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Summer distribution of groundfish on the Scotian Shelf 1970-74

by

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Introduction

Starting in 1970, the staff of the Department of Environment, Biological Station, St. Andrews, New Brunswick, has carried out an annual summer (July-August) trawling survey of groundfish on the Scotian Shelf (Fig. 1). The survey was based on a depth-stratified random sampling design (Halliday and Kohler 1971) using the same vessel *(A. T. Cameron)*, a standard #36 Yankee otter trawl and standard 1/2-hr trawl tows. At each pre-selected station, the total weight and number of each fish species caught was recorded as well as the starting and ending positions of the tow, depth to bottom, bottom temperature and numerous other data. Additional water temperature data were obtained from expendable bathythermograph (XBT) records between fishing stations.

Each annual survey extended from the Fundian Channel and Bay of Fundy in the southwest to the Laurentian Channel in the northeast. The outward limit was about the 200-fathom contour on the slope of the continental shelf. The inner limit was dictated by the suitability of the sea bed for trawling. It was about the 50-fathom contour between the Nova Scotia coast and the offshore banks but extended into about 20 fathoms in the Bay

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of Fundy. The area off southwest Nova Scotia to the north of Brown's Bank was excluded because of the excessively rough bottom and consequent difficulties in operating the fishing gear.

The extensive area covered (approximately 43,500 square nautical miles), and limited vessel time available, resulted in minimal but statistically acceptable coverage of the area, with an average of one fishing station per 300-350 square nautical miles on each annual survey. This coverage was sufficient to provide a measure of changes in relative abundance of the various fishes but not an adequate picture of fish distribution in any one year or to show year-by-year changes in distribution. However, assuming relatively similar dispositions of the fish stocks during a given season from year to year, the aggregate of the 5 year's surveys from 1970 to 1974 inclusive (Fig. 2) is considered to provide sufficient coverage as a basis for at least a qualitative account of the areas frequented by the various fish species. The number of trawl tows made in each year was: 1970 - 143; 1971 - 124; 1972 - 156; 1973 - 146; 1974 - 165; Total - 734.

The fish catches are expressed graphically (Figs. 3-32) as weight (kg) of fish per tow except for a few species of fish which were so small in size and weight as to preclude their inclusion on that basis. The distribution of these small fish is represented in terms of numbers caught; for all other species the figures give no indication of the numbers or sizes of fish involved. This treatment does not affect the pattern of distribution but may not represent fish distribution in terms of numbers of fish if different size groups of a species exhibit different depth preferences, or where catches are predominantly of large specimens, such as in the cases of pollock and angler.

In association with the distribution of the fishes, the disposition of bottom temperatures was examined for evidence of correlation between water temperature and the occurrence of each species. From the records of bottom temperature and bathythermograph traces, isotherms were plotted to show the general pattern of bottom temperatures over the Scotian Shelf and in the Bay of

Fundy for each year from 1970 to 1974 (Figs. 33-37). This necessitated a great deal of subjective extrapolation from, and interpretation of, the recorded data. The number of bottom temperature observations made each year was: 1970 - 143; 1971 - 202, 1972 - 227; 1973 - 191; 1974 - 197.

Groundfish distribution

A brief account of the distribution of the more common groundfish captured during research cruises is given below. Besides the fishes described, many less common species were captured, but so infrequently and in such small numbers that it was not possible to show their distribution. Also, considerable catches of pelagic and meso-pelagic species were made, including herring, gaspereau, mackerel and myctophids. The bottom trawl is not suited for surveying the distribution of species which spend much of their time in mid- or surface - waters and these species are not considered here.

Descriptions, illustrations and accounts of the biology of each of the species described are given by Leim and Scott (1966).

Angler *(Lophius americanus)* (monk fish, goosefish) (Fig. 3). The angler was widely distributed over the Scotian Shelf at all depths and along the edge of the Laurentian Channel, but less common in the Bay of Fundy. It appears to avoid cold water on top of the banks in the Brown's-LaHave area and over Banquereau. The angler was seldon caught in large numbers but large specimens are common and high catch weights usually represent a few large specimens rather than large numbers of fish.

Alligator fish *(Aspidophoroides monopterygius)* (Fig. 4). Catches were sparsely distributed mainly over the eastern part of the Scotian Shelf and in the Bay of Fundy and Brown's Bank areas. The #36 trawl is probably not very effective in capturing these small (length up to 7 inches) slender fish and the catch data may not give a reliable picture of their distribution.

American plaice (*Hippoglossoides platessoides*)(Fig. 5). The plaice was among the most widely distributed of the groundfishes. The distribution shows no apparent relationship with depth or temperature except that the most noticeable concentrations, on

Banquereau, suggest that the fish prefers the cooler temperatures of the eastern part of the Scotian Shelf. Analysis of previous catch data (Scott 1971) indicates that American plaice prefer depths of 50-100 fathoms rather than the shallower water on the banks or the deep water on the slope of the continental shelf. The summer catch distribution gives no evidence of separate stocks in the area.

Atlantic argentine (*Argentina silus*)(Fig. 6). Distribution is mainly limited to deep water (>70 fathoms) of the continental slope, Scotian Gulf and the Fundian Channel. Smaller fish tend to frequent shallower water, larger fish, deeper water. Best catches were made to the southwest of Brown's Bank but the fish is distributed in a narrow band as far east as the continental slope south of Banquereau. The fish presumably prefers the warmer, stable temperatures, characteristic of the deeper waters it frequents.

Atlantic cod (*Gadus morhua*)(Fig. 8). Cod were widespread in depths less than 100 fathoms but catches were noticeably low in cold water areas to the north of Banquereau and in the warm waters of the Scotian Gulf. They were concentrated in 4 principal areas: (1) the edge of the Laurentian Channel, (2) the northern edges of Sable Island and Middle Banks, (3) off the edges of the Banks in the Brown's-LaHave area, (4) in the Bay of Fundy. These concentrations agree with the stocks identified by Kohler (1968) on the basis of commercial landings except that the Sable Island-Middle Bank area supports a group which is distinct from the Laurentian Channel group and the Bay of Fundy group appears to be separate from that of the Brown's-LaHave area. Research effort off southwest Nova Scotia was restricted by rough ground, which may explain the low catch levels between the Bay of Fundy and Browns-LaHave areas.

The distribution in relation to bottom temperature indicates that cod avoid the warm (10-12°C) waters in the Emerald and LaHave basins and along the edge of the Scotian Shelf, and also avoid the cold (<2°C) water overlying the shallower parts of the area to the north of Banquereau. Best catches were mostly in 4-6°C

water along the edge of the Laurentian Channel and in deep waters (>100 fathoms) north of Middle Bank and Banquereau.

The concentrations on the edge of the Laurentian Channel to the east of Cape Breton and northeast of Banquereau are presumably part of the stock complex which overwinters on the eastern offshore banks (Pinhorn and Halliday 1975), but part of the complex obviously remains on the Sable Island-Middle Bank area to the northwest of Banquereau, possibly as a separate stock from those on the edge of Laurentian Channel and in coastal waters of Nova Scotia.

