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SEASONAL AVAILABILITY AND DISTRIBUTION

OF

BENTHIC FISHES OF CHESAPEAKE BIGHT

by

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Summary of Project 3-5-D
Commercial Fisheries Research and Development Act

In considering the potential for expanding the Middle Atlantic fishery, Virginia Institute of Marine Science estimated the seasonal distribution and availability of benthic fishes on the 15,000 square miles of continental shelf between Cape Hatteras and Cape May. The survey, which started in the winter of 1966 and continued through the winter of 1968, was conducted in two phases. The work in 1966 was devoted to determining the seasonal distribution of the various kinds of fishes, especially those which appeared to be under-utilized. For this work a 45-foot semi-balloon shrimp trawl was employed to make 295 tows which were divided among the four seasons. In the second phase, conducted in 1967 and 1968, the objective was to estimate the quantity of fish potentially available to trawlers, should a market be developed. Availability is expressed in terms of the quantity of fishes that were caught by a specific trawl. We used an otter trawl, the Atlantic Western Model IV, which is a four-seam net having a headrope of 54 feet and a footrope of 78 feet. Stretched mesh sizes were 8 inches in the body, 6 inches in the extension, and 4 inches in the codend. Nearly 350 trawl tows were made. The net was fished from the SEA BREEZE, an 88 gross ton side trawler of 340 h.p. This work was supported by the Commercial Fisheries Research and Development Act, Project No. 3-5-D.

To estimate the quantity of fish available to the Atlantic Western trawl, we converted our catch in each one-hour tow to pounds per nautical mile, and finally to pounds (or tons) in the area covered by each of the several depth strata shown in Figure 1. Measurements of an Atlantic Western trawl by the BCF Exploratory Fishing and Gear Research Base at Gloucester, Massachusetts, indicated that the headrope was 9 to 11 feet above the bottom and that the mouth opening was 34 to 37 feet wide. In estimating the quantity of fish available to this trawl we have assumed a lateral mouth opening of 35 feet, thus neglecting any herding effect of the bridles and groundwires. We stress the point that our estimate is of quantity of fish available to a certain type net. Had we used other nets the estimates would be somewhat different. Nevertheless, the estimates are useful as order-of-magnitude indicators of quantity of fish potentially available.

The economic potential of the resources were considered by grouping the species into 3 categories: food fish, spiny dogfish and trash fish. The first category consists of those few species now caught by trawlers and marketed for human food, and which are caught in sufficient quantity to justify the task of separating them from the unsalable portion of the catch. Included are:

scup	*Stenotomus chrysops*
black seabass	*Centropristes striatus*
summer flounder	*Paralichthys dentatus*

butterfish	*Peprilus triacanthus*
Atlantic croaker	*Micropogon undulatus*
spot	*Leiostomus xanthurus*

The spiny dogfish, *Squalus acanthias*, is considered separately because it constitutes the major proportion of the catch and is a potential fishery resource. For lack of market it is at present a nuisance species which is avoided by fishermen.

All other species are lumped as "trash". In using this term we have for convenience adopted the existing terminology. This group of species is a significant protein resource for which markets should be developed. The composition of the trash changes seasonally. In winter important species include:

goosefish	*Lophius americanus*
spotted hake	*Urophycis regius*
red hake	*U. chuss*
silver hake	*Merluccius bilinearis*
northern searobin	*Prionotus carolinus*
rosette skate	*Raja garmani*
little skate	*R. erinacea*
winter skate	*R. ocellata*
clearnose skate	*R. eglanteria*
fourspot flounder	*Paralichthys oblongus*
windowpane flounder	*Scophthalmus aquosus*

In summer several species move northward. Remaining as important components of the trash are:

spotted hake	*Urophycis regius*
northern searobin	*Prionotus carolinus*
rosette skate	*Raja garmani*
clearnose skate	*R. eglanteria*

In deep water the fourspot flounder remains and in shallow water the large roughtail stingray *Dasyatis centroura* becomes important, not so much in numbers as in weight.

Temperature patterns of the bottom waters (Fig. 2) indicate that temperature changes little from summer to winter on the outer shelf, but that nearshore waters are warm in summer and cold in winter. Eddies from the Gulf Stream produce an irregularly changing thermal pattern in the section from Cape Hatteras to about 36° N latitude.

Change in seasonal distribution of the fishes results from two general migratory patterns. One group of fishes migrates to higher latitudes in summer and goes south in winter. The other pattern is primarily a movement inshore in summer and offshore in winter, although some north-south movement may be involved also. Some species move little between one season and another. Migratory patterns of the more numerous under-utilized species are described below.

Spiny dogfish are strongly migratory, being the most abundant fish in the Chesapeake Bight during winter and completely deserting the area for more northern waters in the summer (Fig. 3). Goosefish (allmouth) have a similar migratory pattern (Fig. 4).

The northern searobin, probably the second most abundant bottom species in Chesapeake Bight moves inshore in summer and offshore in winter (Fig. 5). The searobin population probably has a north-south component to its migration also, but our data are not conclusive on that point. The red hake and silver hake (whiting) also move inshore in summer and offshore in winter (Figs. 6, 7). The fact that these two species are more abundant in winter than in summer indicates that they have a north-south component to their migration also. Spotted hake, on the other hand, seem to move mostly inshore and offshore with but little north-south movement (Fig. 8).

Two species of flatfish, windowpane flounder and fourspot flounder, are essentially nonmigratory (Figs. 9 and 10).

Although an otter trawl is not notably effective at catching sea herring and mackerel, especially at night, we noted the rather general occurrence of these two species throughout the Chesapeake Bight in winter. They were not caught in summer (Figs. 11, 12).

In the winter (February and March) of 1967 an estimated 234,000 metric tons were available to our trawl. A greater quantity of fish of all categories was found in the northern sector than in the southern and the overwhelming abundance of spiny dogfish, which comprised 70% to 80% of the available quantity of fishes was notable (Fig. 13). A plot of catch-rates in pounds/mile, indicates that in the north the most productive fishing for food fish, trash fish, or dogfish was in the deepest stratum (Fig. 14).

The shoal water yielded trash fish and dogfish but lacked food fish. In the south, dogfish were most concentrated in depths of 11 to 20 fathoms, trash fish in 21 to 40 fathoms, and food fish were most abundant deeper than 40 fathoms.

Because rough seas restricted our sampling in winter 1967, we sampled again in 1968 (Fig. 15). The total estimated quantity of fish, 340,000 tons, was greater than in the previous winter, but other features were similar. The greatest quantity of fish was in the northern sector. Spiny dogfish were distributed as in 1967 in the south, but in the north were most abundant in mid-depths rather than in deep water. Similarly, the major change in catch rates in the north was a shift in the spiny dogfish (Fig. 16). Food fish were most abundant near the edge of the shelf.

In spring the northward migration of spiny dogfish was apparent (Fig. 17). Only 500 tons remained in the southern sector and about 4,000 in the northern. The total quantity of trash species declined somewhat in both sectors. Food fish became more abundant, especially in the south, but were mostly small. Some inshore movement of both trash fish and food fish was apparent (Figs. 17, 18).

By summer (Fig. 19) the spiny dogfish had almost deserted the area, there being none in the southern sector, and only 400 tons in the northern. Other species from the outer shelf had also gone north. Both the greatest quantity and greatest concentration were in the shoal water (Fig. 10).

Fall (late November and December) brought the return of the spiny dogfish and other species from the north and the offshore movement of the species that had been in shoal waters in summer (Fig. 21). Again the densest concentration of food fish was near the edge of the shelf (Fig. 22).

PROSPECTS FOR EXPLOITATION

The fishing industry can be broadly separated into three parts: recreational, food, and industrial sectors. The first is only slightly involved here. The second now produces and markets fish for direct human consumption. The last produces fish meal, oil, and associated products that are used in animal feeds and in a variety of industrial activities. The popular food fishes which exist in the Chesapeake Bight are now being harvested at the maximum level, or perhaps beyond, catches of scup, sea bass and flounder having declined recently. The trash fish and spiny dogfish are used very little, but they are good sources of protein and markets should be developed.

The industrial fishery is urgently in need of additional resources. In some recent years the domestic fishing industry has been able to supply no more than 25% of the domestic demand for fish meal, with the remainder of the market being met by imports. The question of whether trash fish and spiny dogfish of the Chesapeake Bight can be used by the industrial fishery cannot be answered unequivocally at present. The spiny dogfish, the species comprising 70 to 80% of the available quantity of fish in winter, is without a domestic market either as food or as an industrial fish. It is a desirable food fish in European markets, but export is not economically feasible [Holmsen, Andreas A. 1968. Harvesting and processing dogfish (Squalus acanthias), University Rhode Island Dept. Food & Resource Economics, Occasional Paper 68-275]. At least two problems must be solved before dogfish can be used extensively in an industrial fishery. A method must be developed to handle them efficiently in large quantities. Their large size and tough, rough skin are not compatible with the machinery now in use. Also, urea, a constituent of the blood, is undesirable in poultry feed where fish meal is now used. Either the urea must be removed or a new market must be developed. Perhaps shark meal could be used in cattle feed, since ruminants metabolize urea. Several technological laboratories are attempting to solve problems that presently restrict the use of dogfish.

Although the population of spiny dogfish is large, the reproductive potential of the species is not great, and the sustainable annual yield from this stock might not be as great as the large population would suggest. Probably the population could be fished down to a low level in a brief period of time. Perhaps reduction of the population would be desirable since the species is a nuisance to the existing fisheries. Certainly the reduction of a predator and competitor of such overwhelming dominance would provide an interesting opportunity to observe the responses of prey species and competing predatory species.

Trash fish appear to be sufficiently abundant to sustain a fishery and can be handled by existing machinery, although some modification may be desirable. The major problems seem to be to reduce the cost of catching the fish and to produce meal of constant composition. In winter an additional problem is the rather general occurrence of spiny dogfish along with trash fish. Culling them from the catch is expensive. Increased use of benthic fishes in Chesapeake Bight is feasible but spiny dogfish will be an impediment unless they can be used profitably.

SUMMARY

The fish biomass available to the Atlantic Western trawl IV was estimated at 340,000 tons in winter 1968 consisting of 61,000 tons of trash fish, 273,000 tons of spiny dogfish, and 6,000 tons of food fish (Table 1). In the winter of 1967 the quantity was less, 234,000 tons, but the proportions were about the same: trash fish, 43,000 tons; spiny dogfish, 186,000 tons; food fish, 4,000 tons. In spring 1967 the estimate of 60,000 tons was comprised of 46,000 tons of trash fish, 4,000 tons of spiny dogfish,

and 10,000 tons of food fish. In summer the estimate was 58,000 tons of which 52,000 was trash fish and 6,000 was food fish. Spiny dogfish were absent. In the fall of 1967 the estimate of 356,000 tons was composed of 77,000 tons of trash fish, 257,000 tons of spiny dogfish, and 22,000 tons of food fish. These estimates exclude pelagic fish such as herring, river herring, mackerel, and round herring which occur in some quantity, at least seasonally.

The seasonal change in both kinds and quantities of fish available results from migrations. In winter deeper waters tend to be more productive, but in summer the water shoaler than 10 fathoms has the largest quantity of under-utilized bottom fish.

Chesapeake Bight contains significant quantities of fish that are not being utilized. Most abundant are spiny dogfish, searobins, and hakes. Development of markets for these would enhance the fisheries of the area.

