

DEEP-WATER DEMERSAL FINFISH RESOURCES

AND

FISHERIES OFF SOUTH CAROLINA

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## Abstract

This report presents results of exploratory demersal fishing surveys during 1982 and 1983 in depths of 180-800 m off South Carolina and Georgia. Systematic tracklines in selected areas were surveyed to determine bottom profile and locate fish concentrations. Test fishing with snapper reels and longlines was conducted on fish marks and various types of bottom.

The area along the 200 m curve between 32°32'N and 32°55'N consisted of predominantly rough bottom, with a maximum width in the 180-280 m range of about 19 km. The most productive sites consisted of high-relief, rocky structure. Flat bottom produced little besides blackbelly rosefish (Helicolenus dactylopterus). Deeper than 300 m, the bottom flattened out except for scattered groups of pinnacles and fishing was nonproductive.

Catch rates for snowy (Epinephelus aiveatus) and yellowedge (E. flavolimbatus) groupers were highest in depths < 210 m. The catch rate for tilefish (Lopholatilus chamaeleonticeps) increased with depth, while that for blueline tilefish (Caulolatilus microps) decreased. The mean total length of snowy groupers was positively correlated with depth, while the size of both tilefish and blueline tilefish was independent of depth. There was no difference in size by gear type for any species. Snapper reels appeared to be more effective for blueline tilefish than was longline gear. Gear selectivity did not appear to be a factor for other species.

Although commercial snapper reel catch-per-unit-of-effort (CPUE) for groupers declined considerably between 1977 and 1982, the average size of the fish remained about the same. The mean total length of blueline tilefish remained constant, while that of tilefish declined slightly. As of early in 1983, none of the species appeared to have been overexploited in the rocky area surveyed, however, longline effort there was increasing rapidly.

A large area 70-100 n.m. offshore of South Carolina and Georgia was surveyed in 1983 to evaluate the fishery potential of wreckfish (Polyprion americanus). Depths ranged from 400-800 m and bottom topography was highly variable. Several sites with heavy concentrations of coral lumps were located and fished with various types of hook-and-line gear. Although wreckfish were sighted in these locations from a research submersible, no fish were caught and gear damage/loss was heavy due to swift currents and frequent hangs. Observations of fish distribution from the submersible suggests that the availability of wreckfish to longline gear is very limited.

## Introduction

Since 1976, commercial fishing effort inshore of the continental shelf break has steadily increased off South Carolina and northern Georgia. Shrimpers have sought additional employment opportunities for their vessels to augment reduced returns from shrimping. Commercial handline boats formerly based in Florida now fish out of many ports in South Carolina and southern North Carolina. Several longliners from the middle Atlantic area have moved their operations to South Carolina and new construction has added well-equipped vessels to the growing regional longline fleet in the last two years.

The area and associated resources inshore of the 200 m curve have been surveyed extensively since 1973 by the South Carolina Marine Resources Monitoring, Assessment, and Prediction (MARMAP) program. Through a port sampling program, the Marine Resources Division has collected catch, effort, species and size composition data from the commercial offshore finfishery since 1976. Although both programs provided substantial data applicable to the resources inshore of 200 m, they furnished little information on the stocks in deeper water. As of early 1980, commercial deep-water effort was limited to a small rocky area due east of Charleston, where commercial handline boats fishing primarily in depths of 160-240 m caught snowy (*Epinephelus niveatus*) and yellowedge (*E. flavolimbatus*) groupers, blue-line tilefish (*Caulolatilus microps*), and a few tilefish (*Lopholatilus chamaeleonticeps*).

Results from previous exploratory fishing expeditions indicated that most of the bottom along the 200 m curve off Georgia south of Sapelo Island and from Cape Romain, South Carolina to Cape Lookout, North Carolina is sand and nonproductive for marketable demersal fish<sup>1</sup> (Struhsaker 1969, Wilk and Silverman 1976). In 1980, the South Carolina Marine Resources Division, with funding from the Gulf and South Atlantic Fisheries Development Foundation, initiated an investigation of the extent and development potential of deep-water demersal finfish resources in four areas (Fig. 1) off South Carolina and northern Georgia. Initial effort was targeted on tilefish along the continental shelf edge (areas A and B). This stock and its fishery were described in Low et al. (1983). During 1982 and 1983, area C was surveyed and the fishing potential was evaluated for tilefish, snowy grouper, yellowedge grouper, and blue-line tilefish. In 1983, area D was explored for wreckfish, *Polyprion americanus*. This report describes the 1982-1983 surveys and exploratory fishing in areas C and D, reviews trends in the commercial fishery for deep-water species off South Carolina and northern Georgia, and discusses management aspects in relation to this information.

## Methods

Area C was surveyed during July-September 1982 and in April 1983. Test fishing at several sites was also conducted in September 1983. In July 1982, an exploratory survey was conducted from the DELAWARE II as part of the Southeastern Area Monitoring and Assessment Program (SEAMAP). Bottom topography was recorded and substrate composition was periodically determined from bucket samples. Daytime test fishing with bottom longlines was conducted on different types of substrate. Details of methods and gear are contained in the DELAWARE II 82-04 cruise report<sup>2</sup>.

State surveys were concentrated in sections of the DELAWARE II course that indicated suitable habitat and in locations suggested by commercial fishermen. Test fishing was conducted over suitable bottom structure and/or fish concentrations. Stations consisted of drifts using three snapper reels or longline (setline) sets of 0.5 to 1.0 hour duration. The setline consisted of a 27-m groundline, weighted at each end, with 20 circle hooks (#3, 4, and 7) spaced 1.2 m apart. Snapper reel effort was recorded in boat-hours and setline effort was recorded in sets. For each drift or set, Loran C positions and depths were noted and total lengths, round weights, gonad samples, and aging material were obtained from each fish of the target species (tilefish, blue-line tilefish, snowy and yellowedge groupers). Tracklines and stations are shown in Appendix 1.

Area D was surveyed in May-August 1983. The initial survey was part of the SEAMAP exercise. Bottom topography was continuously recorded along a systematic trackline (Fig. 2) and bottom samples were periodically obtained. During the day, several longline sets were made with 300 m of groundline and about 50 hooks per set. Soak time was about an hour and the gear was set on rough bottom, near coral formations, or over suspected fish marks. A limited portion of area D was surveyed from the state vessel (LADY LISA), although most of the state effort was devoted to test fishing on previously-determined sites. The setlines described previously and longer sections of cable were deployed.

## Results

Station data are contained in the DELAWARE II cruise (82-04) report and Appendix 1. In depths > 280 m (140 fathoms), DELAWARE II catches were sparse and consisted mostly of blackbelly rosefish. Catch rates in shallower depths ranged from three to five fish of target species per 100 hooks. Catch rates during SCHMRD surveys are summarized in

<sup>1</sup>F. Holland, North Carolina Department of Natural Resources, Marine Fisheries Division, pers. comm.

<sup>2</sup>U.S. Department of Commerce. 1982. DELAWARE II Cruise 82-04. NOAA, NMFS, Pascagoula, MS. 16 p.

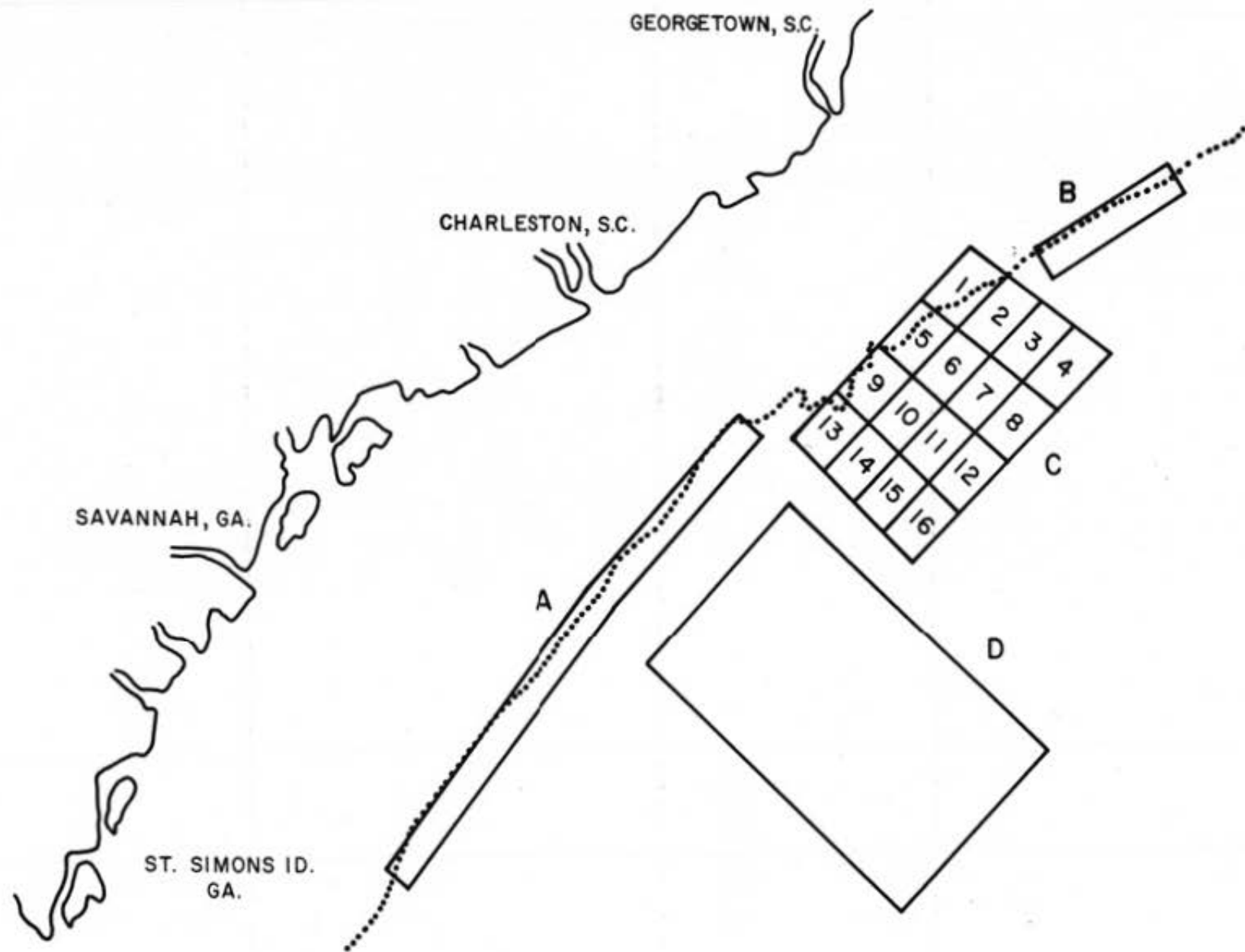


FIG. 1. AREAS SURVEYED OFF SOUTH CAROLINA AND GEORGIA. THE DOTTED LINE DENOTES THE 200-M CURVE.

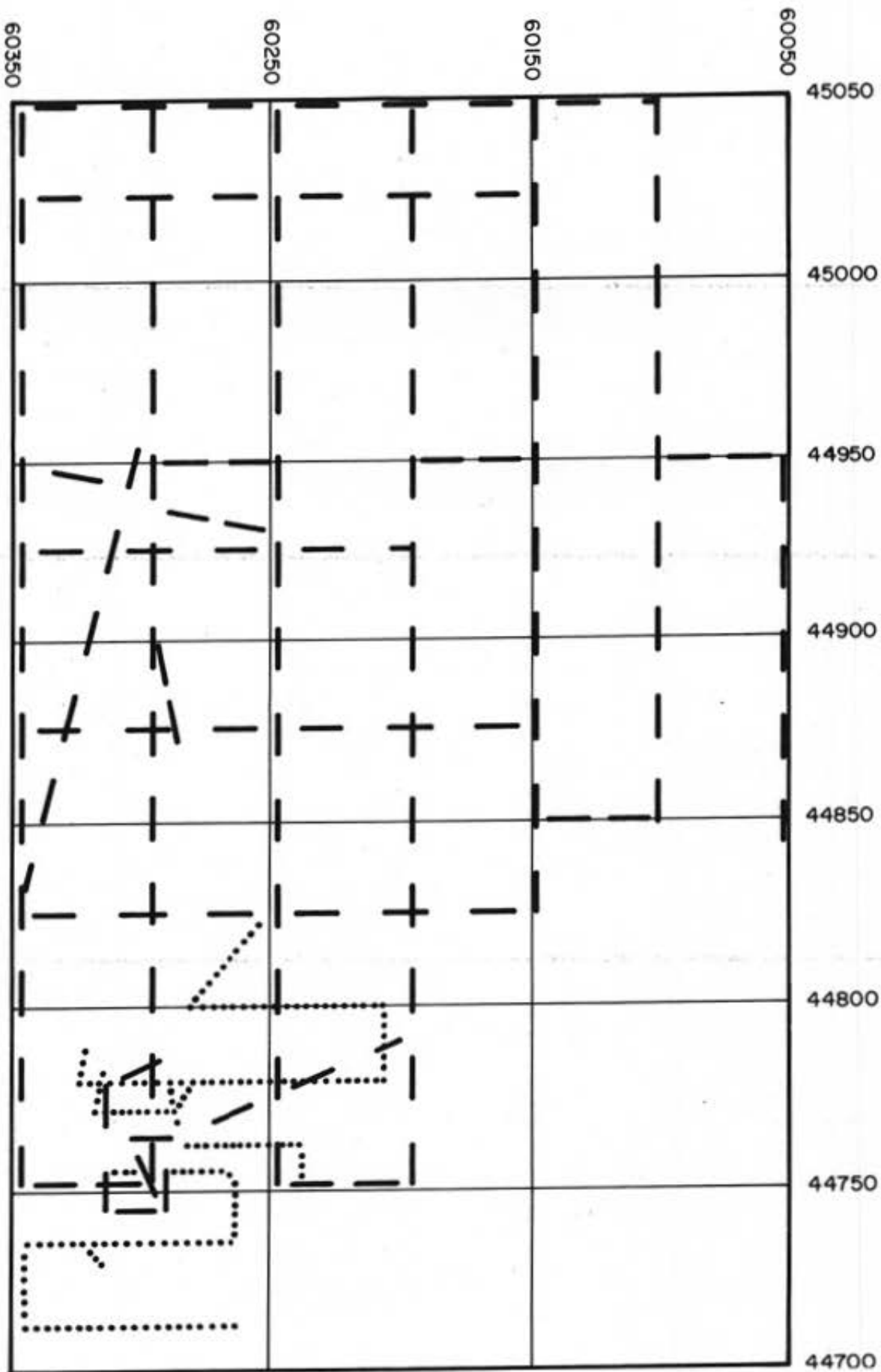


FIG. 2. SURVEY TRACKLINES IN AREA D OF THE DELAWARE II (NMFS) AND THE LADY LISA (SCWMRD). LORAN C LINES OF POSITION (7980 CHAIN) ARE SHOWN IN THE MARGINS. DASHED LINE, DELAWARE II; DOTTED LINE, LADY LISA.



Tables 1 and 2. Catch rates by area grid are illustrated in Figs. 3 (groupers), 4 (tilefish), and 5 (blue line tilefish). Results from September 1983 are not included; due to the time difference they are not comparable, but the station data are included in the Appendix.

#### Bottom Composition and Species Distribution

The inshore part of area C (blocks 1, 5, 9, and 13) is generally < 200 m deep and contains a substantial amount of rough, hard bottom. This section has been fished regularly by commercial fishermen since 1976, with groupers and blue line tilefish comprising the bulk of their catch. Longline fishermen were particularly active in blocks 5 and 9 during 1982. Because this part of area C was fairly well known to local fishermen and routinely fished by them, we expended relatively little effort there.

From the 59690 line northeast (blocks 2, 3, and 4), the bottom is mostly smooth with long, gradual slopes, particularly in depths > 280 m. There are scattered, small patches of productive rough ground in 180-260 m in blocks 2 and 3. The southwestern half of block 6 is very rough and productive for the target species, especially groupers. Eastward of the 45050 line, the bottom grades into gently rolling 4-10 m relief, with a few groups of 20-30 m high peaks in deeper water (blocks 7 and 8). Catches around these peaks were limited to blackbelly rosefish.

Block 10 westward of the 45060 line is rocky and productive for all target species. Eastward and deeper than 260 m, the terrain smooths out and the bottom in blocks 11 and 12 is coarse sand or marl. The northeastern half of block 14 has some cliffs in 220-280 m that are productive for tilefish. In greater depths, the topography flattens out and target species were uncommon. Block 15 is > 300 m deep and the bottom is primarily smooth and unproductive. Nearly all of block 16 is > 400 m deep and also shows little potential.

Blackbelly rosefish were ubiquitous in area C and the only fish commonly caught over flat bottom, particularly in deeper water. Observations from a research submersible showed that groupers were on the tops of ridges and peaks amid large rocks, while tilefish inhabited the sides, lying in holes among the rubble<sup>3</sup>. Distribution of snapper reel catches generally conformed to this pattern, although the setlines (particularly in the 210-239 m stratum) frequently caught snowy groupers, tilefish, and blue line tilefish on adjacent hooks.