Barndoor skate (*Raja laevis*)(Fig. 7). This species was uncommon in catches. It occurred from the Bay of Fundy to the Laurentian Channel, generally in depths less than 100 fathoms, but catches were insufficient to indicate any preference for depth, temperature or area.

Common grenadier (*Nezumia bairdi*)(Fig. 9). Catches were restricted to the deeper water of the continental slope and the edge of the Laurentian Channel. No large catches were made and the fish is so small in the areas fished that the distribution is shown in terms of numbers caught, rather than weights. The distribution suggests that depth determines the occurrence of the fish, but in association with some other factor(s) which appear to prevent movement of the fish into the Fundian Channel and Scotian Gulf.

Cusk (*Brosme brosme*)(Fig. 10). This species was not found on the extreme eastern part of the Scotian Shelf but was generally confined to depths greater than 50 fathoms in the southwestern area of the Shelf and the edge of the Fundian Channel, with an apparently isolated group on the continental slope southwest of Sable Island. The distribution suggests that they favour warm water at moderate depths and avoid the shallow water of the banks. Previous analysis (Scott 1971) indicates best catches are taken in 100-150 fathoms.

Haddock (*Melanogrammus aeglefinus*)(Fig. 11). Three distinct areas of haddock concentration were indicated by catch data: (1) west of Nova Scotia at the mouth of the Bay of Fundy; (2) the Browns-LaHave area; (3) Western Bank. There is the possibility of a fourth group on the western part of Banquereau. The fish was found at depths

below 100 fathoms but was concentrated on the banks in depths less than 50 fathoms and in deeper water on the edge of the banks. It is possible that the Bay of Fundy summer group migrates to overwinter in the Browns-LaHave area as part of the 4X stock. The distribution of research catches is very similar to that of commercial catches (Kohler 1968) but a distinction between the Browns-LaHave and Western Bank stocks is not so sharply defined by the research data as that between the Bay of Fundy group and the Browns-LaHave group.

Haddock appear to avoid the cold water north of Banquereau but to prefer the cool water on the banks in the Browns-LaHave area where best catches were made. Their distribution appears to be governed by depth rather than temperature and, during the summer feeding period, the distribution is presumably determined by the distribution of the benthic organisms which constitute a large part of the fish's diet.

Halibut (*Hippoglossus hippoglossus*)(Fig. 12). Most halibut catches were made in shallow water on the Nova Scotia Banks, but best catches were on the edge of the banks and in deeper water (50-100 fathoms) on the edge of the Shelf. Catches were fairly evenly distributed over the outer half of the Shelf with indication of preference for cool water on the banks but avoidance of the colder water of the Banquereau area and the deeper, warm water of the Scotian Gulf.

Hookear sculpin (*Artediellus uncinatus*)(Fig. 13). This fish was relatively uncommon in catches, probably because of its small size (up to 4 inches in length). Its distribution was similar to that of the alligatorfish: sparsely distributed, mainly on the eastern part of the Shelf but also occurring in the Browns-LaHave area and the Bay of Fundy. It tends to favour intermediate depths between 50 and 100 fathoms. It is probably more common than its recorded occurrence suggests, but is not vulnerable to the otter trawl.

Longfin hake (*Urophycis chesteri*)(Fig. 14). Catches of longfin hake were nowhere great in terms of weight but catches often consisted of small fish only and it occurred in considerable numbers in certain areas. The fish is mainly confined to the deeper water (>100 fathoms)

of the continental slope, edge of the Laurentian Channel and deep holes and channels in the Scotian Shelf, but not in the Scotian Gulf. Although their distribution extended as far west as the Gulf of Maine, they appear to be more common on the eastern part of the area surveyed.

Longhorn sculpin (*Myoxocephalus octodecimspinosus*)(Fig. 15). Distribution was generally restricted to the shallow waters of the Scotian Shelf and the Bay of Fundy with greatest concentrations on Sable Island Bank. It is one of the more abundant of the non-commercial fishes and occasional heavy catches that reflect large numbers of this moderately small (mostly less than 14 inches in length), large-headed fish. The distribution is very similar to that of yellowtail flounder except for its occurrence in the Bay of Fundy.

Lumpfish (*Cyclopterus lumpus*)(Fig. 16). This species appeared only occasionally in catches. There was no particular pattern in the distribution to indicate preference for depth or temperature. Most lumpfish were captured on the eastern part of the Scotian Shelf.

Mailed sculpin (*Triglops murrayi*)(Fig. 17). This small species (length up to 8 inches) was widespread in moderate depths (50-100 fathoms) over the whole of the Scotian Shelf. Catches were concentrated more towards the eastern part of the Shelf than to the west although the fish was not uncommon in the Browns-LaHave area and also occurred in Bay of Fundy catches. It appears to favour the slopes of the banks rather than the shallow water on the banks, but was not caught in the deep waters of the Scotian Gulf or Fundian Channel. The fish's small size indicates that it is not greatly vulnerable to the trawl and its frequent occurrence in the catches suggests that it is abundant on the Scotian Shelf.

Ocean pout (*Macrozoarces americanus*)(Fig. 18). Distribution of ocean pout was sporadic with most catches in the Bay of Fundy and on Western and Sable Island banks. The fish was notably absent from catches on the eastern and western parts of the Scotian Shelf except for infrequent small catches on Browns Bank and to the north of Banquereau. It appears to favour shallow water but was

also found in deeper water along the edge of the banks. Previous estimates of abundance (Scott 1971) support the preference for shallow water with best catches being taken in water less than 50 fathoms in depth.

Pollock (*Pollachius virens*)(Fig. 19). Although pollock were caught as far east as the Laurentian Channel the distribution is mainly confined to the Scotian Shelf west of Sable Island with major concentrations off southwest Nova Scotia, in the Bay of Fundy and in the Scotian Gulf. The pollock tends to be associated with mid-water rather than the ocean floor so its occurrence shows less dependence on bottom depth than on temperature. This is reflected in its concentration in relatively warm bottom water of the Scotian Gulf and Fundian Channel. The fish's tendency to spend considerable time off bottom may result in bottom trawl catches giving an unrepresentative picture of the distribution.

Redfish (*Sebastes marinus*)(Fig. 20). This species was rarely caught in water less than 70 fathoms in depth but was concentrated on the edges of the Laurentian and Fundian Channels, the continental slope and in deep water channels and basins in the Scotian Shelf. Best catches were on the northern edge of LaHave basin, and other major areas of concentration were along the southwest edge of the Laurentian Channel and south of Sable Island Bank. Redfish were uncommon in the shallow water on the banks but were found in fairly shallow water in the Bay of Fundy. The larger fish tend to be found along the edge of the continental shelf, smaller fish in the basins and holes in the Shelf.

Sand lance (*Ammodytes dubius*)(Fig. 21). Sand lance occurs only in the shallow waters of the banks, seldom in depths exceeding 50 fathoms. Its occurrence is very localized and large concentrations may not be located by general research surveys. Besides occurring on Sable Island and Banquereau, it is known to be abundant on Emerald Bank and, also, perhaps seasonally, on Browns, Western and Middle Banks.

