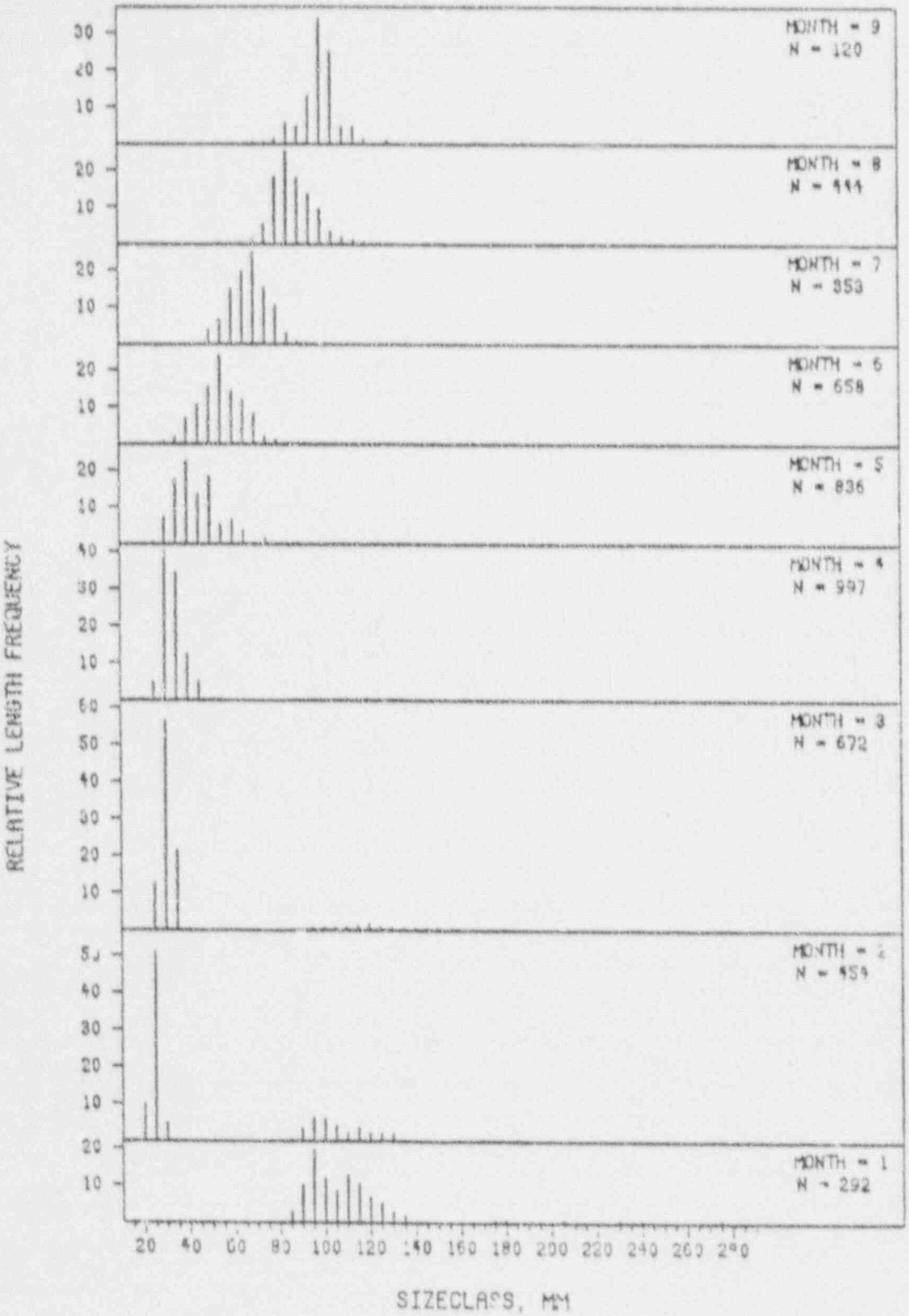


FIGURE 5.16 RELATIVE LENGTH FREQUENCY BY MONTH