TABLE I. AVAILABLE FISH BIOMASS IN CHESAPEAKE BIGHT (METRIC TONS)

SEASON	NORTH	SOUTH	TOTAL
WINTER 1968	204,960	134,922	339,882
WINTER 1967	161,112	72,971	234,083
SPRING 1967	36,843	23,271	60,114
SUMMER 1967	28,327	29,564	57,891
FALL 1967	173,404	182,120	355,524

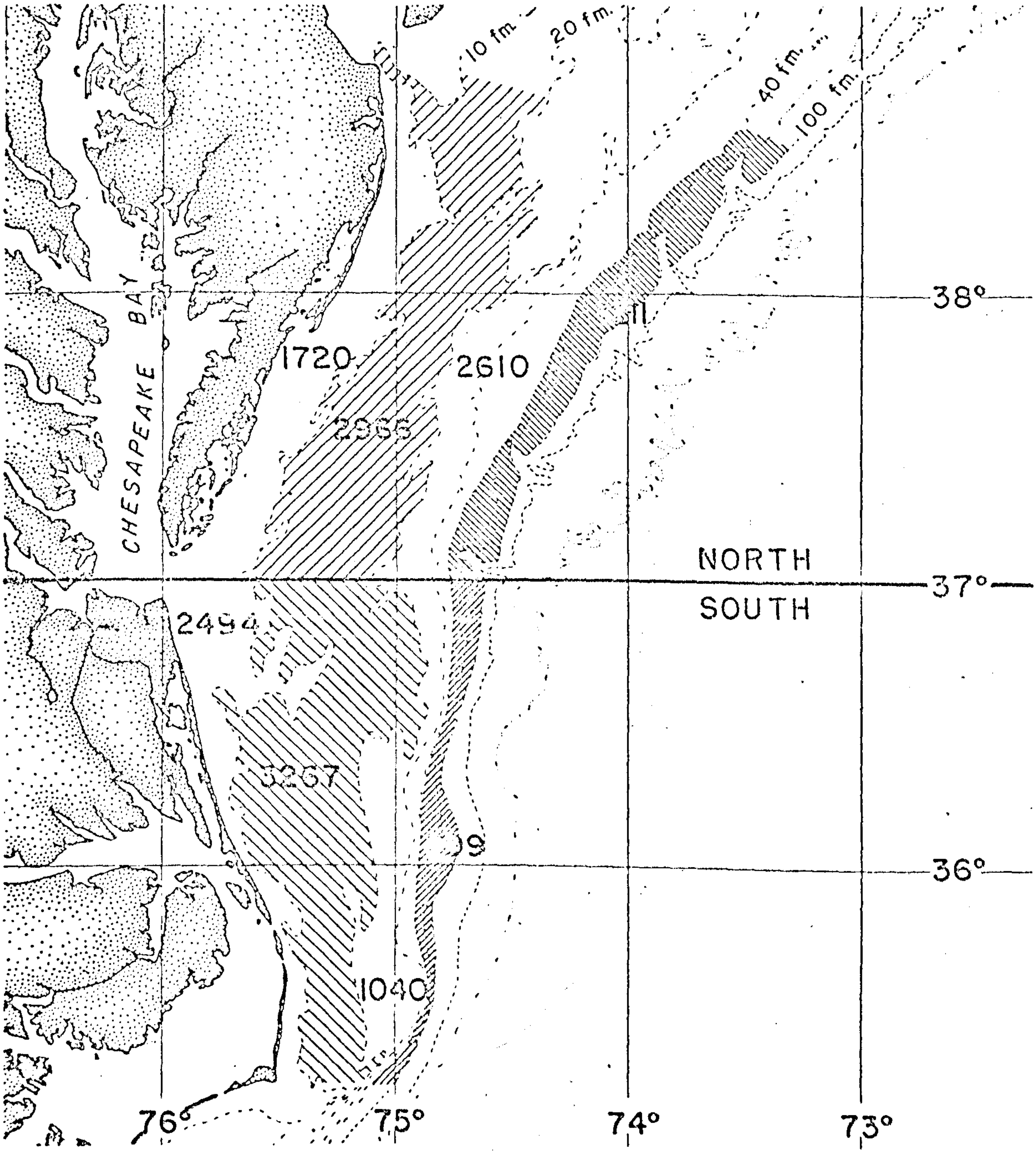

Figure 1. Area, in square nautical miles, of the depth strata used in estimating the availability of benthic fishes in Chesapeake Bight.

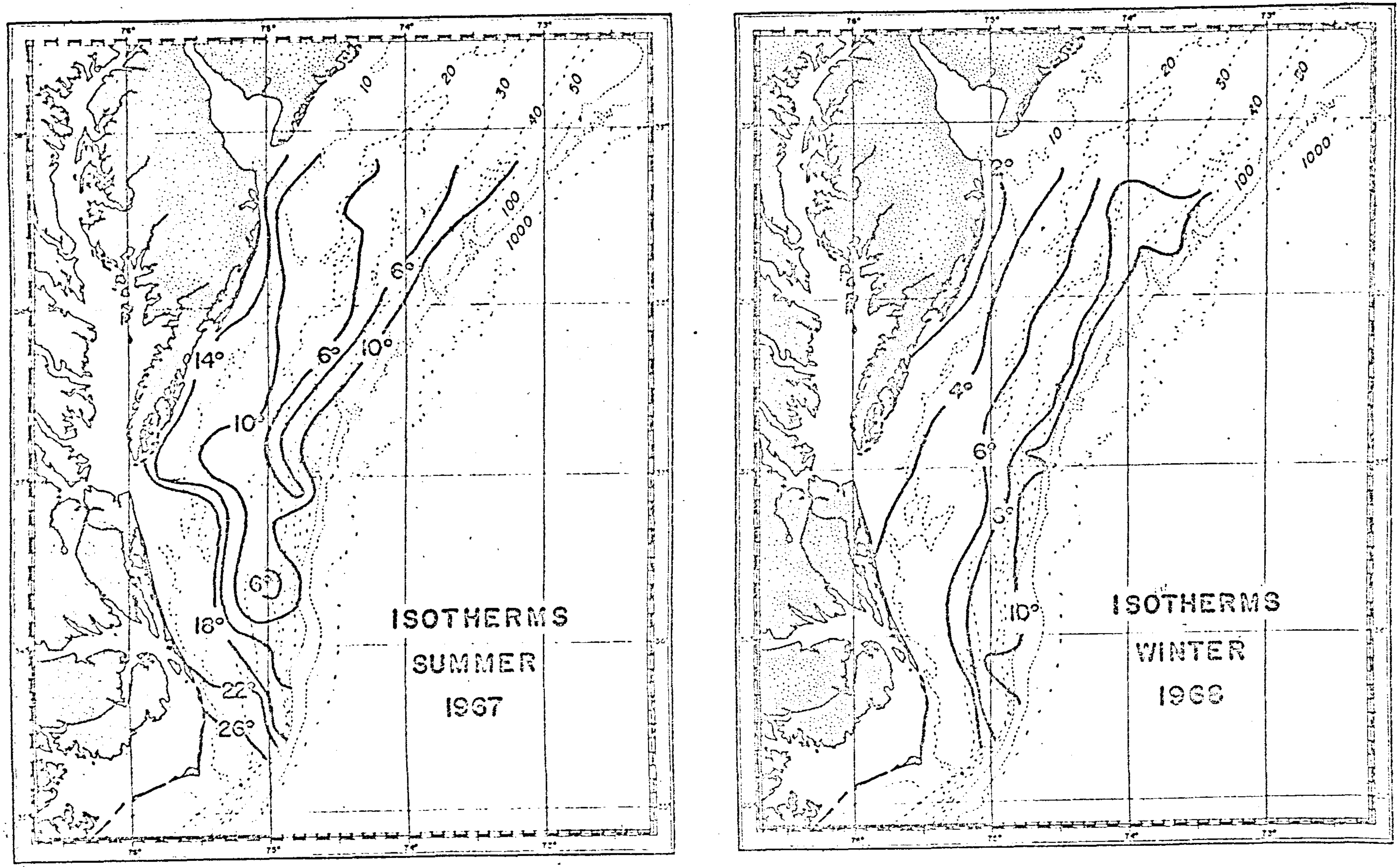

Figure 2. Thermal pattern of the bottom waters of Chesapeake Bight.

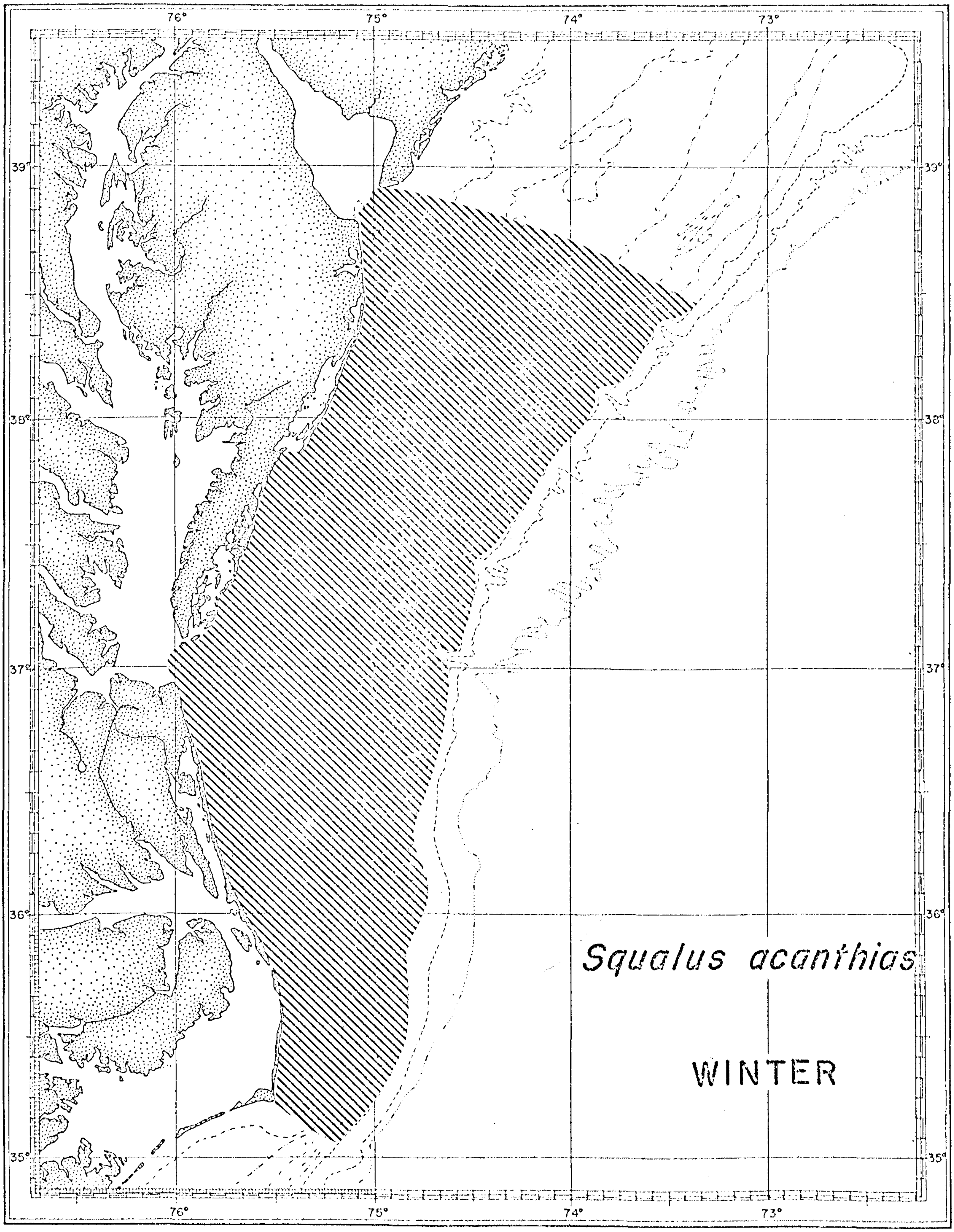

Fig. 3. Distribution of the spiny dogfish.