Sea raven (*Hemitripterus americanus*)(Fig. 22). The distribution of the sea raven is largely restricted to the Bay of Fundy and to

shallow water on the offshore banks from Brown's to Banquereau, but with occasional occurrences in deeper water. There is no obvious correlation with temperature. There is a strong similarity between the distributions of sea raven and winter flounder, its principal prey in Passamaquoddy Bay in the Bay of Fundy.

Silver hake (*Merluccius bilinearis*)(Fig. 23). Summer distribution of silver hake is determined by temperature in relation to depth as the fish move into shallow water to spawn in late summer on Sable Island and Brown's Banks. The fish has a preferred temperature of 6-8°C and remains in deeper water off the edge of the continental shelf and in Emerald and LaHave basins until the water on the banks warms up sufficiently to induce the spawning migration. The distribution of silver hake shown in Fig. 23 corresponds with the distribution of bottom temperatures associated with the intrusion of warm water in the Scotian Gulf, over the western and northern parts of Sable Island and Western Banks, and in the Fundian Channel as well as with the warm water on the continental slope. The fish avoid the cold waters on the banks in the Brown's-LaHave area and north of Banquereau.

Smooth skate (*Raja senta*)(Fig. 24). This was the most widely distributed of the skates, occurring in small numbers in catches from most areas and at all depths, with indications of concentrations in the Bay of Fundy, in moderate depths to the east of Sable Island and along the edge of the Laurentian Channel. It appears to be virtually absent from the continental slope from south of Sable Island to the west.

Spiny dogfish (*Squalus acanthias*)(Fig. 25). The dogfish is associated with warm water and moves on to the Scotian Shelf in early summer then leaves the Shelf as the water cools in fall. The fish may be found in all areas but catches were mainly in the Fundian Channel and in the Bay of Fundy where it penetrates to the head of the Bay. It is caught commonly in herring weirs, indicating its movement into shallow inshore waters. It may be more widely distributed than trawl catches indicate if the fish seeks the layers of warm water which may touch the bottom in

localized areas only. The high catches on Western Bank and Banquereau occurred in 1973 on stations where unusually high bottom temperatures (9.4 and 6.2°C, respectively) were recorded.

Thorny skate (*Raja radiata*)(Fig. 26). This is the most abundant of the skates on the Scotian Shelf and was found over the whole Shelf and in the Bay of Fundy. The fish occurs at all depths but most of the larger catches were in less than 100 fathoms. The major concentration was in the Banquereau area with small concentrations in the Western and Brown's banks areas and in the Bay of Fundy. Elsewhere the fish was fairly evenly distributed except for lower concentrations in the Scotian Gulf and off southwest Nova Scotia. There was no evidence that temperature determined the fish's distribution as it was found in the cold waters north of Banquereau as well as in the warm waters of the Scotian Gulf, Fundian Channel and on the continental slope.

White hake (*Urophysis tenuis*)(Fig. 27). Although widespread at all depths over the central and western parts of the Scotian Shelf, main concentrations of white hake were in deeper water (50-200 fathoms) on the edge of the Laurentian Channel, the mouth of the Bay of Fundy, the Gully, the edges of Emerald and LaHave basins and to a lesser extent, the edge of the continental shelf. There was no obvious correlation between fish distribution and bottom temperature except that there was avoidance of temperatures below about 3°C , such as occurred to the north of Banquereau and on top of the banks in the Brown's-LaHave area.

Commercial catch data (Kohler 1968) do not show the concentration of white hake along the Laurentian Channel.

Winter flounder (*Pseudopleuronectes americanus*)(Fig. 28). This flounder is generally confined to shallow coastal waters but a presumably discrete and substantial stock exists in the shallows of Sable Island and Western Banks where the fish frequently appears in catches with other flatfish. A smaller group exists on Banquereau. The only other significant area of occurrence of winter flounder is in the Bay of Fundy where two groups may be identified, one at the mouth of the Bay and the other in the mid-

part of the Bay. There is no evidence of temperature preference in the research cruise catches, but inshore populations of the fish are known to migrate to deeper water in winter in the Bay of Fundy.

Winter (Eyed) skate (*Raja ocellata*)(Fig. 29). The distribution of this species was largely confined to shallow (<50 fathoms) waters of the Scotian Banks and the Bay of Fundy. The distribution was localized, with major concentrations on Banquereau, Sable Island and Western Banks, and smaller concentration to the west in Brown's Bank and in the Bay of Fundy. The distribution suggests a preference for cooler temperatures.

Witch flounder (Graysole) (*Glyptocephalus cynoglossus*)(Fig. 30). This flounder was widely distributed and found at all depths. It was absent from catches off southwest Nova Scotia, much of the Scotian Gulf and from most of the shallow waters (<50 fathoms) on the offshore banks except Banquereau. Greatest concentrations were along the edge of the Laurentian Channel and in the Bay of Fundy. The witch has a preference for depths in the 100-150 fathom range (Scott 1971), evidently associated with temperatures below about 9°C as it apparently avoids the higher temperatures in the Scotian Gulf, but is common at even the low temperatures associated with the area to the north of Banquereau. Its distribution would seem to be determined by factors determining the occurrence of its major prey, polychaete worms, which are associated with mud or mud-sand bottoms found mainly in deeper water.

Wolffish (*Anarhichas lupus*)(Fig. 31). Distribution of wolffish was concentrated on the banks in the Brown's-LaHave area and on the edges of the banks in the central part of the Scotian Shelf, with scattered distribution at moderate depths on the northeastern part of the Shelf and in the Bay of Fundy and Gulf of Maine. The fish appears to prefer the cooler temperatures in these areas and was not caught in the warmer waters of the Scotian Gulf, Fundian Channel or continental slope. Previous catch data (Scott 1971) indicate that wolffish have a preferred depth range of 50-99 fathoms.

Yellowtail flounder (*Limanda ferruginea*)(Fig. 32). This species was confined to shallow water, generally less than 50 fathoms, on the Nova Scotia banks and in coastal waters off Cape Breton, with major concentrations on Western, Sable Island and Banquereau Banks and with an apparent increase in abundance from southwest to northeast. The only other area showing significant concentrations of yellowtail was Brown's Bank. The distribution indicates a preference for cool water temperatures to the northeast of the Shelf. There are at least two stocks, separated by the Scotian Gulf. It is possible that the Gully also constitutes a barrier separating a Banquereau stock from the Sable Island-Western Bank group(s).

BOTTOM TEMPERATURE DISTRIBUTION

An interpretation of bottom temperature distribution was made for each cruise in the years 1970-1974 (Figs. 33-37). Because of the wide dispersal of the bottom temperature records, the interpretation is very subjective, particularly in the case of unusually low or high readings which may be interpreted as local aberrations, or as extensive areas of cold or warm bottom water. The bottom temperature was closely related to water depth. The diagrams are generalized presentations to show only the principal features of the bottom temperature regime, except for some localized features which appear to be characteristic of the hydrography but are not obviously related to the depth. The temperature as general temperature distribution appears to be distribution changes from season to season (McLellan 1954) and the present data refers to the July-August period only.