FOR DIVERSION DEVICE STUDY, 1979, SMALL TRAWLS
SPECIES = SPOT

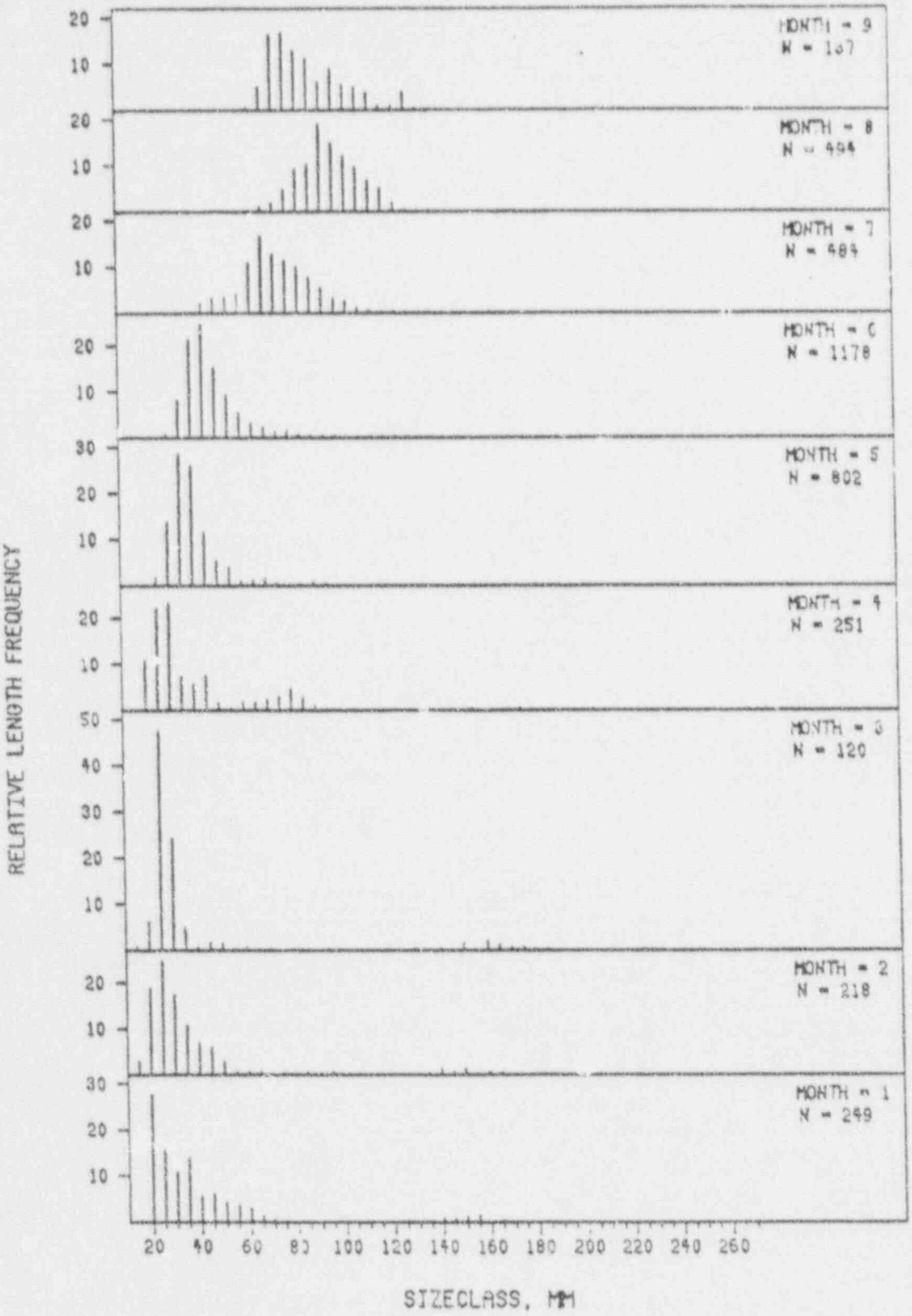
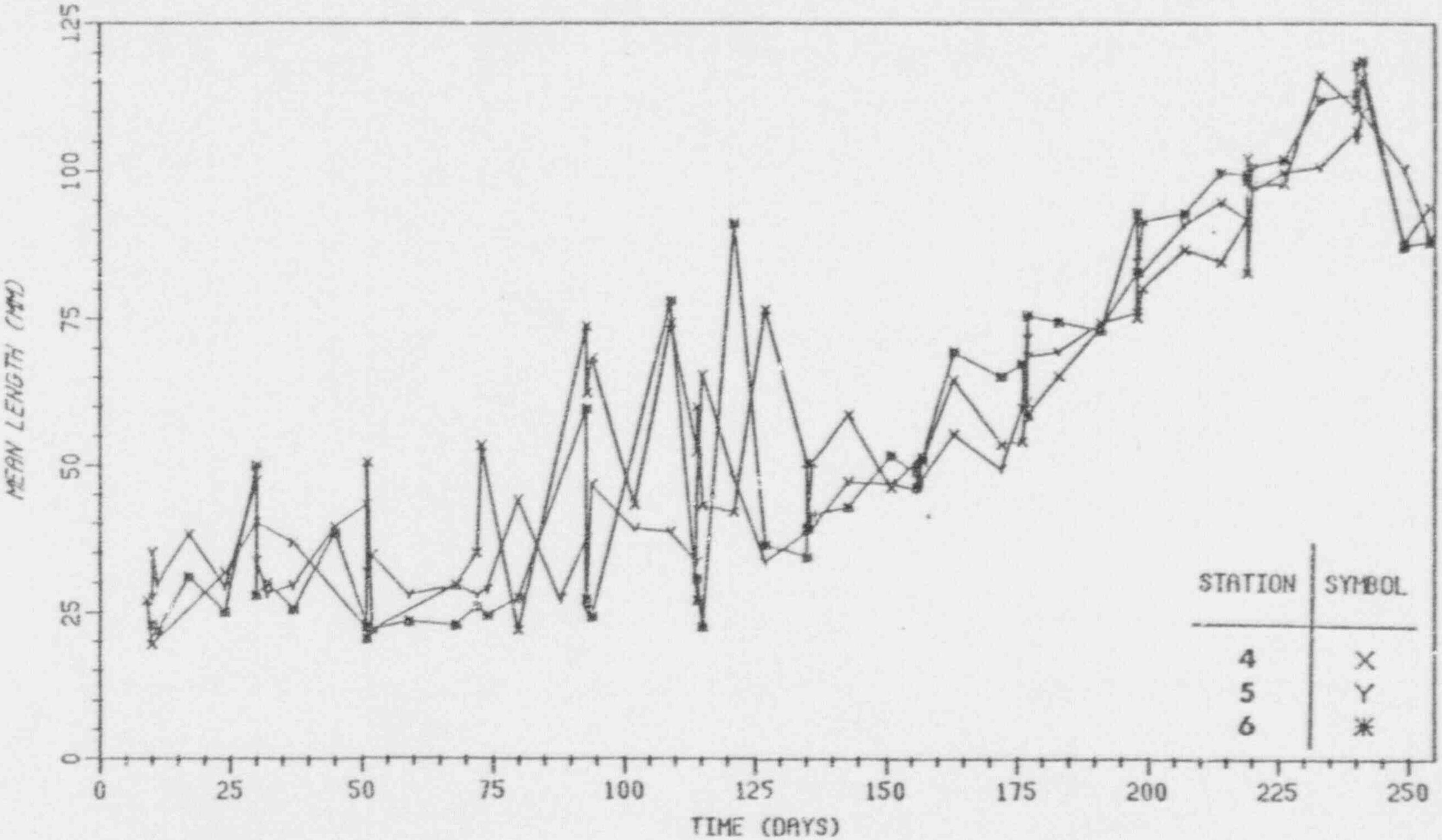


