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L. Carl Blackwell

PERFORMANCE REPORT

RESEARCH AND SURVEYS

FEDERAL AID PROJECT NO. F-41-R-7

FACTORS INFLUENCING FISH POPULATIONS IN OKLAHOMA LAKES AND PONDS

JOB NO. 10

POPULATION PARAMETERS OF STRIPED BASS X WHITE BASS HYBRIDS IN A TURBID OKLAHOMA RESERVOIR

JULY 1, 1984 TO JUNE 30, 1985

PERFORMANCE REPORT

STATE: Oklahoma PROJECT NUMBER: F-41-R-7

PROJECT TITLE: Factors influencing fish populations in Oklahoma Lakes and ponds

JOB NO. X

JOB TITLE: Population parameters of striped bass x white bass hybrids in a turbid Oklahoma reservoir.

CONTRACT PERIOD: 1 July 1984 to 30 June 1985

PROGRAM NARRATIVE OBJECTIVE X:

OBJECTIVE: Evaluate population parameters of striped bass x white bass hybrids in a turbid Oklahoma reservoir.

I. Job Objective:

To gather data on relative abundance, condition, growth, age, food habits, and habitat of striped bass x white bass hybrids, white bass and largemouth bass.

II. Summary of Progress:

Fish populations in all habitat types were randomly sampled using gill nets, trap nets, and barrel nets. Relative abundance, length-frequency relationships, length-weight relationships, condition indices (Fulton's K and relative weight, proportional stock densities), age and growth, food habits, gear selectivity and habitat use were determined. Changes in fish condition, relative abundance, and growth rate parameters were measured. The correlation between condition and total length was also determined. In 1983-1984, 2592 fish were captured and in this report period 2669 fish were captured.

III. Significant Deviation from Objectives: None

IV. Conclusions, Evaluation and Recommendations:

A. Procedures:

Fish populations were sampled monthly with nylon multifilament experimental gill nets (bar mesh measures 25.4, 50.8, 76.2, and 101.6 mm, respectively), trap nets, and barrel nets. During each month the total effort for all gear types was at least 36 net-nights. The trap nets used were in accordance with the recommendations of the ODWC standard sampling procedure (SSP). Data collected from each piscivorous fish species included total length (mm), weight (g), maximum buccal gape (mm), and maximum body depth (mm). Total length, weight and maximum body depth data were collected from the prey species. Length and weight data were also collected for 'rough fish' such as carp and freshwater drum.

Four to six scales were taken from each fish from the area just below the lateral line on the left side posterior to the distal end of the pectoral fin. Scale impressions were made on acetate slides and annulus and scale radius lengths were measured to the nearest mm using an Eberbach and Son's scale viewer. Lengths at age were estimated by the regression method for largemouth bass, white bass, and striped bass x white bass hybrids by means of the expression:

$$L = a + bS \qquad (1)$$

where L = total length, S = scale radius, and a and b are constants (Carlander 1981).

The Lee method was employed to determine the body-scale relationships for the above three species as follows:

$$Li = a + \frac{(Lc-a)}{Sc} Si \qquad (2)$$

where Li is the total length (TL) at annulus "i", a is the constant from equation (1), Lc is the length of the fish at capture, Si is the scale radius measurement to annulus "i", and Sc is the scale measurement to the edge of the scale.

The length-weight relationships for all species were determined using the expression:

$$W = aL^b \quad (3)$$

where W is weight (g), L is total length (mm) and a and b are empirically determined constants obtained by regressing Log_{10} W on Log_{10} L.

Fulton's condition factor, K, was employed to determine the condition of the fish in these populations using the expression:

$$K = \frac{W}{L^3} X \quad (4)$$

where W is the weight (g), L is length (mm), and X is an arbitrary constant (usually 100,000 in metric units).

The relative weight, Wr, was determined for white bass, white crappie, largemouth bass, channel catfish, gizzard shad, and striped bass x white bass hybrid. This index of fish condition compares the actual weight (W) with a standard weight (Ws) for fish of the same length (Wege and Anderson 1978).

$$Wr = \frac{W}{Ws} \times 100 \quad (5)$$

The perfect relative weight is 100. The proposed working standard weights were determined using the following expressions:

Largemouth bass $Log_{10}W_s = -5.315 + 3.191 \log_{10}TL$ (6) Wege and Anderson (1978)

Channel catfish $Log_{10}W_s = -5.649 + 3.243 \log_{10}TL$ (7) Anderson (1980)

Bluegill $\quad Log_{10}W_s = -5.374 + 3.316 \log_{10}TL$ (8) Anderson (1980)

White crappie $\quad Log_{10}W_s = -5.102 + 3.112 \log_{10}TL$ (9) Anderson (1980)

Gizzard shad $\quad Log_{10}W_s = -5.376 + 3.170 \log_{10}TL$ (10) Anderson (1980)

Proportional stock density (PSD) was computed for largemouth bass, bluegill, striped bass x white bass hybrid, white crappie and white bass, channel catfish, and freshwater drum. The PSD is defined as the percentage of "stock-length" fish that are equal to or longer than a specified "quality-length" (Anderson 1980). Quality length is the mimimum size of fish that most anglers like to keep, while stock length is the length at which most fish reach maturity. Quality and stock lengths for selected species were from Gablehouse (1984). The desirable PSD range for largemouth bass is 40-60 and for bluegills in combination with largemouth bass, is about 80. These ranges depend, of course, on the population density and other population variables.

Data on buccal gape of predators and maximum body depth of prey were used to compute the maximum prey size available to predators of given sizes. These relationships were determined by using the expressions:

$$Log_{10} \text{ buccal gape} = a + c \log_{10} TL \quad (11)$$

$$Log_{10} \text{ body depth} = b + d \log_{10} TL \quad (12)$$

where a and c, and b and d are empirically determined constants for predator and prey species, respectively.

Correlations were obtained between condition factor and length for some species to determine whether there was any significant difference in condition factor relative to fish size. The relationship between condition factor, K, and fish length was examined using the expression:

$$\text{Log}_{10}\ K = a + b \log_{10} TL \qquad (13)$$

where a and b are empirically determined constants.

B. Results and Discussion

White crappie (Pomoxis annularis) made up 67.5% of the total catch in 1984-1985 (Table 1) but in 1983-1984 they represented only 46.8% of the catch (Performance Report F-41-R-6, 1983-84). As a group, centrarchids comprised 75.9%

in 1983-1984. The relative abundance of gizzard shad (Dorosoma cepedianum) remained constant from 1983-1984 to 1984-1985, while bluegill (Lepomis macrochirus) dropped from 9.7% to 5.0%. Channel catfish (Ictalurus punctatus) and largemouth bass (Micropterus salmoides) dropped from 11.7% and 1.3% to 8.9% and 0.4%, respectively.

The increase in relative abundance of white crappie appears to be evidence of a real shift in the fish assemblage of Lake Carl Blackwell. Beginning in 1980 (Kleinholz 1982) white crappie increased from 13.0% of the catch, to 21.3% in 1981, 46.8% in 1984, and are currently 67.5%. Conversely the gizzard shad has decreased in abundance from 28.2% in 1980, to 19.7% in 1981 (Kleinholz 1982), 8.3% in 1984 and are presently only 7.2%.

The reduction in the relative abundance of largemouth bass from 1983-84 to the present may represent a real decline or be the result of gear selectivity due to low susceptibility of largemouth bass to nets.

Both the white bass and striped bass x white bass hybrids had bimodal length frequency distributions (Figures 1-2) with the very

small fish of the first mode being absent due to gear selectivity and (or) differential mortality. Bimodality may be due to a portion of each population having reduced growth rates.

The largemouth bass (Figure 3) length-frequency distribution seems to indicate a geometric distribution with the smaller fish being absent due to gear selectivity. However, the distribution is based on 11 fish and may be an artifact of the sample size.

The white crappie length-frequency distribution (Figure 4) indicates a tightly packed population of fairly small white crappie; 98.3% of the entire population was less than 200 mm in length. This distribution suggests either differential mortality of the larger white crappie or a slow growing population. However, a large number of the very small white crappie were in spawning condition.

The length-frequency of channel catfish (Figure 5) represents a fairly stable population as suggested by its geometric length frequency distribution. This does not appear to be a sampling artifact since the data is based on a large sample. Gear selectivity, because of large gill net mesh size, is probably responsible for the reduced numbers of smaller fish.

Based on length-frequency distributions, the longear sunfish (Lepomis megalotis), and bluegill seem to have stable populations (Figures 7 and 8).

The length-weight regressions for largemouth bass, striped bass x white bass hybrids, and white bass had slopes greater than 3.18 (Table 2). These slopes indicate that these fish species may be in relatively good condition and that growth of each is allometric. The white

crappie, a species of significant abundance and a potentially important food source for the other game fishes, had a length-weight regression slope of 3.00 and the gizzard shad regression had a slope of 2.89.

The mean condition factors for the three major piscivorous species--white bass, striped bass x white bass hybrids, and largemouth bass increased slightly from their 1983-84 values (Table 3). White crappie, on the other had, experienced a slight decrease in mean condition factor. For some species, the condition factor, K, was positively correlated to total length. For example, bluegill, white bass, and channel catfish had significant correlations between $\log_{10}$ K and $\log_{10}$ TL, whereas largemouth bass showed no positive correlation (Table 4). Further analysis of the data indicated that for most species, the slope of the regression of $\log_{10}$ K versus $\log_{10}$ TL (Table 4) corresponded approximately to the difference from 3.00 of the slope of the regression of $\log_{10}$ weight versus $\log_{10}$ TL (Table 4).

Largemouth bass had relative weights distributed about 100 (Figure 11). That figure indicates that while the largemouth bass are in good overall condition, there also seems to be a trend toward increasing relative weight with size. The apparent increase might indicate the utilization of a wider variety of food sources by the larger fish than the smaller fish. Gizzard shad had relative weights that were distributed about a mean of approximately 75 (Figure 12) but it is noteworthy that fish less than 110 mm TL exhibited decreasing relative weights, whereas those greater than 180 mm TL tended to have increasing relative weights.

Relative weight of channel catfish seems to increase with total length (Figure 13). The low relative weights associated with the

majority of channel catfish, 120 to 300 mm TL, could indicate limited forage availability for fishes within that size range.

White crappie, less than 200 mm TL, had relative weights distributed around 80 (Figure 14) but those greater than 250 mm TL tended to have higher relative weights. Higher relative weights with greater size could be an indication of release from the possible competition for forage within the smaller size classes.

Relative weights for bluegills averaged 90 (Figure 15) and seemed to be relatively stable within all size classes. Stability in relative weight could be due to steady availability of food resources to all size classes.

The proportional stock densities for largemouth bass, bluegill and white crappie were 50%, 35%, and 2%, respectively (Table 5). Anderson (1976) determined that PSD values such as these are, indicative of stable largemouth bass-bluegill assemblages. The low PSD for white crappie is a result of the preponderance of fish of less than quality size (98.3% less than 200 mm). The PSD values determined for the largemouth bass, bluegill, white bass, and white crappie are similar to those obtained during 1983-84. Although the PSD for white bass is fairly high, 85%, the desirable range has not been determined. Similarly the desirable range of PSD for striped bass x white bass hybrids has not been determined.

Analysis of scales indicated that largemouth bass growth rates during 1984-85, averaged 110 mm TL by age I and 219 mm TL by age II (Table 6). Only three age classes of largemouth bass were identified. The three age classes, I, II, and III, in the sample are probably not representative and may reflect gear selectivity for smaller fish.

White bass grew an average of 204 mm during their first year of life, and 85 mm during year II. These growth rates may be a reflection of the availability of forage for the white bass. Striped bass x white bass hybrids also attained large average sizes (240 mm TL) during their first year of life and had relatively fast growth rates during year II. Although gear selectivity may account for the apparent negative skew in the age distribution of the various species, there is a notable absence of age IV+ and older striped bass x white bass hybrids and white bass. High fishing pressure and high natural mortality among the larger, older fish might be implicated in the age distribution observed.

Regressions of the log of gape width against the log of total length for piscivores and the log of body depth against log of total length for prey suggests that largemouth bass 50 mm TL could handle bluegill, white crappie, and gizzard shad of total lengths 26, 31, and 21 mm, respectively (Table 7). Bluegills larger than 100 mm TL are less susceptible to largemouth bass predation due to the body depth in larger bluegills.

The maximum lengths of forage fish available to the white bass and striped bass x white bass hybrids indicate that striped bass x white bass hybrids had larger buccal gape widths and could handle larger prey items than white bass of equivalent lengths (Tables 8 and 9). Although the white crappie constitutes the majority of the forage assemblage, it is not necessarily preferred by either the white bass or the striped bass x white bass hybrids (Kleinholz 1985).

All of the white bass and most of the striped bass x white bass hybrids were collected in gill nets (Figures 16-25). This pattern of gear selectivity is expected since both species school and are pelagic.

Largemouth bass were caught in both gill nets and trap nets with the majority taken in gill nets. However, few largemouth bass were taken. Barrel nets were used to collect the majority of white crappie. This gear selectivity would be expected since barrel nets were set in areas of reduced natural cover and their presence resulted in their being used for cover. The channel catfish, freshwater drum, and gizzard shad were collected primarily in gill nets. These species are highly mobile and occupy deep water. The pelagic schooling activity of gizzard shad would also contribute to high gill net effectiveness. The longear sunfish inhabits shallow water and as might be predicted trap nets were the most effect gear.

A majority of the white bass, 28 (68.3%), and the striped bass x white bass hybrids, 23 (57.5%), taken in 1984-1985 were collected in the southern region of the lake (Table 10). Most gizzard shad were also captured (63.9%) in this region. Food habits for white bass, white crappie, largemouth bass, and striped bass x white bass hybrids will be presented in the final report.

These distributions may be a result of the lower turbidities of the southern region (Appendix I). Gizzard shad are planktivorous and may be moving into the clearer water to take advantage of higher planktonic growth. The white bass and striped bass x white bass hybrid may move into the clearer water to prey on the shad. Alternatively, since both the white bass and the striped bass x white bass hybrids are sight feeders, they may not be tracking the shad but rather may be selecting clearer water.

Channel catfish were equally distributed across all habitat types, and showed no preferential habitat use. White crappie were collected in

all three habitat types but only 19.9% (358) of the white crappie population was collected in the northern section. However, actual numbers of crappie were so high that heavy use is indicated throughout the lake.

Bluegill and freshwater drum occurred more frequently in the west end of the lake. The preference for this area may be due to warmer temperatures and the use of higher turbidities for protection.

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PREPARED BY:

Chris Henry, M.S. candidate
Maurice Muoneke, Ph.D. candidate

O. Eugene Maughan

O. Eugene Maughan, Principal Investigator

Date: 9/24/85

Aproved By: Harold Namminga

Harold Namminga, D-J Coordinator

Table 1. Relative abundances of fishes caught in Lake Carl Blackwell in 1983-1984 and 1984-1985.

Species	1983-1984 Number of fish	1983-1984 Percent of total number	1984-1985 Number of fish	1984-1985 Percent of total number
White bass	52	2.0	41	1.5
Striped bass x white bass	14	0.6	40	1.5
Largemouth bass	33	1.3	11	0.4
White crappie	1,217	46.8	1801	67.5
Longear sunfish	76	2.9	76	2.8
Bluegill sunfish	253	9.9	134	5.0
Redear sunfish	3	0.1	4	0.2
River carpsucker	70	2.7	3	0.1
Freshwater Drum	90	3.6	114	4.3
Gizzard shad	216	8.5	191	7.2
Channel catfish	304	11.9	236	8.8
Flathead catfish	8	0.3	-	-
Carp	96	3.1	18	0.7
Red shiner	2	0.1	-	-
Silverside	3	0.1	-	-
Orangespotted sunfish	137	5.4	-	-
Green sunfish	18	0.7	-	-

Table 2. Length-weight relationships for fish caught in Lake Carl Blackwell in 1984-1985.