The general pattern of isotherms is similar to that given by McLellan (1954) for August-September, 1952. The main features were areas of comparitively warm bottom water in the deeper waters of Emerald and LaHave basins, the Fundian Channel and the Gully, a tongue of cold water lying against the outer edge of Sable Island Bank and colder water masses overlying the northeast part of the Shelf than in the southwest. The distribution of bottom temperatures was determined to a large extent by bottom depth in relation to the intermediate cold layer (Hachey 1938; 1942) which lay between about 25-50 fathoms and extended over the whole of the

Shelf to near the edge of the continental shelf from Banquereau in the northeast to Brown's in the southwest. At depths below the intermediate layer, temperatures increased with increasing depth to at least 200 fathoms, and at depths above the intermediate layer, temperatures increased with decreasing depth to the surface. Thus, on the tops of some of the shallower banks lying above the cold layer (Banquereau, Sable Island) bottom temperatures were high but decreased in deeper water on the slopes of the banks, whereas at the tops of some other banks (LaHave, Roseway, Little LaHave), which reached but did not rise above the cold layer, bottom temperatures were conspicuously lower than in adjacent areas in most years.

The extent of the cold and warm water masses varied from year to year. In 1970 (Fig. 33)low bottom temperatures associated with the tongue of cold water to the south of Sable Island extended further to the west than in the following 4 years. Bottom temperatures in the Scotian Gulf and to the west were also lower in 1970 than in ensuing years, but those in the Banquereau area were slightly higher, nowhere falling below 2°C, whereas much of the northwest part of the Shelf was covered with 1°C water in the years 1971-1974 (Figs. 34-37). In 1974 the cold water layer apparently did not touch the bottom on Sable Island and Western Banks, so bottom temperatures were higher (6-8°C) to the south and west of Sable Island than in the previous 4 years (2-4°C).

The distribution of isotherms over Sable Island and Western Banks varied greatly from year to year, depending on the depth of the cold water layer. In general, the area was characterized by a zone of warm bottom water (10°C in 1971 and 1974) to the northeast of Sable Island, with considerably colder water ($\leq$6°C) to the west and south. Localized areas of warm bottom water were observed on the southeast part of Banquereau Bank in 1970 and 1973 (Figs. 1,4). McLellan (1954) attributed similar localized warm areas to unusual localized stirring of the waters. Local 'pockets' of warm water were noted also to the north of Banquereau in deep water basins in 1973 and 1974.

The Fundian Channel was characterized by a tongue of warm water which penetrated northwards to the mouth of the Bay of Fundy. In the Bay of Fundy the isotherms conform to the pattern of a body of comparitively cool water in the deeper parts of the Bay with warmer waters in the shallower coastal parts and a general increase in temperature towards the head of the Bay. This pattern agrees with that determined by Hachey (1952).

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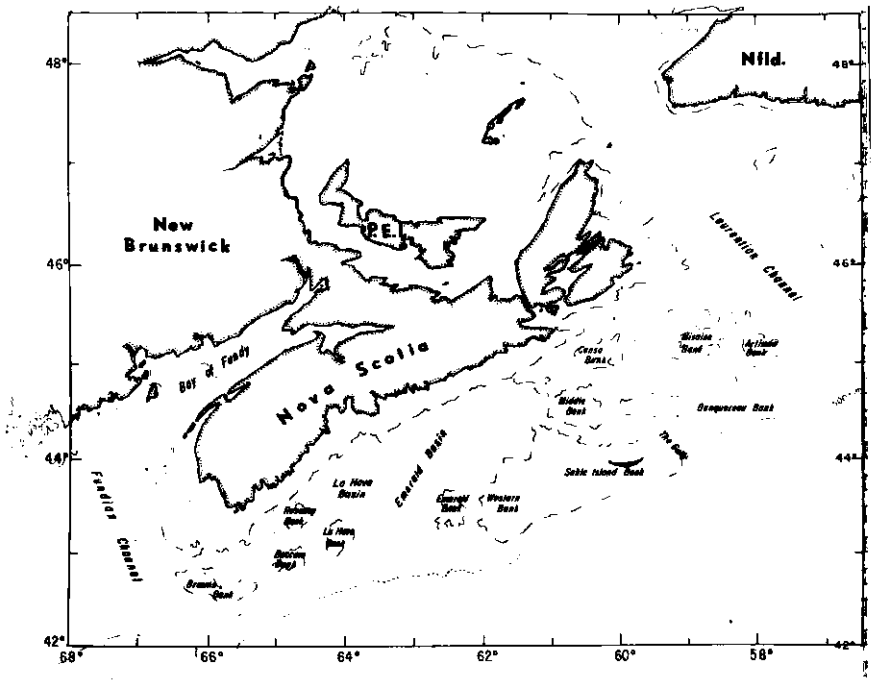

Fig. 1. Scotian Shelf between Laurentian and Fundian Channels, showing depth zones.

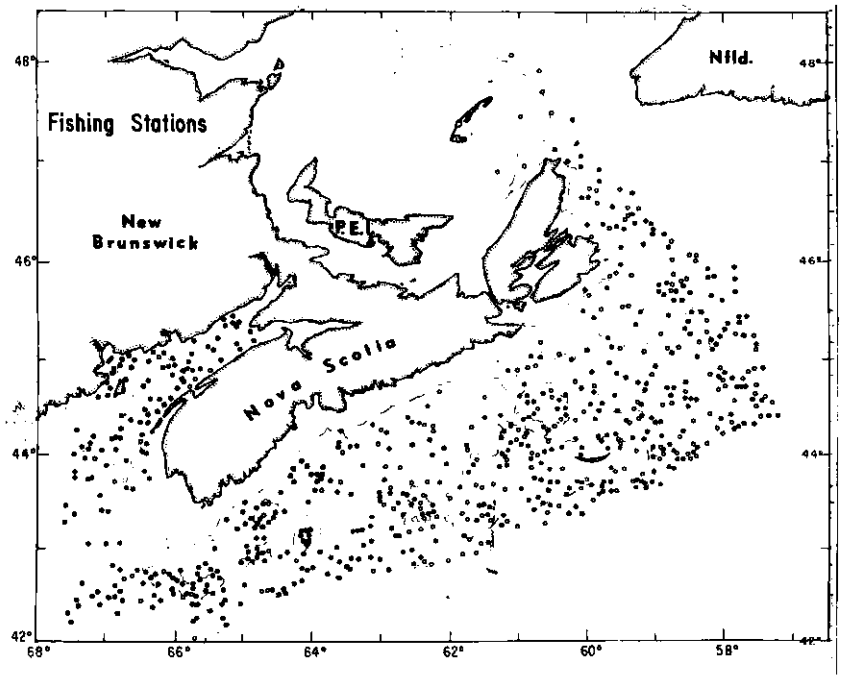

Fig. 2. Distribution of fishing stations on groundfish research survey cruises in summers 1971-1974.