FIGURE 5.17. RELATIVE LENGTH FREQUENCY BY MONTH
FOR DIVERSION DEVICE STUDY, 1979, SMALL TRAWLS
SPECIES = CROAKER

FIGURE 5.18. MEAN LENGTH (MM) BY STATION
FOR DIVERSION DEVICE STUDY JAN 1979 - SEPT 1979
SPECIES=CROAKER AGE=YOUNG OF YEAR



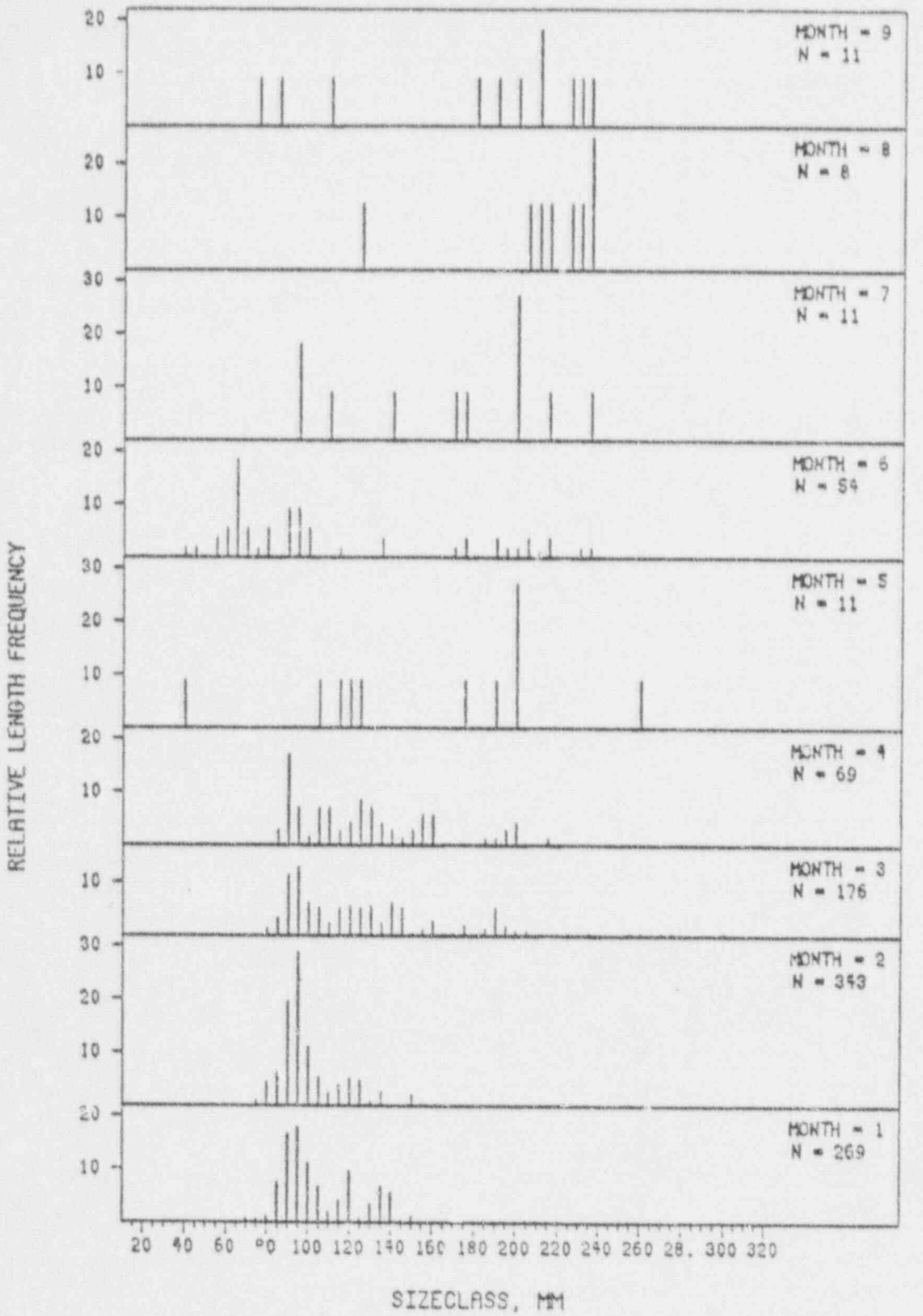
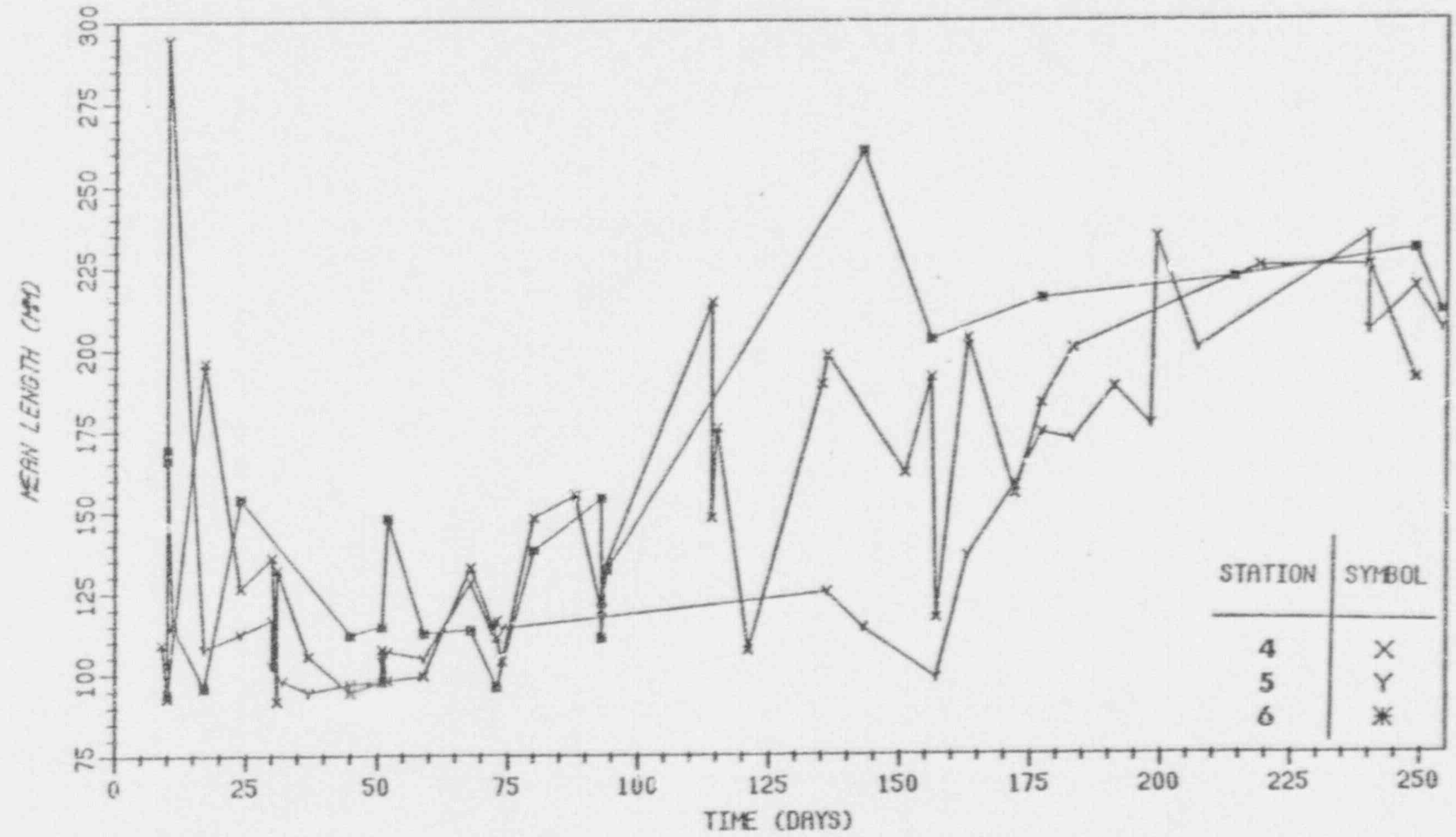