Concentrations of barrelfish (*Hyperoglyphe perciformis*) have been suspected along the continental shelf south of Cape Hatteras, particularly around canyons with strong currents (Haedrich 1965). Although commercial fishermen occasionally catch a few barrelfish, only three were caught during the surveys.

Perhaps the absence of canyons accounted for their scarcity, or they may have been concentrated off-bottom away from the gear.

The bottom topography in area D is highly variable, but the most prominent features are 20-60 m high peaks, deep gullies, and broad expanses of smooth, gently sloping bottom. Much of the bottom appears to be fairly hard, perhaps due to a high content of coral rubble as identified in bottom samples. Since the axis of mean maximum strength of the Gulf Stream passes through the middle of the area, the bottom is continually scoured by strong currents. A distinctive feature of area D, particularly in the central portion, is the abundance of coral-covered lumps (presumably rock piles), which show on a whiteline recorder as distinctive dark, symmetrical, rounded masses 5-20 m in height. These tend to occur in clusters. These structures were considered to be the most likely locations for wreckfish, so most of the fishing effort was concentrated on them.

Longline sets from the DELAWARE II produced one small shark, with nearly all of the baits being recovered intact. The gear frequently drifted several miles and often hung up. Small pieces of coral were occasionally recovered when the line was set on structure. No fish were caught from the LADY LISA. Gear loss with the setlines was substantial due to hangs and strong currents. The longer cable gear proved impractical due to hangs and strong surface currents.

In September 1983, the research submersible from the Harbor Branch Foundation made two dives at suggested sites. Several wreckfish were seen in the downcurrent eddies behind the coral lumps. They were positioned, one to each structure, very close to the side of the lump and one to two m off the bottom<sup>4</sup>. These observations suggested a solitary distribution in areas characterized by coral lumps and strong bottom currents.

#### Length Composition

Results from 1982 and 1983 were sufficiently similar that data for both years were combined for analysis.

Total length composition of snowy groupers caught with both types of gear during 1982-1983 is shown in Fig. 6. About 92% of the total catch (by number of fish) came from the depth strata indicated in the figure. Precision levels about the means for the sample sizes shown range from + 4-7% at the 95% confidence level. There is a significant difference in mean total length for the different strata ( $F = 17.4$ ), with a significant positive correlation ( $r = 0.55$ , 172 df) between total length and depth. The slightly larger mean total length of longline-caught fish (79 cm) vs. reel-caught fish (74 cm) probably reflects the fact that a smaller percentage of the longline catch (20% by number vs. 31% of the

<sup>3</sup>C. Wenner, Marine Resources Research Institute, Charleston, S.C., pers. comm.

<sup>4</sup>W. Nelson, National Marine Fisheries Service, Pascagoula Lab., Pascagoula, MS., pers. comm.

TABLE 1. Catch rates in area C during state surveys in 1982 and 1983.

Year	Species	All Depths		N/Boat-hr	Kg/Boat-hr
		N	Kg		
Snapper Reel					
1982	Grouper	112	745.1	2.1	14.1
	Tilefish	126	739.7	2.4	14.1
	Blueline tile	100	270.3	1.9	5.1
1983	Grouper	43	262.9	2.2	13.4
	Tilefish	43	286.7	2.2	14.6
	Blueline tile	88	215.0	4.5	11.0
Longlines					
1982	Grouper	40	329.9	N/Set <sup>A</sup> 1.1	Kg/Set <sup>A</sup> 8.9
	Tilefish	41	252.4	1.1	6.8
	Blueline tile	38	110.9	1.0	3.0
1983	Grouper	21	146.8	0.7	4.9
	Tilefish	32	208.1	1.1	6.9
	Blueline tile	20	54.9	0.7	1.8
CPUE <sup>B</sup> by Depth Stratum					
Year	Species	Gear	< 210 m	210-239 m	≥ 240 m
1982	Grouper	Reel	3.2	1.4	1.6
		Longline	1.6	0.5	1.2
	Tilefish	Reel	0.5	2.1	4.3
		Longline	0.6	1.1	1.7
	Blueline tile	Reel	3.3	1.9	0.1
		Longline	1.6	1.3	0
1983	Grouper	Reel	2.4	2.2	1.3
		Longline	0.4	0.8	-
	Tilefish	Reel	0.9	2.0	7.3
		Longline	1.1	1.0	-
	Blueline tile	Reel	5.5	4.7	0.4
		Longline	0.8	0.6	-

<sup>A</sup>Lost sets not included<sup>B</sup>Fish per boat-hr (reel) or set (longline)

TABLE 2. Total catch rates in area C during state surveys for 1982 and 1983 combined.

Snapper Reel				
Depth(m)	Boat-hours	Grouper	Fish(kg)/boat-hour Tilefish	Blueline tile
< 210	26.5	3.0(20.2)	0.6(3.7)	4.0(10.6)
210-239	26.0	1.7(11.5)	2.1(12.9)	2.9(7.7)
≥ 240	18.6	1.6(10.8)	4.6(28.2)	0.1(0.3)
All	71.1	2.2(14.8)	2.4(14.7)	2.6(6.9)
Longline				
Depth(m)	Sets	Grouper	Fish(kg)/set Tilefish	Blueline tile
< 210	19	1.1(7.4)	0.8(4.9)	1.3(3.4)
210-239	37	0.7(4.7)	1.1(6.8)	0.9(2.4)
≥ 240	10	1.2(8.1)	1.7(10.4)	0 (0)
All	66	0.9(6.1)	1.1(6.8)	0.9(2.4)

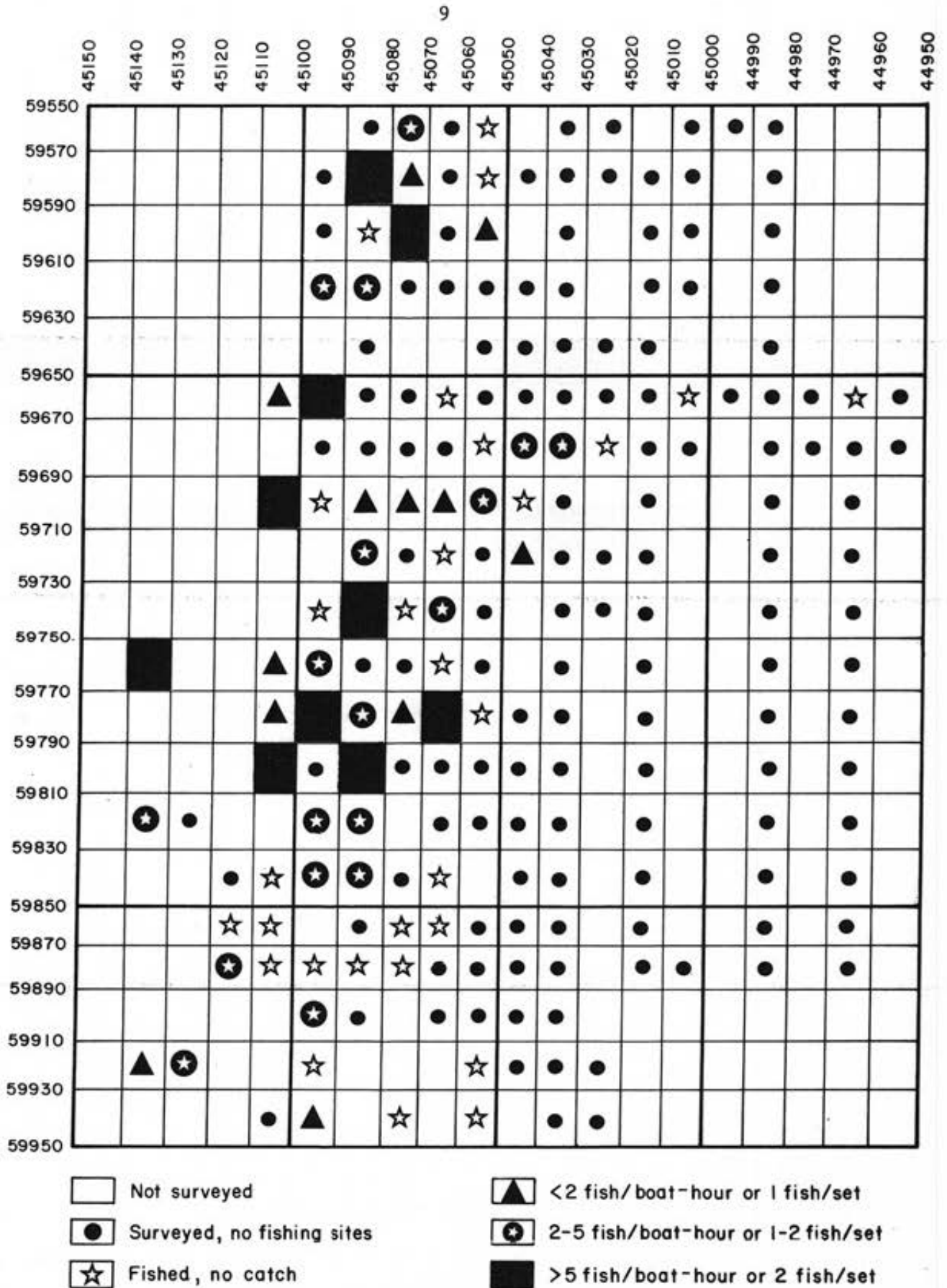


FIG. 3. CATCH RATES OF GROUPERS (*EPINEPHELUS NIVEATUS* AND *E. FLAVOLIMBATUS*) IN AREA C. LORAN C LINES OF POSITION ARE SHOWN IN THE MARGINS.

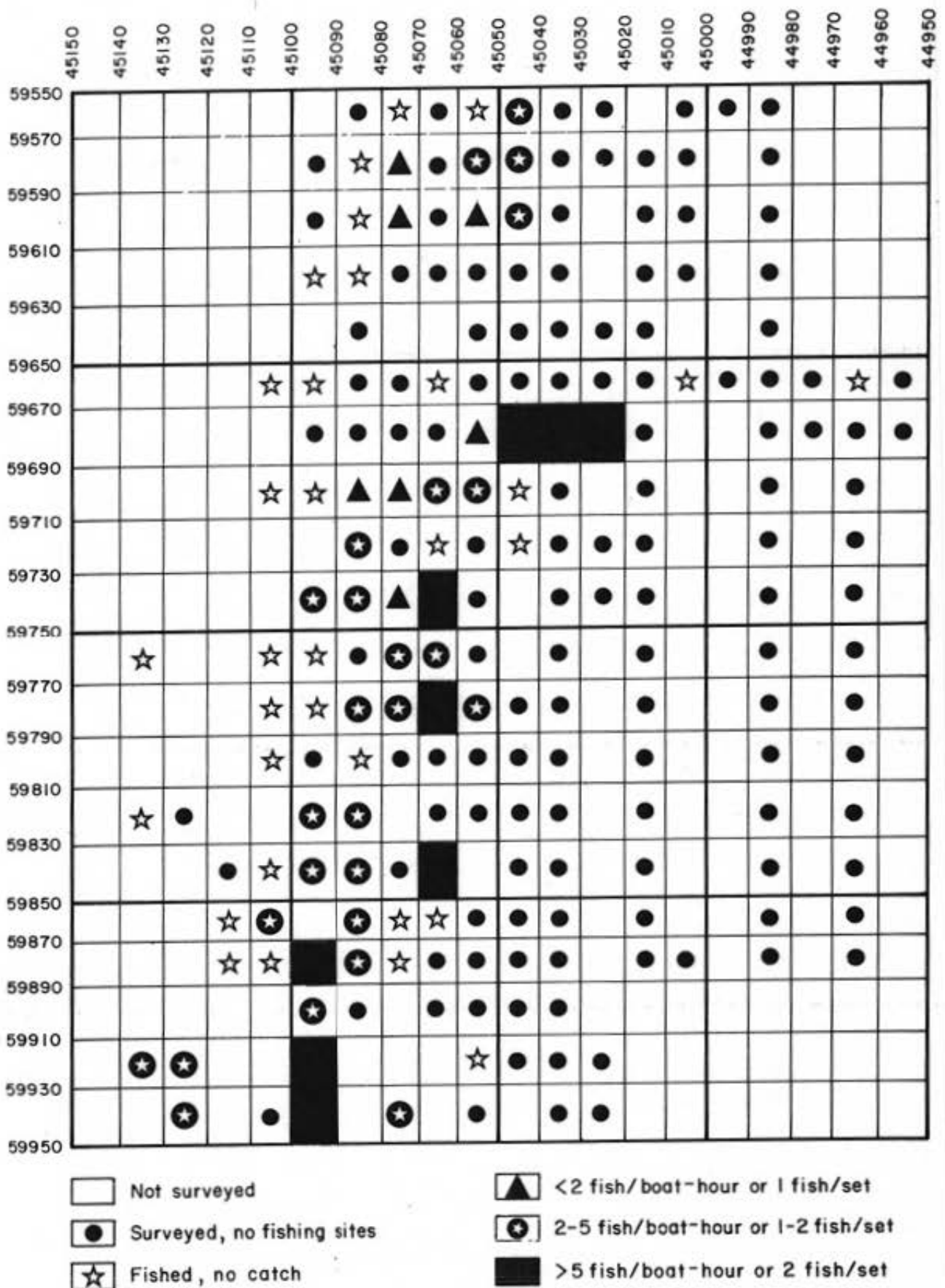


FIG. 4. CATCH RATES OF TILEFISH (*LOPHOLATILUS CHAMAELEONTICEPS*) IN AREA C. LORAN C LINES OF POSITION ARE SHOWN IN THE MARGINS.

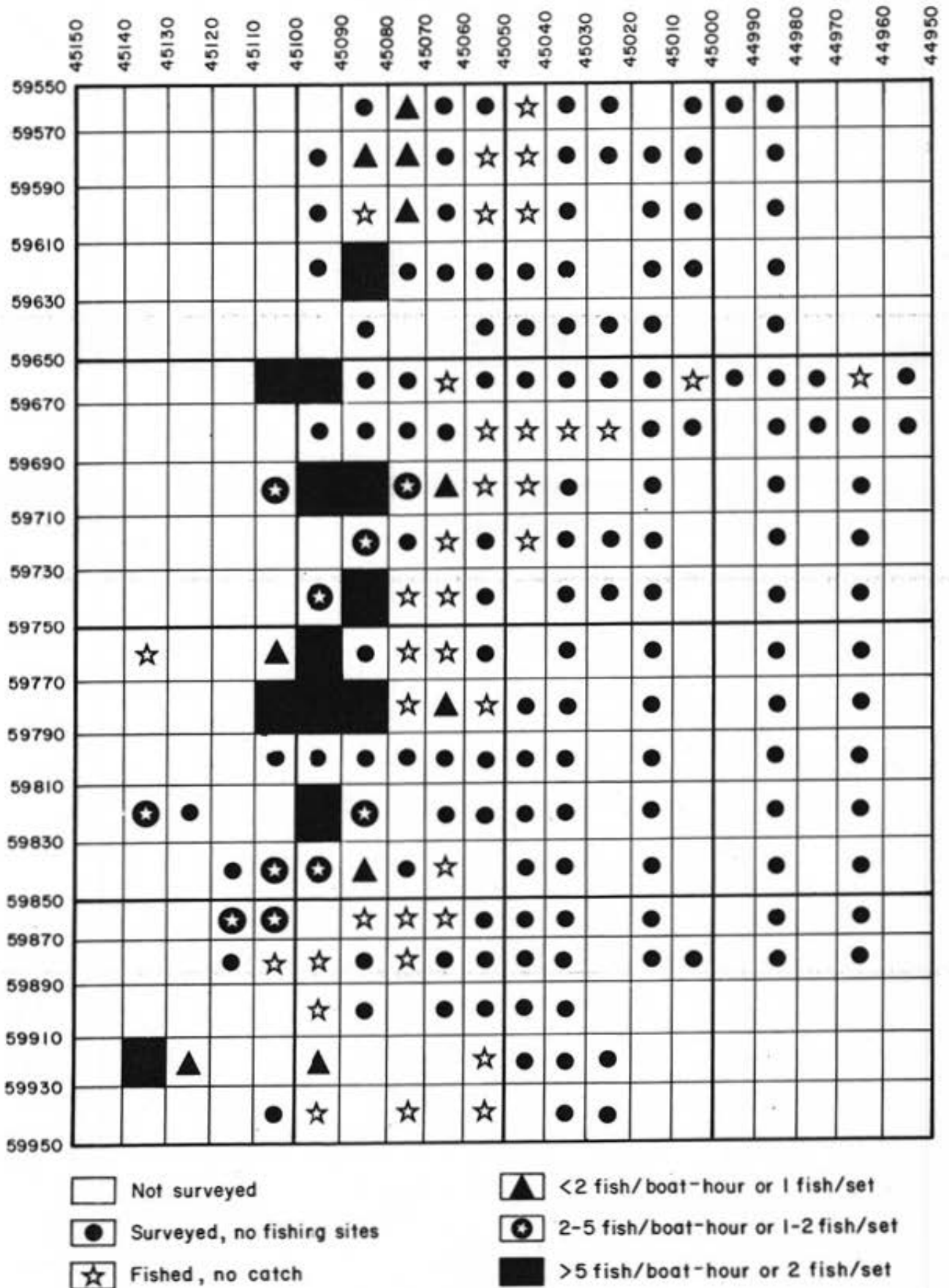


FIG. 5. CATCH RATES OF BLUELINE TILEFISH (*CAULOLATILUS MICROPS*) IN AREA C.  
 LEGEND C LINES OF POSITION ARE SHOWN IN THE MARGINS