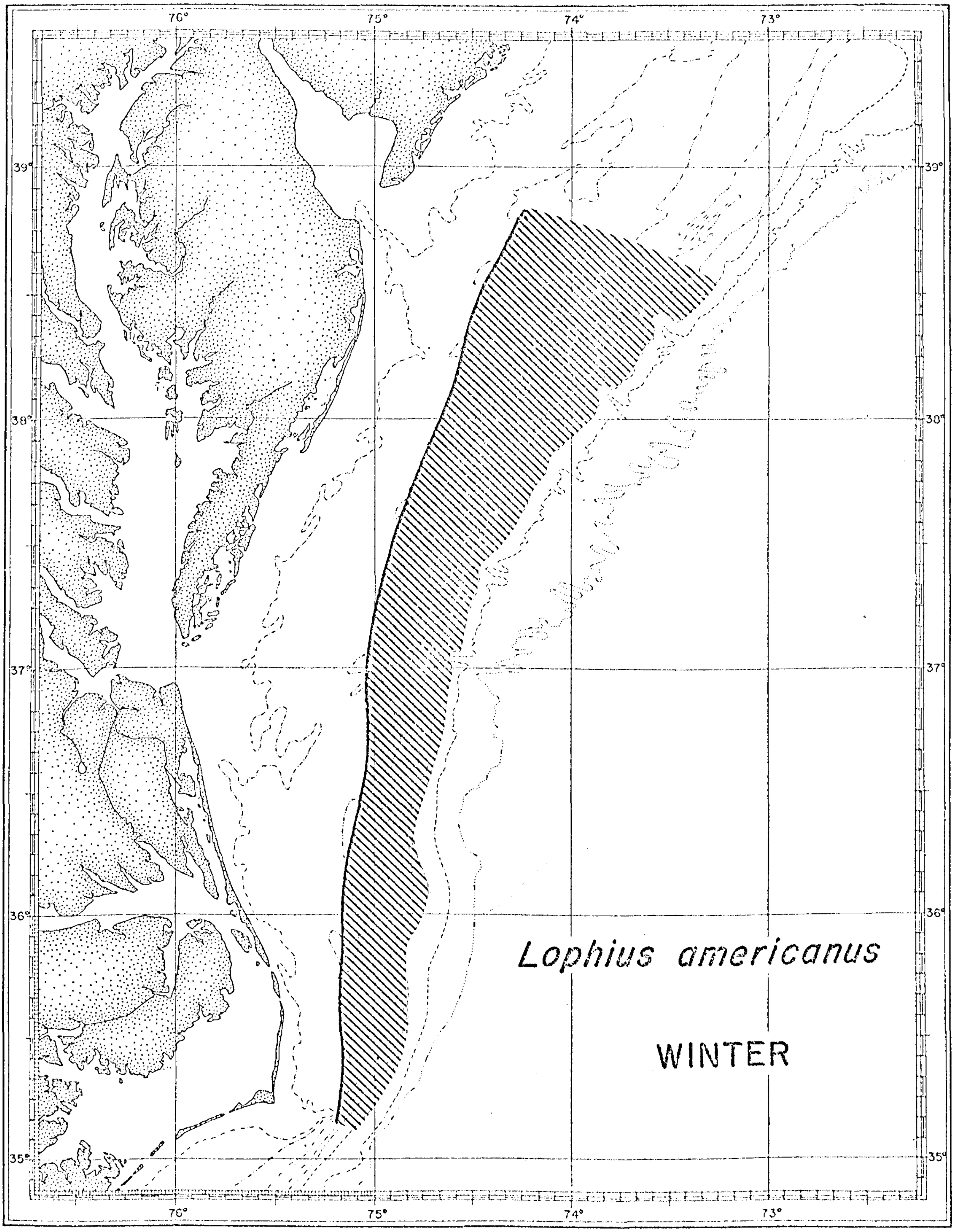

Fig. 4. Distribution of the goosefish.

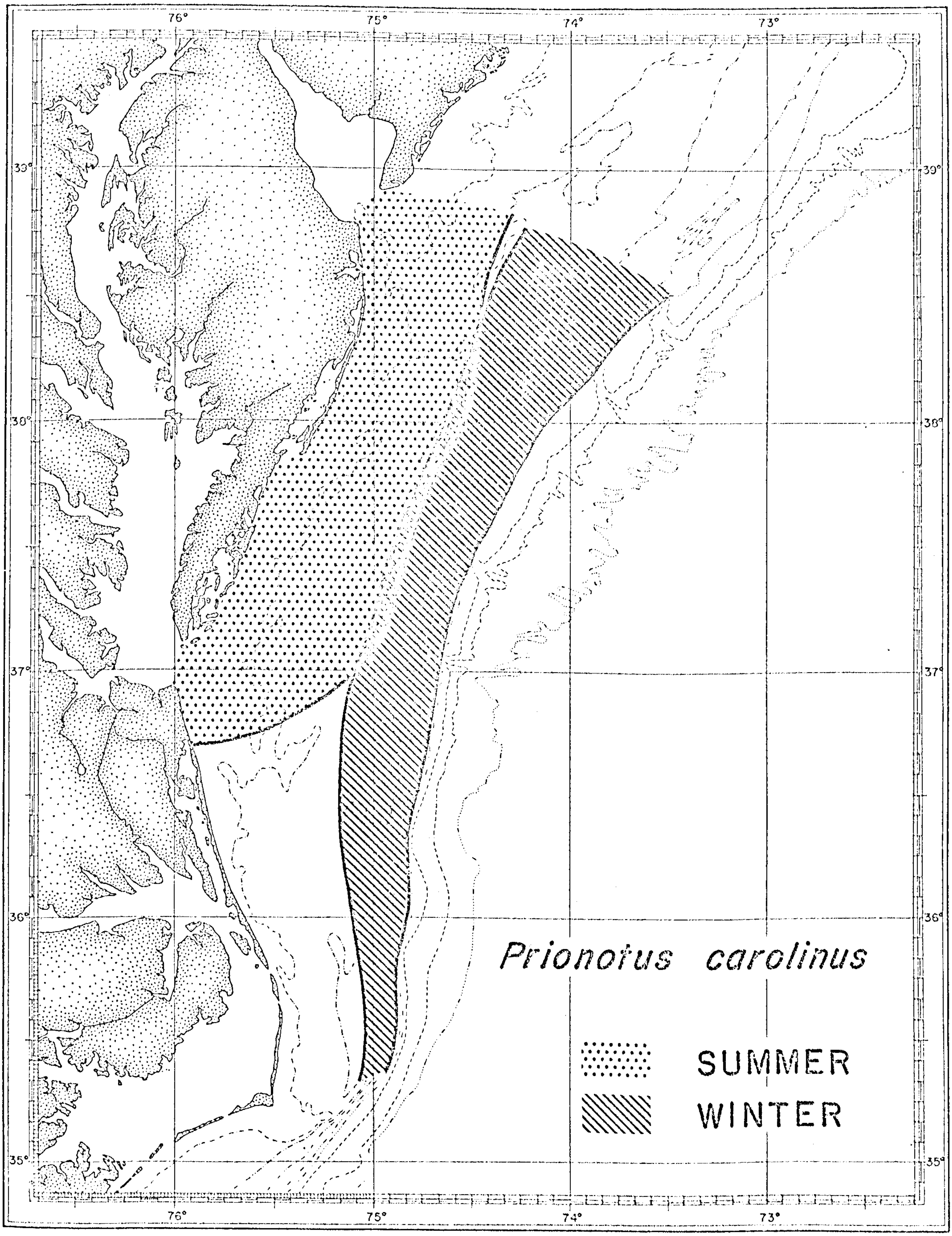

Fig. 5. Distribution of the northern searobin.

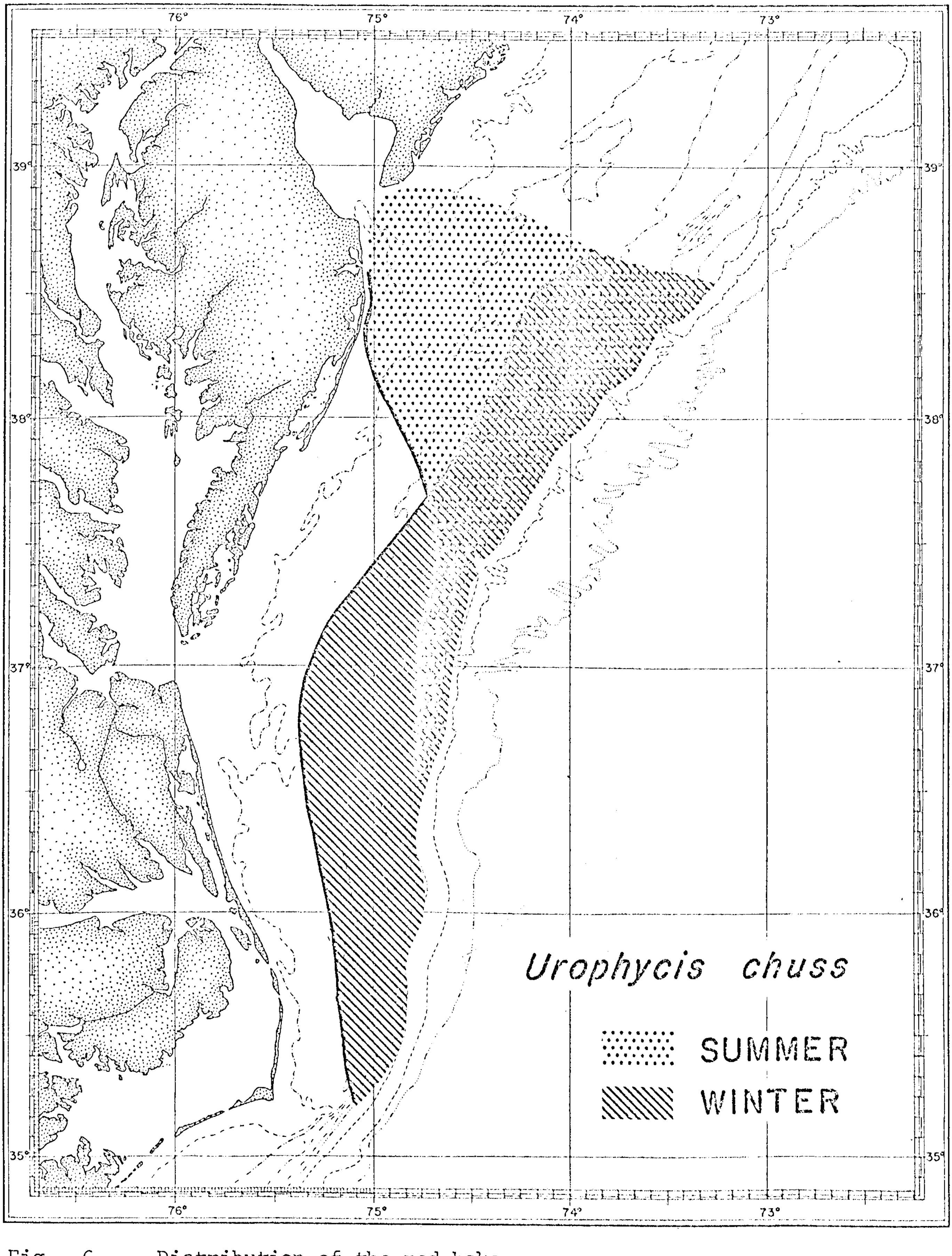

Fig. 6. Distribution of the red hake.