FIGURE 5.19 RELATIVE LENGTH FREQUENCY BY MONTH FOR DIVERSION DEVICE STUDY, 1979, SMALL TRAWLS SPECIES = MENHADEN

FIGURE 5.20. MEAN LENGTH (MM) BY STATION
FOR DIVERSION DEVICE STUDY JAN 1979 - SEPT 1979
SPECIES=MENHADEN AGE=JUVINILE & ADULT



6.0 Conclusions

Spot, croaker, menhaden, brown shrimp, flounder, and mullet constitute the majority of larval and postlarval fish in the Cape Fear estuary during the period from September to May (Table 2.4). The arrival and departure times of particular larval species into the estuary were consistent through the years 1974 to 1979. Spot occur from December through April, croaker from September through May, menhaden from February through May, brown shrimp from March through May, flounder from December through April, and mullet from December through March. During this same five-year period, night densities were greater than day densities and bottom densities were greater than surface densities, with an increase of surface densities at night (Figs. 2.16, 2.17, and 2.18).

Trend analysis performed on spot, croaker, menhaden, brown shrimp, flounder, and mullet to indicate long-term effects show increasing numbers of larvae over the years from 1974 through 1979 with the exception of brown shrimp which showed a downward trend (Fig. 2.19). This downward trend can be explained as a response to the colder temperatures experienced in 1977 and 1978 and the heavy freshwater flow during recruitment of 1978. Considering the overall increase in larval densities, it appears that the overall ecological system of the Cape Fear estuary remains healthy and that the plant impact due to entrainment, if any, is negligible.

The mean density of total larval and postlarval fish entrained from September 1978 through May 1979 ranged between 24 and 1400/1000 m^3. Based on plant flows, the total number entrained ranged from 94,000/day in early November to 4.9 million/day in mid-May.

The six representative species (spot, croaker, mullet, flounder, menhaden, and brown shrimp) represent approximately 65% of the total number of larvae entrained. These species are ocean spawners whose larvae and young use the estuary as a nursery ground. Responding to different environmental cues, the larvae are transported to shallow nursery ground in the marshes or to deep water nursery areas in the vicinity of the saltwater/freshwater interface. Migration to these areas removes the larvae from the immediate vicinity of the plant and reduces entrainment losses. A negative response to light also enables the larvae to avoid entrainment during the day as cooling water is primarily taken from the surface.

The plant has been withdrawing water from the estuary since early 1974. During this time, population estimates for five out of six representative species in the estuary showed an overall increase in abundance. Entrainment on the other hand decreased for croaker, menhaden, and brown shrimp and increased for spot, flounder, and mullet. These trends in abundance for both river and entrainment suggest negligible plant impact.

The plant flow rate during the sampling period ranged from 1.5 to 5.4 million cubic meters/day. Normally six to eight intake pumps are operating to cool the plant's condensers, but reduced plant load or outages may reduce this number. As described in Section 3.2.1 of the Interpretive Report, certain modifications could be undertaken to allow the plant to operate at near full capacity with reduced flow requirements. Using ambient water temperature as a guideline, the flow requirements could be reduced to around 2.25 million cubic meters of water per unit per day from mid-April to the end of November, with an additional 466,000 cubic meters per day required if ambient water temperatures reached 29°C (85°F). The flow could be reduced to 1.5 million cubic meters of water per unit per day between December 1 and around April 15.

If this flow reduction scheme had been used during the 1978-79 sampling period, the maximum number of larvae entrained could have been reduced as shown below.

Species	Maximum Number ($X\ 10^3$) of Larvae Entrained Per Day		
	1978-1979 Actual	1978-79 Under Flow Reduction	% Reduction
Spot	2132	1584	25.8
Croaker	2101	1165	44.6
Flounder	333	185	44.5
Menhaden	141	103	30.0
Mullet	313	174	44.4
Shrimp	799	594	25.7

Peak recruitment for most of these species coincide with the period of coldest water temperature permitting the largest reduction in plant flow.