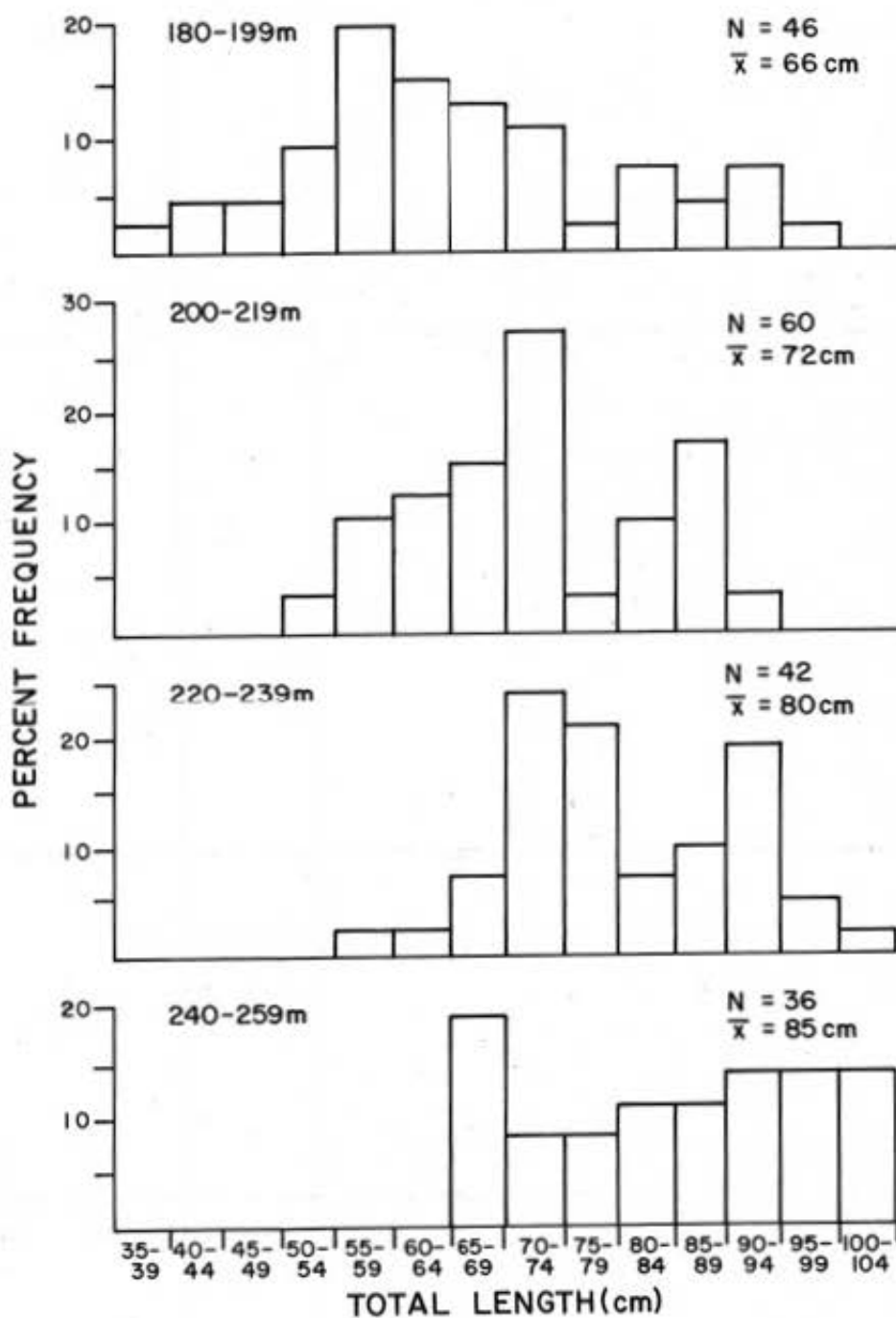


FIG. 6. LENGTH COMPOSITION OF SNOWY GROUPERS, EPINEPHELUS NIVEATUS, CAUGHT WITH SNAPPER REELS AND LONGLINES IN FOUR DEPTH STRATA DURING 1982-1983.

reel catch) was taken in < 200 m. The mean total length for the entire sample was 75 cm.

Source	SS	df	Mean Square	F
Treatment	8912.9	3	2970.97	17.4
Error	30791.0	180	171.06	
Total	39703.9	183		

Most of the snowy groupers landed commercially in South Carolina came from the inshore part of area C and their length distribution, compiled from port sampling, is shown in Fig. 7. Size composition in numbers of fish, estimated using Matheson's (1981) length-weight equation

$$W = 7.0 \cdot 10^{-8} L^{2.755}$$

where W is in grams and L is in mm, is shown in Table 3.

Yellowedge groupers (N = 15) averaged 86 cm and were caught in 192-212 m. The weight ratio of yellowedge: snowy groupers over all depths was 0.096. No other analysis was done because of the small sample size.

Total length composition of tilefish caught in all depths using both types of gear is shown in Fig. 8. Mean total length in each depth stratum, as well as for each gear type, was identical (78 cm). Mean total lengths in the 1982 commercial catch were 73 cm for fish caught on tub longline gear, 78 cm for those caught with snap-on longline gear, and 79 cm for reel-caught fish. Length distribution of commercial catches (all gears) in 1977-1982, as estimated from port sampling, is shown in Fig. 9. Size composition of the 1980-1982 catch in numbers of fish, estimated using the equation

$$W = 1.1 \cdot 10^{-6} L^{3.3353}$$

where W is gutted weight in grams and L is total length in mm, is listed in Table 4. All of the 1977-1979 catch came from area C, while most of the 1980-1982 catch was taken from area A (Fig. 1).

There was no substantial difference in mean total length of blue-line tilefish by gear. Since 72% of the catch came from 180-219 m, no analysis of size by depth was done. Length distribution of the commercial catch is shown in Fig. 9 and that of our sample in Fig. 10.

#### Fishery Trends

Survey catch rates with reels are not directly comparable to commercial rates, since substantial time was spent over relatively unproductive bottom. For the 23 days in which fishing time was recorded, average effort and catch per day for groupers were 3.1 boat-hours and 43.8 kg round weight, respectively. Average commercial reel

catch rates for groupers in the shallow part of area C were 323 kg, 241 kg, and 250 kg gutted weight per day fished in 1977, 1978, and 1979, respectively. Peak success normally occurred in spring and summer. After the data have been seasonally adjusted using the average percentage method (Spiegel 1961) (seasonal indices W = 0.8, Sp. = 1.4, Sm = 1.2, F = 0.6), the trend in commercial reel catch per-effort (CPUE) is shown in Fig. 11.

Longlining for groupers in area C began in August 1981, with six boats reporting catches during the fall. Their mean CPUE was 1,182 kg gutted weight per landing. In 1982, 12 boats reported 47 landings of longline-caught deep-water groupers, with a CPUE distribution as shown in Fig. 12. Mean catch rates were 209 kg per day and 618 kg per landing (based on log-transformed data). During January-May 1982, longliners reported a mean CPUE of three groupers per 100 hooks. About 61% of the total reported 1982 catch of deep-water groupers was landed by longliners.

The trend in seasonally adjusted commercial reel CPUE for tilefish is shown in Fig. 13 (seasonal indices W = 1.2, Sp = 0.8, Sm = 1.0, F = 1.0). Most of the effort was directed to area A. The declining trend (r = -0.89) prompted many boats to convert to longline gear (Low 1983). During 1982, 20 boats reported 81 landings of longline-caught tilefish (Fig. 12). Longliners accounted for about 79% of the total tilefish catch. The average catch rates were 995 kg per landing and 524 kg per day of fishing (based on log-transformed data). In area C, the reported mean CPUE for longliners during January-May 1982 was about one tilefish per 100 hooks.

## Discussion

There is no standard for judging the relative effectiveness of the setlines, since the hook spacing was about one-third that of most commercial longlines and sets were positioned directly on fish marks to the extent possible. In conventional longlining over habitat such as that found in area C, many of the hooks are fishing over barren bottom because the fish have an aggregated distribution. The survey per-hook catch rate (14.50 fish per 100 hooks) was therefore higher than the reported commercial rate (4.25 fish per 100 hooks). Whether this gear offers any advantage over motor-fishing for small boats is speculative. For large boats that engage in the deep-water fishery on a part-time basis and rely primarily on drift-fishing, the setline gear offers advantages. Initial investment (particularly if a hydraulic system is already installed) is low, since the gear can be hauled with a pot hauler. The gear can be fished in conditions that preclude effective drift-fishing, e.g. strong currents or surface winds. Since the



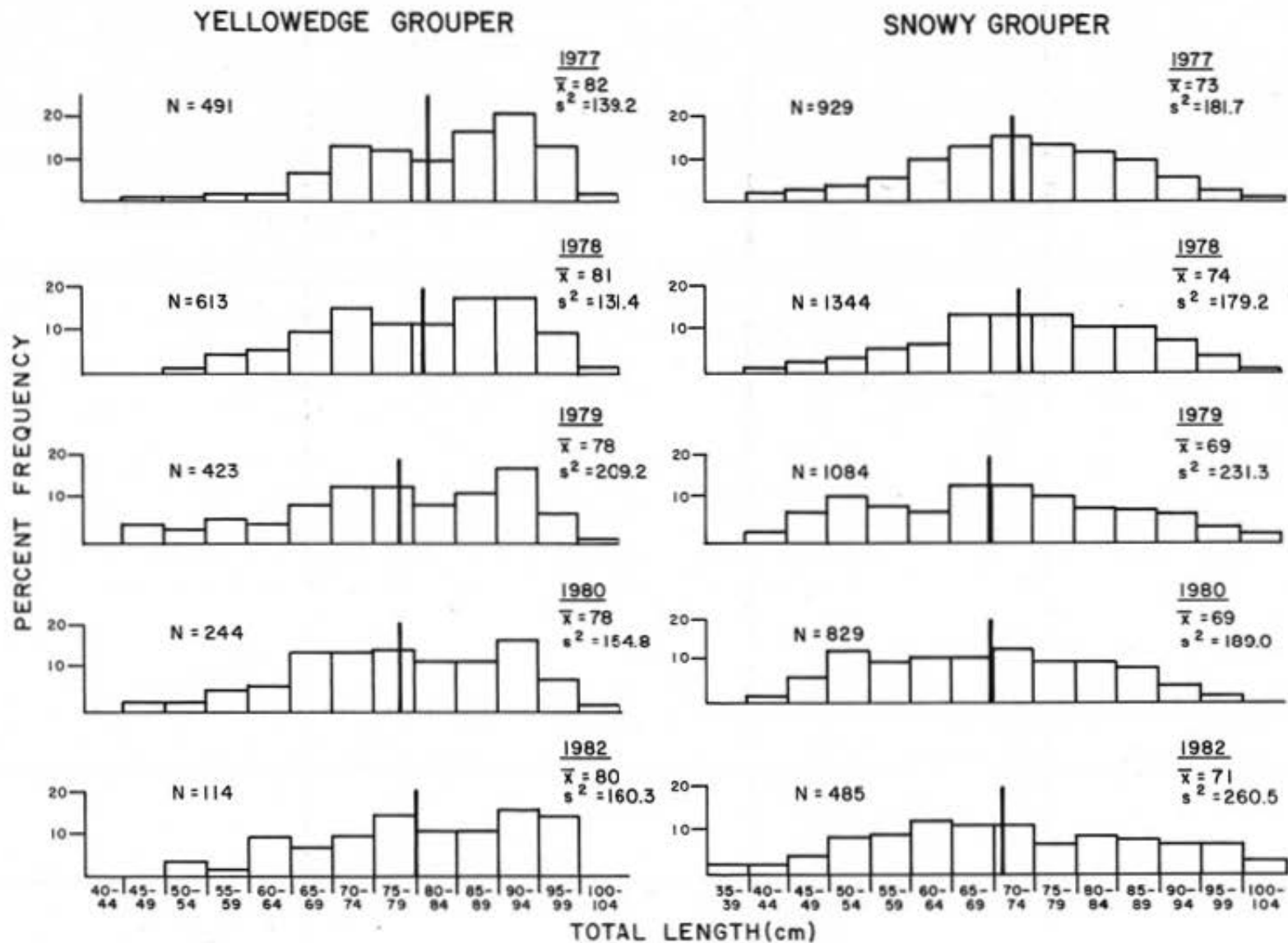


FIG. 7. LENGTH COMPOSITION OF DEEP-WATER GROUPERS (EPINEPHELUS FLAVOLIMBATUS AND E. NIVEATUS) LANDED COMMERCIALY IN SOUTH CAROLINA DURING 1977-1982.

TABLE 3. Approximate size composition of commercial snowy grouper catches in numbers of fish.

TL (cm)	MEAN ROUND WEIGHT (kg)	1978	1979	1980	1982
35-39	0.833	69	87	13	222
40-44	1.181	237	184	36	177
45-49	1.610	485	528	159	417
50-54	2.127	675	814	320	833
55-59	2.739	985	588	284	986
60-64	3.453	1,080	554	291	1,294
65-69	4.275	2,290	931	307	1,140
70-74	5.213	2,242	958	360	1,140
75-79	6.272	2,194	849	271	790
80-84	7.459	1,827	602	288	964
85-89	8.780	1,803	534	238	833
90-94	10.241	1,246	425	112	790
95-99	11.848	617	233	53	702
100-104	13.608	166	75	7	307
105-109	15.526	-	-	-	44
OTHER	-	24	48	-	-
ESTIMATED TOTAL NUMBER		15,940	7,410	2,739	10,639

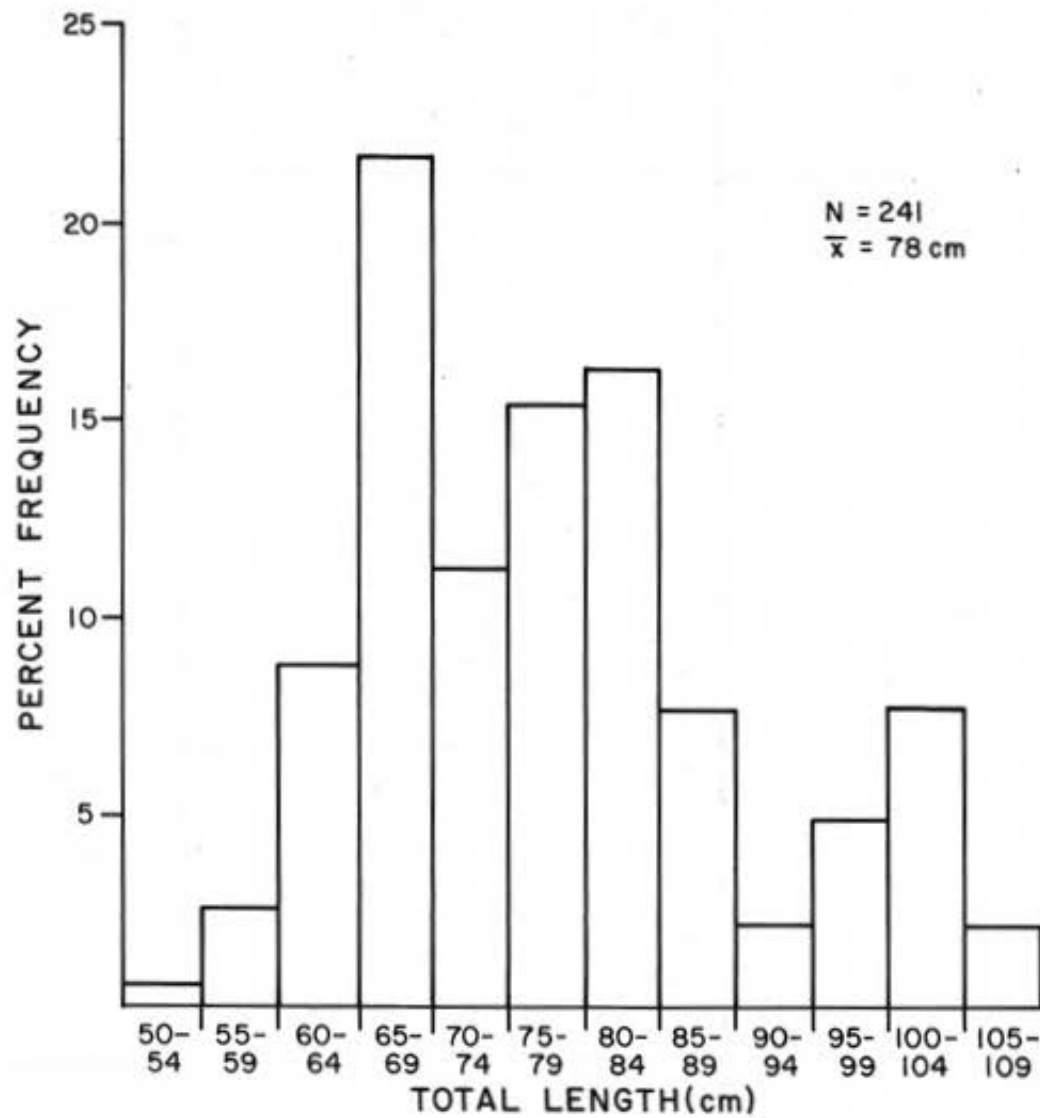


FIG. 8. LENGTH COMPOSITION OF TILEFISH, LOPHOLATILUS CHAMAELEONTICEPS, CAUGHT WITH SNAPPER REELS AND LONGLINES DURING 1982-1983.