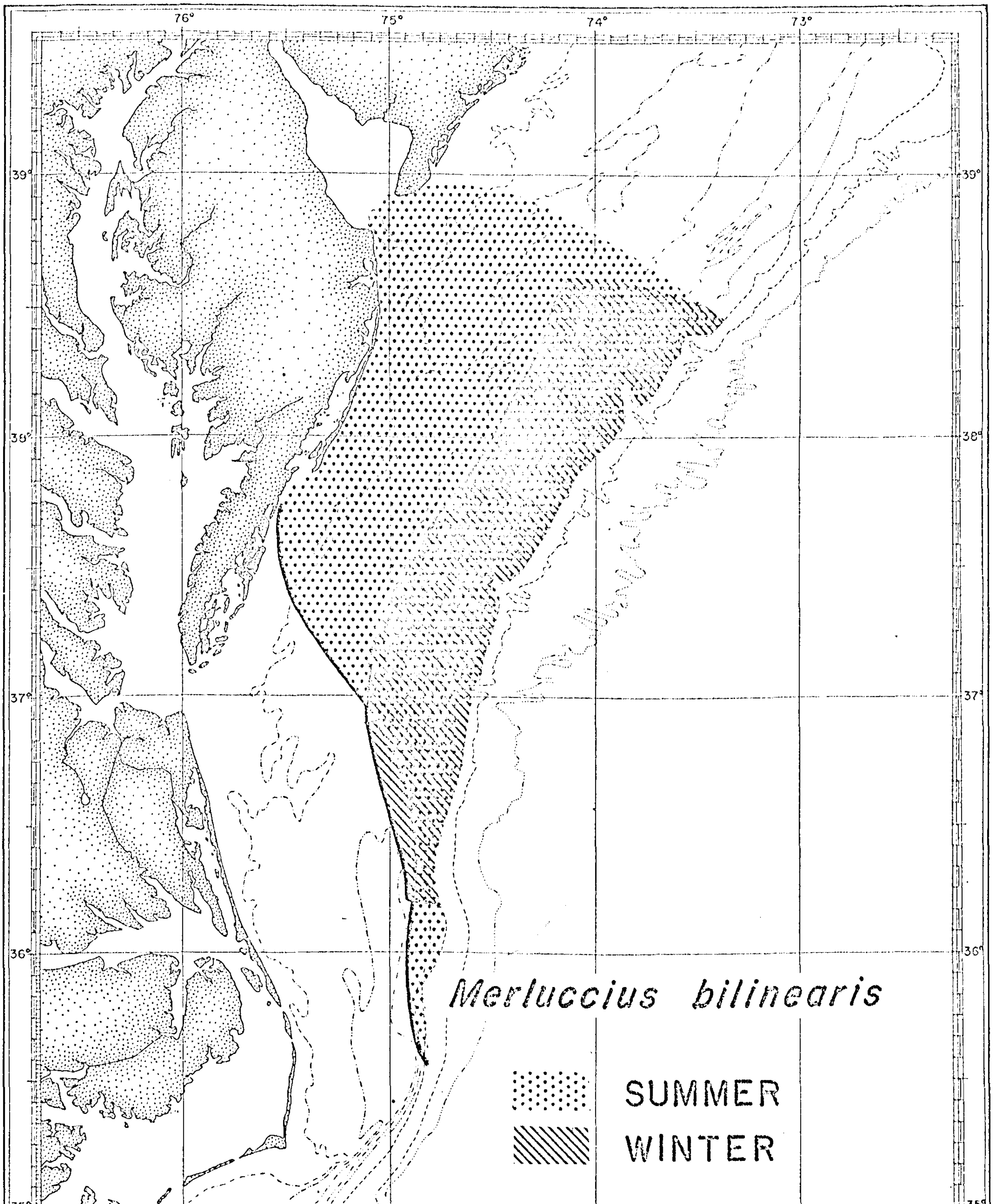

Fig. 7. Distribution of the silver hake.

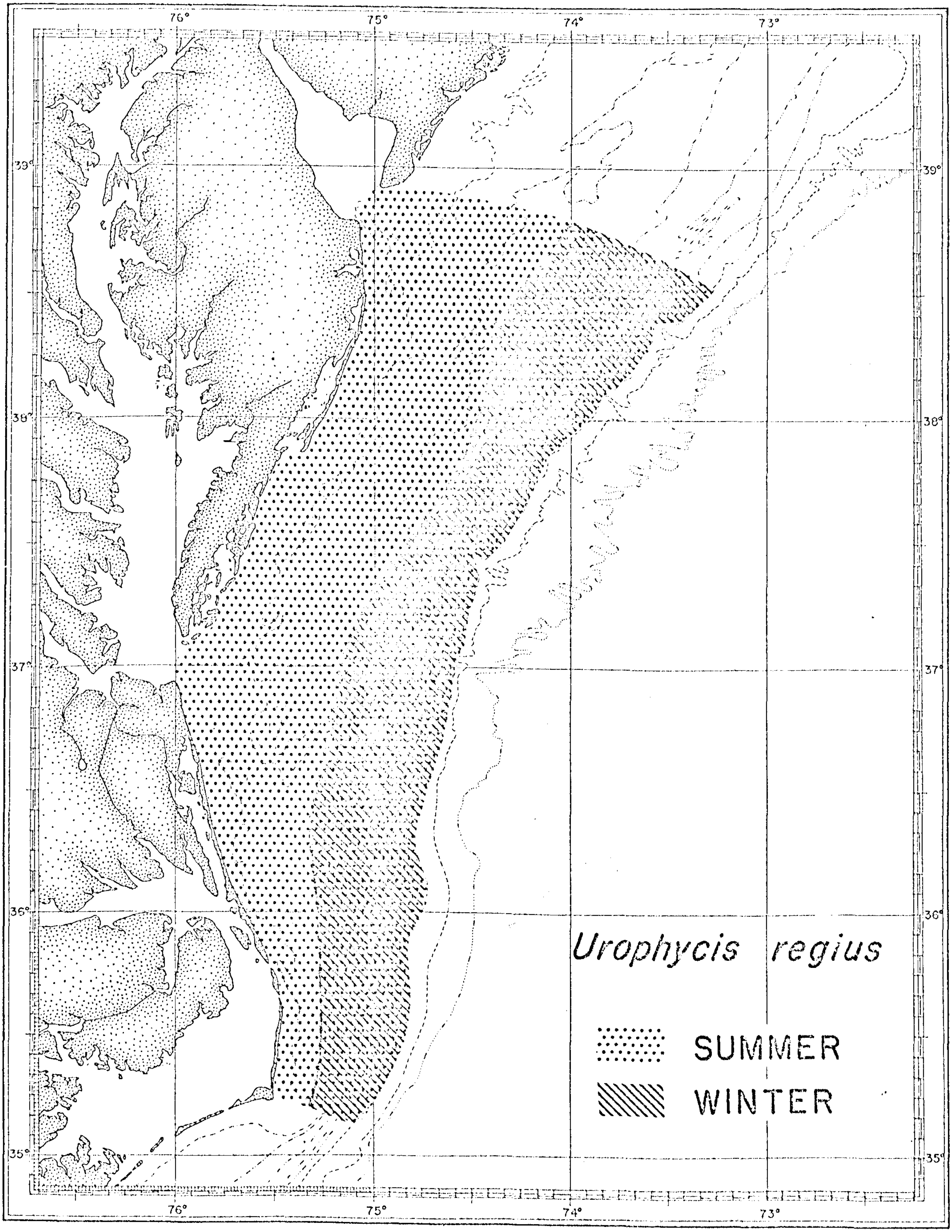

Fig. 8. Distribution of the spotted hake.

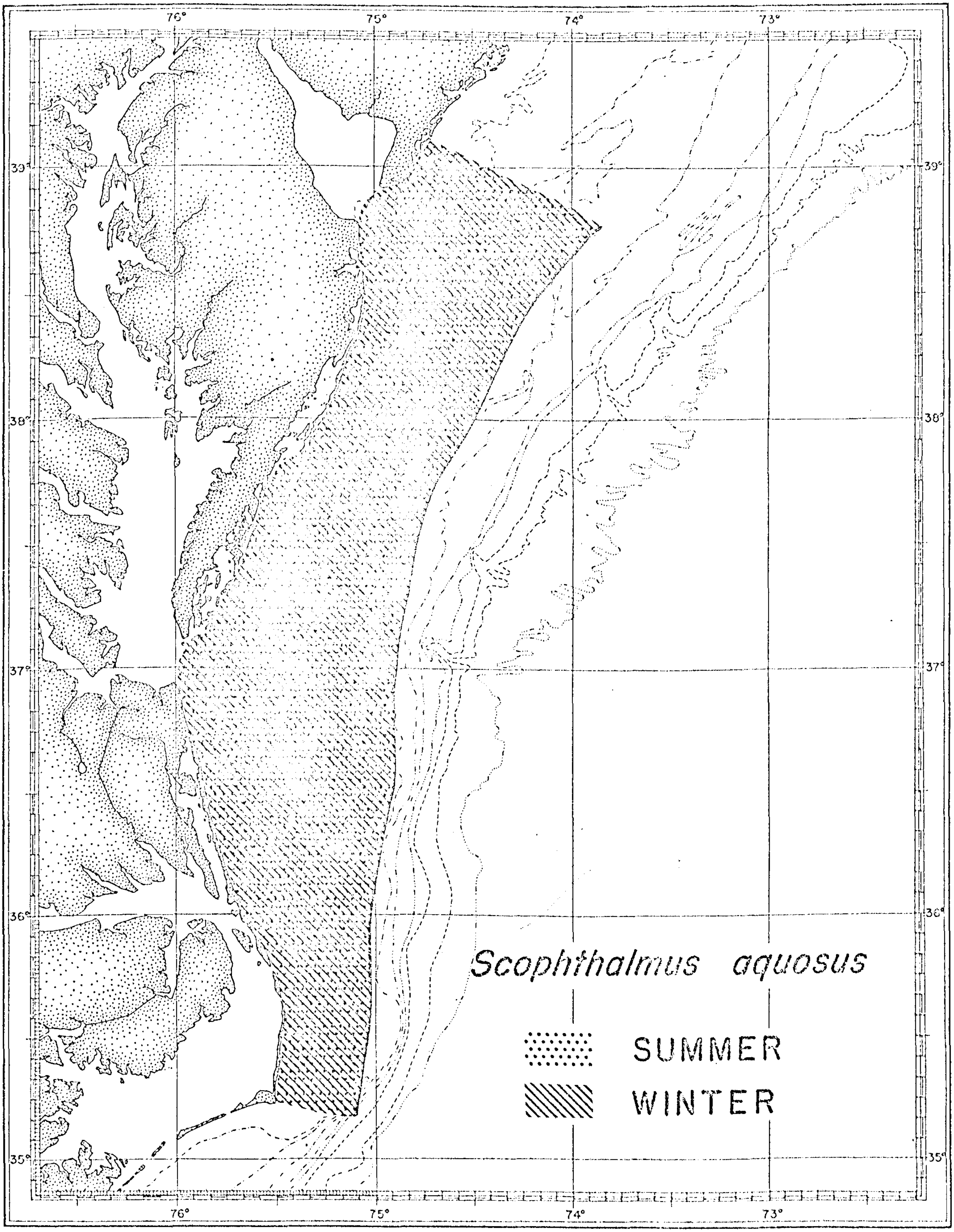

Fig. 9. Distribution of the windowpane flounder.

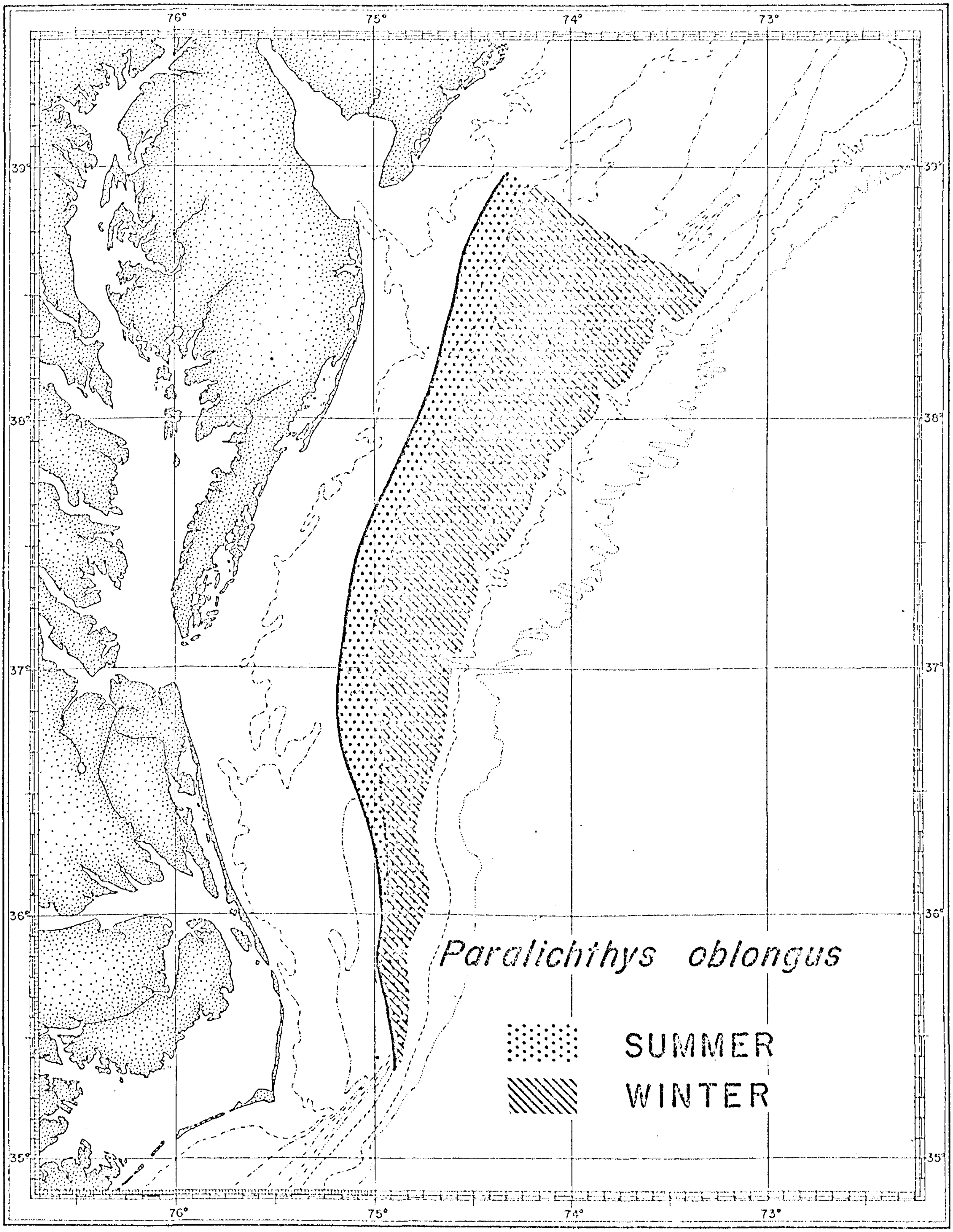

Fig. 10. Distribution of the fourspot flounder.