Species	N	Model	R^2	P>F
Bluegill	134	Log W = -5.27 + 3.25 Log L	.965	.0001
Carp	18	Log W = -4.089 + 2.68 Log L	.989	.0001
Channel catfish	236	Log W = -5.625 + 3.21 Log L	.954	.0001
White crappie	1801	Log W = -5.988 + 3.00 Log L	.910	.0001
Largemouth bass	11	Log W = -5.347 + 3.21 Log L	.990	.0001
River carpsucker	3	Log W = -16.006 + 7.24 Log L	.892	.0001
Freshwater drum	114	Log W = -5.531+ 3.22 Log L	.947	.2128
Longear sunfish	76	Log W = -4.978 + 3.14 Log L	.943	.0001
Redear sunfish	4	Log W = -3.553 + 2.373 Log L	.993	.0001
Gizzard shad	190	Log W = -4.878 + 2.892 Log L	.900	.0001
White bass	41	Log W = -5.986 + 3.445 Log L	.932	.0001
Striped bass x white bass hybrid	40	Log W = -5.326 + 3.182 Log L	.963	.0001

Table 3. Mean condition factors (Fulton's K) for fish species in Lake Carl Blackwell.

Species	Mean condition factor		
	1980/81	1983/84	1984/85
White bass	1.44	1.14	1.36
Striped bass x white bass hybrid	-	1.25	1.33
Largemouth bass	1.34	1.51	1.46
White crappie	1.00	1.13	1.04
Bluegill	1.93	1.67	1.78
Carp	1.29	1.20	1.30
Channel catfish	0.85	0.75	0.76
Flathead catfish	1.28	0.96	-
Freshwater drum	1.02	1.02	0.94
Gizzard shad	.84	1.13	0.79
Longear sunfish	-	2.11	2.04
Green sunfish	-	1.67	-
River carpsucker	-	1.15	1.26
Orangespotted sunfish	-	2.14	-

Table 4. Correlation between Log_{10} condition factor and Log_{10} total length for some fish species from Lake Carl Blackwell.

Species	N	Corr. coeff.	Prob. R=0
Largemouth bass	11	.335	.3126
Bluegill	134	.348	.0001
Carp	18	-.748	.0004
Channel catfish	236	.535	.0001
Striped bass x white bass hybrid	40	.280	.0794
White bass	41	.432	.0048

Table 5. Proportional stock density (PSD) for some fish species in Lake Carl Blackwell 1984-1985.

Species	No. ≥ quality length	No. ≥ stock length	PSD (%)
Largemouth bass	3	6	50
Bluegill	35	101	35
Channel catfish	8	42	19
White crappie	12	566	2
Freshwater drum	1	11	9
Striped bass x white bass hybrid	10	28	36
White bass	35	41	85

Table 6. Growth and age composition of selected fish species in Lake Carl Blackwell. Data are reported as mean total length (mm) at annulus and number of fish (N) in each sample (1984-1985).

	I	II	III	IV	V
Largemouth bass	110(2)	219(2)	486(1)		
Increment	110	109	267		
White bass	204(7)	289(10)	307(3)	336(1)	
Increment	204	85	18	29	
Striped bass x white bass hybrid	240(4)	311(8)	314(4)	317(2)	
Increment	240	71	3	4	

Table 7. Maximum length of forage fish available to largemouth bass of various sizes in Lake Carl Blackwell, Oklahoma.

Largemouth bass total length (mm)[1]	Forage fish species and TL (mm)		
	Bluegill[2]	White crappie[3]	Gizzard shad[4]
50	26	31	21
100	46	57	46
150	63	81	73
200	80	104	101
250	95	126	131
300	110	148	161
350	124	170	191
400	138	191	223
450	152	212	255
500	165	233	287

[1] Log_{10} gape = -.744 + 0.948 Log_{10} TL. $R^2 = 0.91$, N=11, P>F = 0.0001.

[2] Log_{10} body depth = -.820 + 1.187 Log_{10} TL. $R^2 = 0.96$, N=133, P>F = 0.0001.

[3] Log_{10} body depth = -.738 + 1.078 Log_{10} TL. $R^2 = 0.90$, N=1777, P>F = 0.001.

[4] Log_{10} body depth = -.241 + .836 Log_{10} TL. $R^2 = 0.81$, N=189, P>F = 0.0001.

Table 8. Maximum length of forage fish available to white bass of various sizes in Lake Carl Blackwell, Oklahoma.

White bass[1]	Forage fish species and TL (mm)		
	Bluegill[2]	White crappie[3]	Gizzard shad[4]
50	22	26	17
100	39	48	38
150	54	69	59
200	69	88	82
250	82	107	105
300	94	126	130
350	107	144	155
400	119	162	180
450	131	180	206
500	143	198	232

[1] Log_{10} gape = -.819 + .947 Log_{10} TL. $R^2 = 0.84$, N=40, P>F = 0.0001.

[2] Log_{10} body depth = -.820 + 1.187 Log_{10} TL. $R^2 = 0.96$, N=133, P>F = 0.0001.

[3] Log_{10} body depth = -.738 + 1.078 Log_{10} TL. $R^2 = 0.90$, N=1777, P>F = 0.001.

[4] Log_{10} body depth = -.241 + .836 Log_{10} TL. $R^2 = 0.81$, N=189, P>F = 0.0001.

Table 9. Maximum length of forage fish available to striped bass x white bass hybrids of various sizes in Lake Carl Blackwell, Oklahoma.

Striped bass x white bass hybrid[1]	Forage fish species and TL (mm)		
	Bluegill[2]	White crappie[3]	Gizzard shad[4]
50	29	34	24
100	46	56	46
150	60	76	68
200	73	95	90
250	83	112	111
300	96	128	133
350	107	144	155
400	117	159	176
450	127	174	198
500	136	188	219

[1] Log_{10} gape = -.463 + .807 Log_{10} TL. $R^2 = 0.86$, N=39, P>F = 0.0001.

[2] Log_{10} body depth = -.820 + 1.187 Log_{10} TL. $R^2 = 0.96$, N=133, P>F = 0.0001.

[3] Log_{10} body depth = -.738 + 1.078 Log_{10} TL. $R^2 = 0.90$, N=1777, P>F = 0.001.

[4] Log_{10} body depth = -.241 + .836 Log_{10} TL. $R^2 = 0.81$, N=189, P>F = 0.0001.

Table 10. Habitat use, based on frequency of occurrence, of various fish species caught in Lake Carl Blackwell in 1984-1985. Equal efforts were expended in all habitat types.

Species	North (N) Number of fish	South (S) Number of fish	West (W) Number of fish
White bass	4	28	9
Striped bass x white bass hybrid	9	23	8
Largemouth bass	3	3	5
White crappie	358	776	667
Channel catfish	72	75	89
Gizzard shad	18	122	51
Bluegill	28	43	63
Freshwater drum	12	41	61
Carp	6	9	3

*For qualitative descriptions of each habitat type see Appendix I.

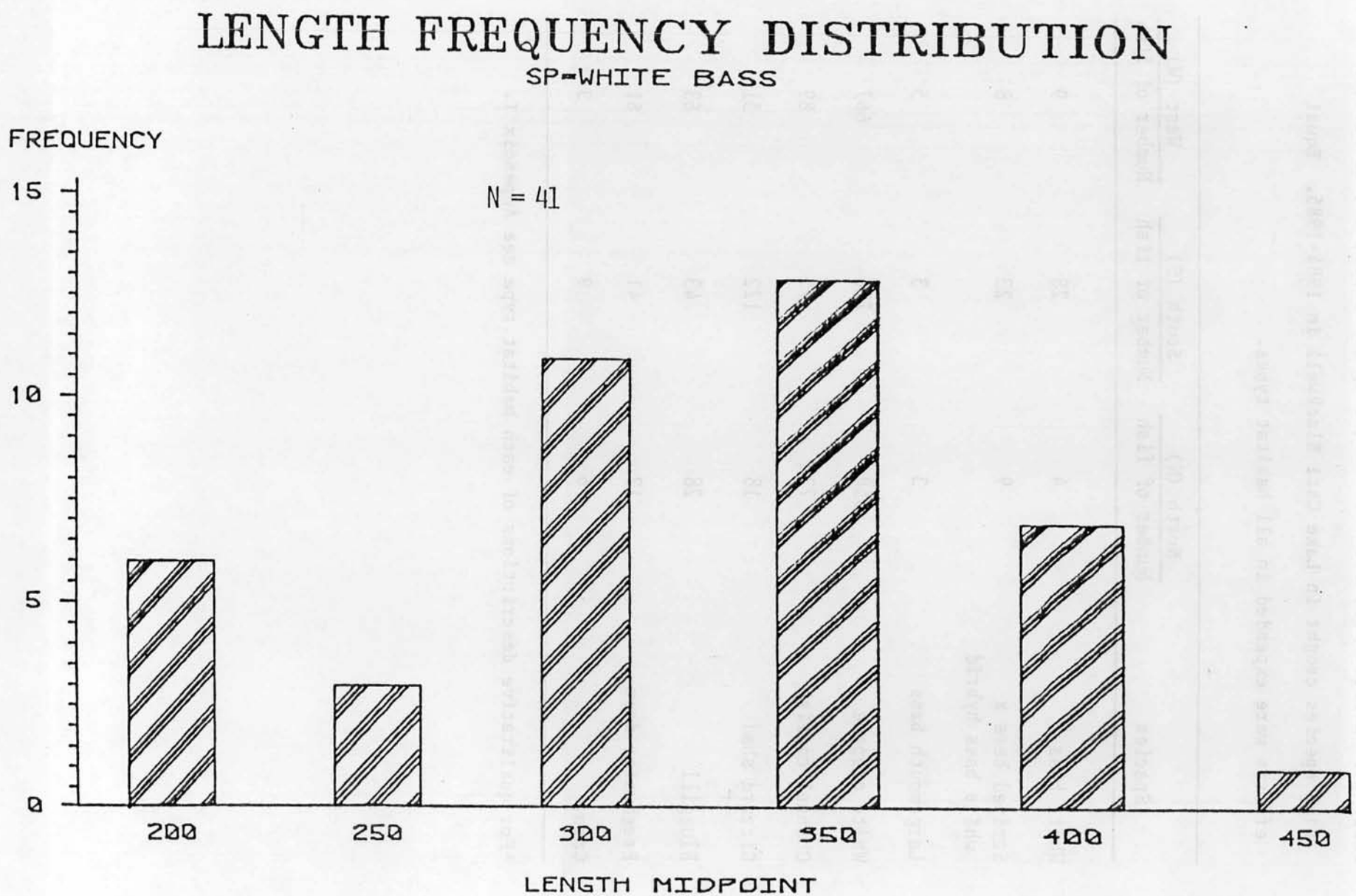


FIGURE 1. LENGTH FREQUENCY RELATIONSHIPS FOR WHITE BASS CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

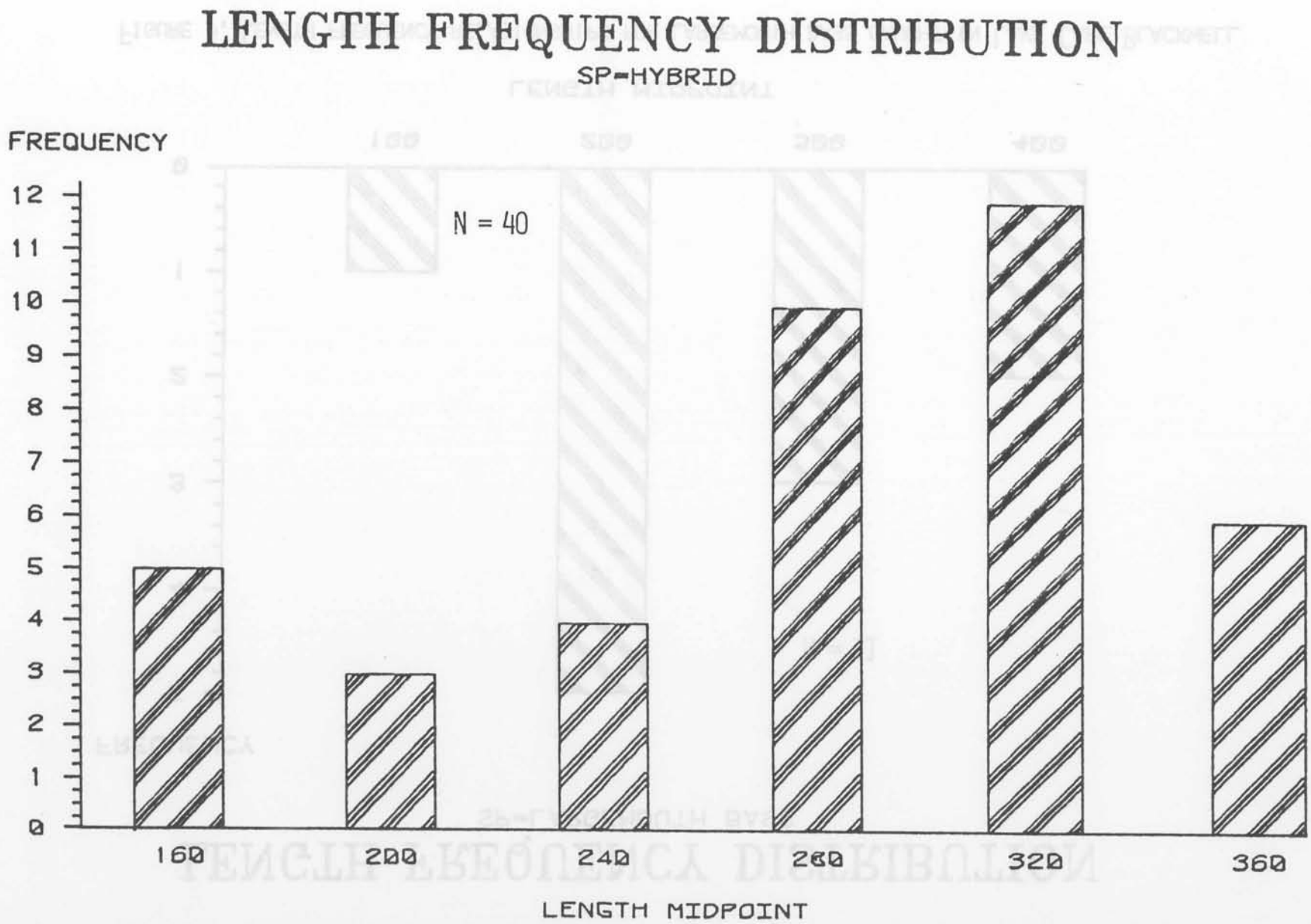


FIGURE 2. LENGTH FREQUENCY RELATIONSHIPS FOR STRIPED BASS X WHITE BASS HYBRIDS CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