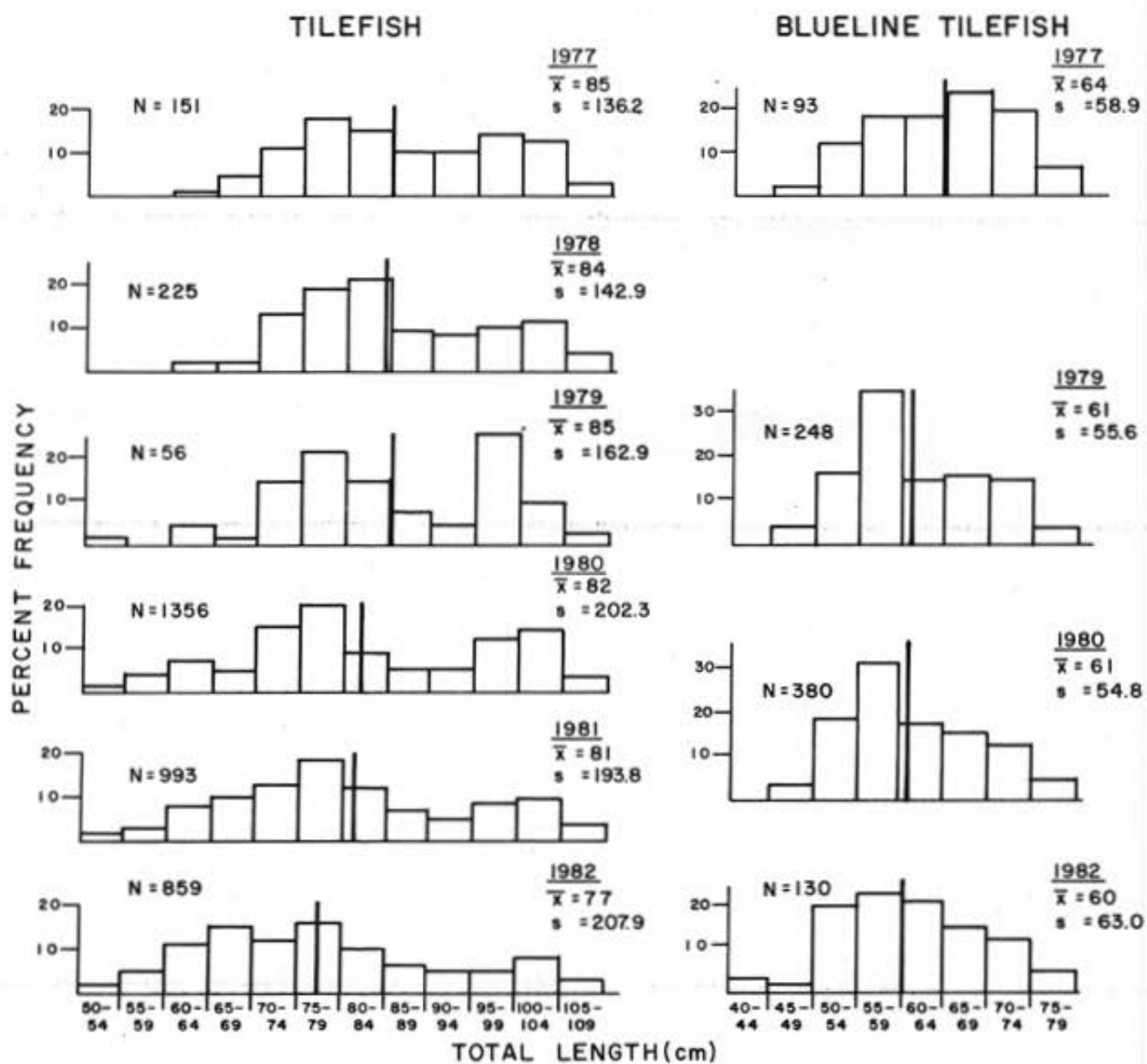


FIG. 9. LENGTH COMPOSITION OF TILEFISHES (LOPHOLATILUS CHAMAELEONTICEPS AND CAULOLATILUS MICRIPS) LANDED COMMERCIALY IN SOUTH CAROLINA DURING 1977-1982.

TABLE 4. Approximate size composition of commercial tilefish catches in numbers of fish.

TL (cm)	MEAN GUTTED WEIGHT (kg)	1980	1981	1982
40-44	0.618	-	15	89
45-49	0.899	30	126	152
50-54	1.259	49	188	620
55-59	1.710	193	266	1,393
60-64	2.264	406	1,162	2,727
65-69	2.932	289	1,484	3,792
70-74	3.728	918	2,058	3,052
75-79	4.663	1,176	2,863	4,061
80-84	5.752	551	1,809	2,461
85-89	7.008	284	1,083	1,600
90-94	8.443	306	696	1,275
95-99	10.073	717	1,424	1,333
100-104	11.912	804	1,532	2,075
105-109	13.973	201	650	801
110-114	16.272	-	16	29
ESTIMATED TOTAL NUMBER .....		5,924	15,372	25,460

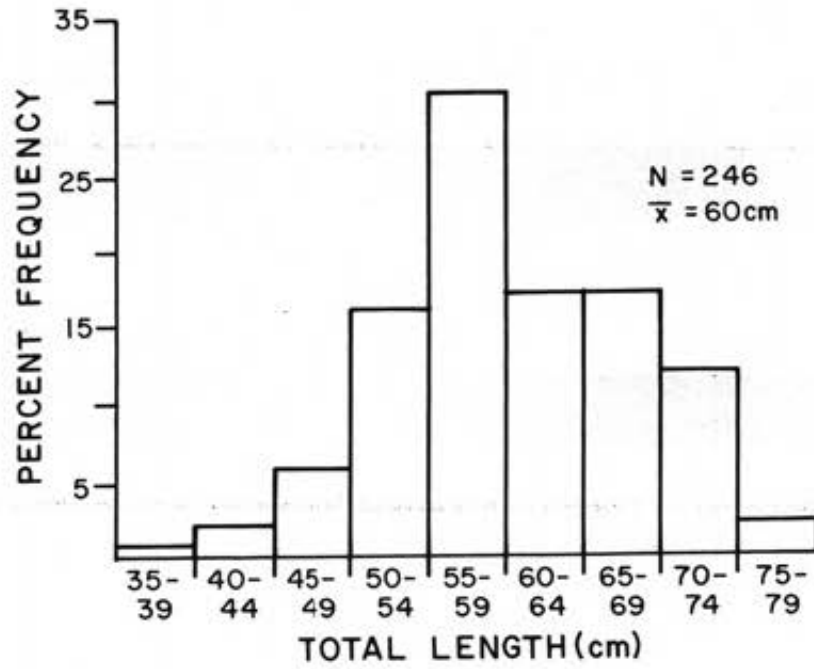


FIG. 10. LENGTH COMPOSITION OF BLUELINE TILEFISH, CAULOLATILUS MICROPS, CAUGHT WITH SNAPPER REELS AND LONGLINES IN 1982 AND 1983.

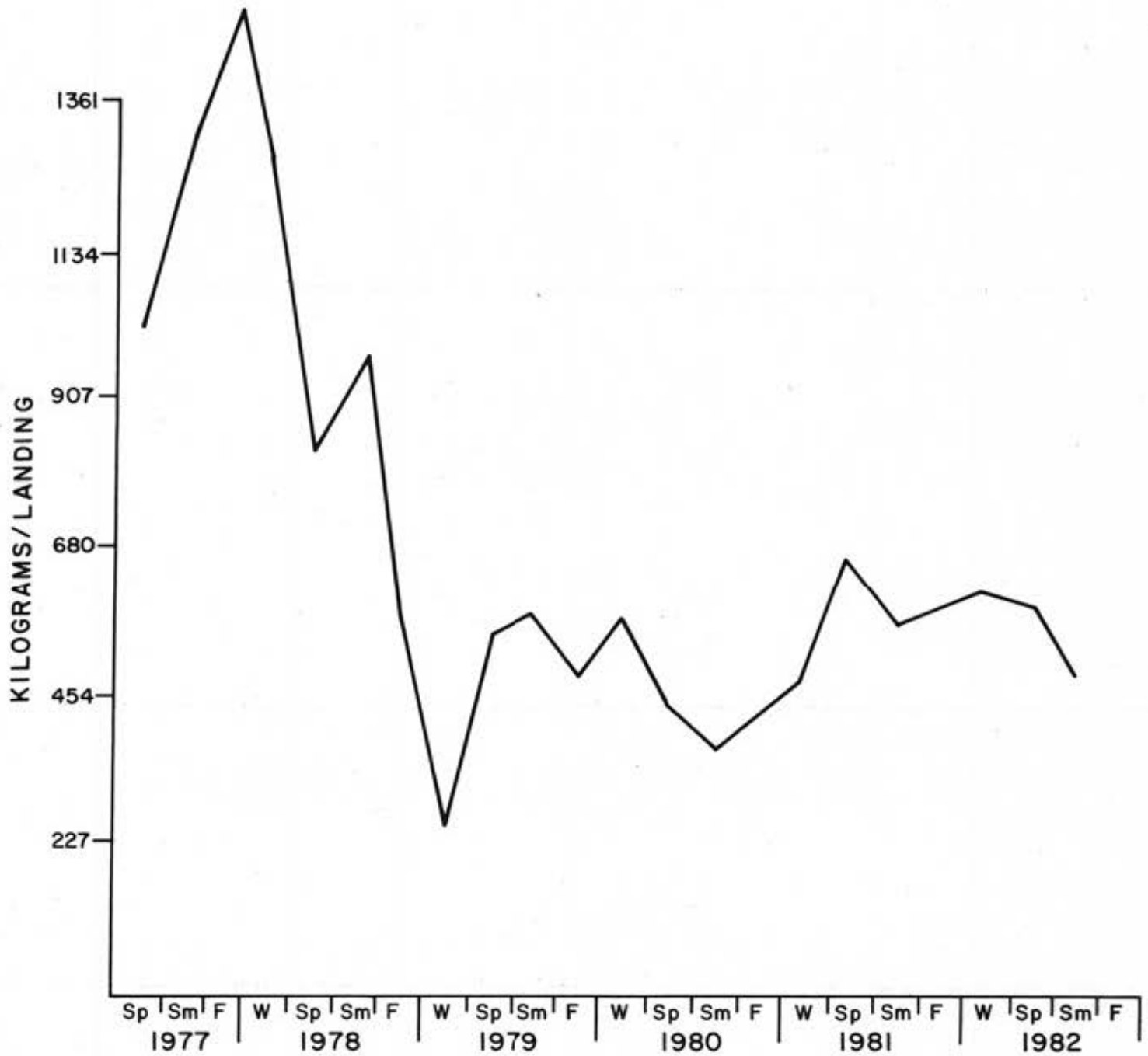
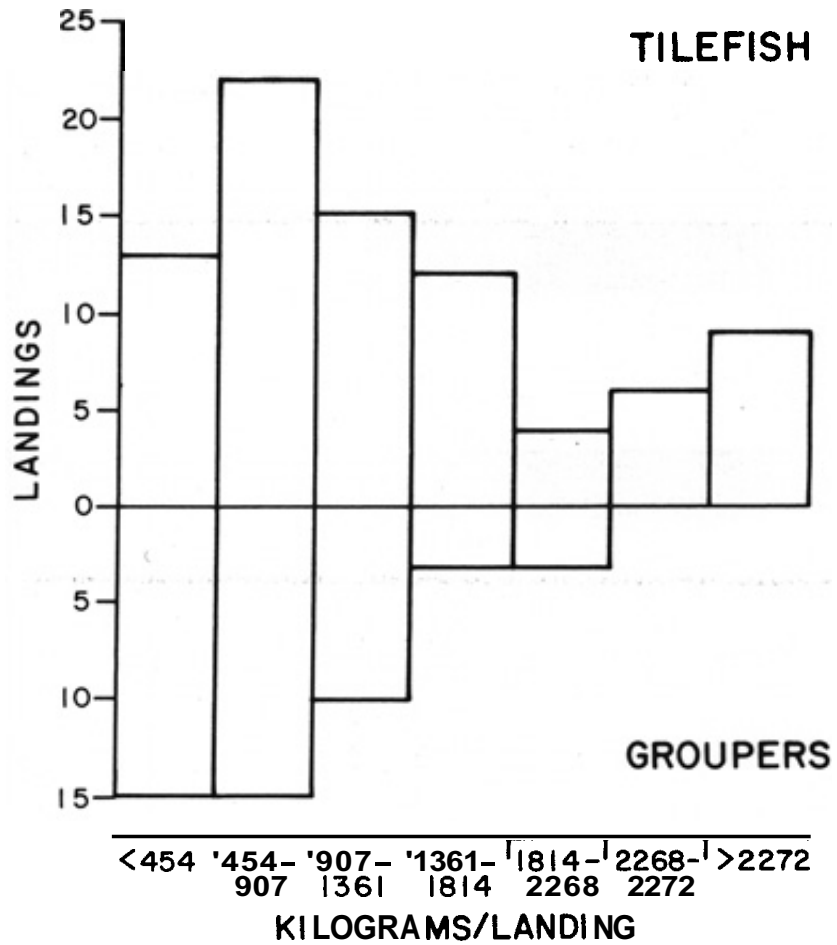


FIG. 11. TREND IN SEASONALLY ADJUSTED COMMERCIAL SNAPPER REEL CPUE FOR DEEP-WATER GROUPERS IN SOUTH CAROLINA DURING 1977-1982.



FIG, 12. DISTRIBUTION OF LONGLINE CPUE FOR DEEP-WATER GROUPERS AND TILEFISH IN SOUTH CAROLINA IN 1982,



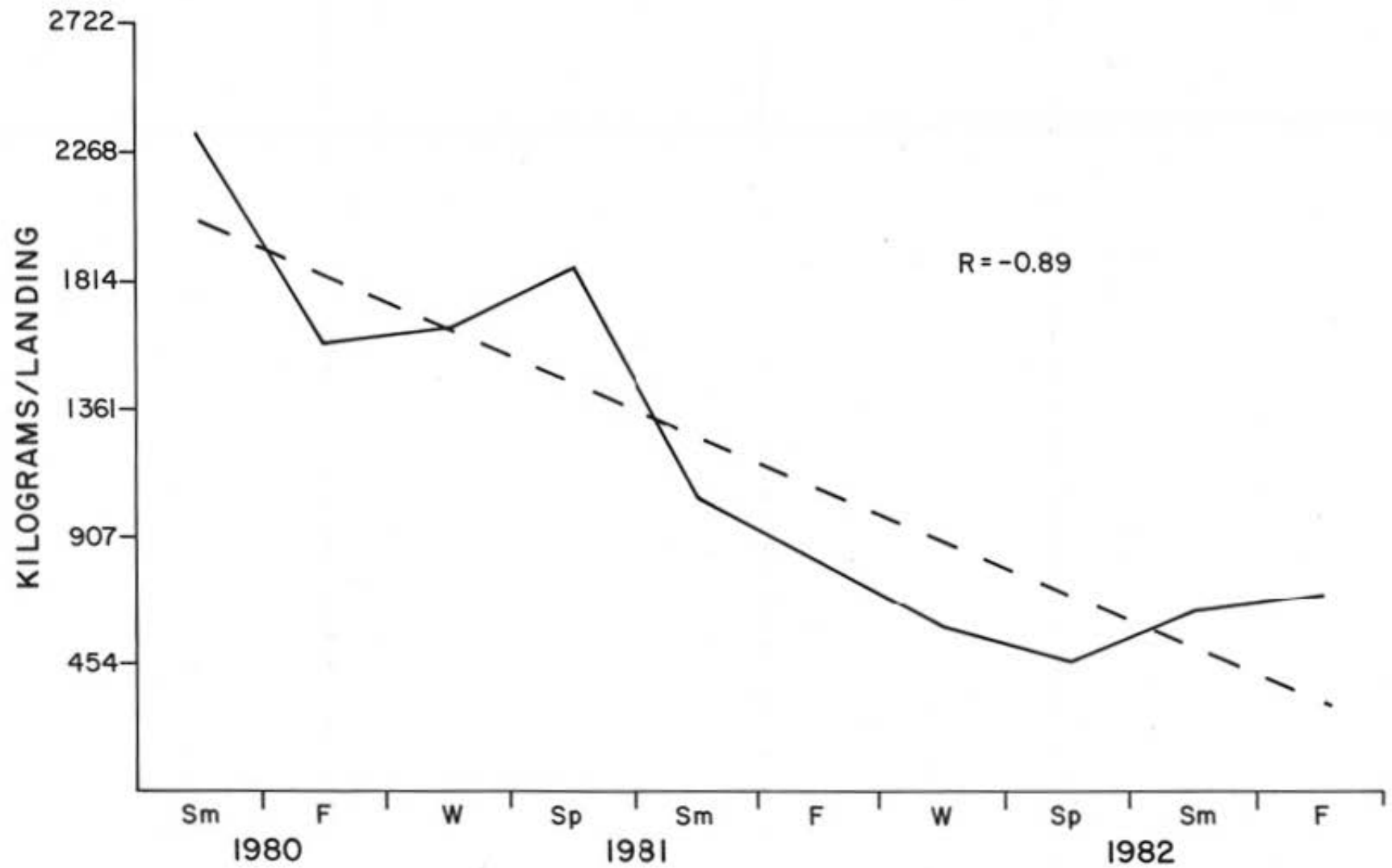


FIG. 13. TREND IN SEASONALLY ADJUSTED COMMERCIAL SNAPPER REEL CPUE FOR TILEFISH IN SOUTH CAROLINA DURING 1980-1982.

gear can be positioned on fish or structure, efficiency of effort is maximized.