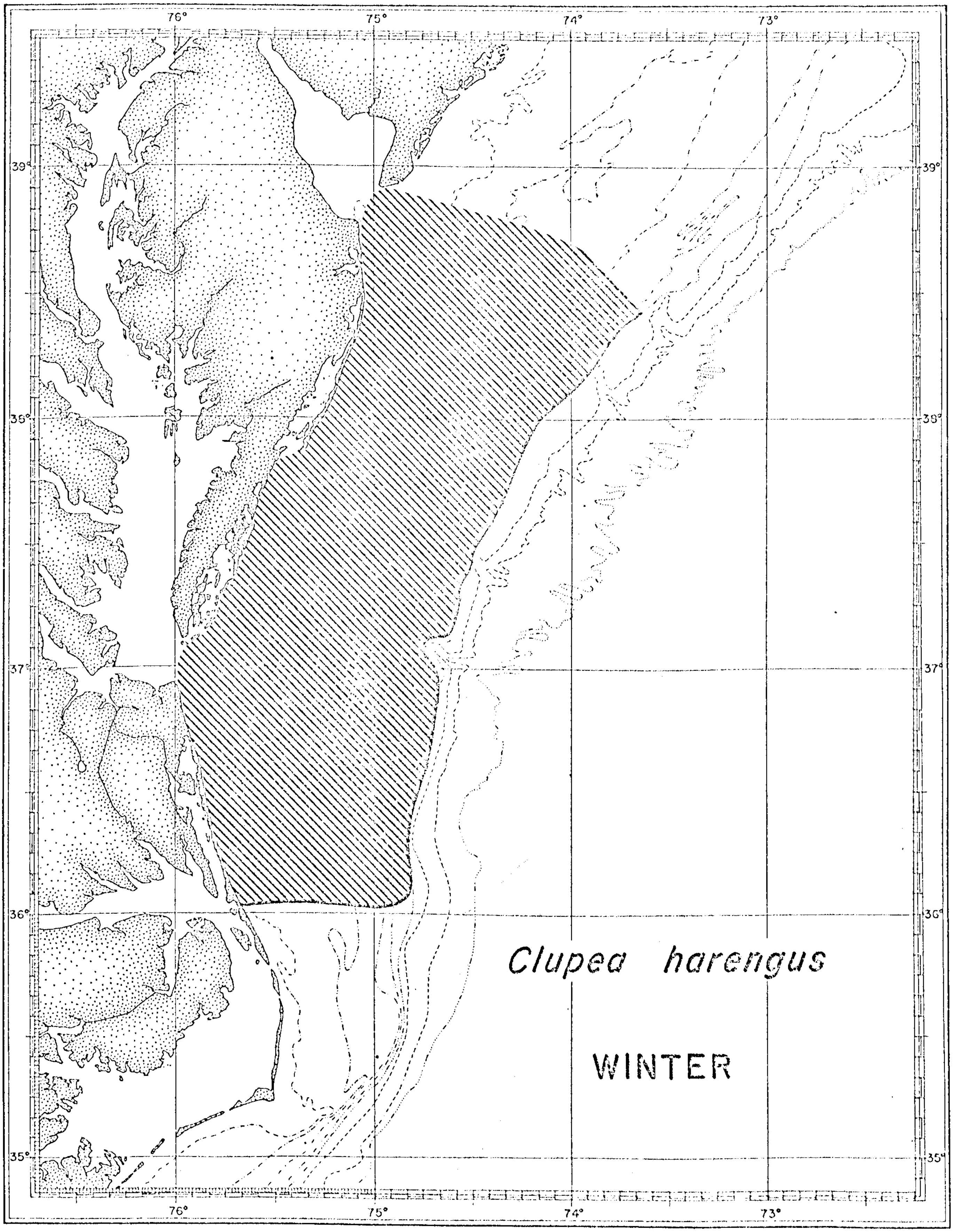

Fig. 11. Distribution of the herring.

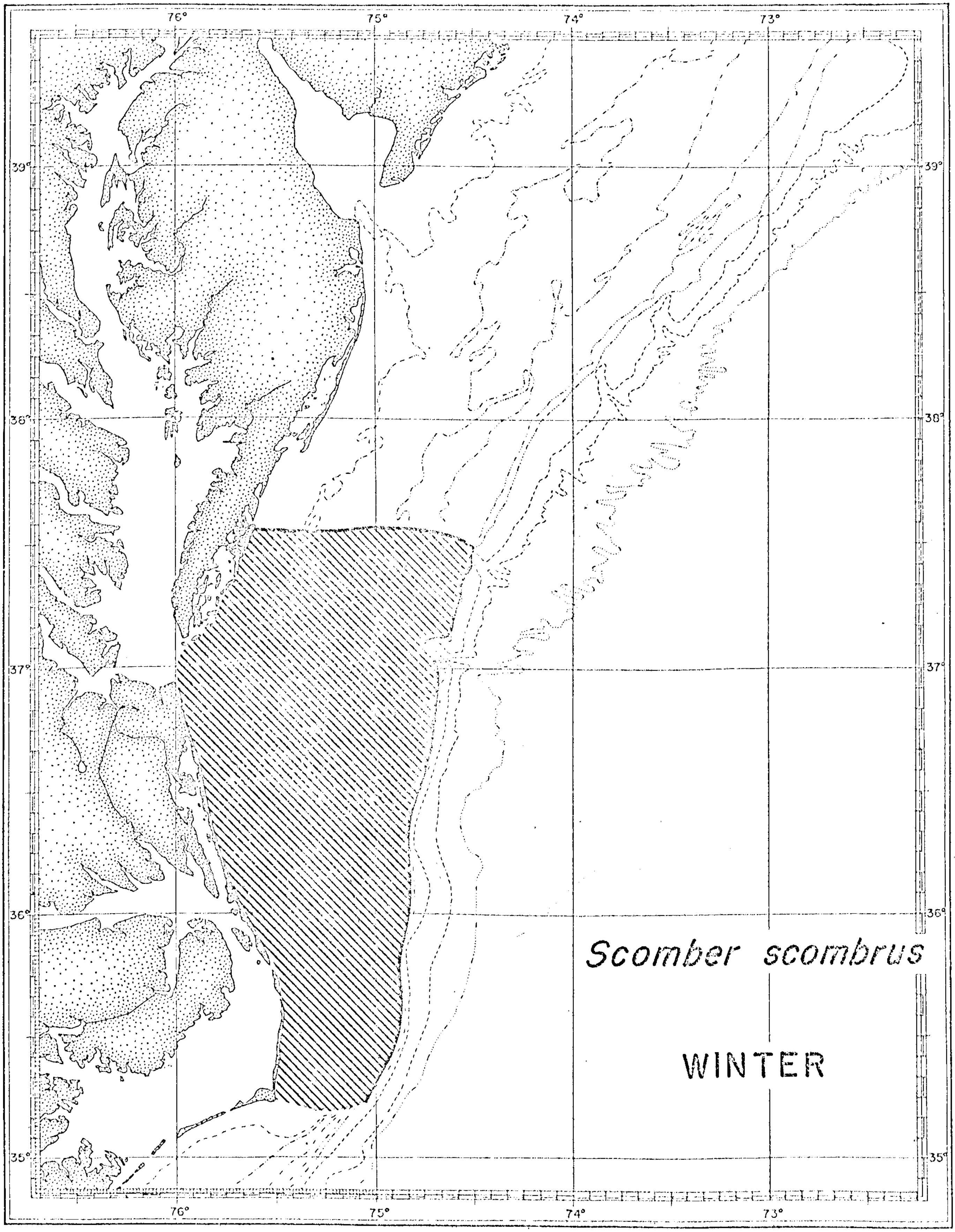

Fig. 12. Distribution of the mackerel.

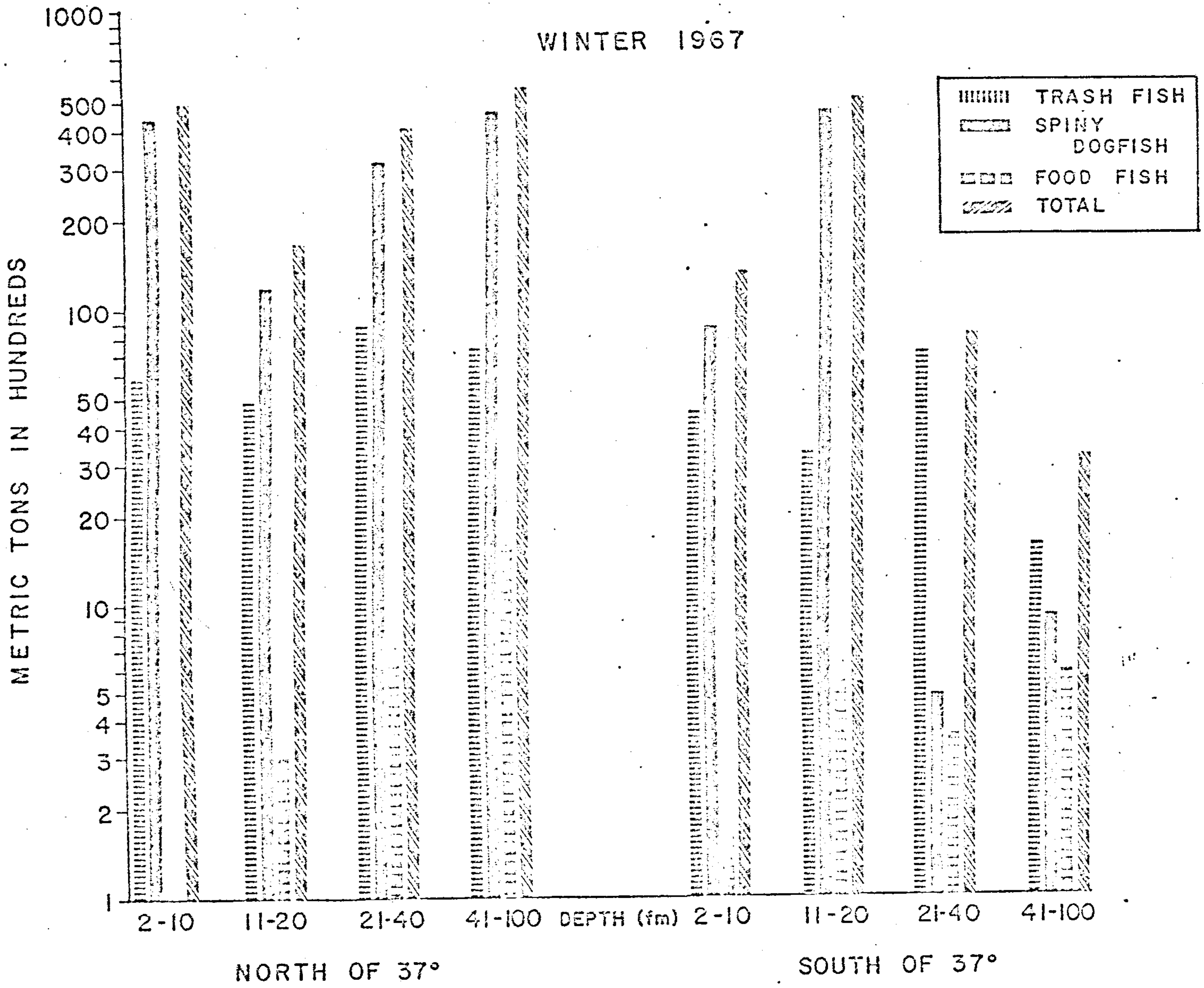

Figure 13. Distribution of benthic fishes of Chesapeake Bight in winter 1967.