With nekton sampling gear, a total of 223,039 fish and 145,818 invertebrates were caught, primarily with the small trawl. The ten most abundant fish, in order of decreasing abundance, were spot, croaker, bay anchovy, menhaden, weakfish, tonguefish, spotted hake, southern flounder, star drum, and silver perch. The five most abundant invertebrates caught, in order of decreasing abundance, were grass shrimp, brown shrimp, blue crabs, brief squid, and pink shrimp.

Statistically (Table 4.5), the CPUE of total organisms with each gear was higher at Station 5 than the other stations, although the individual CPUEs for bay anchovies, croaker, brown shrimp, pink shrimp, and weakfish were not significantly different from those at Station 1. Both of these stations are in man-made, soft bottom canals, intermediate in depths to the channel and tidal creek stations. Areas of this type probably serve as nursery areas for most estuarine dependent species during at least part of their stay in the estuary.

Total weight of organisms impinged this year (VI) was down from the two previous years (IV and V). This year's weight was 45% lower than Year IV and 62% lower than Year V. Even though Year VI's total weight was higher than Year III's (by 28%), this was expected because only one unit was in operation during Year III, thus less cooling water was needed. The number of organisms impinged was also less this year than in Years IV and V, 35% and 54% less, respectively. Numbers impinged in Year VI were 47% higher than Year III for the same reason explained above. Weights for menhaden, miscellaneous species, mullet, other finfish, spot, and trout were less in Year VI than in Years IV and V. Bay anchovy and flounder were impinged less this year than last year and croaker were impinged in less weight this year than in Year IV. Weights for blue crabs and other shellfish were higher this year than in the Years III, IV, and V. The weight of shrimp increased over Years IV and V, but did not reach the weight impinged in Year III (see Table 5.4 for weights impinged Years III-VI).

The diversion device was considered to be in effective operation from mid-January through mid-May 1979. After this time it remained in place, but due to severe under washing on the Walden Creek side when several panels broke away from the pilings, it was considered ineffective. Total weight of impinged organisms for this time period was 82% less than in Year V and 69% less than in Year IV. The average weight per organism impinged was 22% less than Year V, 18% less than Year IV, and 36% less than Year III. This indicates that the diversion device may have decreased impingement by excluding larger fish.

Spot were the most abundant organism comprising 43.2% of the total catch of organisms in the diversion device trawling program. Croaker were second with 16.4% of the total catch. These were followed by bay anchovy (12.7%), grass shrimp (8.7%), brown shrimp (6.6%), blue crabs (2.9%), Atlantic menhaden (2.5%), and weakfish (1.7%). All other organisms combined, representing 83 more species, accounted for 5.3% of the total. Catch per unit effort (CPUE) for each of the species groups is presented by station in Table 5.16.

Diversion device studies showed that while the diversion device was in effect, spot of significantly greater mean length (Fig. 5.16) were caught outside and just inside the diversion device at Stations 4 and 6 than at the plant (Station 5). Also, spot at Station 4 were slightly larger (2-5 mm) than at Station 6 and 5-10 mm larger than Station 5 (Fig. 5.16). This tends to support the theory that the diversion device does exclude larger fish. Length frequency for croaker also showed that while the diversion device was in effect (January to mid-May), mean lengths for croaker were larger at Station 4 than at Stations 6 and 5 (Fig. 5.18). These fish were from 5-10 mm larger. After failure of the diversion device, catches of croaker increased inside the diversion device and mean lengths of the croaker also increased.

If the problems associated with leaving the diversion device in year-round (biofouling and under washing of the screens) can be solved and movement around the diversion device is eliminated by construction of the "crab fence," impingement should be reduced substantially. With the diversion device in effective use, the only organisms susceptible to impingement will be those that can move through the mesh in the screening. This cannot be eliminated, but impingement catches resulting from these organisms would be substantially lower than past years. Year-round use of the diversion device and/or return to the estuary of the reduced number of impinged organisms by the improved nekton return system should ensure that the plant's effects upon the estuarine system be minimal.