Although mean total length of snowy groupers in the commercial catch has declined slightly since 1977-1978, the mean length observed in the survey sample was similar to the 1977-1978 standard. The survey catch probably contained a larger percentage of fish from deeper water, where the mean size is larger. The positive correlation between total length and water depth is relevant to the current management strategy based on yield-per-recruit (YPR). Snowy groupers inhabit a wide depth range. Excessive effort in deep water probably would not result in significant catches of small fish. The total catch, although reduced, would consist of fish similar in size to those taken prior to overexploitation because of the limited size range available.

There may be a declining trend in the abundance of yellowedge groupers. Commercial landings have declined drastically since 1977-1978, although the statistics for 1981 and 1982 are misleading because one dealer reported all deep-water groupers as snowy groupers. In 1977, the weight ratio of yellowedge to snowy groupers in commercial landings was 0.376. In both 1978 and 1979, it was 0.206, then it dropped to 0.191 in 1980. Our sample ratio was 0.096. Part of the decline could be attributable to an increase in effort in depths greater than those inhabited by yellowedge groupers. It is interesting to note, however, that the mean total length of yellowedge groupers (both in commercial landings and in our sample) has remained virtually constant. This again relates to the appropriateness of the YPR strategy for preventing over-exploitation of deepwater groupers.

Tilefish were insignificant in commercial landings from area C during 1977-1980. This may be due to the fact that most of the fishing took place in 170-200 m, where tilefish appear to be much less abundant than groupers (Fig. 4). Fishermen probably avoided them because of their relatively low market value at that time. The increase in recent landings may be due to increased effort in deeper water, where the abundance of tilefish relative to groupers increases substantially, the introduction of longlining on a significant scale, and the increase in ex-vessel value. In motor-fishing, the fishermen can stay positioned over groupers, whereas in longlining some of the gear will fall over tilefish habitat (i.e., the sides of ridges and peaks rather than on top of them).

The mean total length of blue-line tilefish in our sample was similar to that reported several years ago by Ross (1978, Ross and Huntsman 1982). He noted that blue-line tilefish first become vulnerable to hook-and-line at about 41 cm total length and are completely recruited at about 51 cm. A

substantial percentage of the females has spawned at least once before attaining this size. By these benchmarks, the population in area C is not overexploited.

Catch size and species composition probably are accurate representations of the population structure in the various depth strata. Although we used a wide range of hook sizes, a study of the effect of circle hook size on length composition of catches in the Hawaiian deep-water reel fishery showed that there was little size difference due to different hook sizes (Ralston 1982). In our study, the size composition for all species was similar for both types of gear. The ratios of numbers of fish caught on setlines: reels over all depths were 0.39 for groupers, 0.43 for tilefish and 0.31 for blue-line tilefish. This suggests that blue-line tilefish were somewhat more vulnerable to snapper reels than longline gear, compared to the other species.

The success rate for groupers was highest in shallower depths, while that for tilefish increased progressively with depth (out to a limiting depth of around 300 m, where bottom temperature approached the minimum threshold of about 7.5°C). The catch rate for blue-line tilefish decreased sharply with increasing depth.

At the completion of the survey in mid-April 1983, stocks of snowy grouper, tilefish, and blue-line tilefish in area C appeared to be moderately exploited. The total amount of habitat, while not extensive, appears capable of supporting relatively high densities of fish, judging from initial observations from the research submersible. About 65 km along the 200 m curve between 32°32'N and 32°55'N consists of predominantly rough, hard bottom, with the maximum width (of the 180-280 m zone) being about 19 km. Within this area, the most productive locations are characterized by high vertical relief. Such sites, while individually limited in extent, are numerous. The relatively flat surrounding bottom, which comprises a substantial part of the deeper area, yielded little other than blackbelly rosefish. Deeper than 300 m, there appear to be few locations with much commercial potential and these tend to consist of scattered pinnacles rather than systematic ridge formations.

Although there have been a few reports of small catches of wreckfish from both areas C and D, a directed fishery for this species does not appear feasible. They appear to be very uncommon in area C. In area D, where they presumably are more abundant, the surface currents are usually strong due to the proximity of the axis of maximum strength of the Gulf Stream. Bottom currents likewise appear to be strong most of the time. The currents make it very difficult to precisely position gear on structure, such as coral lumps, particularly in 500-800 m of water. Once on the bottom, the gear is usually swept by the current, with resultant hangs. The observed distribution of the fish suggests

that the gear must be positioned in the downcurrent eddies of structure in order to fish effectively. Most of the time, then, the gear probably is not fishing effectively. The rather solitary distribution of wreckfish suggests that large catches per unit of effort are unlikely. In times when the current abates, a swordfish boat could set some gear around the coral lumps and perhaps land a few fish, as has been done several times, if the captain is willing to sacrifice some gear. This target-of-opportunity situation appears to represent the extent of the fishery potential for wreckfish.

During January through July in 1983, reported longline catch and effort off South Carolina have increased greatly since the comparable period in 1982. From 10-18 vessels have reported landings in each month, compared to 3-8 in 1982. Effort in total number of trips has increased 108%. Landings of snowy grouper have increased 204%, while those of tilefish are up 228%. Nearly all of the grouper catch has come from area C, while tilefish are being exploited in both areas A and C. Fishermen are expanding their knowledge of the areas and the distribution of the fish. It is therefore reasonable to project a substantial increase in fishing mortality for all of the deep-water commercial species. Given the clustered distribution of the fish, concentrated at specific small sites, it is also reasonable to project that the populations in area C are likely to be reduced substantially within a fairly short period, given present levels of effort.

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# **Appendix I**

STATION DATA.

Block	45 Loran	59 Loran	Depth (fm)	Gear	Boat-hours	Catch <sup>1</sup>
2	084.3 083.9	593.9 596.7	99 101	SR	0.50	No catch
2	085.4 086.0	589.3 590.4	98 99	SR	0.42	6 snowies 1 blue-line tile
2	085.2	589.0	99	SR	0.33	1 snowy
2	073.6 074.4	563.2 561.5	104 107	SR	0.50	3 snowies 1 blue-line tile
2	072.9 074.2	564.1 562.0	116 106	SR	0.75	No catch
2	073.4 074.5	574.1 571.7	104 104	SR	0.50	1 yellowedge 2 blue-line tile
2	074.3 074.7	574.1 573.1	104 104	SR	0.25	No catch
2	073.7 074.2	575.9 574.8	103 103	SR	0.33	No catch
2	070.2	587.7	104	SR	0.50	1 tilefish
2	070.3 070.9	600.8 597.1	104 105	SR	0.50	1 yellowedge 1 tilefish
2	070.1 070.5	602.1 597.7	112 103	SR	0.67	5 snowies 1 tilefish
2	070.6	598.4	104	SR	0.50	4 snowies 1 blue-line tile
2	069.5 072.6	598.4 599.5	104 105	SR	0.75	2 snowies 1 tilefish 1 blue-line tile
2	089.4 087.7	625.2 628.3	97 100	SR	0.83	1 yellowedge 6 snowies 8 blue-line tile
2	082.7 087.9	625.6 627.5	102 104	SR	0.33	No catch
2	083.0 082.5	624.5 626.1	99 102	SR	0.25	No catch
2	083.3 082.4	623.7 626.3	99 102	SR	0.17	1 snowy 1 blue-line tile
2	086.4 086.3	626.7 628.5	100 102	SR	0.17	No catch
2	087.5 087.2	625.7 628.6	96	SR	0.17	1 snowy 1 blue-line tile
2	087.3 087.4	624.7 629.1	97 100	SR	0.33	3 snowies
2	087.2 087.9	625.5 628.4	97 99	SR	0.25	1 snowy 1 blue-line tile
2	088.9	623.9	99	SR	0.33	2 blue-line tile
2	089.6 091.6	624.8 632.3	97 97	SR	0.42	2 snowies 4 blue-line
2	058.3 058.0	607.5 604.7	116 118	SR	1.00	2 snowies 2 tilefish

<sup>1</sup>Target species only

Block	45 Loran	59 Loran	Depth(fm)	Gear	Boat-hours	Catch <sup>1</sup>
2	056.8	605.8	121	SR	0.25	No catch
2	054.8	605.7	119	SR	0.50	2 snowies
	054.9	604.2	123			1 tilefish
2	054.4	604.0	118	SR	0.42	1 tilefish
	054.5	602.7	124			
2	055.8	582.4	117	SR	0.33	1 tilefish
	056.0	583.0	117			
2	052.7	581.6	119	SR	0.17	No catch
	053.2	582.2	119			
2	082.8	624.9	100	LL		1 blueline tile
2	083.1	623.5	98	LL		2 blueline tile
2	080.7	624.5		LL		2 snowies
2	052.7	569.8	121	LL		No catch
3	049.0	604.3	118	SR	0.50	1 tilefish
3	043.6	570.5	128	SR	0.33	1 tilefish
	043.9	570.3	128			
3	043.7	570.0	127	LL		8 snowies
						2 tilefish
3	046.0	569.9	127	LL		1 snowy
						1 tilefish
3	044.2	569.3	135	LL		1 snowy
						1 tilefish
3	045.8	570.2	130	LL		1 snowy
						2 tilefish
3	047.8	566.5	137	LL		1 tilefish
5	100.6	666.8	88	SR	0.92	6 blueline tile
	100.7	661.5	97			
5	100.6	664.9	88	SR	0.42	2 snowies
	100.6	667.0	99			5 blueline tile
5	106.0	704.5	86	LL		3 snowy
						2 blueline tile
6	050.1	691.1	130	SR	0.50	1 snowy
	054.1	695.3	134			1 tilefish
6	051.6	691.9	129	SR	0.50	1 snowy
	053.0	695.0	126			1 tilefish
6	049.7	688.6	126	SR		No catch
	053.5	690.0	132			
6	066.7	665.9	133	SR	0.25	No catch
	067.8	665.8	133			
6	064.3	705.9	108	SR	0.42	1 snowy
	065.4	704.6	109			1 tilefish
6	062.2	699.7	123	SR	1.00	4 snowies
	062.4	699.4	126			2 tilefish
6	064.5	705.0	109	SR	0.58	2 tilefish
	065.1	701.4	116			
6	062.2	700.1	117	SR	0.50	No catch
	062.5	698.0				
6	061.0	705.2	124	SR	0.50	2 tilefish
	060.6	704.5	130			
6	060.8	706.0	127	SR	0.25	1 tilefish
	060.5	705.9	127			

Block	45 Loran	59 Loran	Depth (fm)	Gear	Boat-hours	Catch <sup>1</sup>
6	068.7	718.4	110	SR	0.25	No catch
	069.7	718.8	112			
6	063.4	730.0	130	SR	0.83	1 snowy
	064.1	732.8	129			4 tilefish
6	067.2	734.7	131	SR	1.00	5 snowies
	068.7	734.9	119			6 tilefish
6	075.8	704.2	111	SR	1.00	3 snowy
	068.2	704.2	111			1 tilefish
						2 blueline
6	073.0	705.0	112	SR	0.25	No catch
	071.0	706.3	110			
6	072.3	706.0	108	SR	0.33	1 tilefish
						2 blueline tile
6	076.0	704.0	110	SR	0.50	2 blueline tile
6	077.6	703.2	115	SR	0.50	1 tilefish
						1 blueline tile
6	077.2	705.1	112	SR	0.58	2 blueline tile
6	079.7	709.1	115	SR	0.25	2 tilefish
						3 blueline tile
6	071.5	734.2	116	SR	0.17	No catch
	071.0	734.8	117			
6	072.1	734.2	117	SR	0.42	1 tilefish
	071.2	734.9	117			
6	081.6	707.4	107	SR	0.17	1 tilefish
	080.6	706.5	117			2 blueline tile
6	082.3	707.1	109	SR	0.42	2 blueline tile
	080.3	705.2	113			
6	081.9	707.4	109	SR	0.33	3 blueline tile
	080.1	706.4	117			
6	086.0	705.4	106	SR	0.42	1 tilefish
						3 blueline tile
6	085.0	703.6	110	SR	0.50	1 snowy
						6 blueline tile
6	087.4	705.0	104	SR	0.33	No catch
6	097.0	703.4	97	SR	0.33	2 blueline tile
6	088.8	707.3	102	SR	0.17	2 blueline tile
	088.6	707.1	102			
6	088.7	708.7	99	SR	0.50	3 snowies
	088.6	709.7	99			1 blueline tile
6	086.2	700.9	111	SR	0.17	No catch
6	085.1	710.9	111	SR	0.17	2 blueline tile
	084.0	708.2	109			
6	085.4	731.4	108	SR	1.25	4 snowy
	085.2	727.2	118			1 tilefish
						6 blueline tile
6	084.3	731.1	110	SR	0.58	4 snowy
	084.8	727.7	118			2 tilefish
						4 blueline
6	084.9	732.1	112	SR	1.00	3 tilefish
	084.6	724.0	117			3 blueline
6	081.7	740.8	110	SR	1.00	5 snowies
	086.5	743.1	102			5 tilefish
						9 blueline tile

Block	45 Loran	59 Loran	Depth(fm)	Gear	Boat-hours	Catch <sup>1</sup>
6	090.8	734.6		SR	1.00	1 yellowedge 2 snowies 6 blue-line tile
6	100.6 095.8	666.9 659.9	93 97	SR	0.83	6 snowy 1 yellowedge 5 blue-line
6	093.9 094.0	660.6 658.8	95 99	SR	0.17	2 snowy 2 blue-line
6	094.0	661.8	97	SR	0.33	1 blue-line
6	100.7 100.2	705.0 708.2	95	SR	0.25	No catch
6	051.7	691.0	130	LL		1 snowy 1 tilefish
6	050.6	689.1	121	LL		Lost
6	062.7	701.1	115	LL		1 blue-line tile
6	063.1	702.6	116	LL		1 snowy 2 tilefish 2 blue-line tile
6	064.5	705.2	110	LL		2 snowies 2 tilefish
6	079.7	709.1	105	LL		1 snowy 1 blue-line
6	072.3	705.3	106	LL		No catch
6	072.1	707.4	109	LL		1 tilefish 3 blue-line tile
6	078.7	703.5	110	LL		3 snowies 2 blue-line tile
6	079.6	702.9	110	LL		1 tilefish
6	082.8	704.1	111	LL		1 tilefish 3 blue-line tile
6	084.9	706.9	106	LL		1 yellowedge 1 tilefish 1 blue-line tile
6	085.9	704.8	105	LL		1 blue-line tile
6	081.2	709.9	106	LL		1 snowy 1 tilefish 1 blue-line
6	081.6	706.9	107	LL		2 snowy 1 tilefish 3 blue-line
6	083.6	700.7	111	LL		No catch
6	084.5	703.7	109	LL		1 tilefish 1 blue-line
6	084.8	706.2	105	LL		1 snowy 2 blue-line
6	084.5	710.1	104	LL		1 tilefish 3 blue-line tile
6	083.8	716.1	103	LL		1 blue-line tile
6	084.0	706.7	106	LL		1 blue-line tile
6	095.2	748.1	100	LL		1 tilefish 2 blue-line tile



Block	45 Loran	59 Loran	Depth (fm)	Gear	Boat-hours	Catch <sup>1</sup>
7	042.4 043.5	677.9 677.3	132 133	SR	0.06	1 tilefish
7	041.2 043.0	677.9 676.9	135 139	SR	0.17	1 tilefish
7	039.8	682.1	124	SR	0.33	6 tilefish
7	042.9	676.8	138	SR	0.17	1 snowy
7	040.9 041.3	704.0 705.3	132 130	SR	0.17	No catch
7	040.3 041.4	702.5 706.1	135 131	SR	0.25	No catch
7	046.9 047.2	711.4	133	SR	0.33	No catch
7	047.2 048.1	725.9 732.7	141 136	SR	0.83	1 snowy
7	008.2	659.8	117	LL		No catch
7	024.1	670.3	134	LL		1 tilefish
7	025.4	670.6	138	LL		6 tilefish
7	048.1	688.0	124	LL		1 snowy 4 tilefish
7	040.6	677.9	127	LL		1 tilefish
7	039.8	682.1	127	LL		2 snowies 1 tilefish
8	(44)968.4	661.8	205	LL		No catch
9	132.1 130.8	813.5 816.7	88 90	SR	0.42	1 snowy 1 blueline tile
9	107.5 106.0	837.7 840.7	102 101	SR	0.33	1 blueline tile
9	103.0 101.5	840.7 845.1	102 115	SR	0.33	2 blueline
9	138.0	769.0	62	SR	0.33	2 snowy
9	106.6 103.0	759.5 762.0	98 103	SR	0.75	1 snowy 1 blueline
9	107.8 105.0	787.1 794.0	96 96	SR	1.00	2 yellowedge 10 snowy 6 blueline tile
9	100.5	830.4	104	SR	0.50	No catch
9	101.6	787.6	97	LL		None
9	100.9	785.5	98	LL		1 yellowedge
10	053.3 054.5	780.3 781.5	135 134	SR	0.50	2 tilefish
10	054.0 056.8	785.2 788.0	140 136	SR		No catch
10	068.2 067.5	753.2 753.3	122 122	SR	0.25	No catch
10	069.1 067.9	755.3 754.7	119 122	SR	0.50	1 tilefish
10	068.8 067.8	753.8 753.1	120 121	SR	0.67	2 tilefish
10	069.1 072.0	760.2 764.9	125 123	SR	0.42	2 tilefish