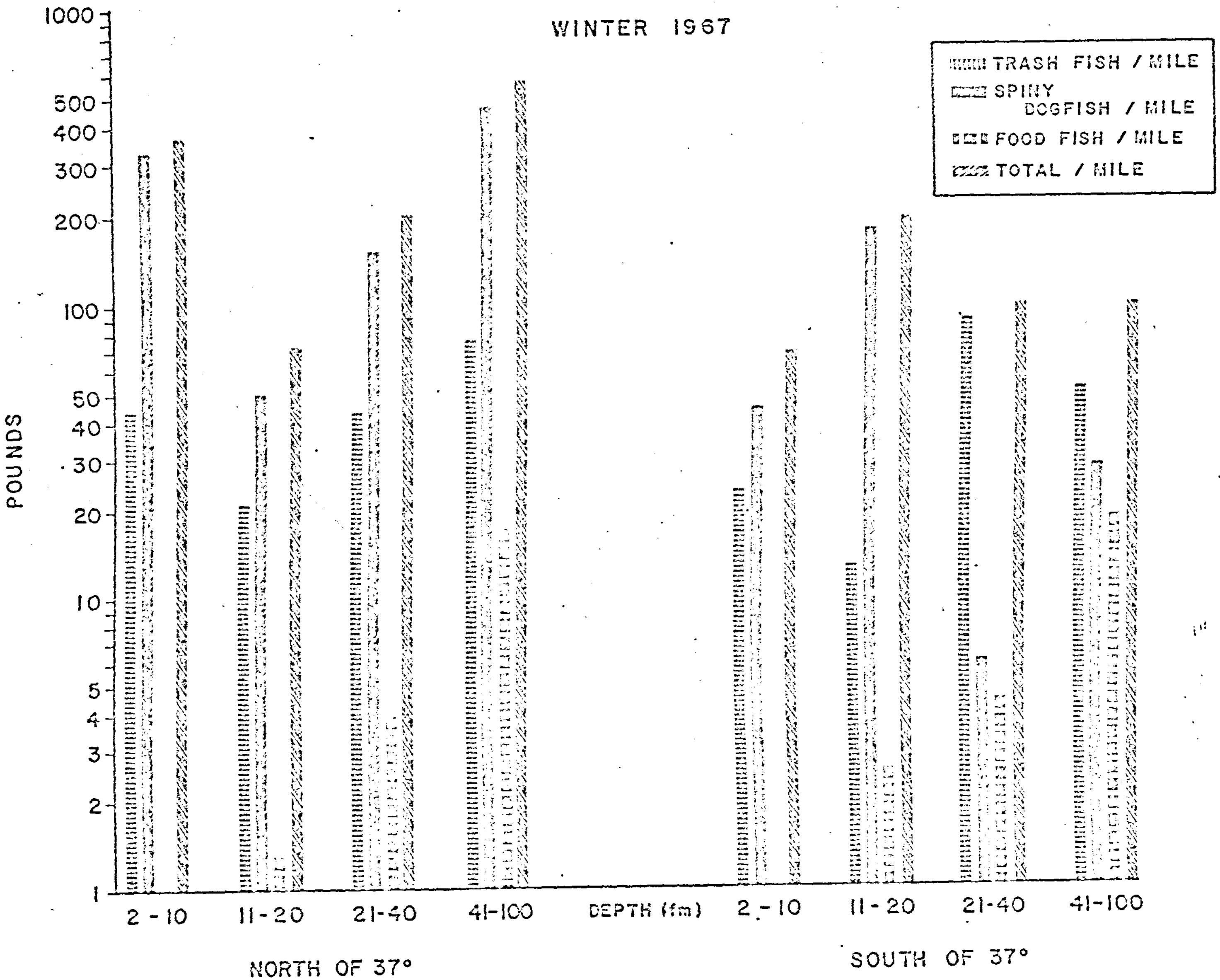

Figure 14. Catch rate of benthic fishes in Chesapeake Bight in winter 1967.

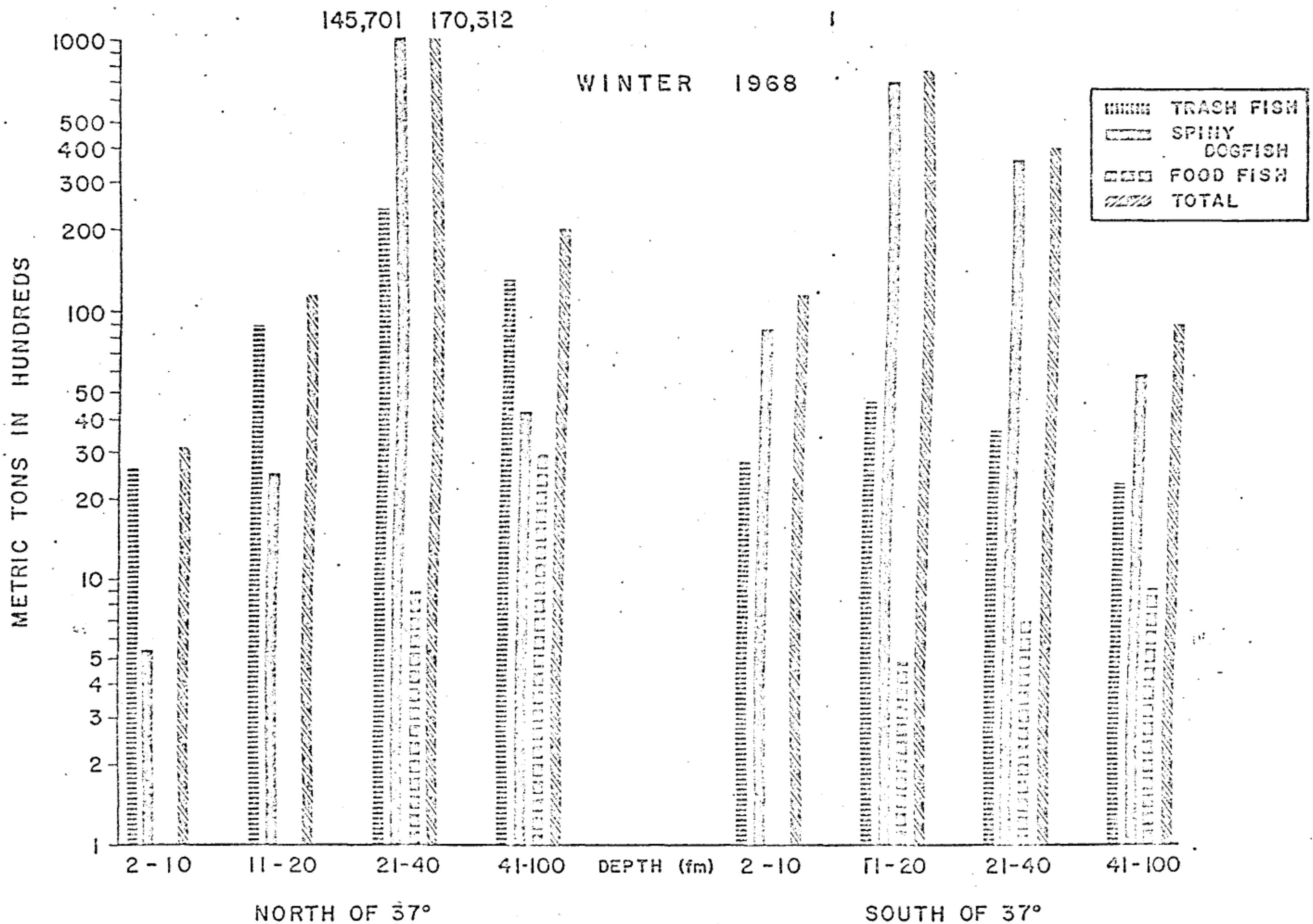

Figure 15. Distribution of benthic fishes of Chesapeake Bight in winter 1968.

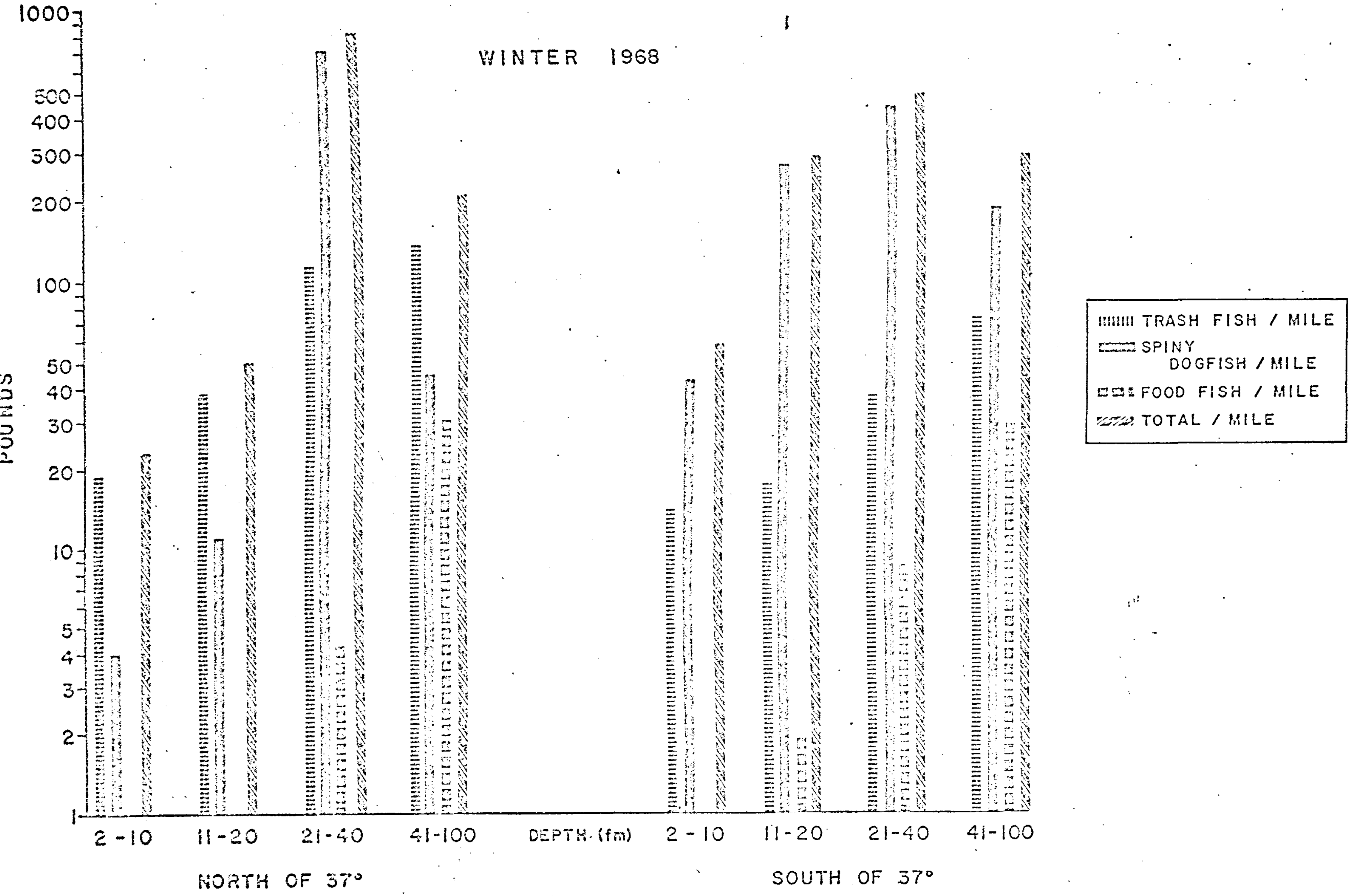

Figure 16. Catch rate of benthic fishes in Chesapeake Bight in winter 1968.