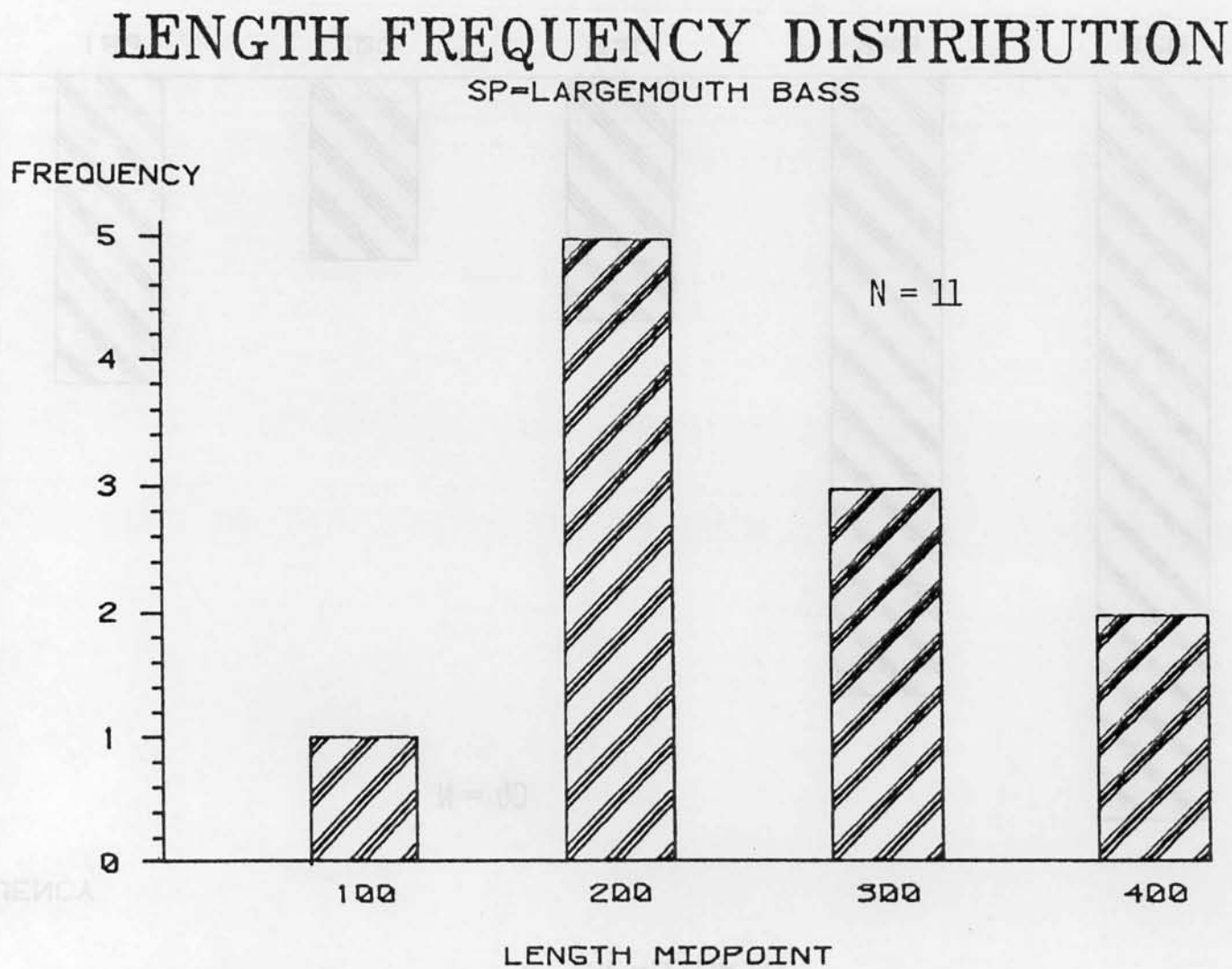


FIGURE 3. LENGTH FREQUENCY RELATIONSHIPS FOR LARGEMOUTH BASS CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

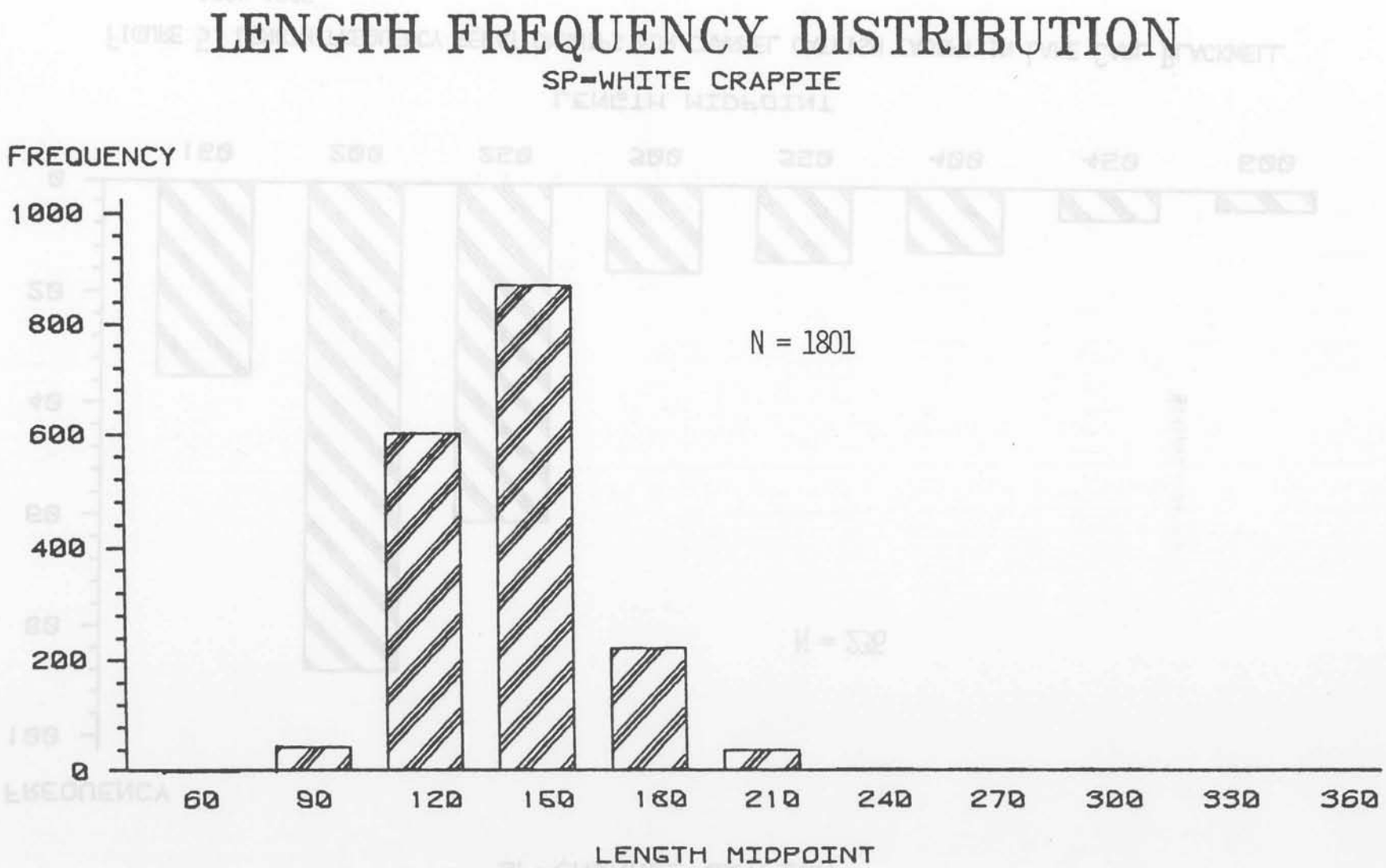


FIGURE 4. LENGTH FREQUENCY RELATIONSHIPS FOR WHITE CRAPPIE CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

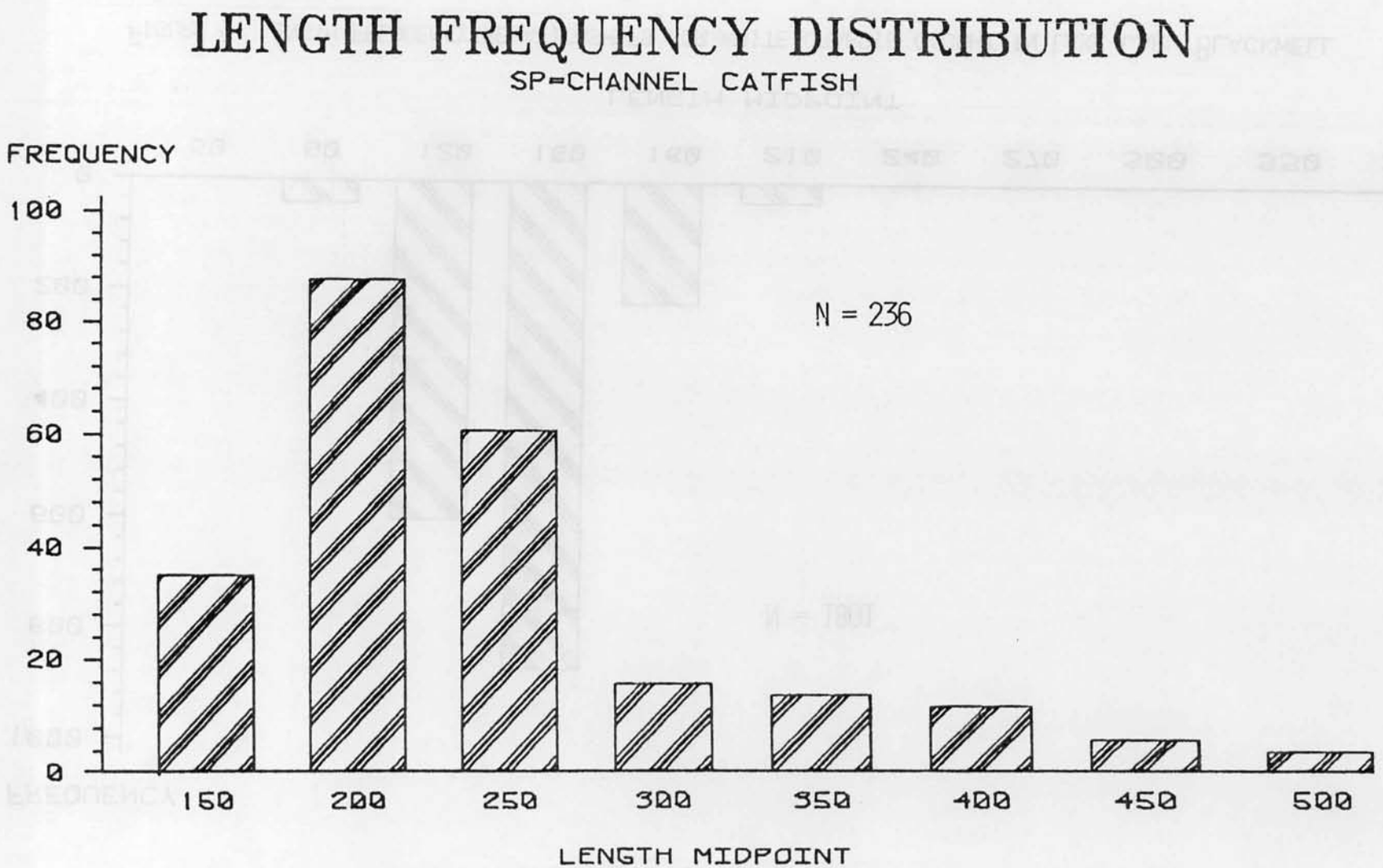


FIGURE 5. LENGTH FREQUENCY RELATIONSHIPS FOR CHANNEL CATFISH CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

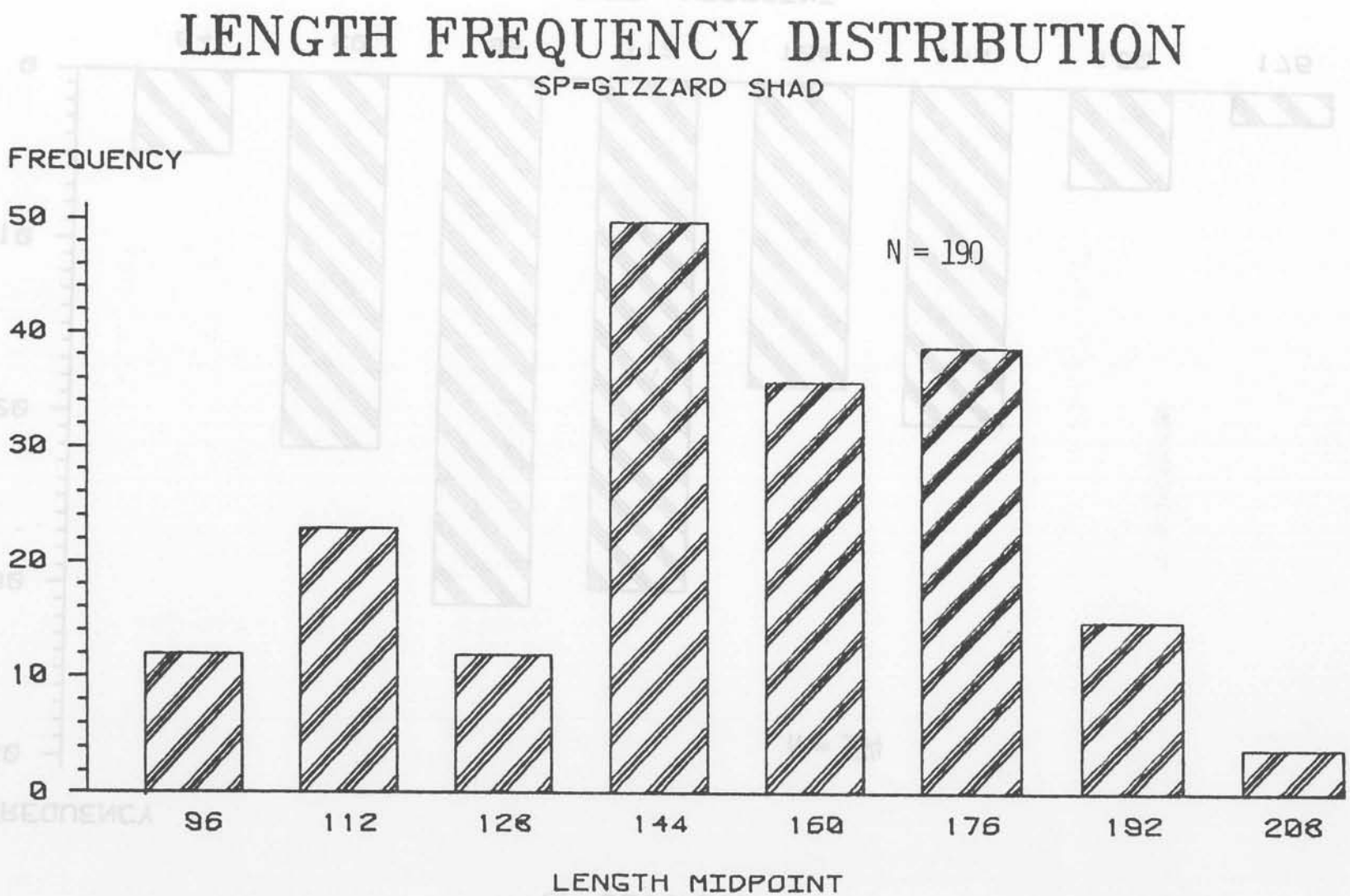


FIGURE 6. LENGTH FREQUENCY RELATIONSHIPS FOR GIZZARD SHAD CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

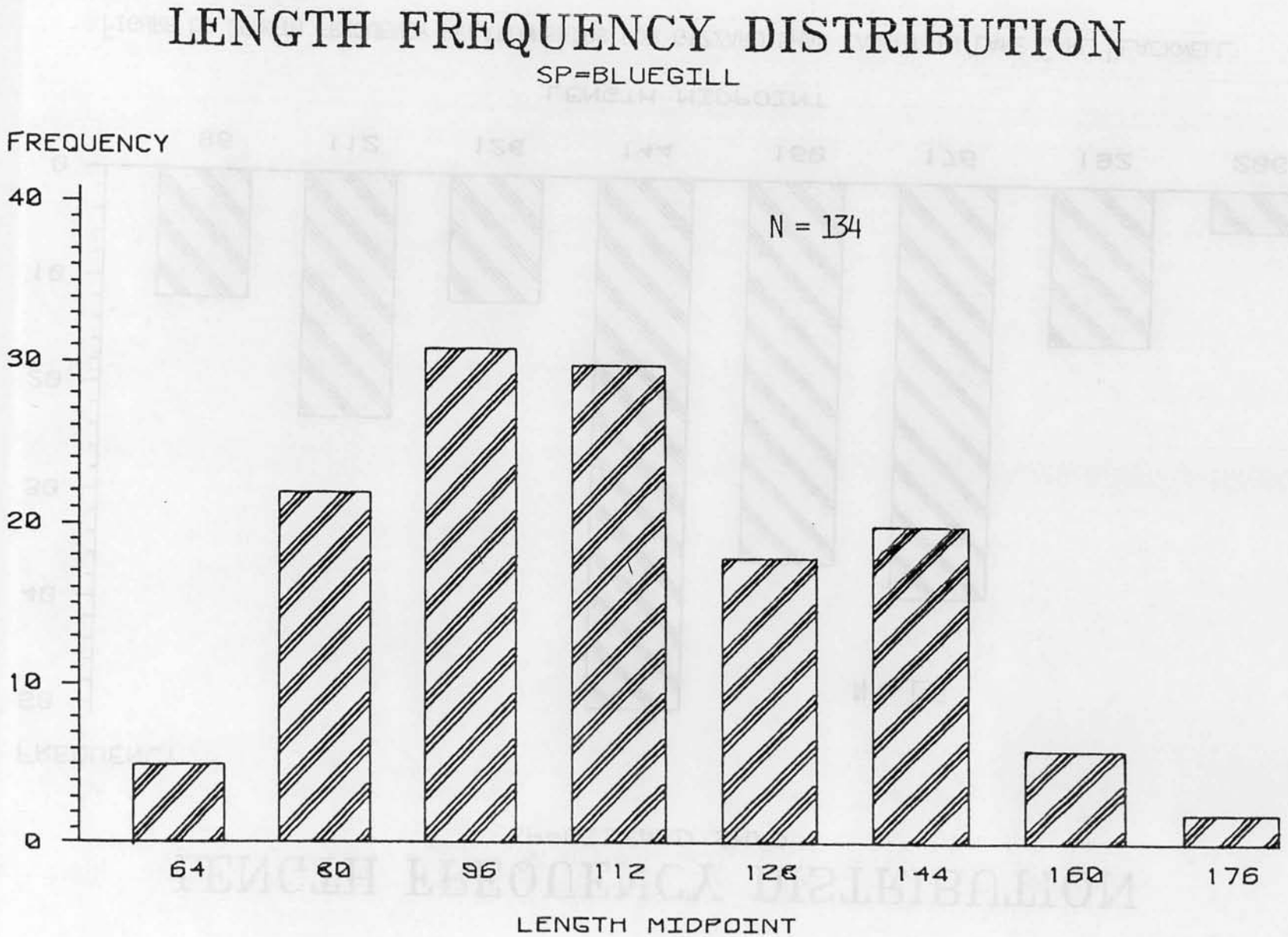