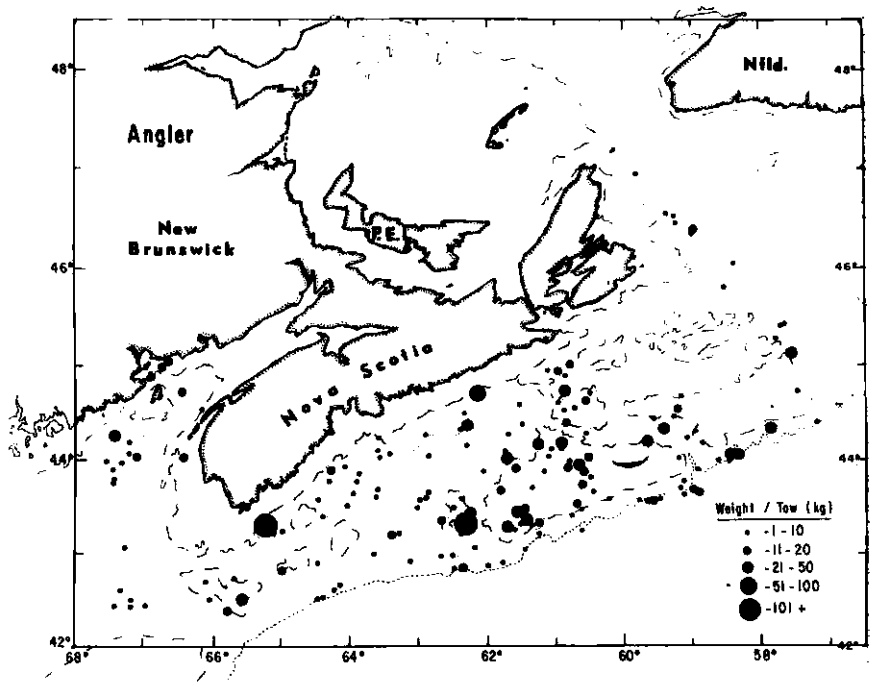

Fig.3. Angler (*Lophius americanus*)

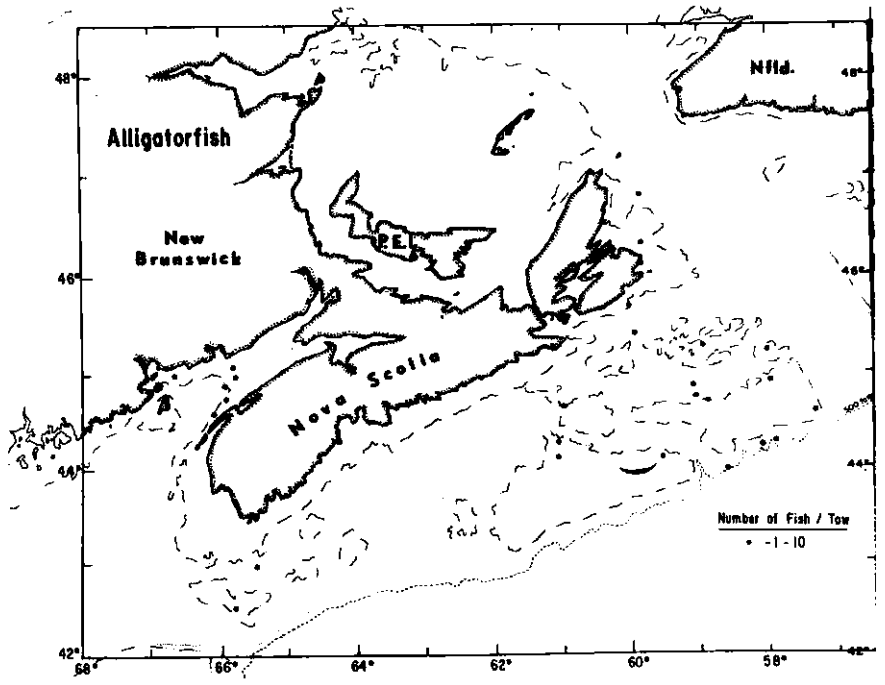

Fig. 4. Alligatorfish (*Aspidophoroides monopterygius*)

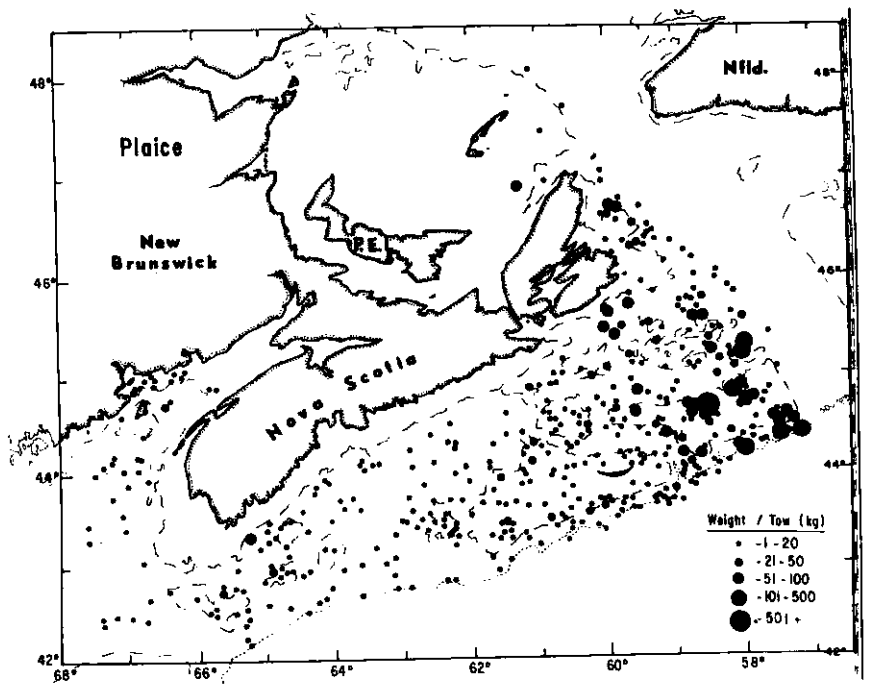

Fig. 5. American plaice (*Hippoglossoides platessoides*)

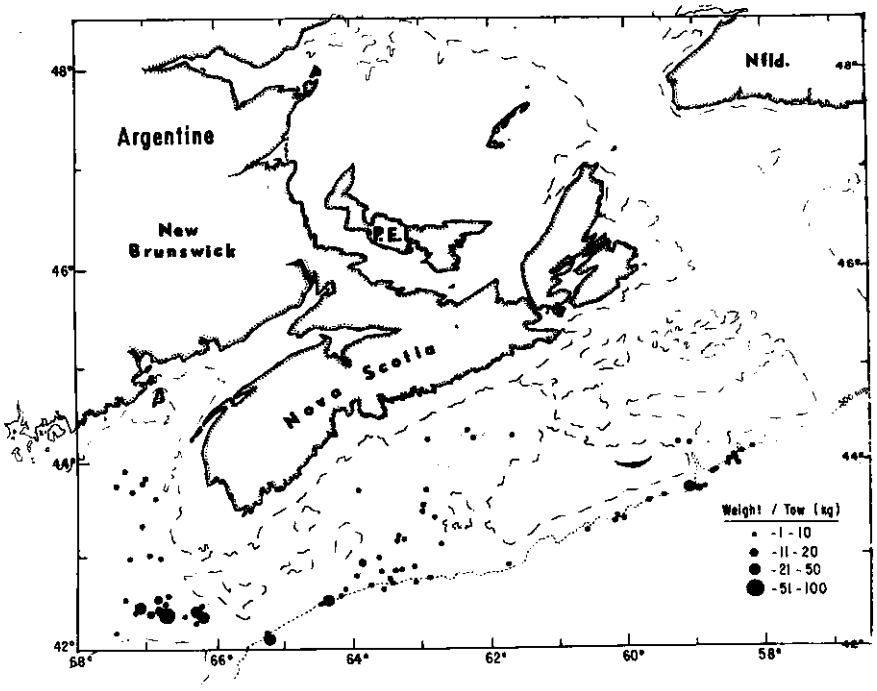

Fig. 6. Atlantic argentine (*Argentina silus*)