Block	45 Loran	59 Loran	Depth (fm)	Gear	Boat-hours	
10	069.4	779.9	124	SR	0.33	1 tilefish
10	061.7 063.5	780.2 780.4		SR	0.25	1 tilefish
10	060.6 065.2	780.5 780.9	130 127	SR	0.58	8 snowies 14 tilefish 1 blueline tile
10	070.0 069.6	849.1 843.8	128 130	SR	0.33	2 tilefish
10	073.6 071.9	775.4 774.5	120 120	SR	0.50	2 tilefish
10	073.9 073.8	762.3 761.4	119 119	SR	0.42	No catch
10	074.1 072.7	759.8 757.2	115 117	SR	0.58	3 tilefish
10	073.0	755.2	118	SR	0.25	No catch
10	073.0	781.4	121	SR	0.58	2 snowies 3 tilefish
10	089.3	782.4	102	SR	1.00	2 snowies 2 tilefish 12 blueline tile
10	089.2	787.0	102	SR	2.00	7 snowies 5 tilefish 5 blueline tile
10	087.6 087.5	813.6 810.6	106 108	SR	0.75	1 yellowedge 1 snowy 3 tilefish 3 blueline tile
10	090.1	752.0	105	SR		No catch
10	087.8	798.8	108	SR	0.17	2 snowy
10	095.0 094.4	754.1 755.8	101 104	SR	0.17	2 blueline tile
10	099.7	782.8	102	SR	0.33	1 blueline tile
10	086.6 085.9	815.7 819.6	113 116	SR	0.33	1 tilefish
10	086.0 084.6	812.5 815.1	111 119	SR	0.50	3 tilefish 1 snowy
10	087.0 086.8	816.0 817.6	110 111	SR	0.17	1 tilefish
10	087.5 087.5	815.3 819.1	115 114	SR	0.50	1 tilefish
10	090.8	817.0	104	SR	0.50	3 blueline tile
10	095.8	823.8	105	SR	0.67	2 snowy 6 blueline
10	093.4 095.4	822.5 819.4	104 105	SR	0.83	2 tilefish 3 blueline
10	093.4 095.2	825.6 822.5	104 101	SR	0.83	1 blueline
10	098.5 100.7	827.1 825.5	99 105	SR	0.67	3 snowy 4 blueline tile
10	097.3 100.7	827.6 825.5	98 106	SR	0.75	2 snowy 1 yellowedge 6 blueline

Block	45 Loran	59 Loran	Depth (fm)	Gear	Boat-hours	Catch <sup>1</sup>
10	095.6 096.1	824.3 824.0	108 102	SR	0.33	1 blue line
10	099.1 098.8	830.2 834.5	98 102	SR	0.25	No catch
10	090.2 090.5	840.2 839.8	103 105	SR	0.42	3 snowies
10	090.3 091.6	837.3 837.1	105 105	SR	0.50	1 snowy
10	094.9 095.4	844.4 841.3	101 106	SR	0.50	1 snowy 1 tilefish
10	095.2	840.9	105	SR	0.50	1 snowy 10 blue line
10	083.3	827.8	116	LL		1 snowy 1 tilefish
10	086.3	836.7	107	LL		2 snowy 2 tilefish
10	080.0 076.4	833.3 836.7	117 123	SR	0.67	2 tilefish
10	082.7	839.5	116	LL		2 snowy 1 tilefish
10	083.4	842.2	115	LL		2 tilefish
10	086.4	835.1	111	LL		2 snowy 2 tilefish 2 blue line tile
10	085.6	837.0	112	LL		2 tilefish
10	084.6	837.2	116	LL		2 snowy 2 tilefish
10	096.1	752.0	101	LL		1 yellowedge 1 snowy 4 blue line tile
10	094.6	754.9	102	LL		1 snowy
10	099.2	784.8	99	LL		3 yellowedge 2 snowies 4 blue line tile
10	091.2	826.6	117	LL		1 snowy 2 tilefish 2 blue line tile
10	090.8	829.2	110	LL		4 tilefish 2 blue line tile
10	098.8	831.9	96	LL		4 snowies 6 tilefish 1 blue line tile
10	090.9	839.9	105	LL		1 tilefish 2 blue line tile
10	099.6	843.8	108	LL		2 tilefish 1 blue line tile
10	098.7	848.9	100	LL		1 snowy 2 blue line tile
13	100.9 101.8	863.3 865.8	96 98	SR	0.33	1 tilefish 1 blue line tile
13	100.3 101.9	873.8 877.0	102 106	SR	0.33	No catch
13	102.6 103.2	869.9 876.6	105 111	SR	0.17	None

Block	45 Loran	59 Loran	Depth(fm)	Gear	Boat-hours	Catch <sup>1</sup>
13	118.8 121.2	855.9 848.9	94 94	SR	0.50	2 blue-line tile
13	118.8 119.2	869.3 865.2	94 94	SR	0.33	No catch
13	120.0 119.6	877.2 868.2	88 102	SR	0.50	1 snowy 1 blue-line tile
13	122.1 124.1	928.6 924.8	115 117	SR	0.42	1 tilefish
13	121.5 123.6	929.5 925.6	102 123	SR	0.42	3 snowy 1 tilefish
13	128.8 132.0	931.0 926.5	98 103	SR	0.67	1 snowy 3 tilefish 5 blue-line
13	128.7 132.9	930.4 927.3	97 105	SR	0.67	4 blue-line
13	132.2 133.4	927.4 924.8	98 105	SR	0.25	1 tilefish 1 blue-line
13	125.3	920.1	104	LL		1 tilefish 1 blue-line
13	127.0	917.3	104	LL		1 snowy 1 tilefish
13	127.8	918.6	102	LL		1 snowy 1 tilefish 1 blue-line
13	121.8	928.3	115	LL		2 tilefish
13	121.9	928.6	108	LL		No catch
13	122.0	930.1	103	LL		2 tilefish
13	133.5	925.6	102	LL		Hung, lost part of set No catch
13	132.4	925.1	99	LL		1 snowy 3 tilefish
13	131.3	927.3	98	LL		1 tilefish 1 blue-line
13	132.4	924.9	99	LL		2 tilefish 1 blue-line
13	131.2	927.6	98	LL		1 blue-line
13	131.0	927.2	98	LL		1 snowy 1 tilefish
14	059.5 055.8	947.1 941.9	134 140	SR	0.42	1 tilefish
14	059.8 058.1	920.1 918.2	130 132	SR	0.17	No catch
14	067.0	850.1	135	SR		No catch
14	078.1 077.4	850.9 852.4	122 126	SR	0.25	No catch
14	076.9	939.0	142	SR	0.33	1 tilefish
14	078.8	874.6	125	SR	0.25	No catch
14	080.0 079.9	885.5 886.8	126 124	SR	0.50	1 tilefish
14	090.0 089.7	853.4 853.2	107 112	SR	0.25	No catch

Block	45 Loran	59 Loran	Depth (fm)	Gear	Boat-hours	Catch <sup>1</sup>
14	080.4 080.5	866.5 867.5	115 116	SR	0.25	2 tilefish
14	090.0 089.7	878.7 877.3	118 119	SR	0.67	3 tilefish
14	090.0 089.9	871.4 871.2	113 112	SR	0.33	No catch
14	089.4 092.1	880.6 886.2	119 127	SR	0.67	7 tilefish
14	094.7 095.2	884.0 884.6	110 110	SR	0.08	No catch
14	100.0 099.8	902.5 901.2	116 120	SR	0.75	1 snowy 3 tilefish
14	092.5 092.5	910.7 907.9	125 125	SR	0.58	2 snowy 2 tilefish
14	098.6	916.8	115	SR	1.67	snowy tilefish blueline tile
14	099.4 099.9	915.5 915.5	110 110	SR	0.33	2 tilefish
14	099.9 099.7	913.8 912.8	116 126	SR	0.50	3 tilefish
14	099.8 100.4	924.9 925.6	110 114	SR	0.25	2 tilefish
14	100.1 100.6	917.9 918.5	110 109	SR	0.25	No catch
14	096.9 098.8	938.1 934.8	113 118	SR	0.50	1 snowy 2 tilefish
14	097.2	935.4	119	SR	0.42	1 tilefish
14	097.7	935.0	116	LL		1 snowy
14	096.5	938.0	116	LL		1 tilefish
14	098.1	937.3	114	LL		2 snowy 1 tilefish

## BLOCK DIAGRAMS

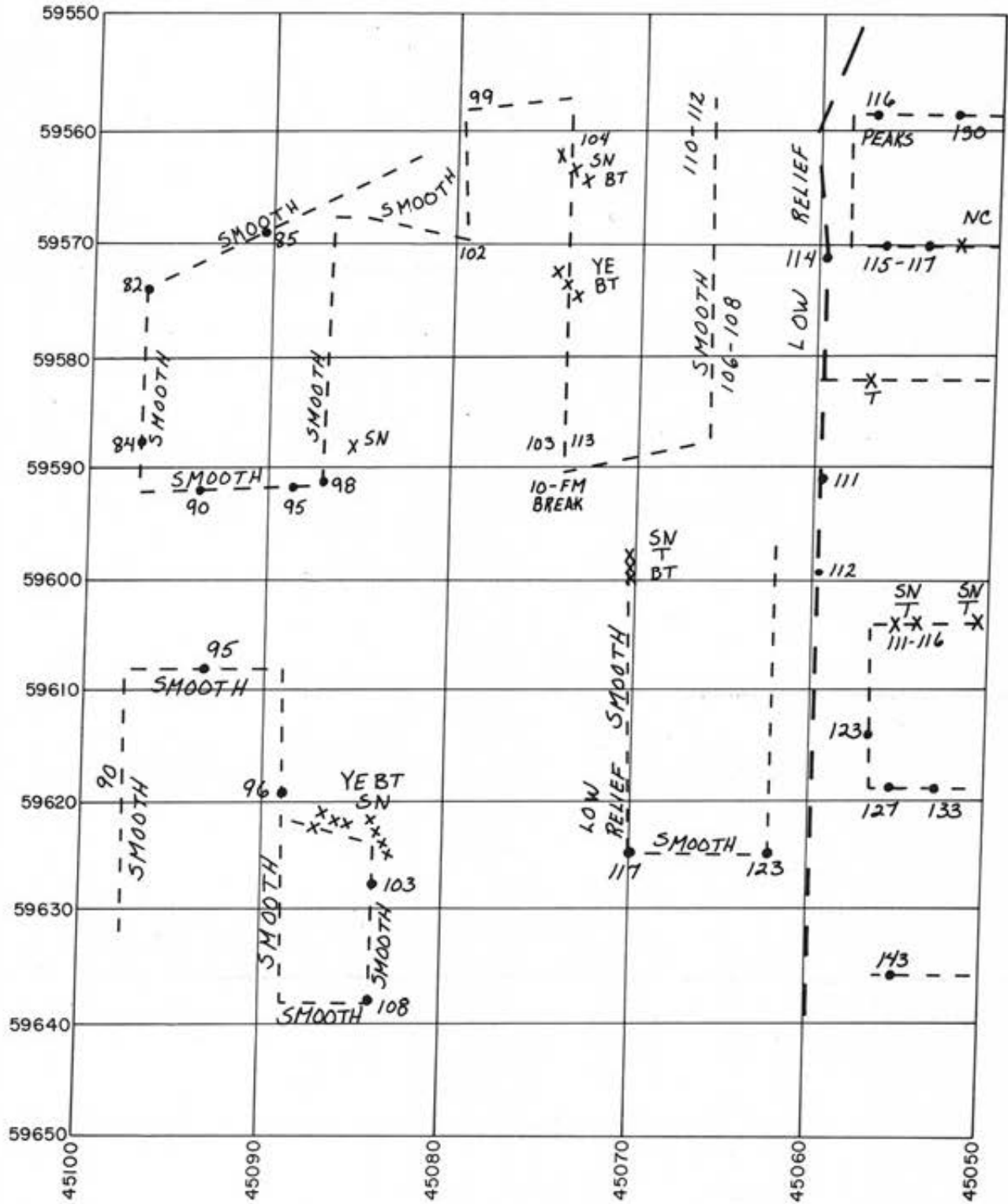
These figures are not drawn to scale and station locations are approximated.

LEGEND:

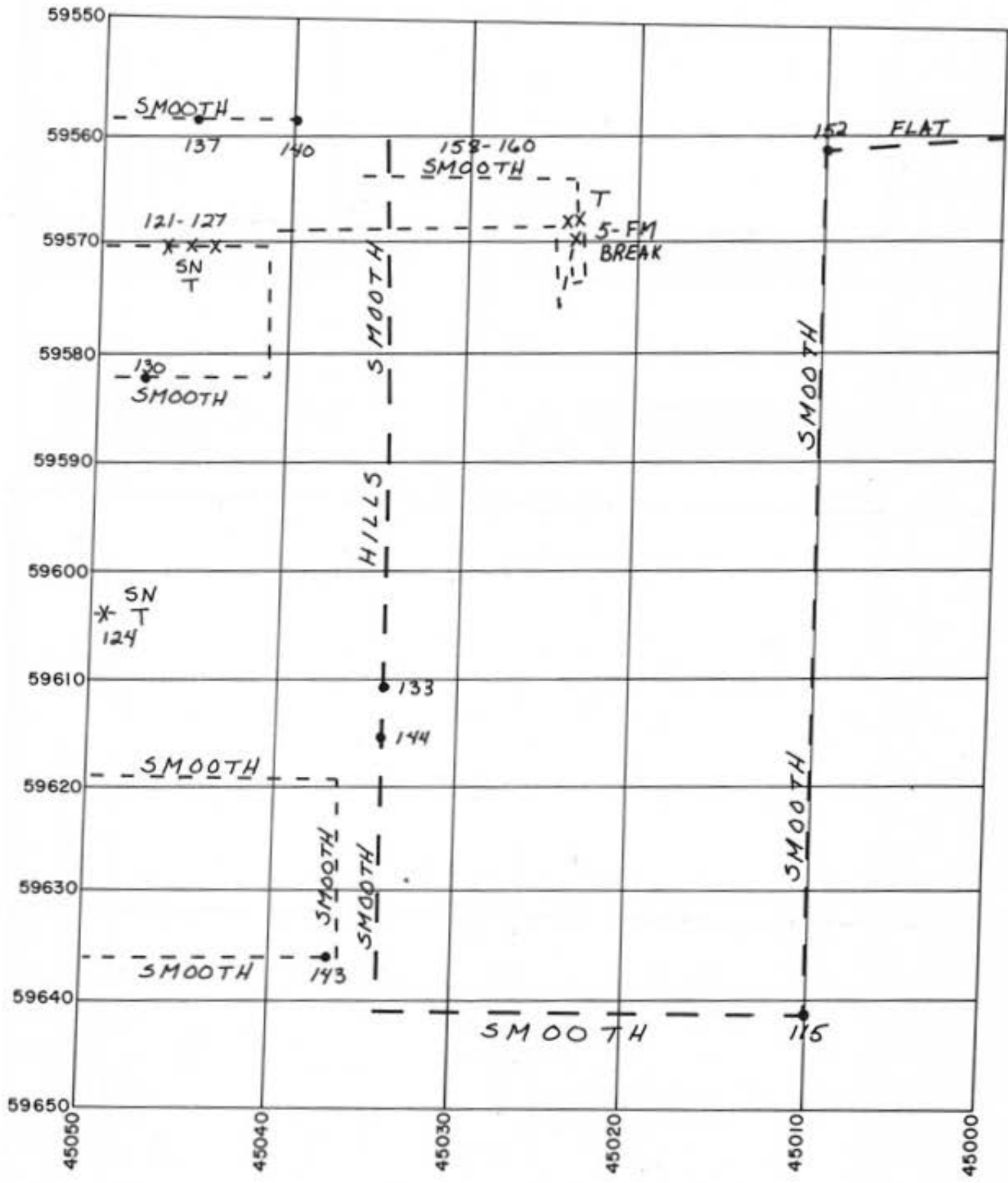
— —	<u>DELWARE II</u> track
- - - -	<u>LADY LISA</u> track
●	Depth reading (fathoms)
X	Fishing station
YE	Yellowedge grouper
SN	Snowy grouper
T	Tilefish
BT	Blueline tilefish
NC	No catch (of target species)

Loran C lines of position (7980 chain) in margins.