FIGURE 7. LENGTH FREQUENCY RELATIONSHIPS FOR BLUEGILL CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

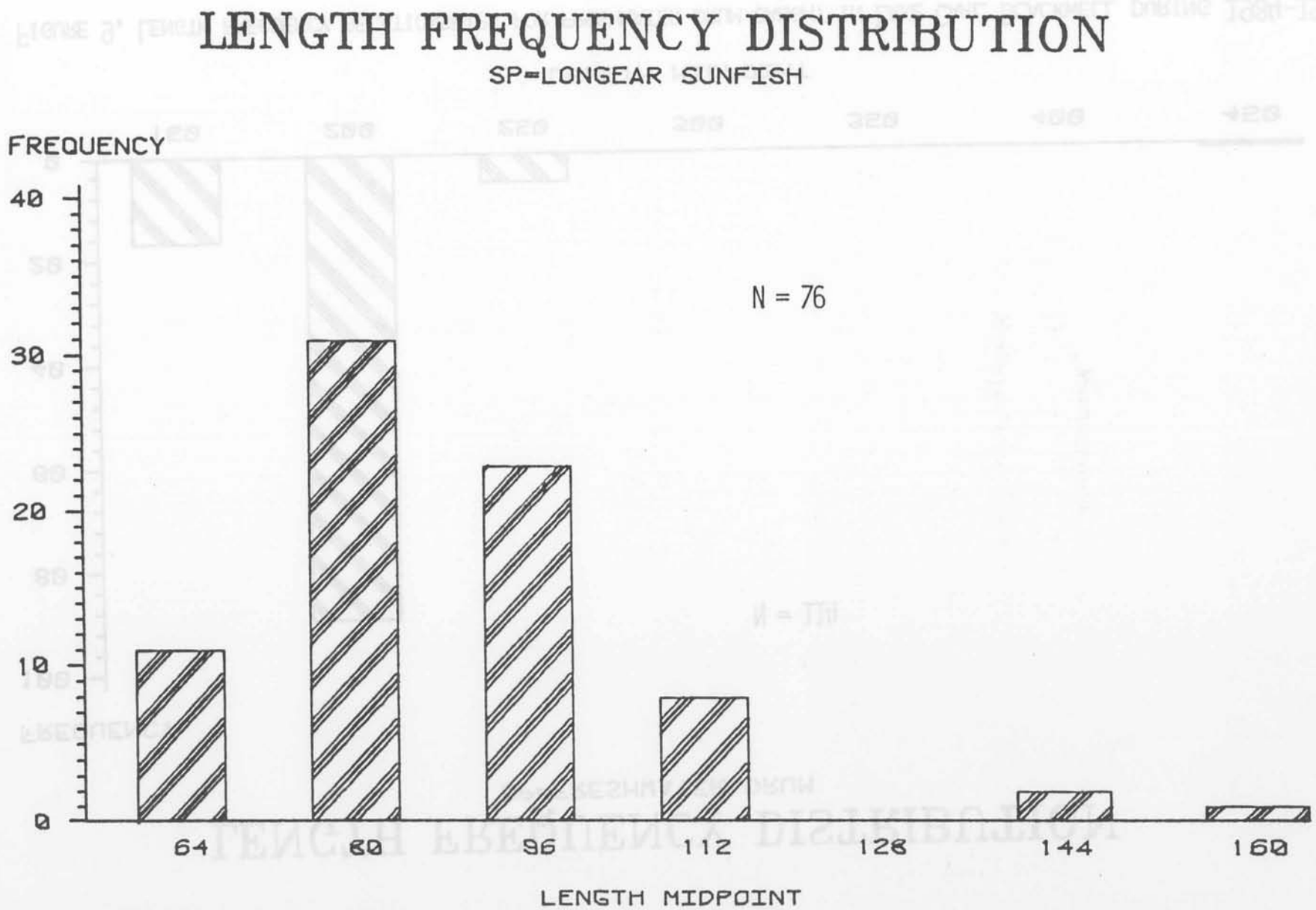


FIGURE 8. LENGTH FREQUENCY RELATIONSHIPS FOR LONGEAR SUNFISH CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

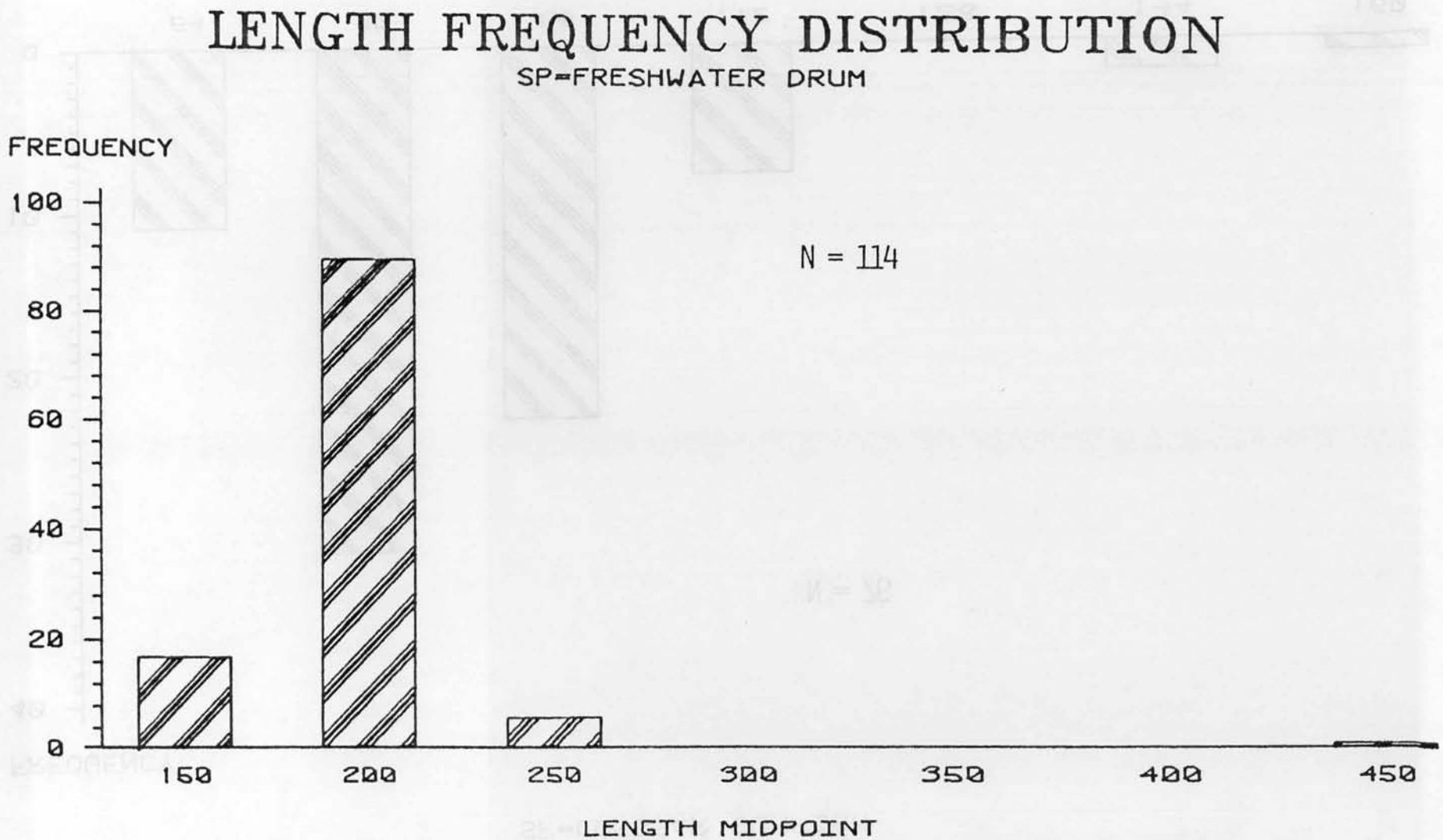


FIGURE 9. LENGTH FREQUENCY RELATIONSHIPS FOR FRESHWATER DRUM CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

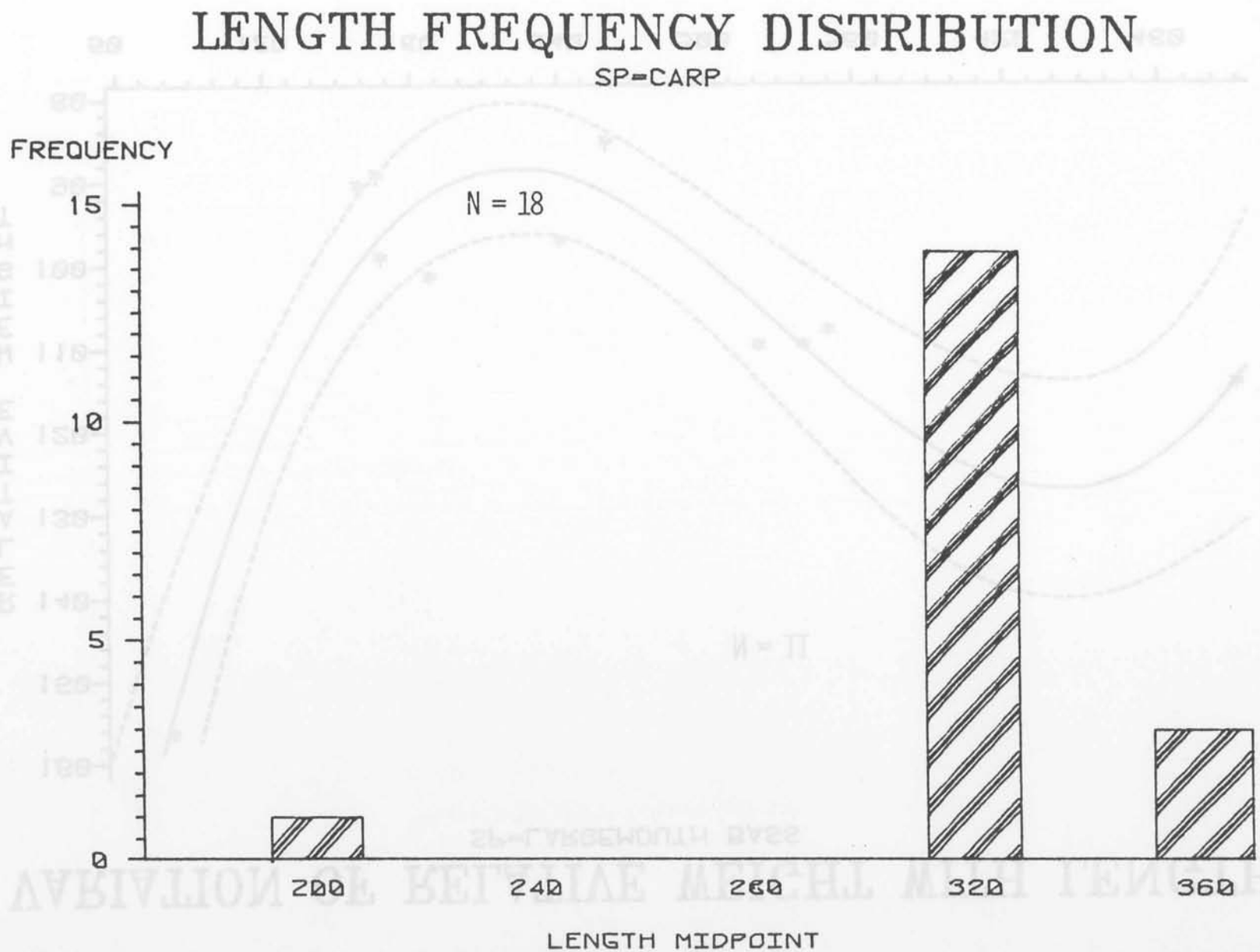


FIGURE 10. LENGTH FREQUENCY RELATIONSHIPS FOR CARP CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

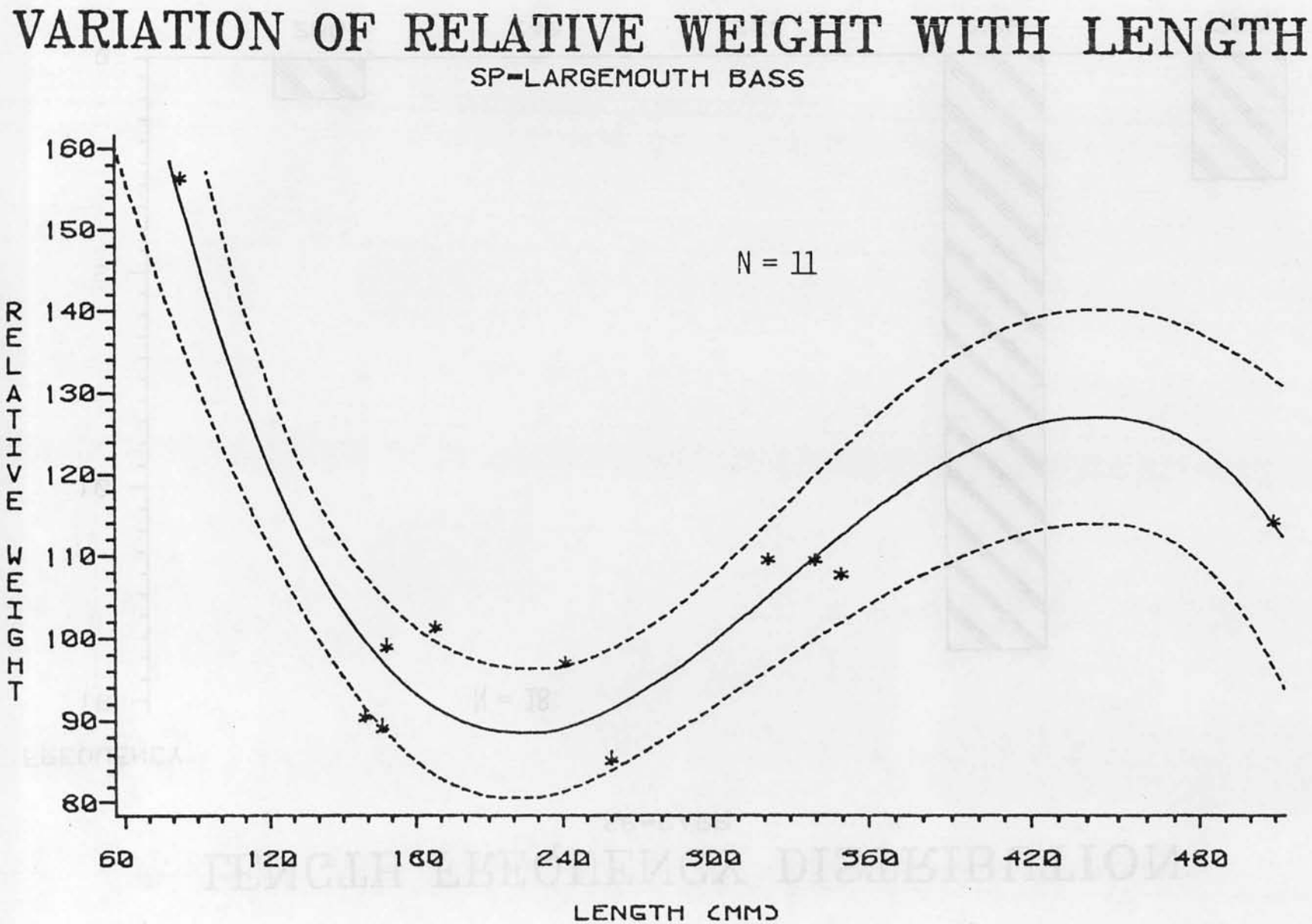


FIGURE 11. VARIATION OF RELATIVE WEIGHT WITH LENGTH FOR LARGEMOUTH BASS CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985. DASHED LINE REPRESENTS A 95% CONFIDENCE INTERVAL.