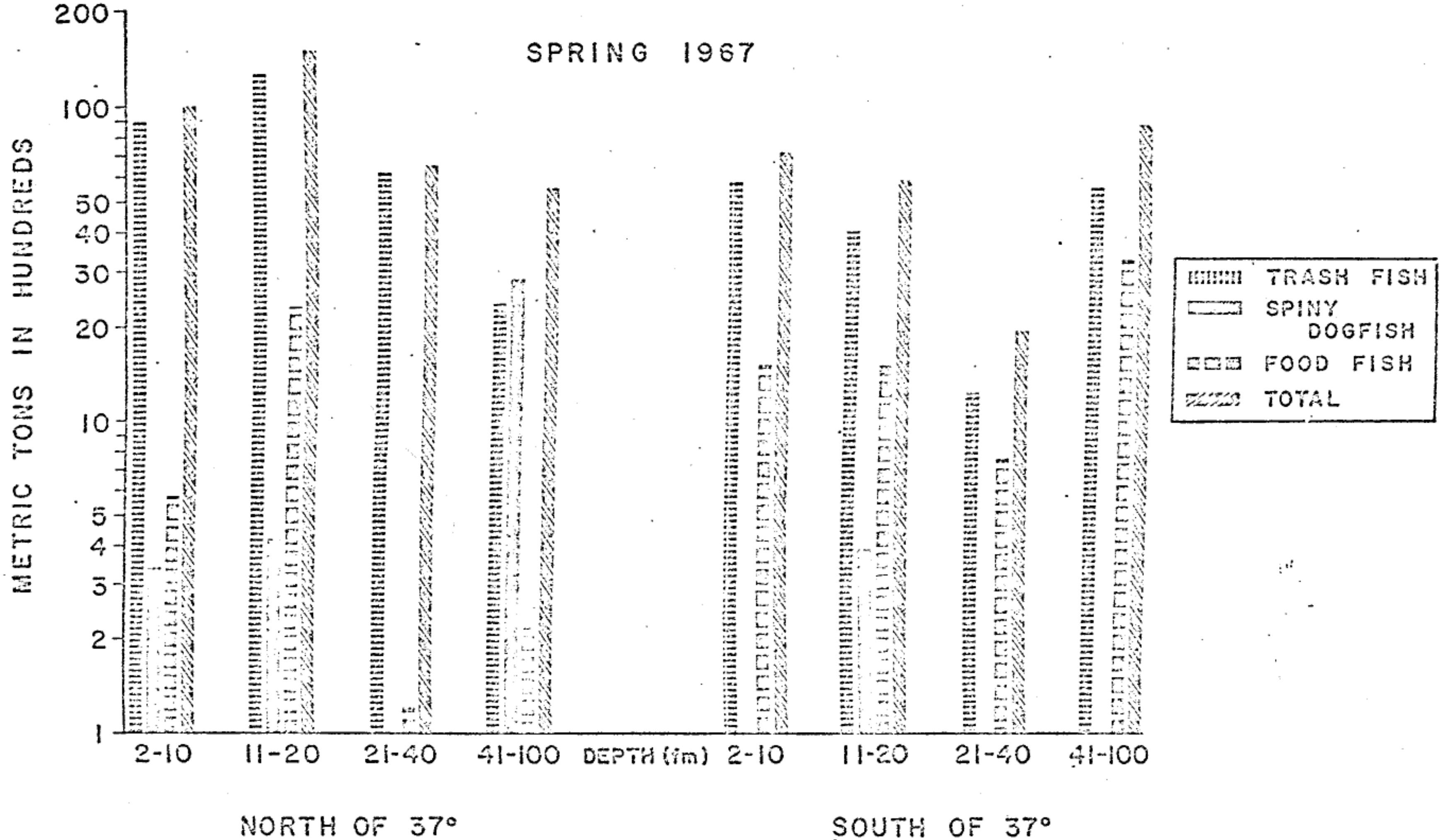

Figure 17. Distribution of benthic fishes of Chesapeake Bight in spring 1967.

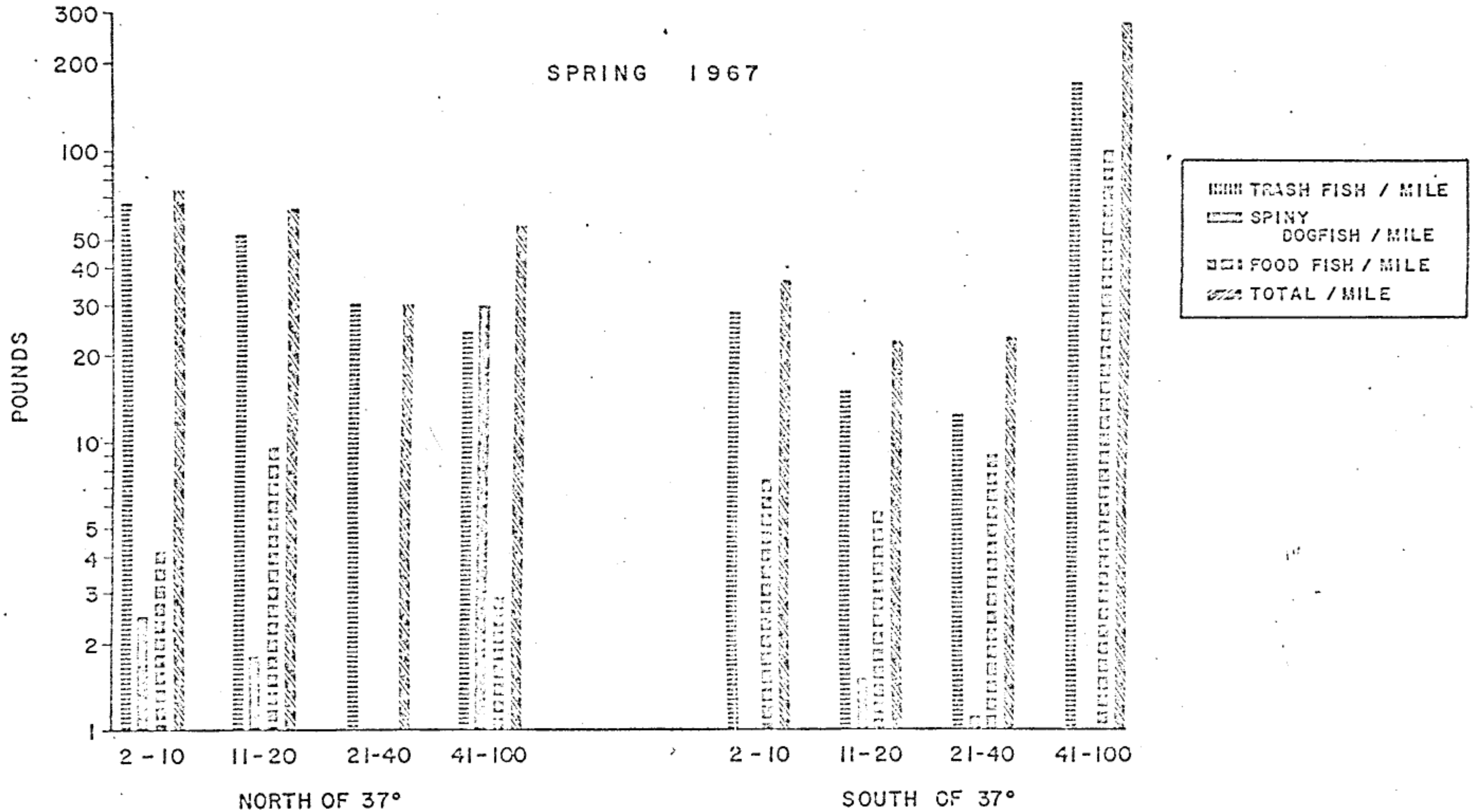

Figure 18. Catch rate of benthic fishes in Chesapeake Bight in spring 1967.

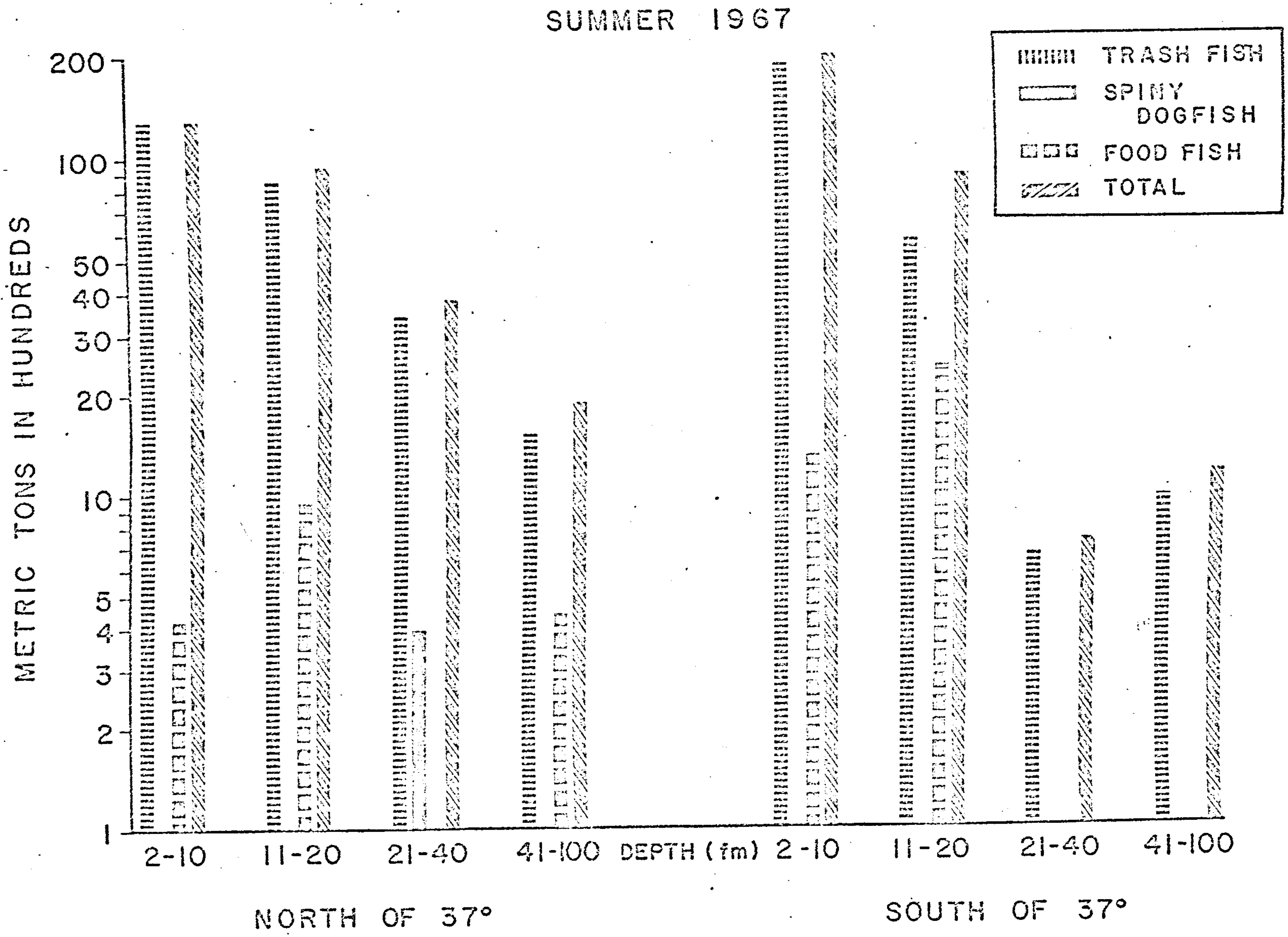

Figure 19. Distribution of benthic fishes of Chesapeake Bight in summer 1967.