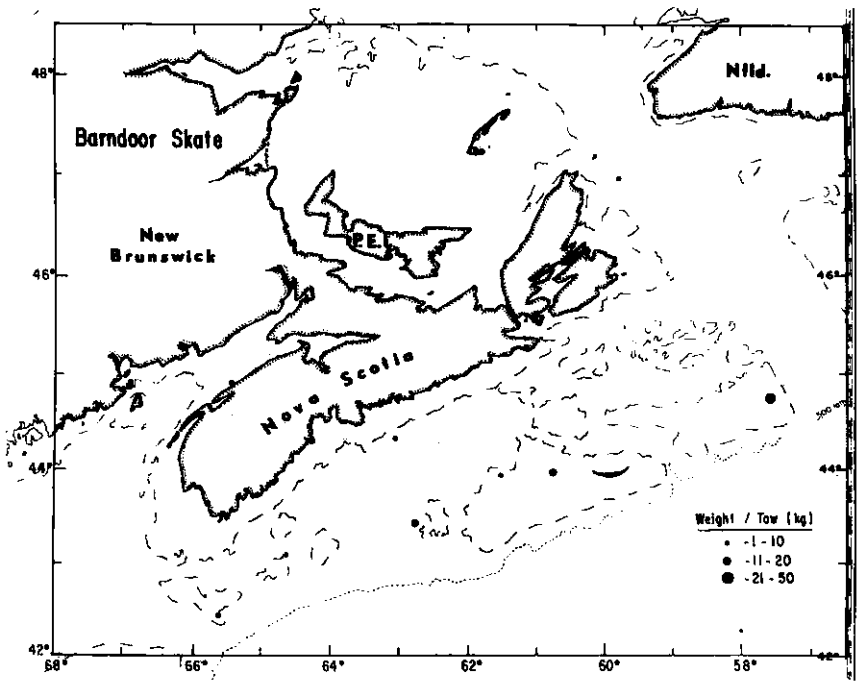

Fig. 7. Barndoor skate *(Raja laevis)*

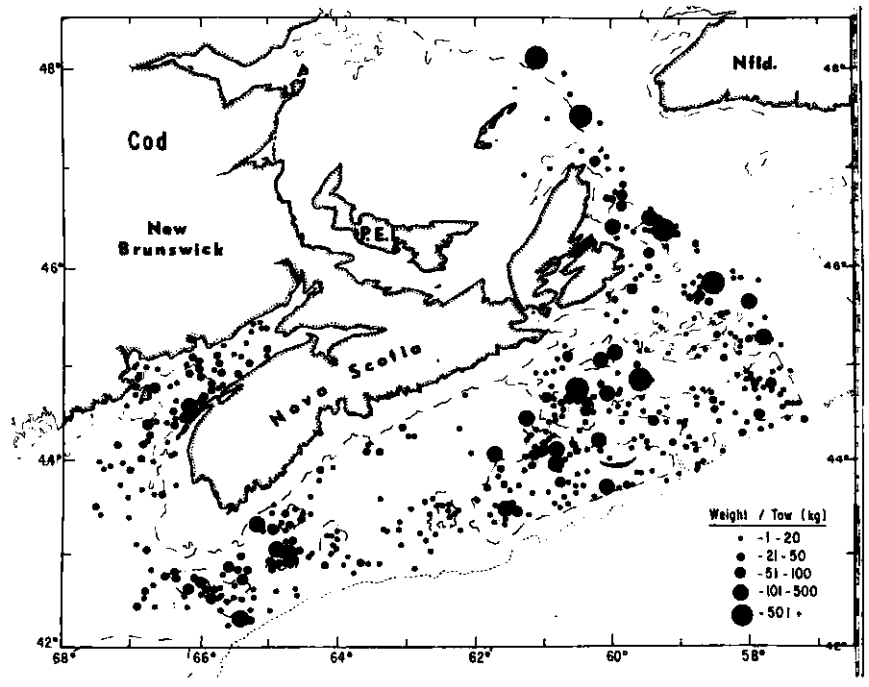

Fig. 8. Cod *(Gadus morhua)*

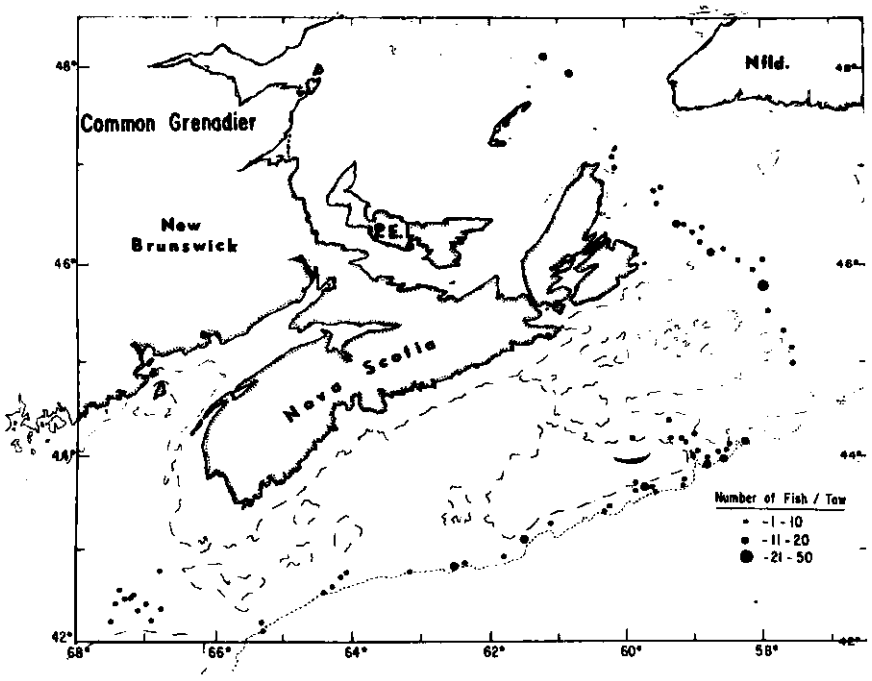

Fig. 9. Common grenadier (*Nezumia bairdi*)