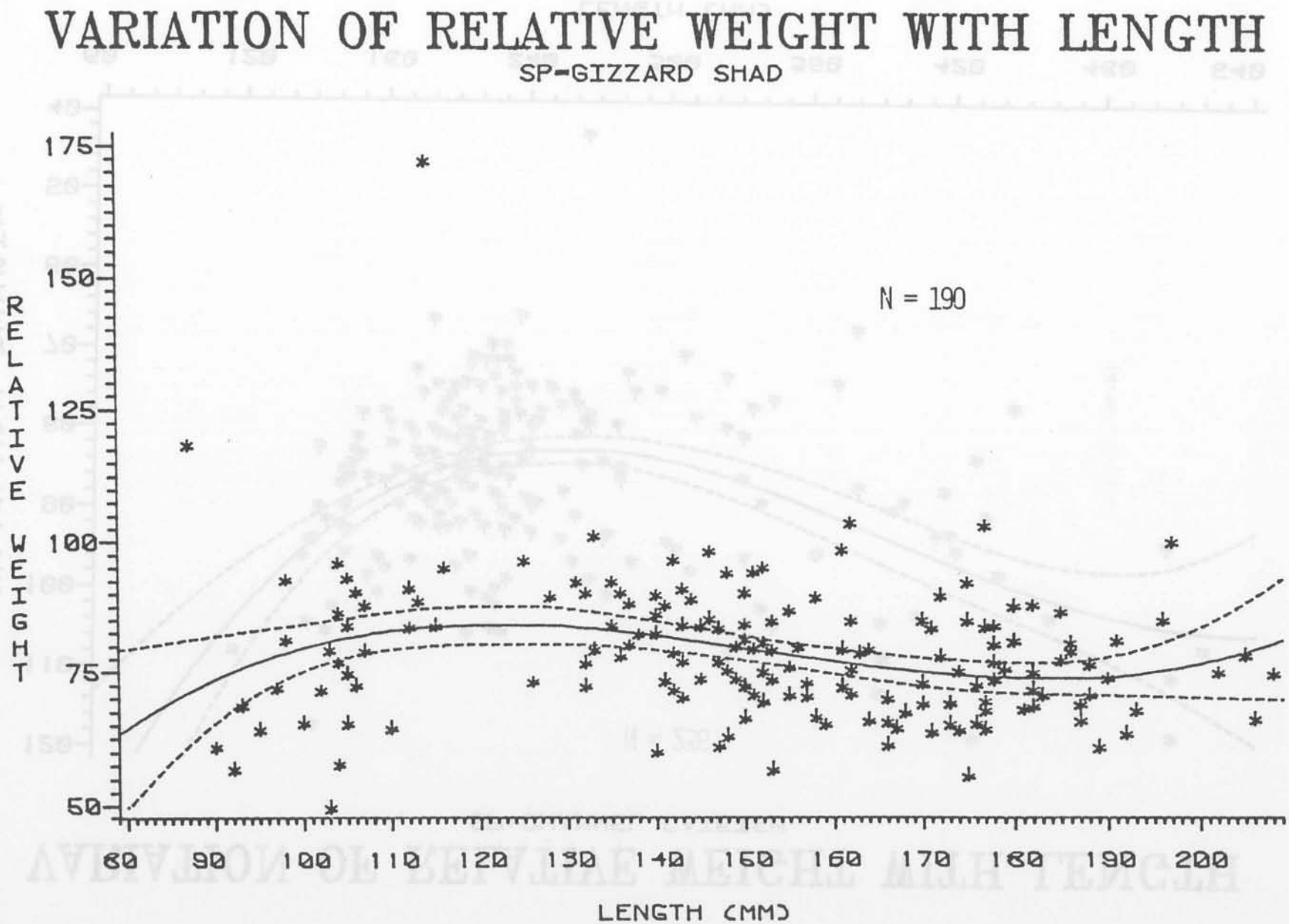


FIGURE 12. VARIATION OF RELATIVE WEIGHT WITH LENGTH FOR GIZZARD SHAD CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985. DASHED LINE REPRESENTS A 95% CONFIDENCE INTERVAL.

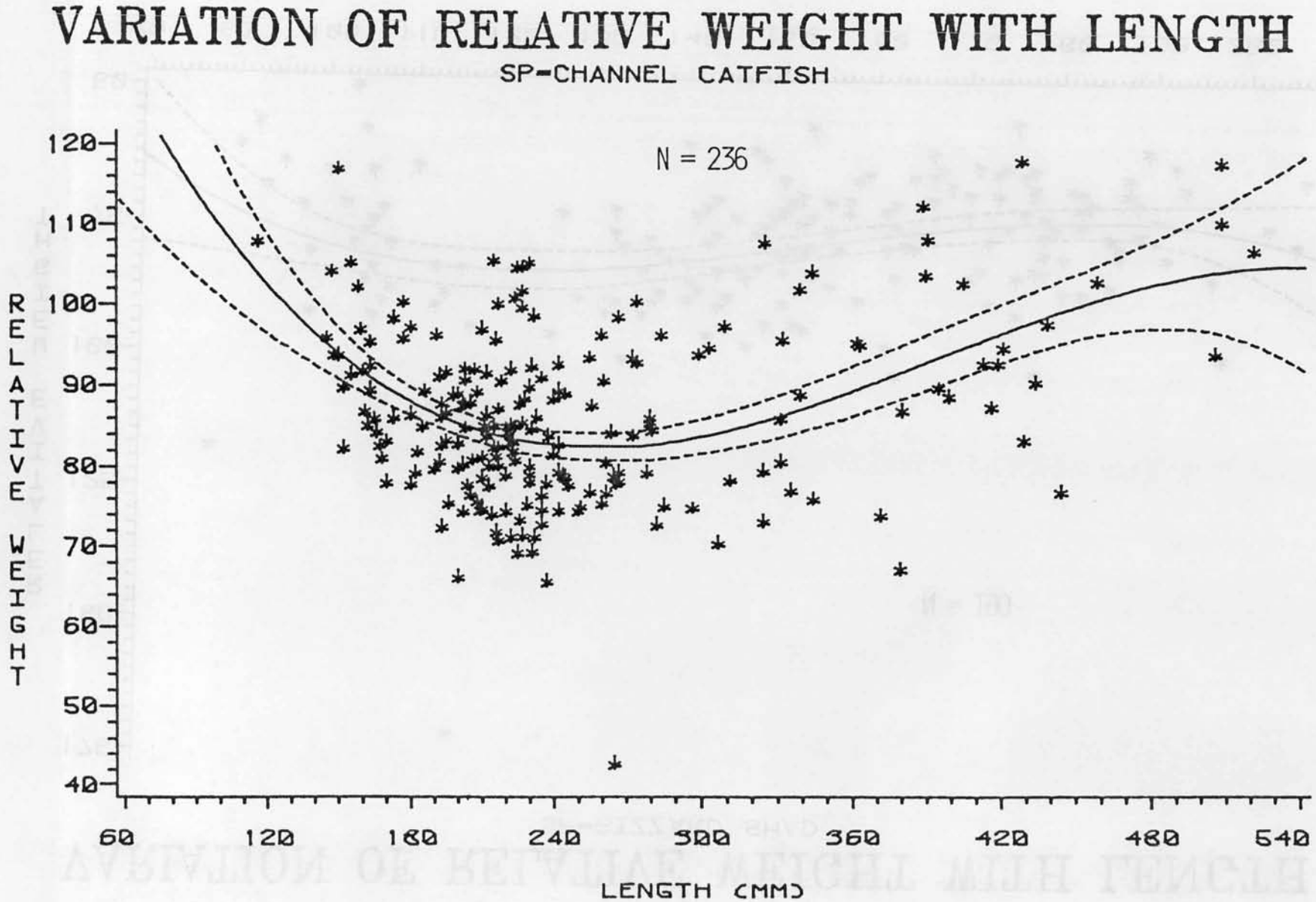


FIGURE 13. VARIATION IN RELATIVE WEIGHT WITH LENGTH FOR CHANNEL CATFISH CAUGHT IN LAKE CARL BLACKWELL IN 1984-1985. DASHED LINE REPRESENTS A 95% CONFIDENCE INTERVAL.

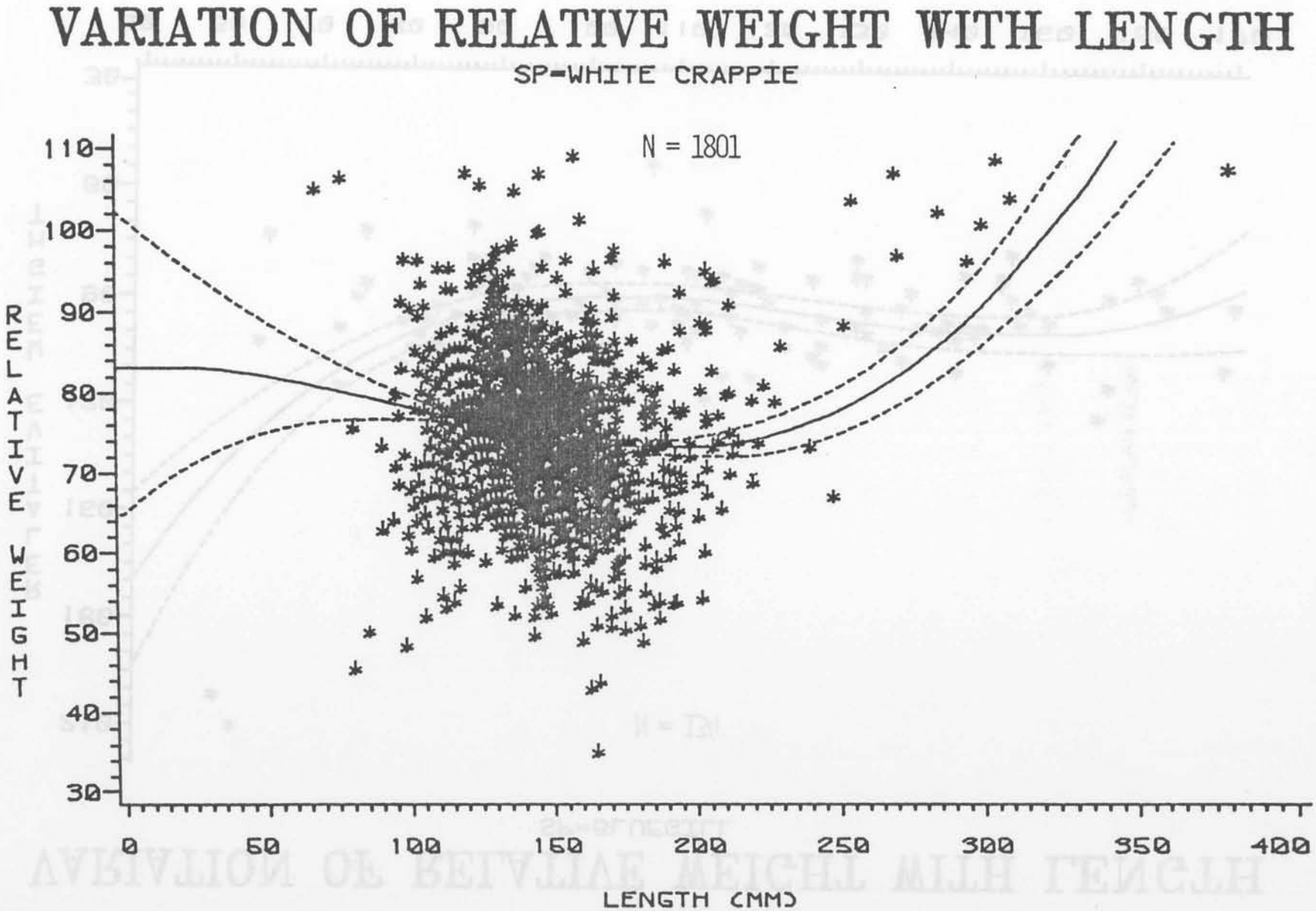


FIGURE 14. VARIATION OF RELATIVE WEIGHT WITH LENGTH FOR WHITE CRAPPIE CAUGHT IN LAKE CARL BLACKWELL IN 1984-1985. DASHED LINE REPRESENTS A 95% CONFIDENCE INTERVAL.