A-11

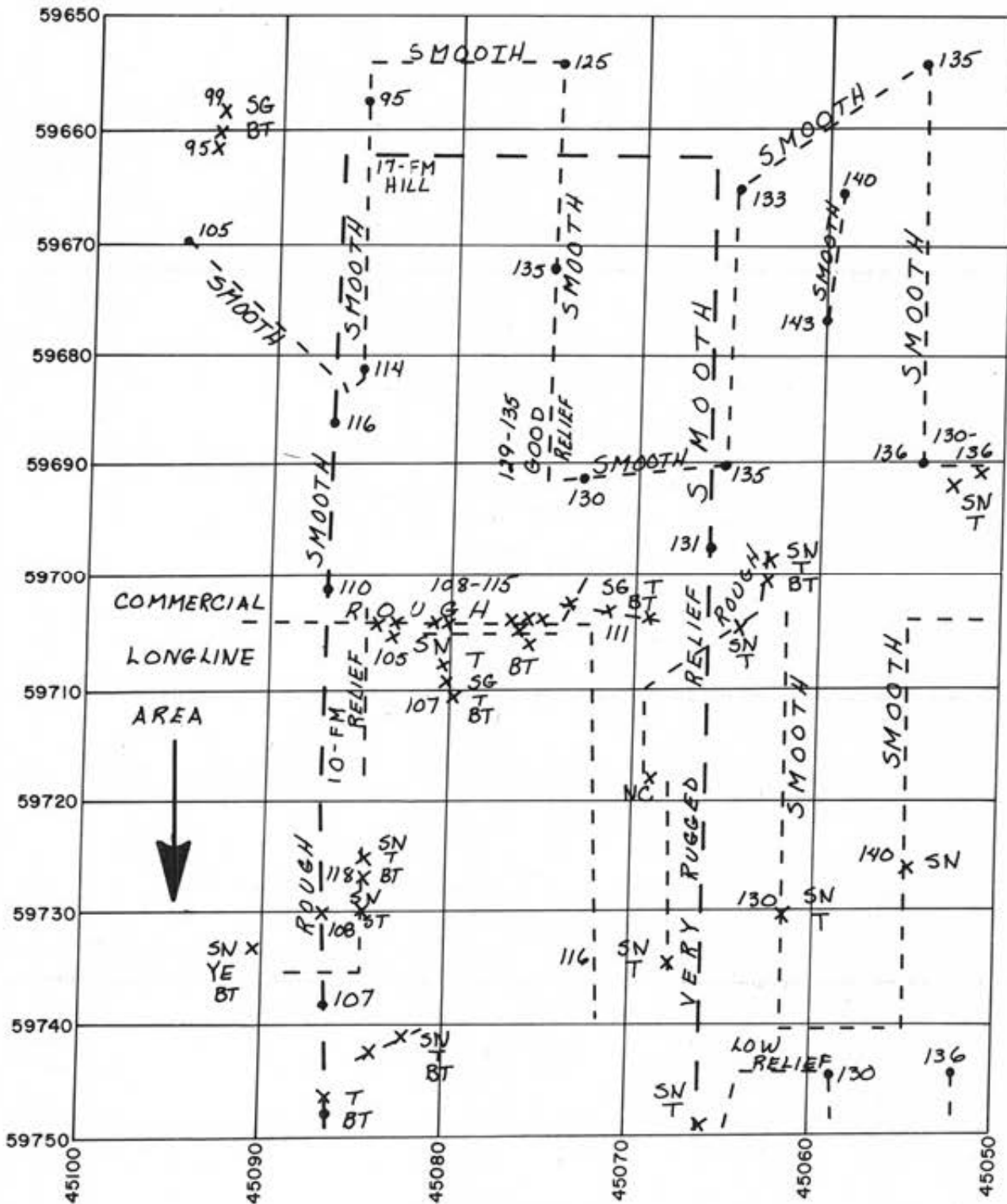


BLOCK 2



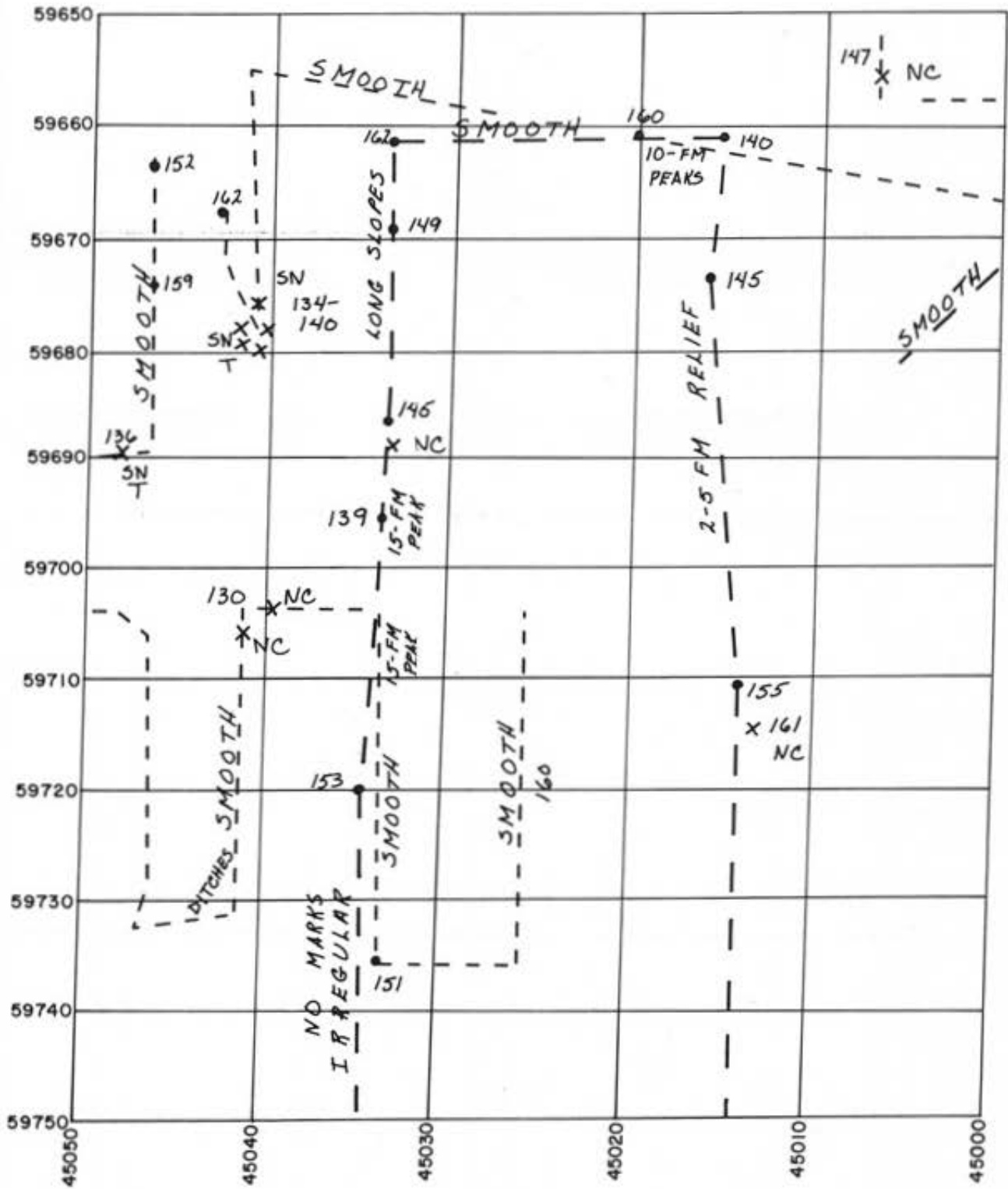
BLOCK 3



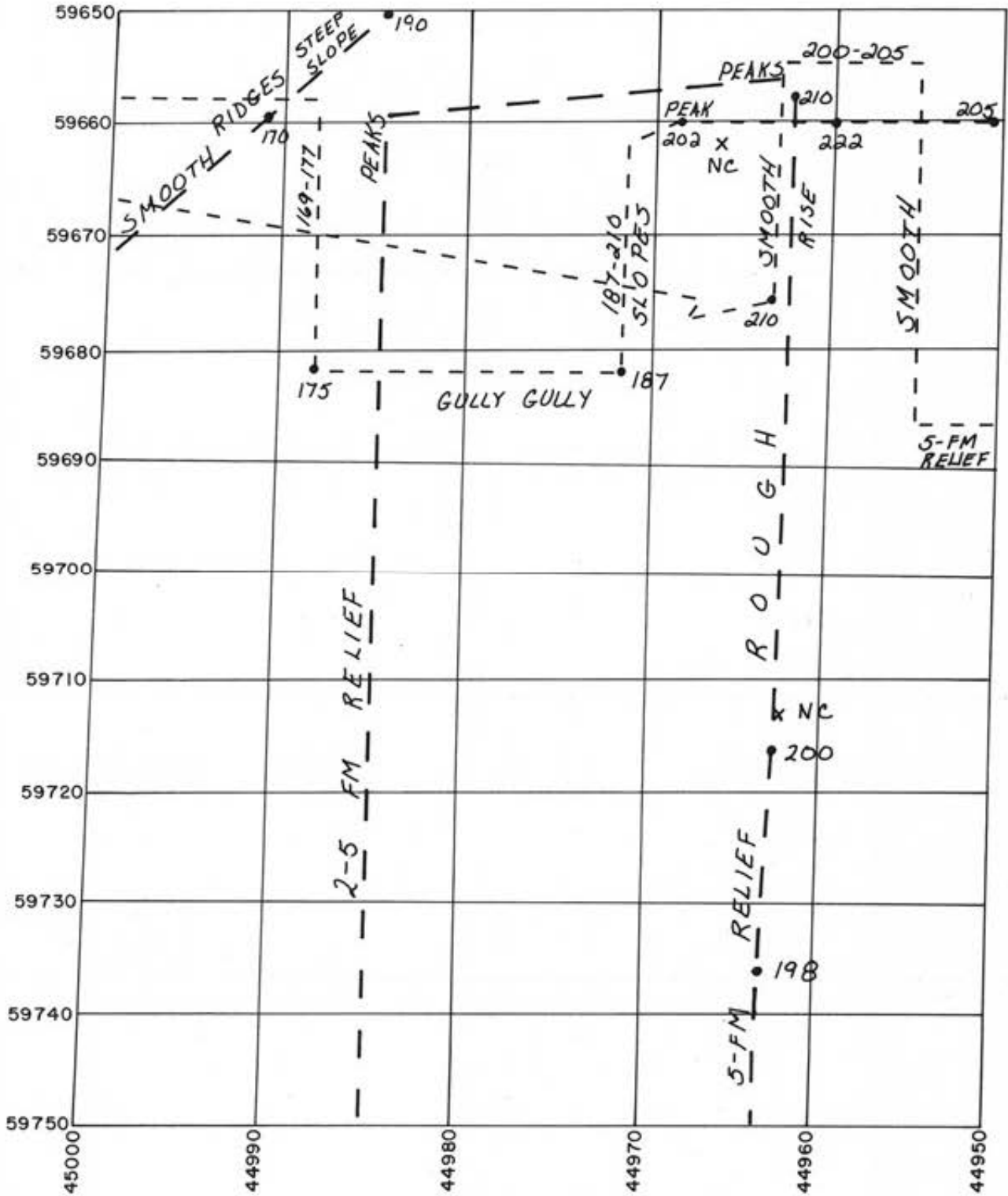


BLOCK 6

A-14

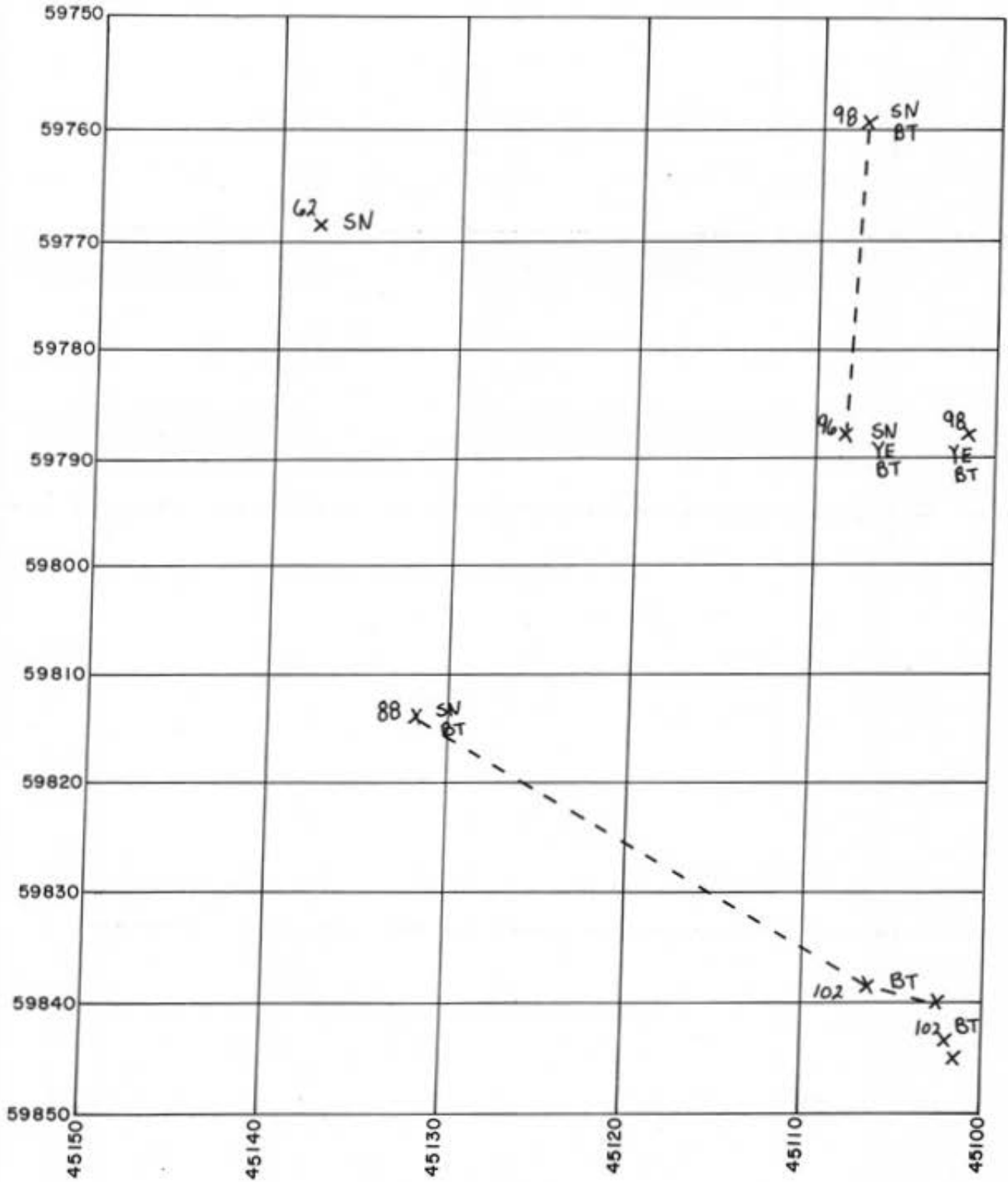


BLOCK 7

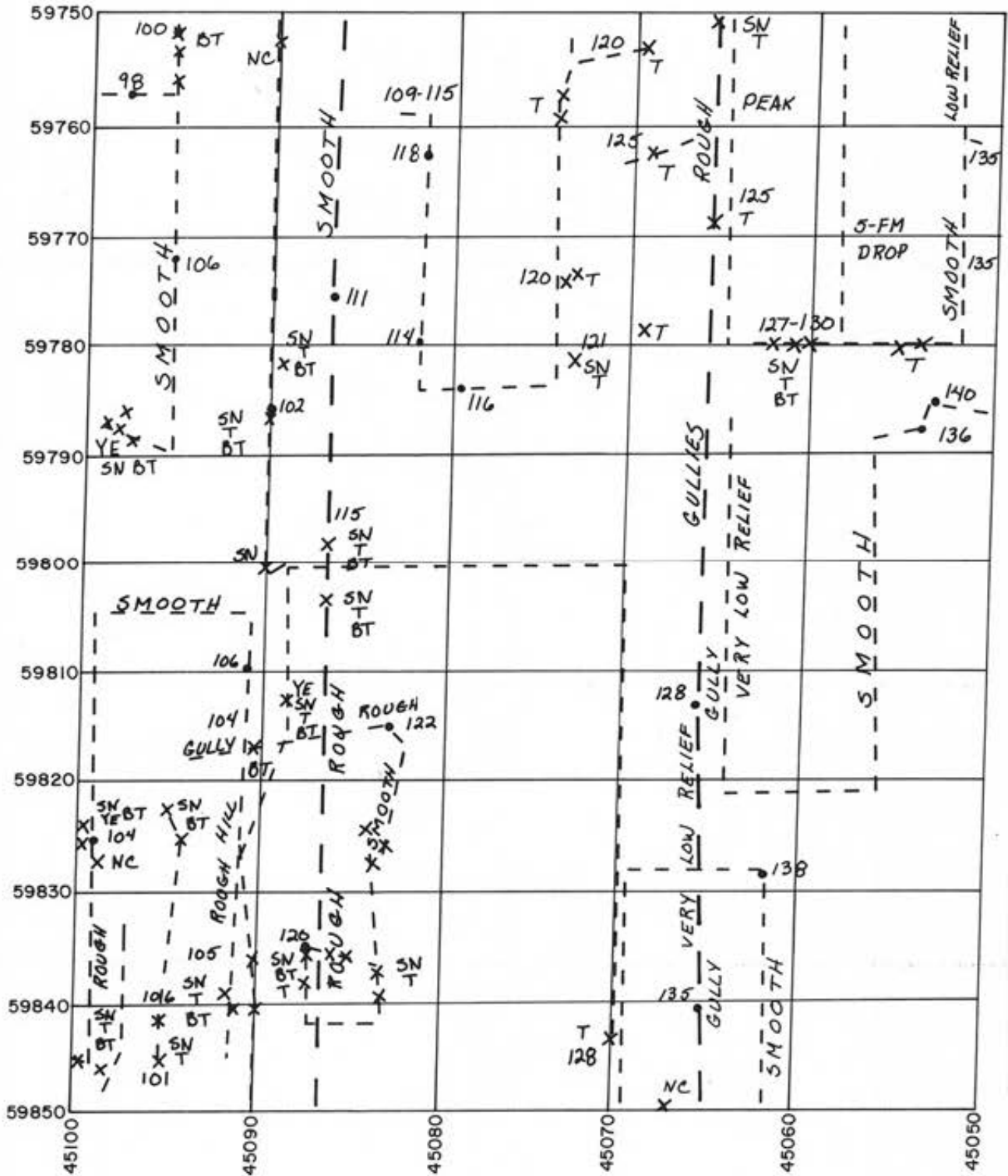