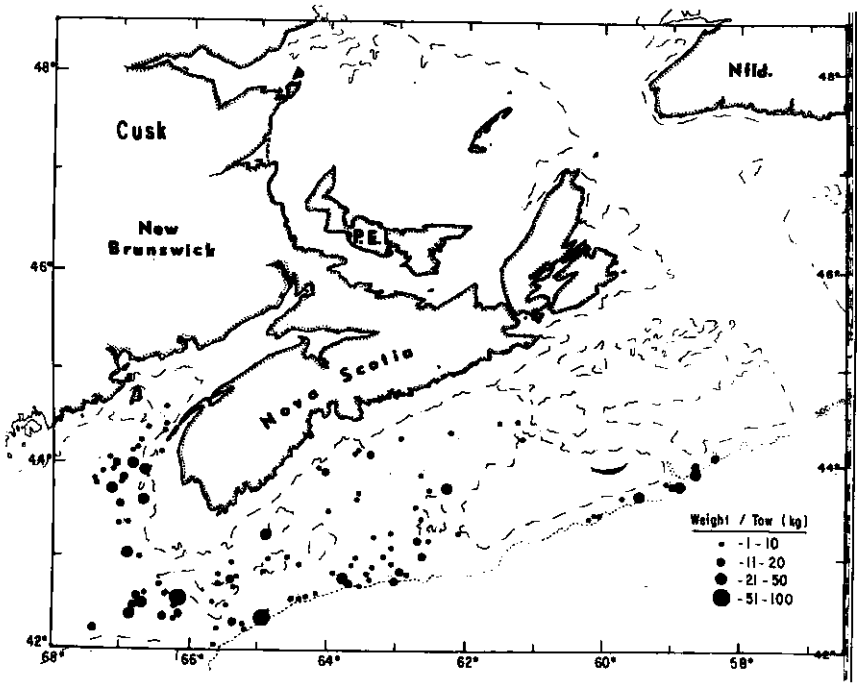

Fig. 10. Cusk (*Brosme brosme*)

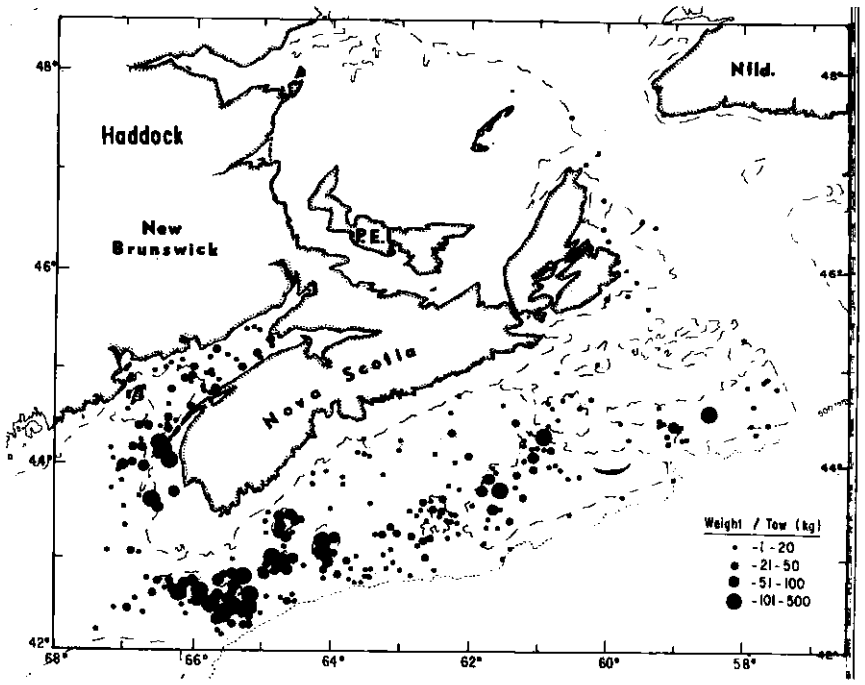

Fig. 11. Haddock (*Melanogrammus aeglefinus*)

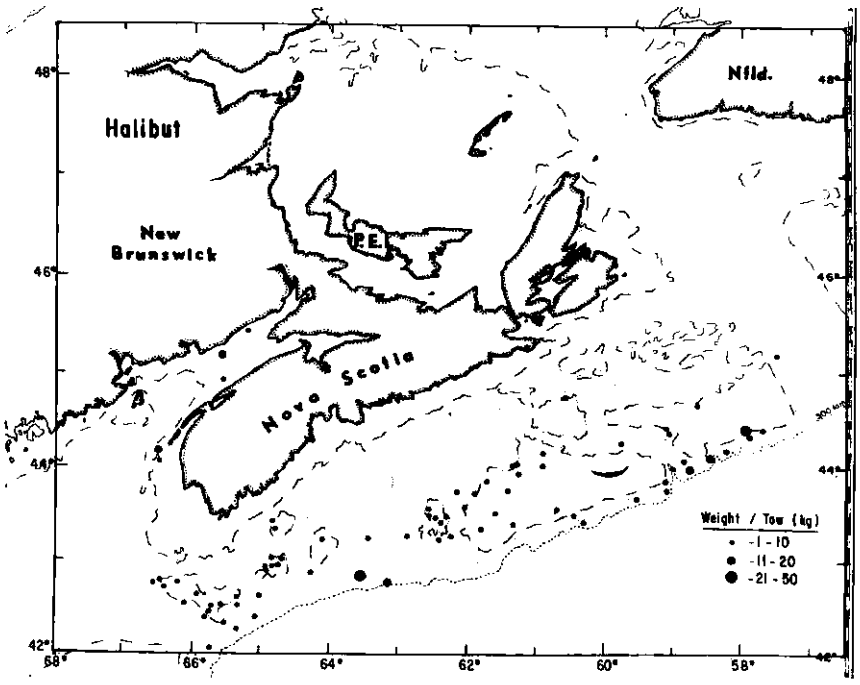

Fig. 12. Halibut (*Hippoglossus hippoglossus*)

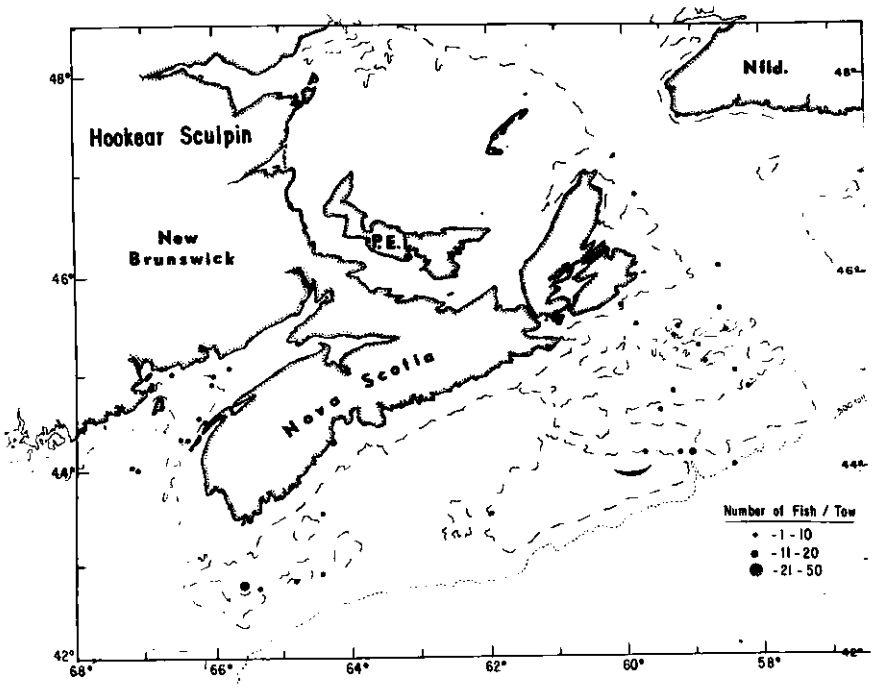

Fig. 13. Hookear sculpin (*Artediellus uncinatus*)