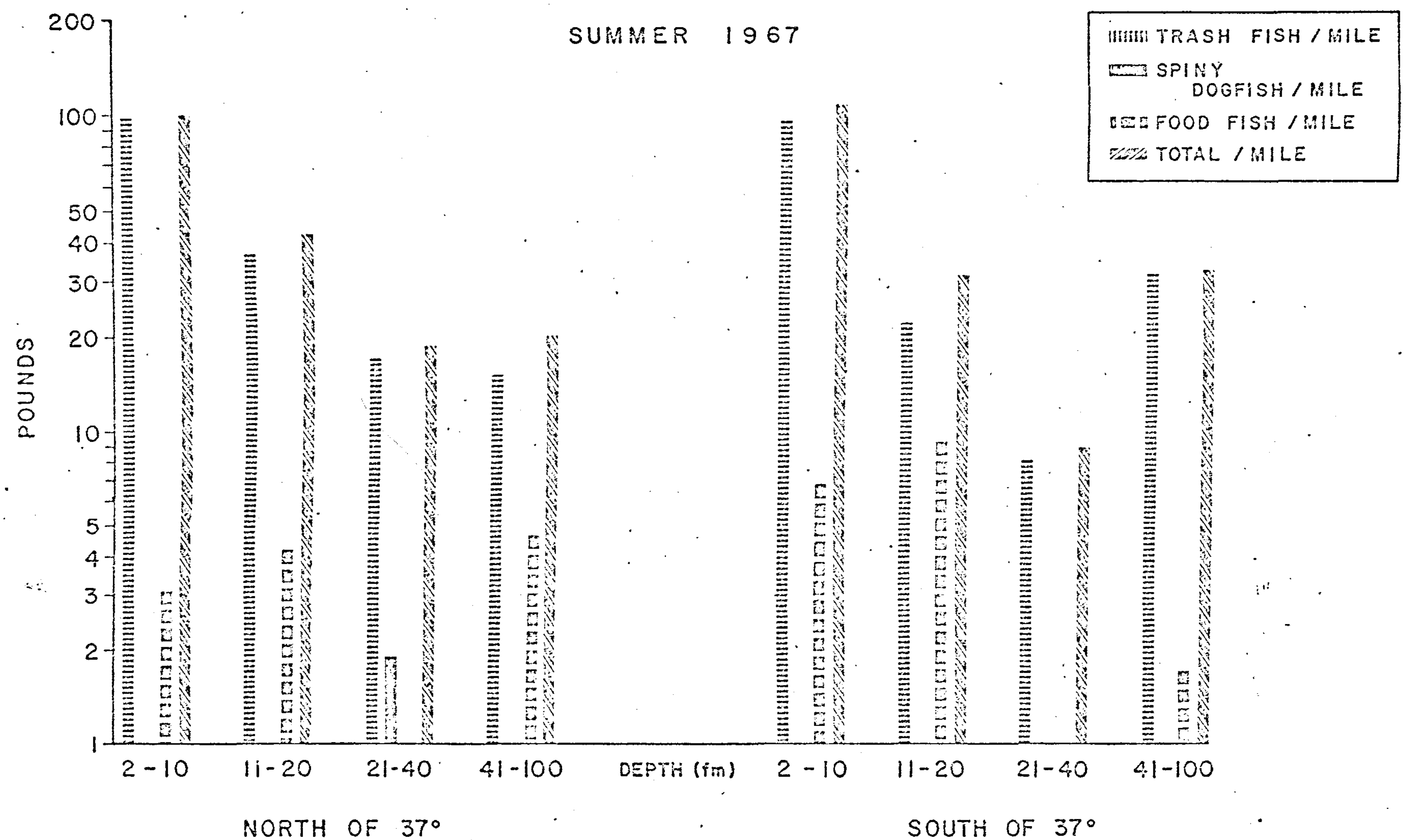

Figure 20. Catch rate of benthic fishes in Chesapeake Bight in summer 1967.

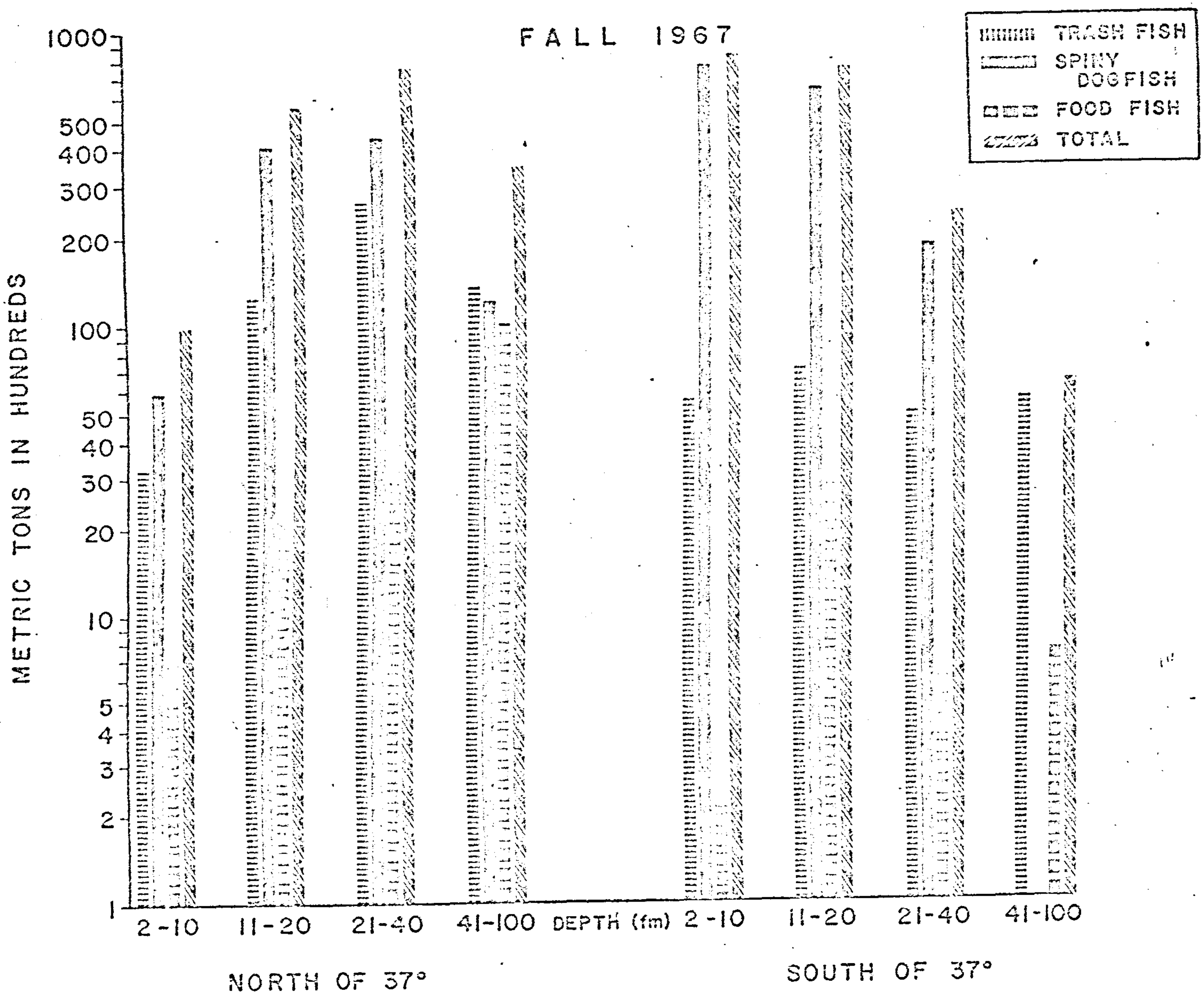

Figure 21. Distribution of benthic fishes of Chesapeake Bight in fall 1967.

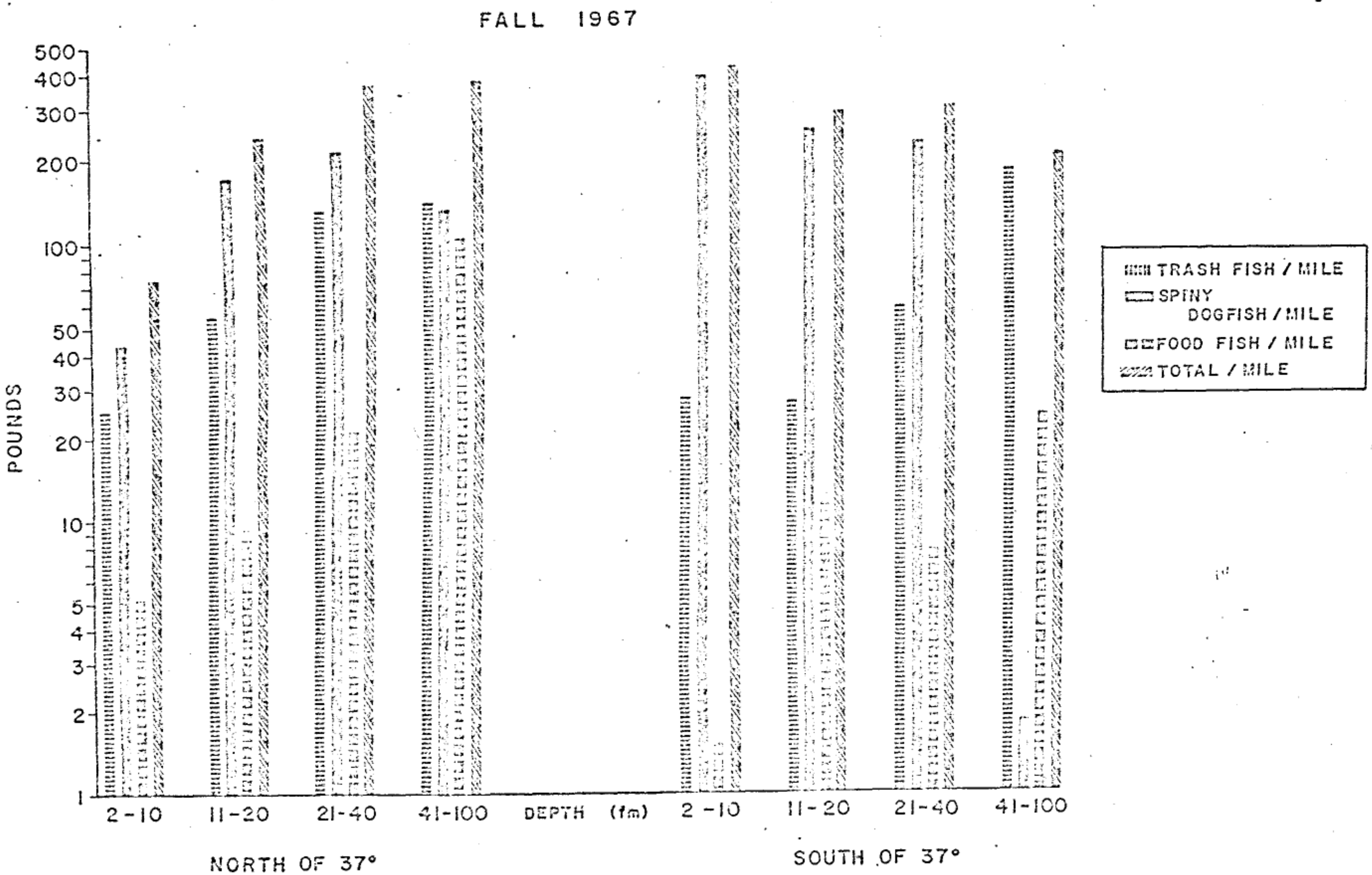

Figure 22. Catch rate of benthic fishes in Chesapeake Bight in fall 1967.