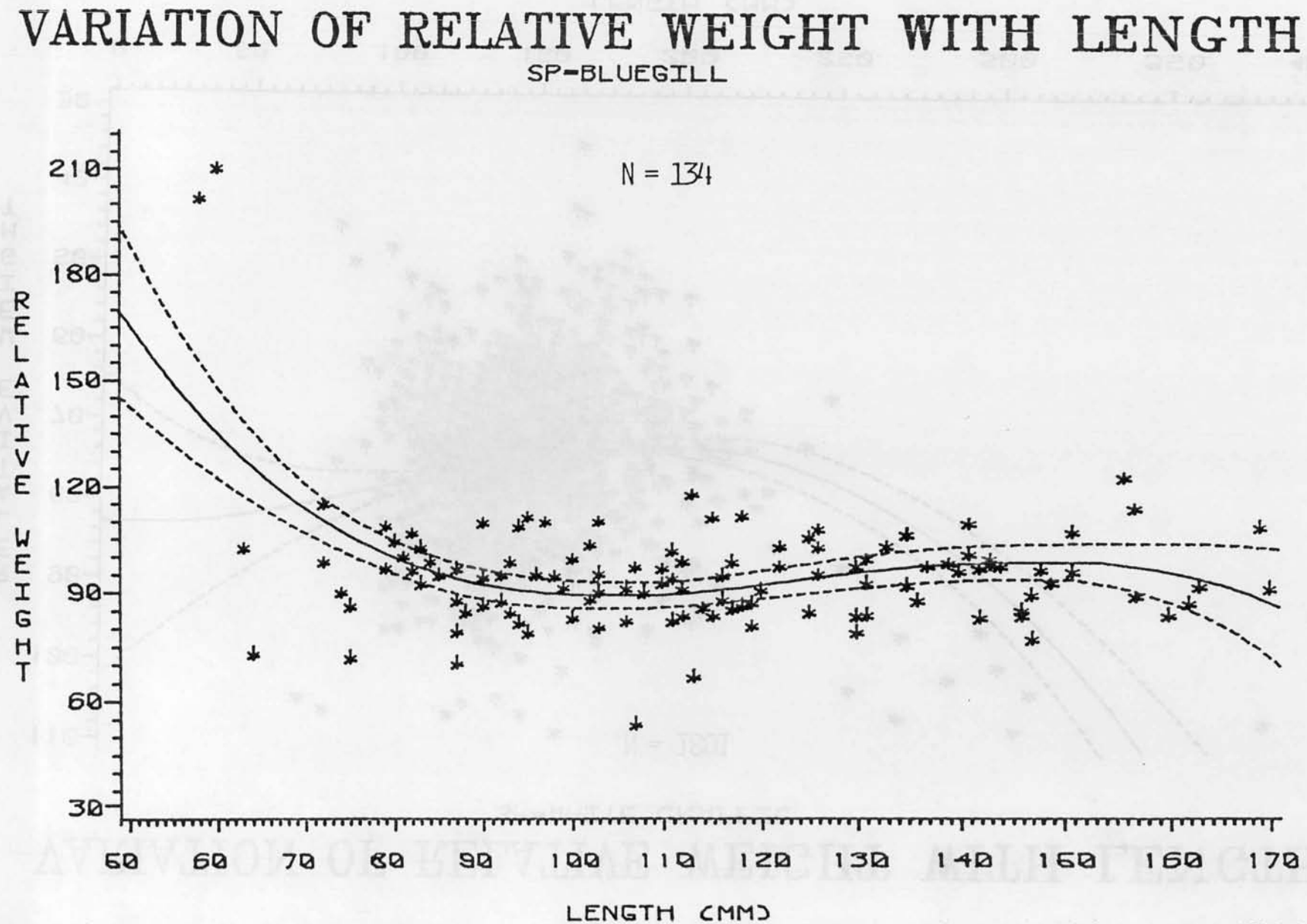


FIGURE 15. VARIATION OF RELATIVE WEIGHT WITH LENGTH FOR BLUEGILL CAUGHT IN LAKE CARL BLACKWELL IN 1984-1985. DASHED LINE REPRESENTS A 95% CONFIDENCE INTERVAL.

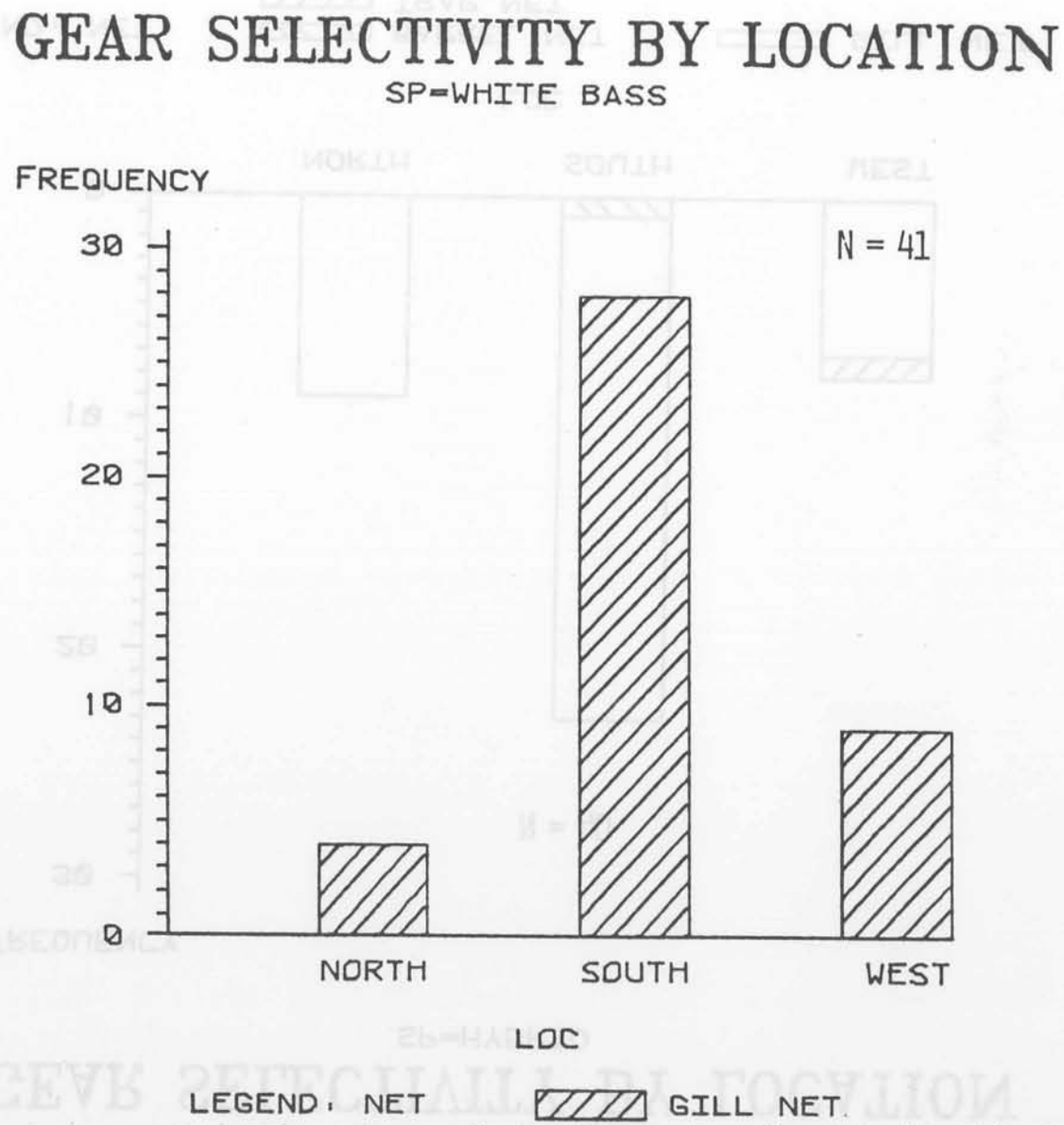


FIGURE 16. GEAR SELECTIVITY BY LOCATION FOR WHITE BASS CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

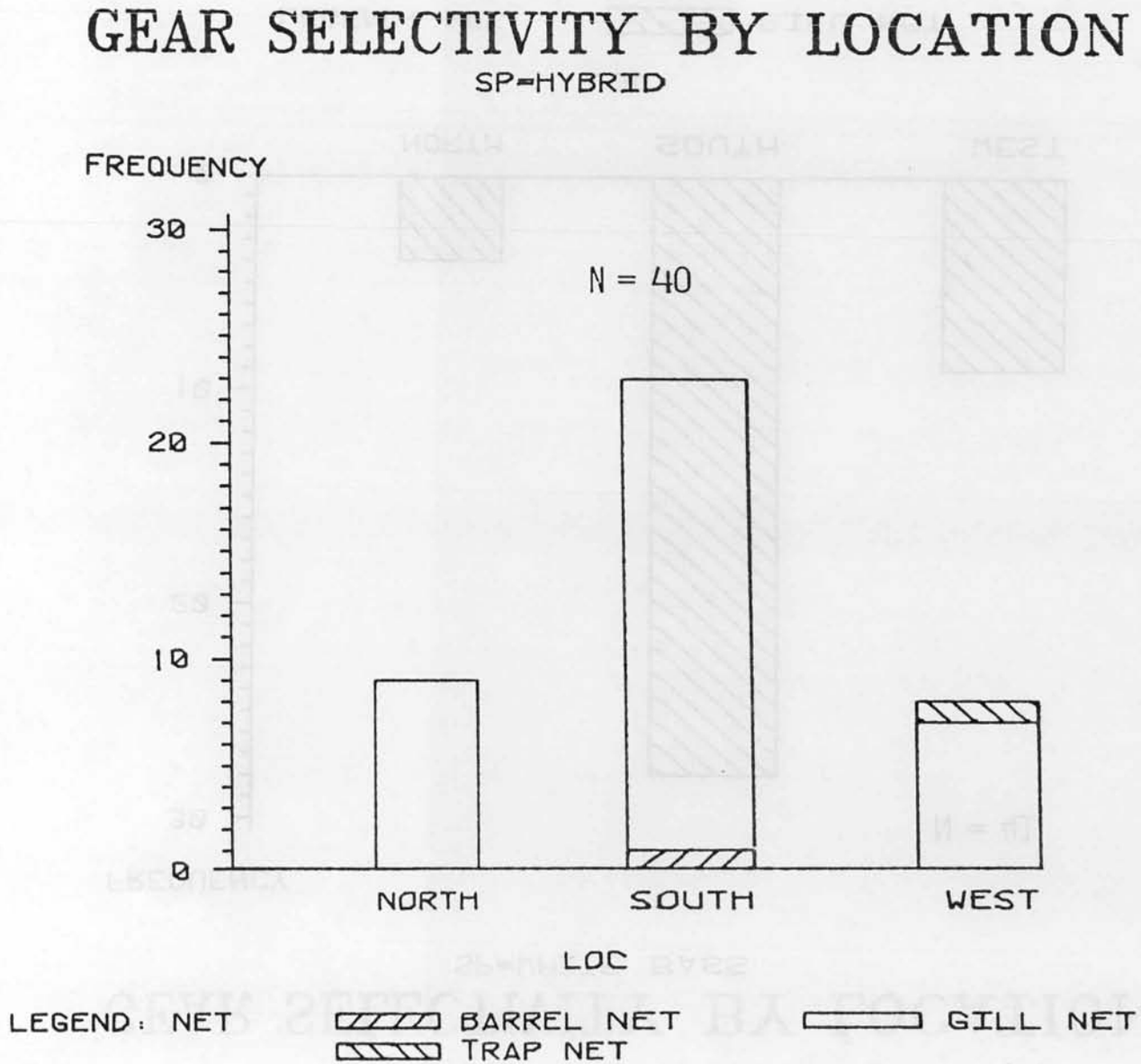


FIGURE 17. GEAR SELECTIVITY BY LOCATION FOR STRIPED BASS X WHITE BASS HYBRID CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