BLOCK 8

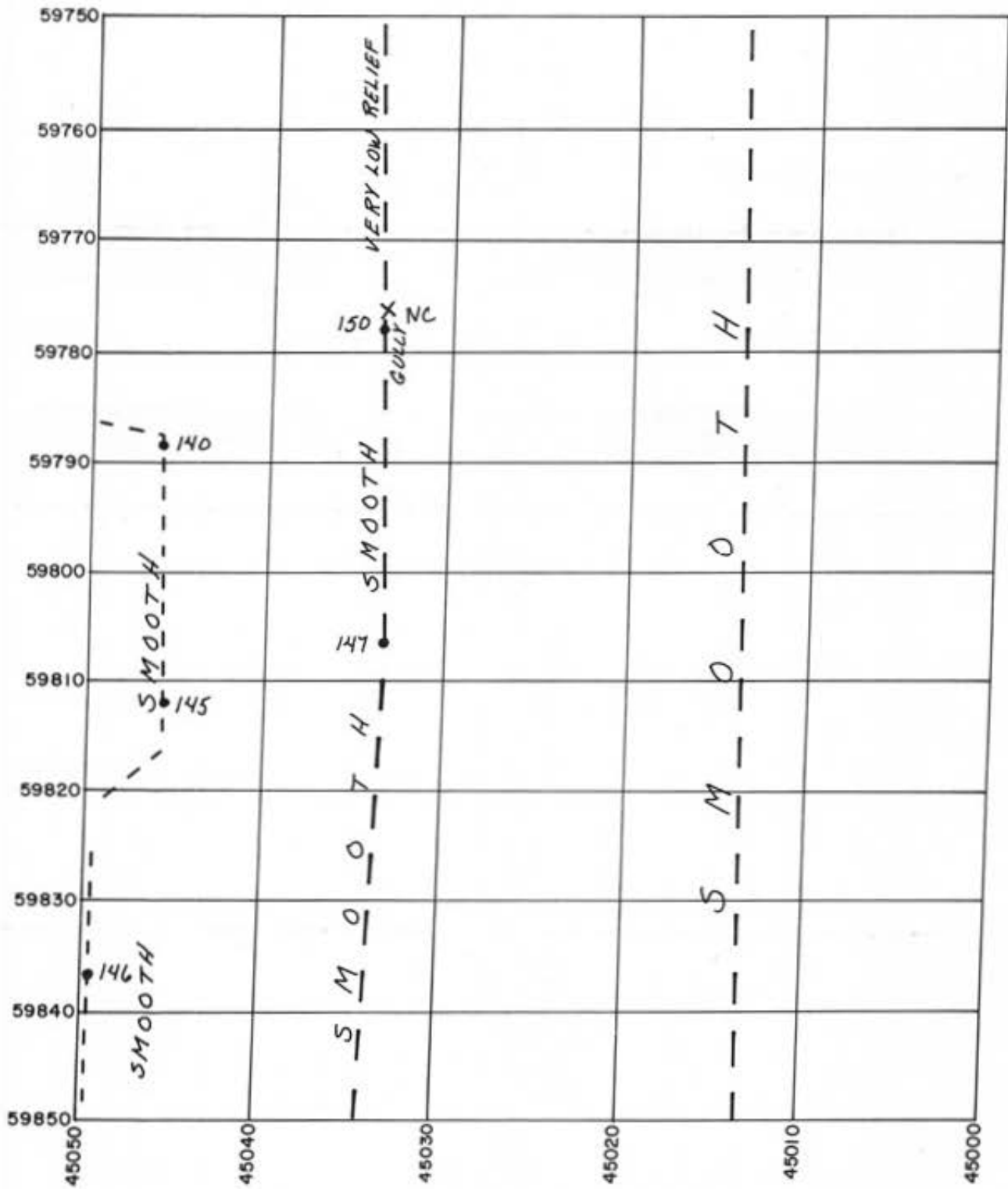
A-16



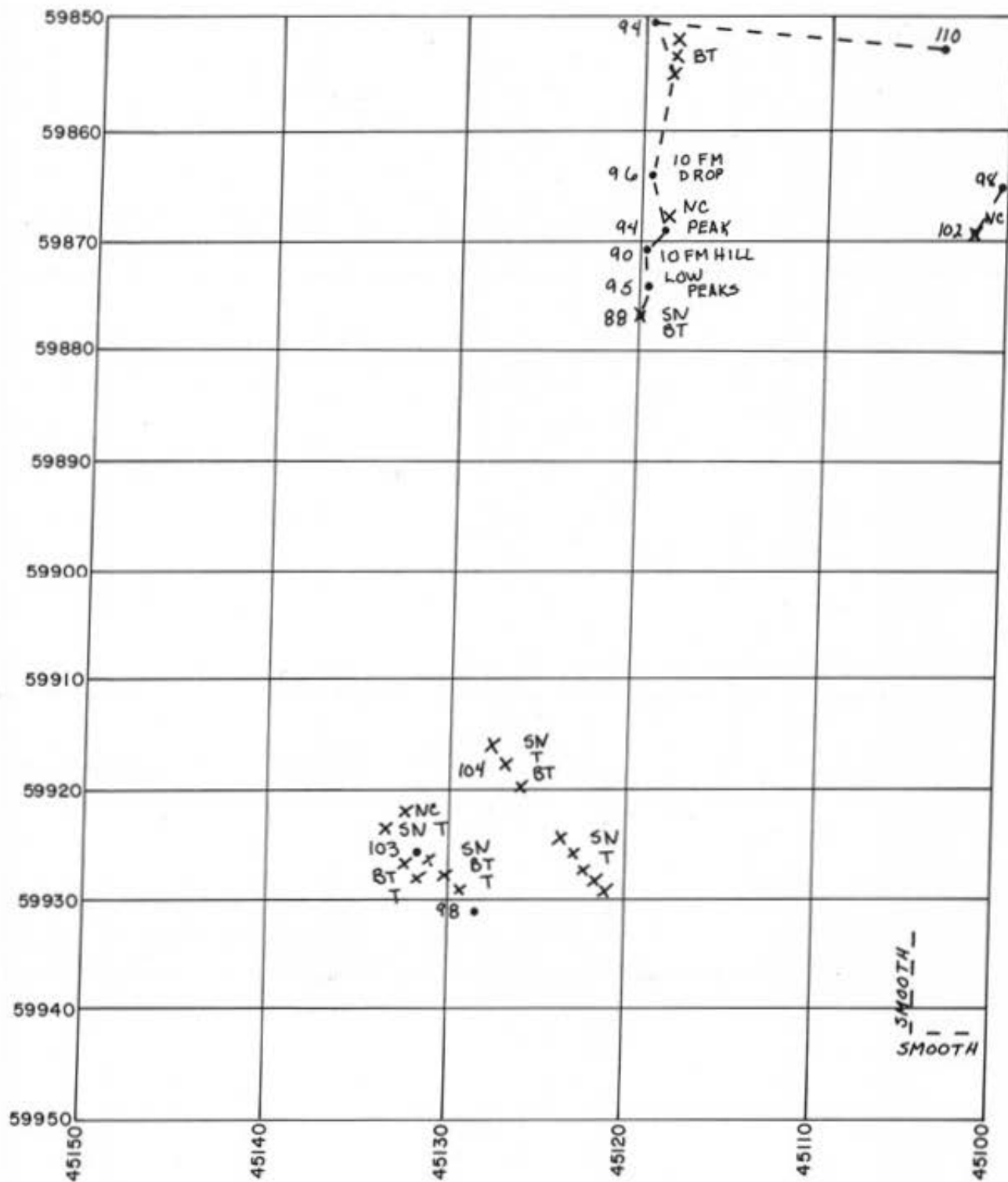
BLOCK 9



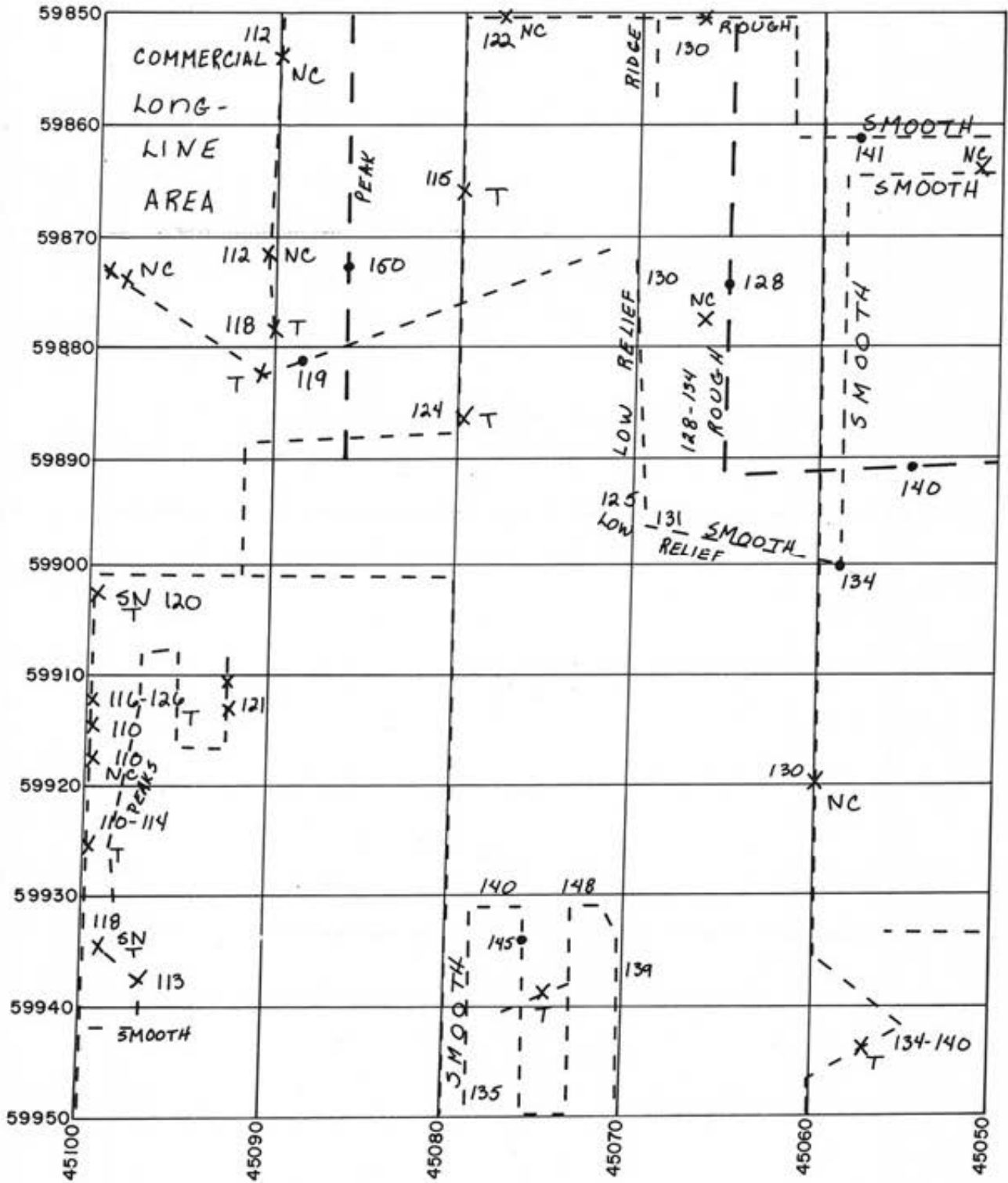
BLOCK 10



BLOCK II

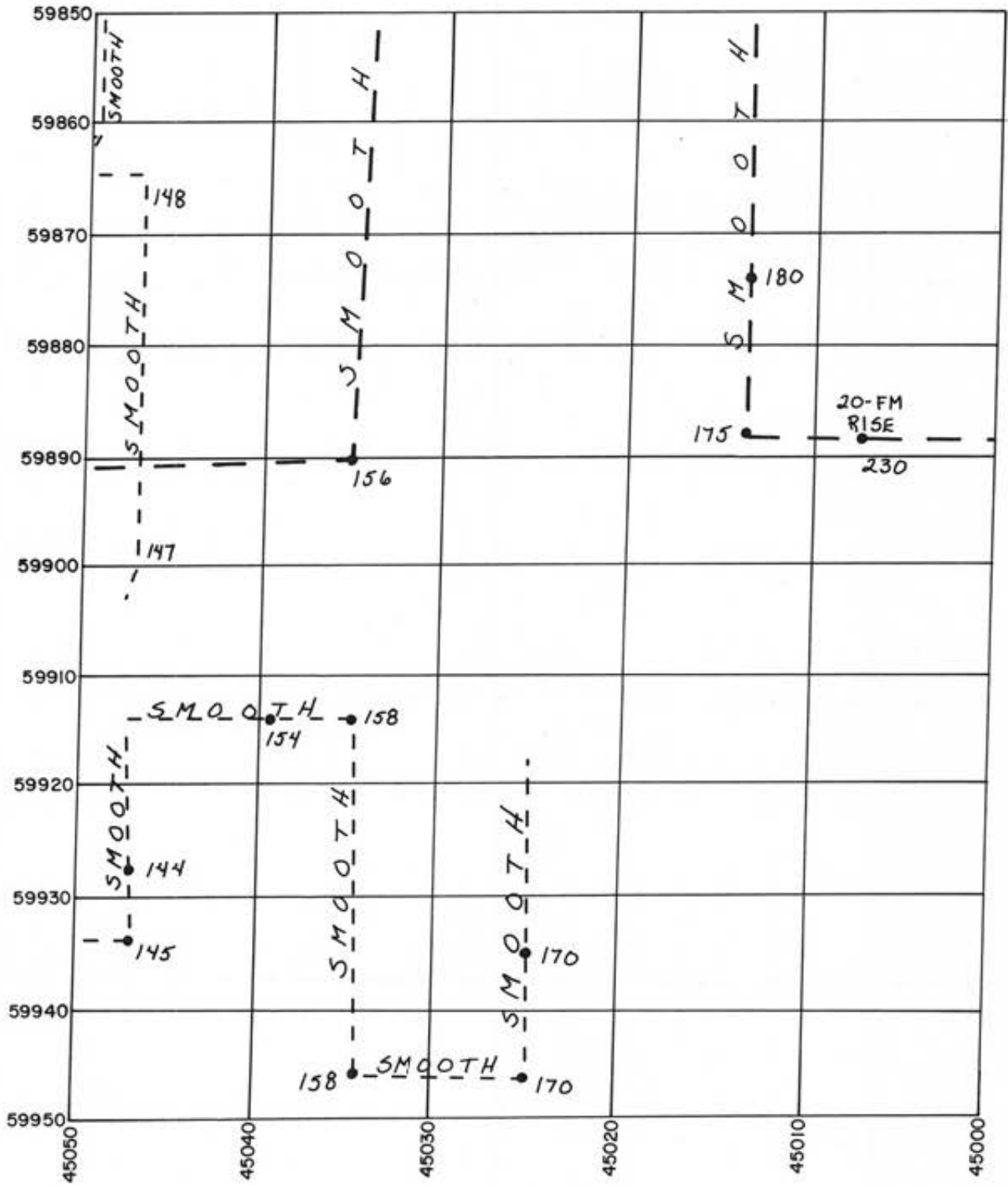


BLOCK 13



BLOCK 14





BLOCK 14