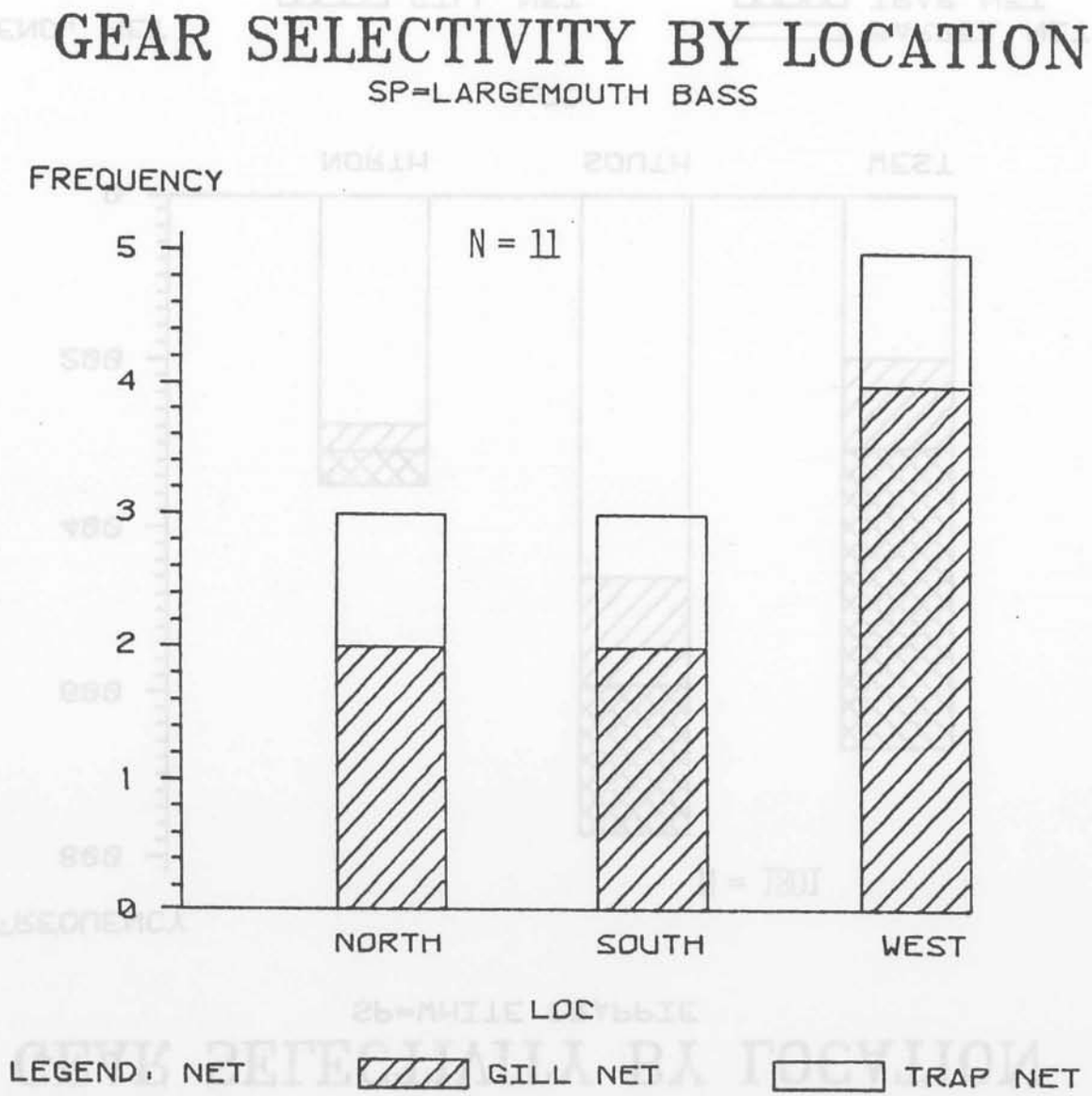


FIGURE 18. GEAR SELECTIVITY BY LOCATION FOR LARGEMOUTH BASS CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

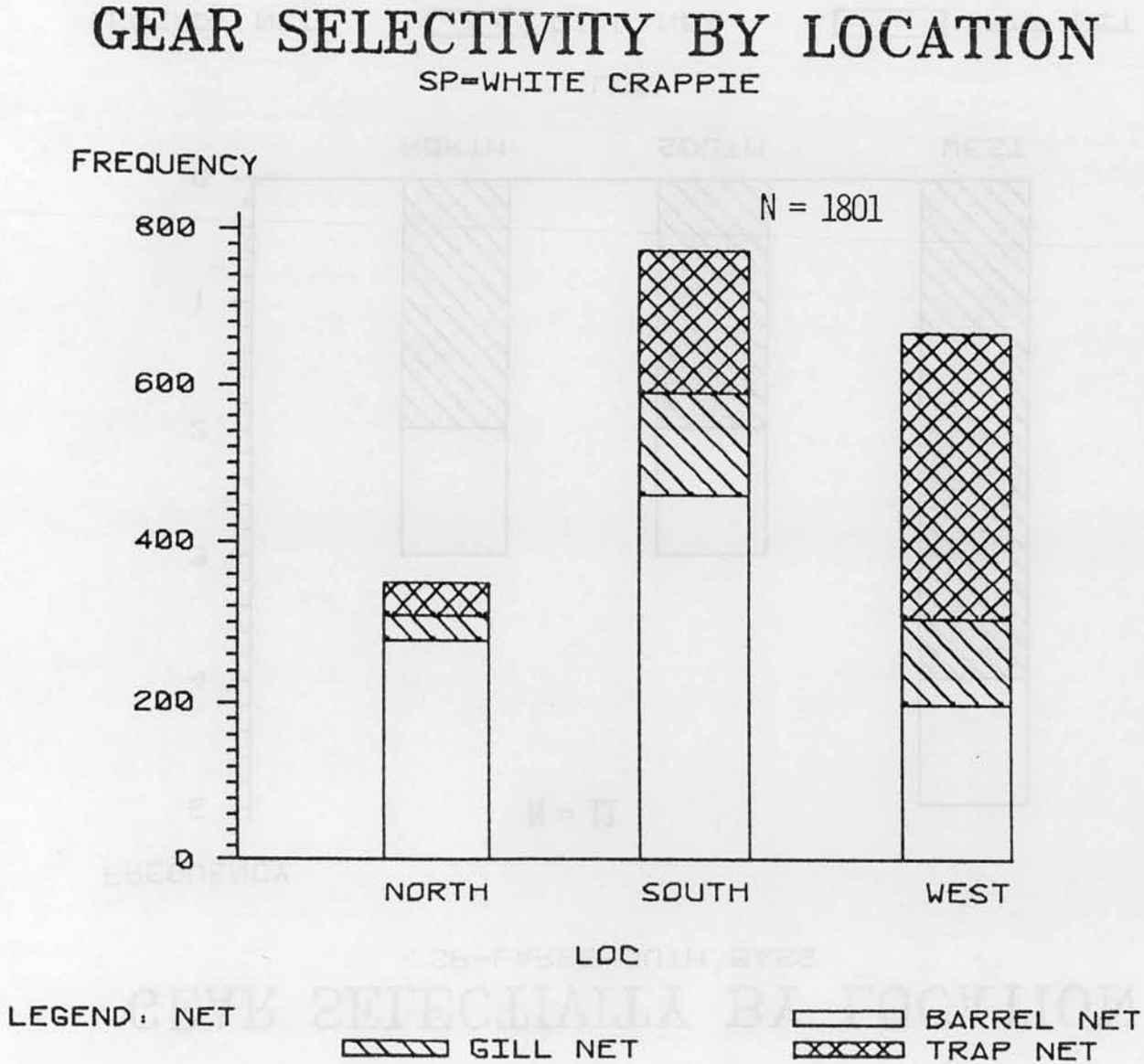


FIGURE 19. GEAR SELECTIVITY BY LOCATION FOR WHITE CRAPPIE CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

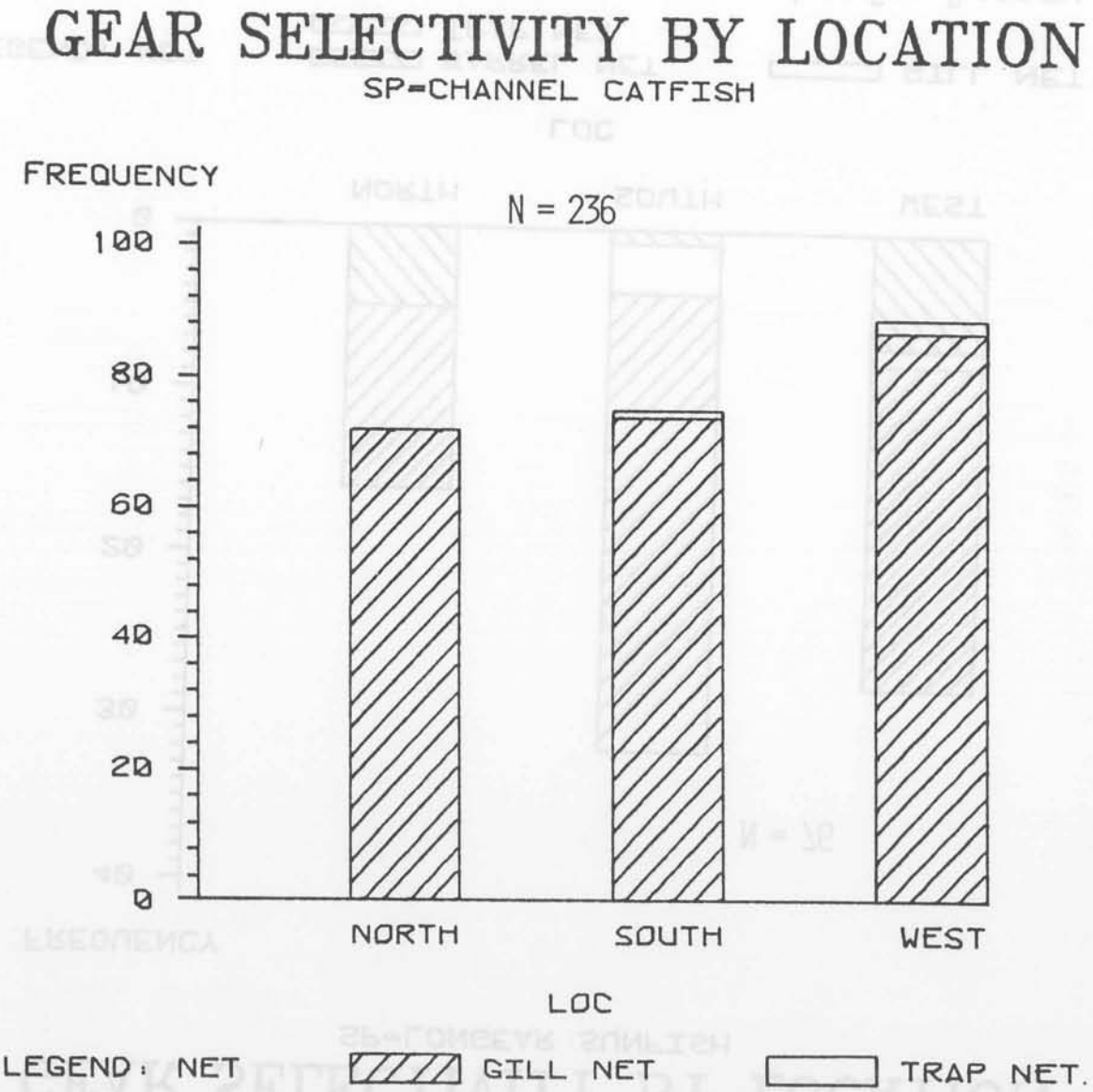


FIGURE 20. GEAR SELECTIVITY BY LOCATION FOR CHANNEL CATFISH CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

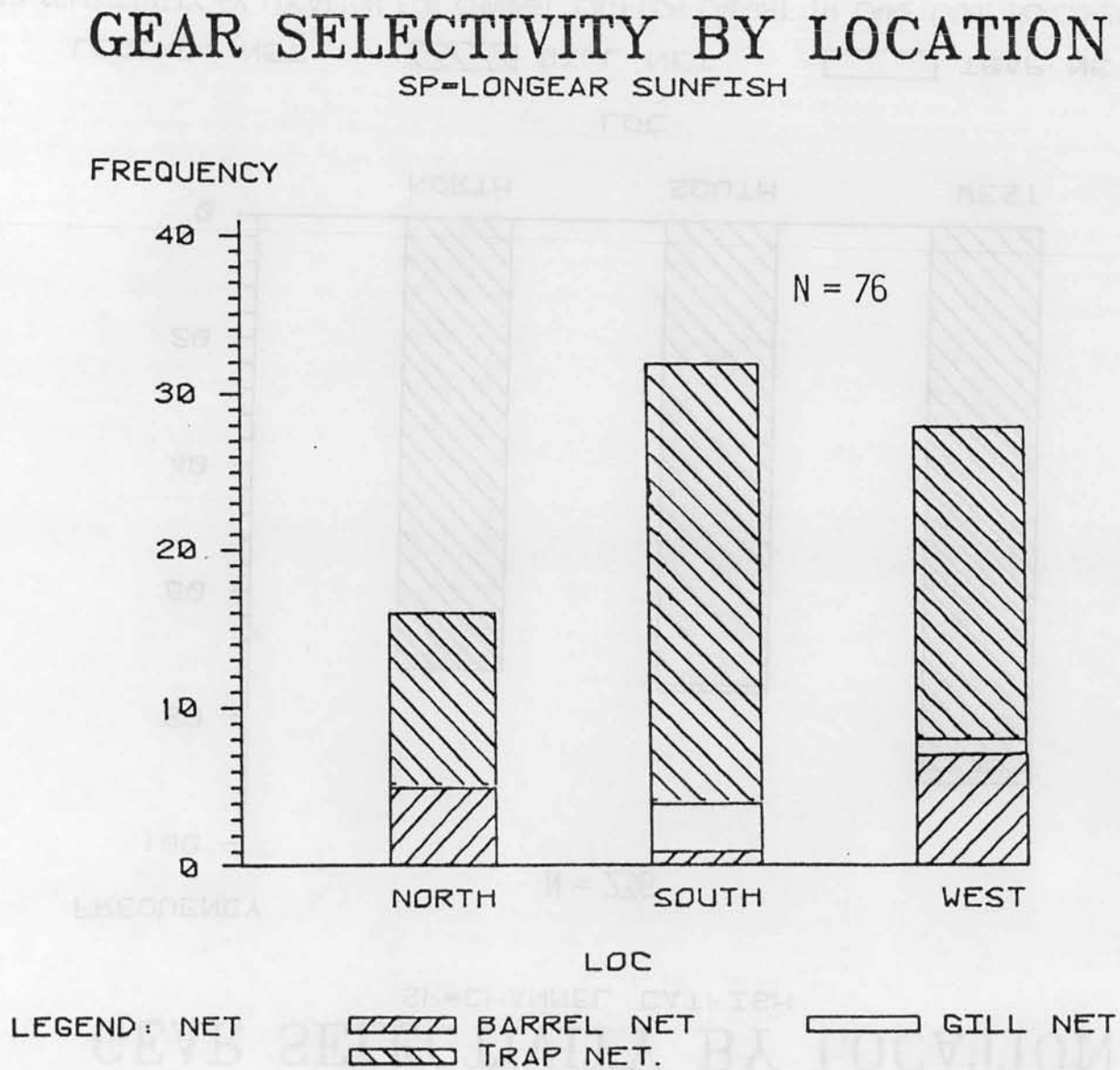


FIGURE 21. GEAR SELECTIVITY BY LOCATION FOR LONGEAR SUNFISH CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

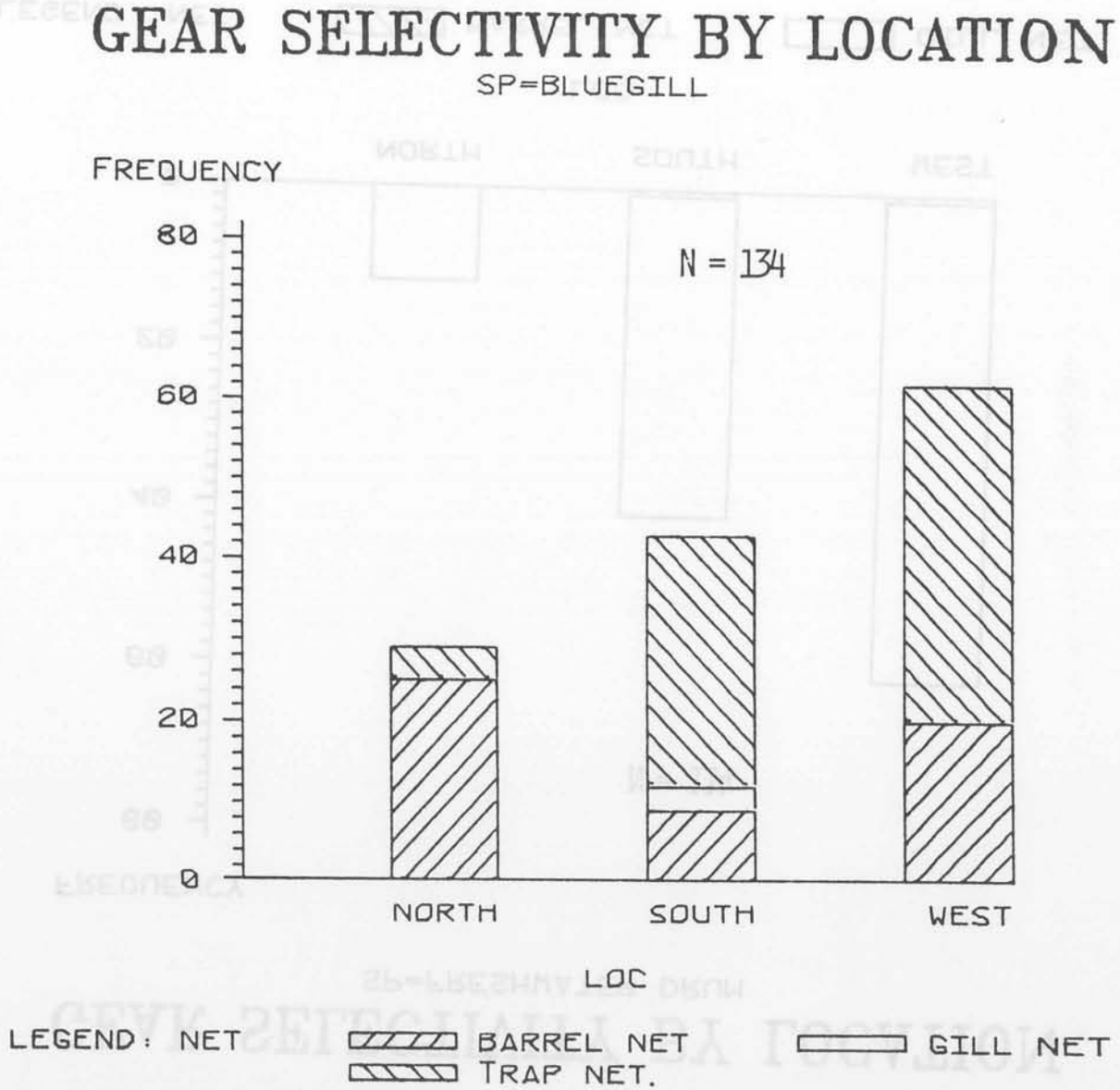


FIGURE 22. GEAR SELECTIVITY BY LOCATION FOR BLUEGILL CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

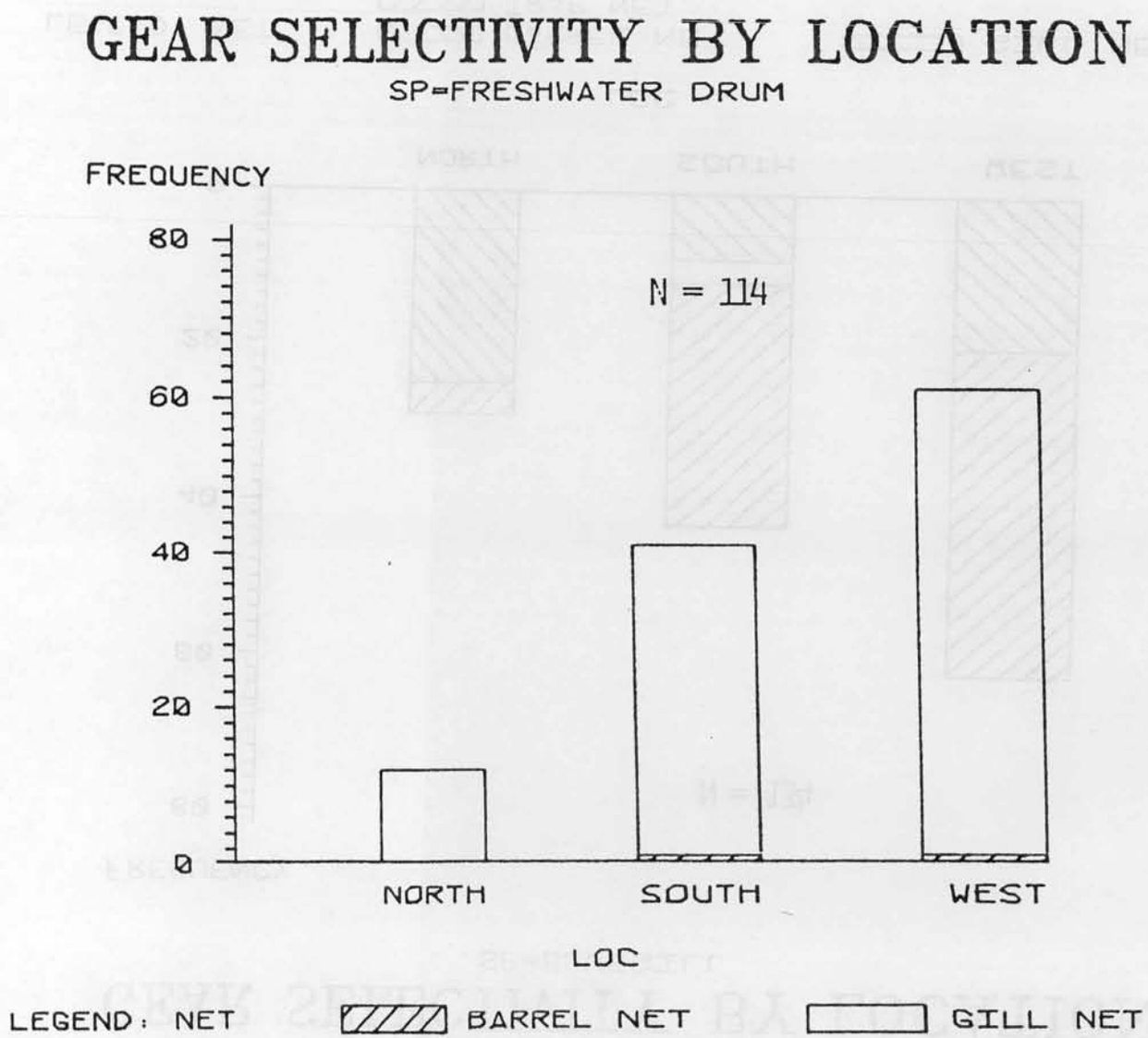


FIGURE 23. GEAR SELECTIVITY BY LOCATION FOR FRESHWATER DRUM CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

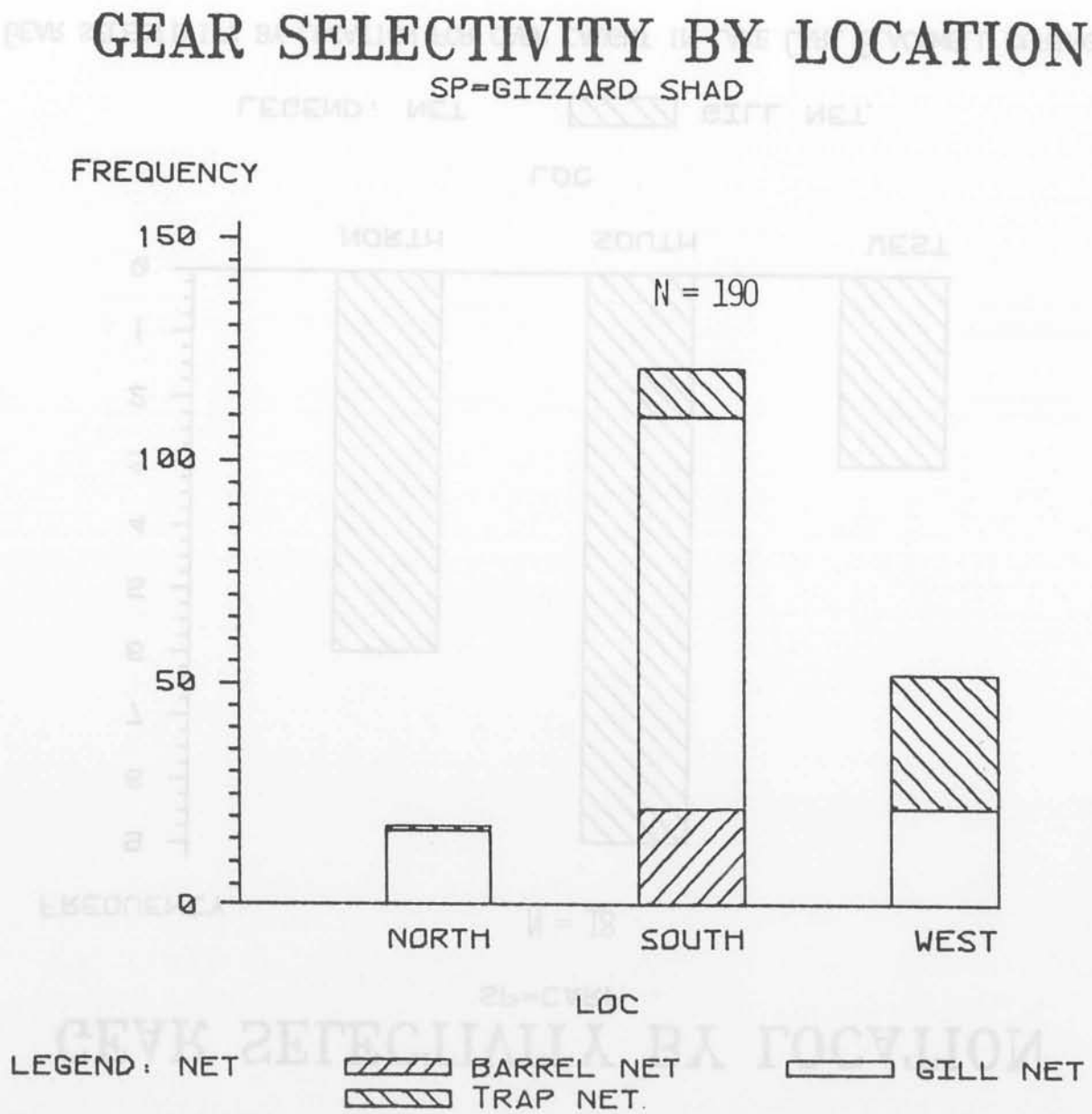


FIGURE 24. GEAR SELECTIVITY BY LOCATION FOR GIZZARD SHAD CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

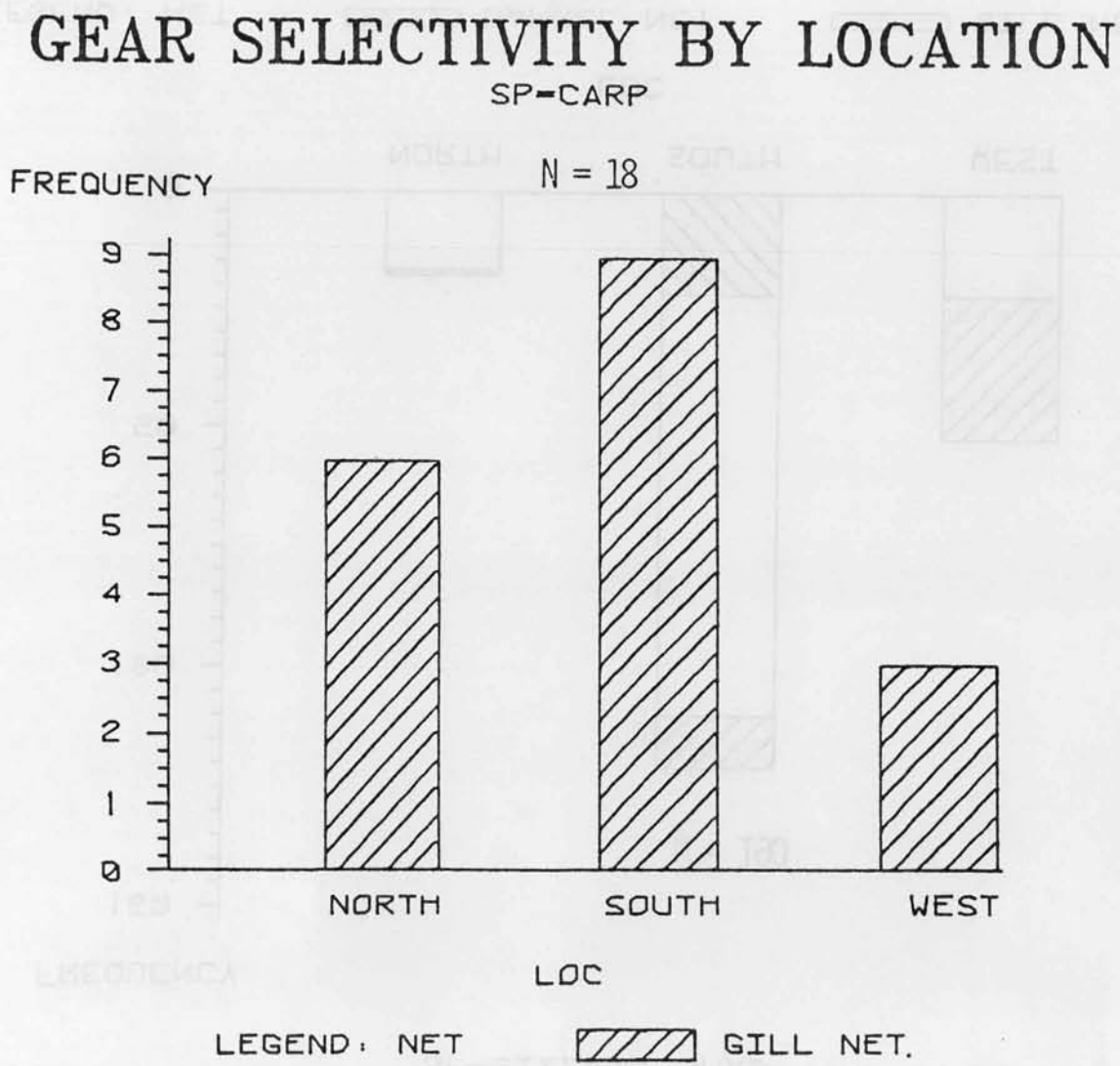
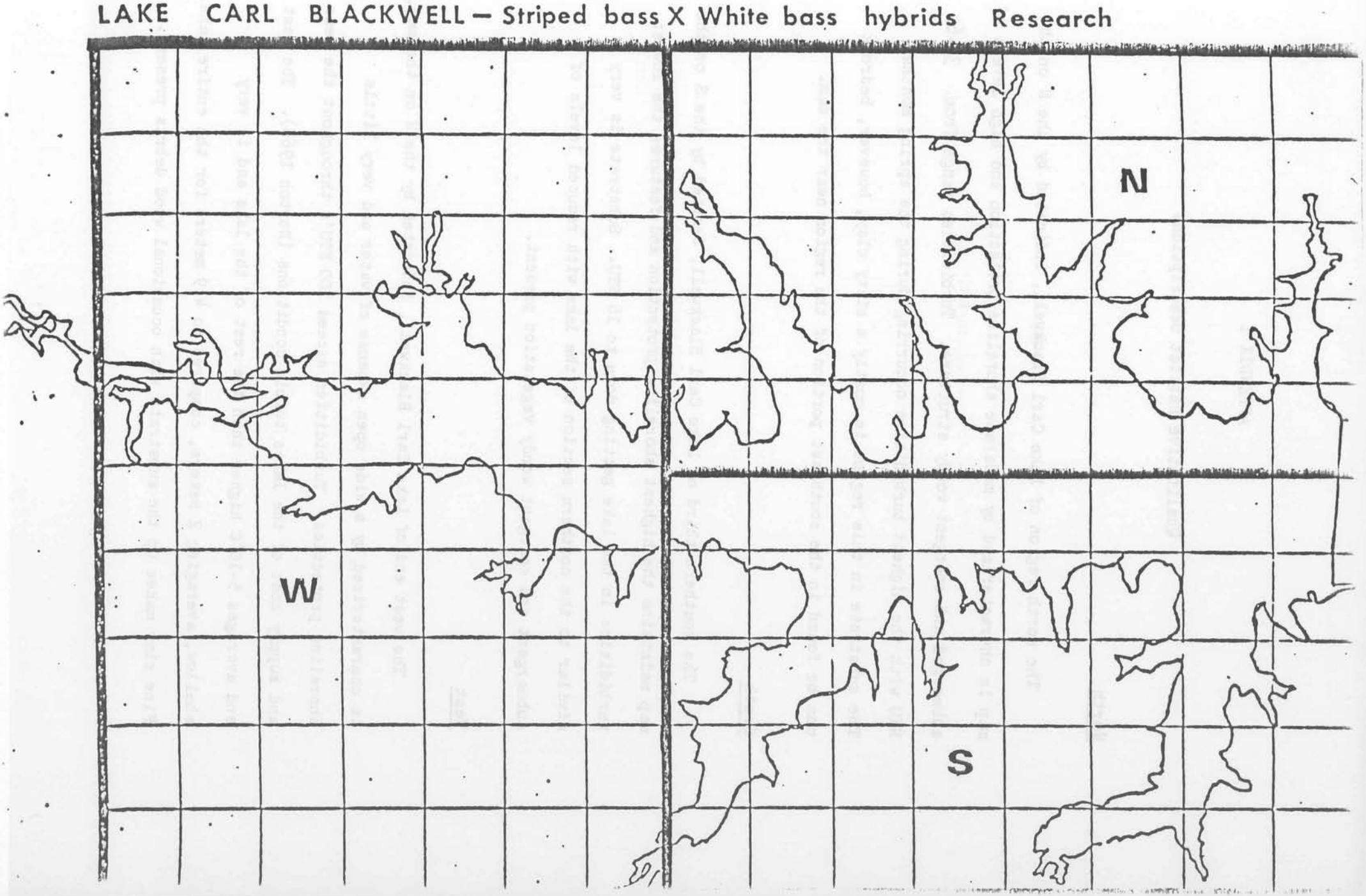


FIGURE 25. GEAR SELECTIVITY BY LOCATION FOR CARP CAUGHT IN LAKE CARL BLACKWELL DURING 1984-1985.

FIGURE 26. MAP OF LAKE CARL BLACKWELL INDICATING HABITAT REGIONS SAMPLED.



APPENDIX I

Qualitative Habitat Descriptions

North

The north region of Lake Carl Blackwell, indicated by the N on the map is characterized by moderate shoreline protection and high levels of submerged and emergent woody structure. Turbidities range from 30-60 NTU with the highest turbidities occurring during the spring months. The substrate in this region is mostly a silty clay, however, bedrock can be found in the southeast portion of the region near the dam.

South

The southern third of Lake Carl Blackwell, denoted by the S on the map maintains the highest shoreline protection and features the lowest turbidities in the lake getting down to 18 NTU. Substrate is very similar to the northern section of the lake with reduced levels of submergent and emergent woody vegetation present.

West

The west end of Lake Carl Blackwell, indicated by the W on the map, is characterized by a wide open expanse of water and very little shoreline protection. Turbidities exceed 100 NTU's throughout the year and supply most of the lakes turbid conditions (Norton 1968). The west end averages 5-10°C higher than the rest of the lake and is very shallow, averaging 2 meters, compared to 4.9 meters for the entire lake. Fine clay makes up the substrate with occasional wood debris present.