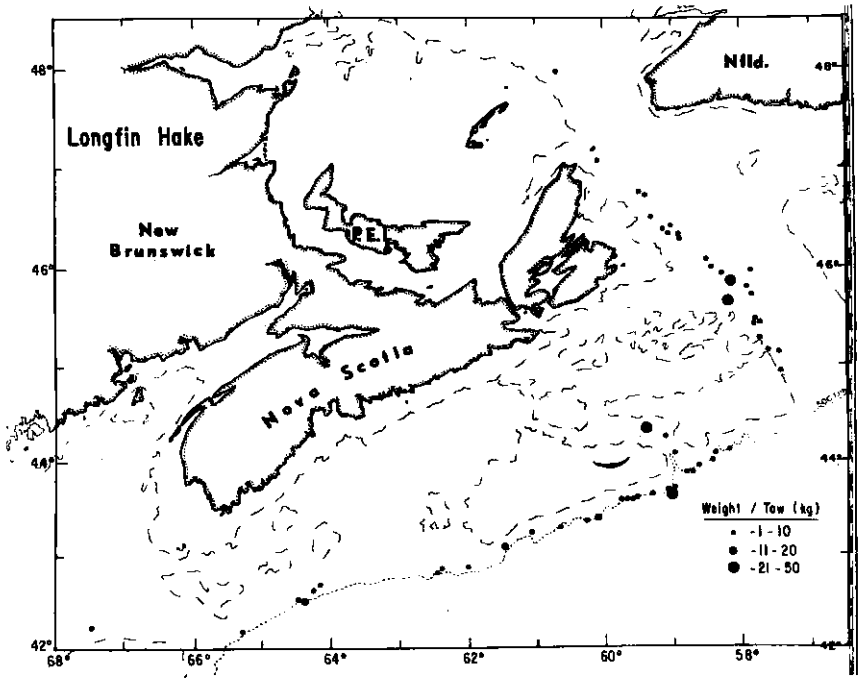

Fig. 14. Longfin hake (*Urophycis chesteri*)

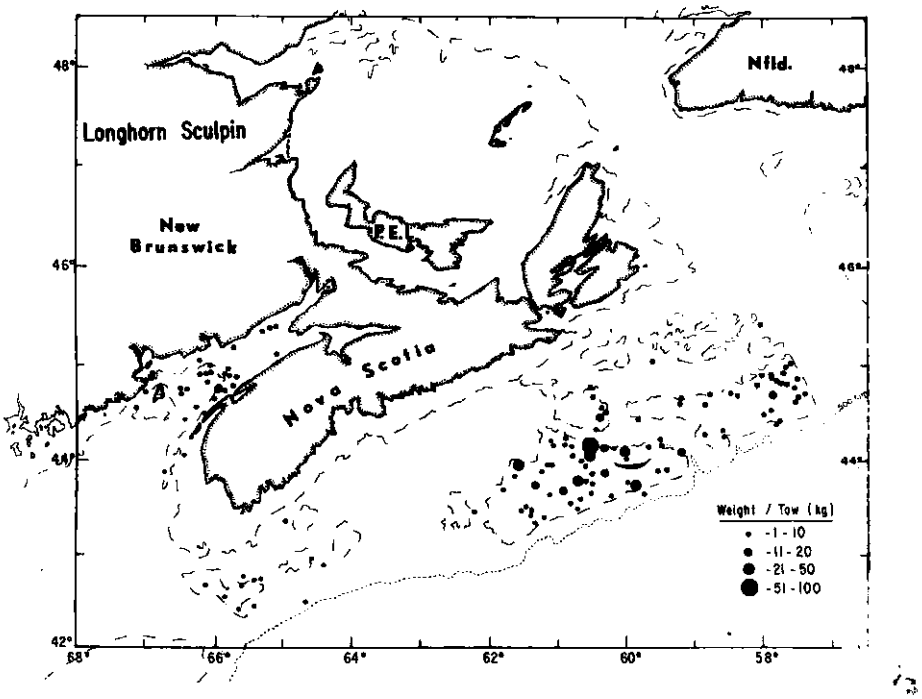

Fig. 15. Longhorn sculpin (*Myoxocephalus octodecemspinosus*)

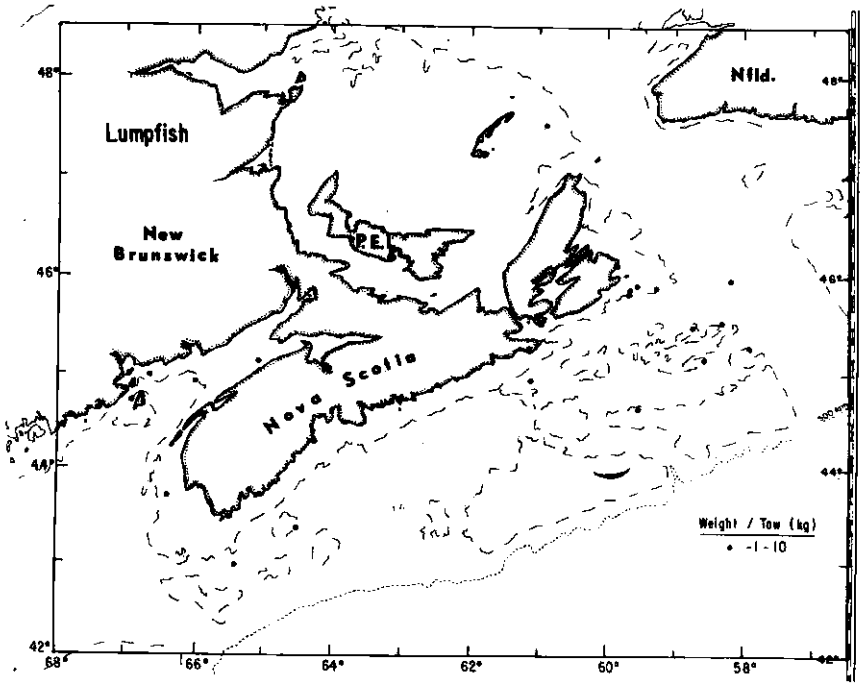

Fig. 16. Lumpfish (*Cyclopterus lumpus*)

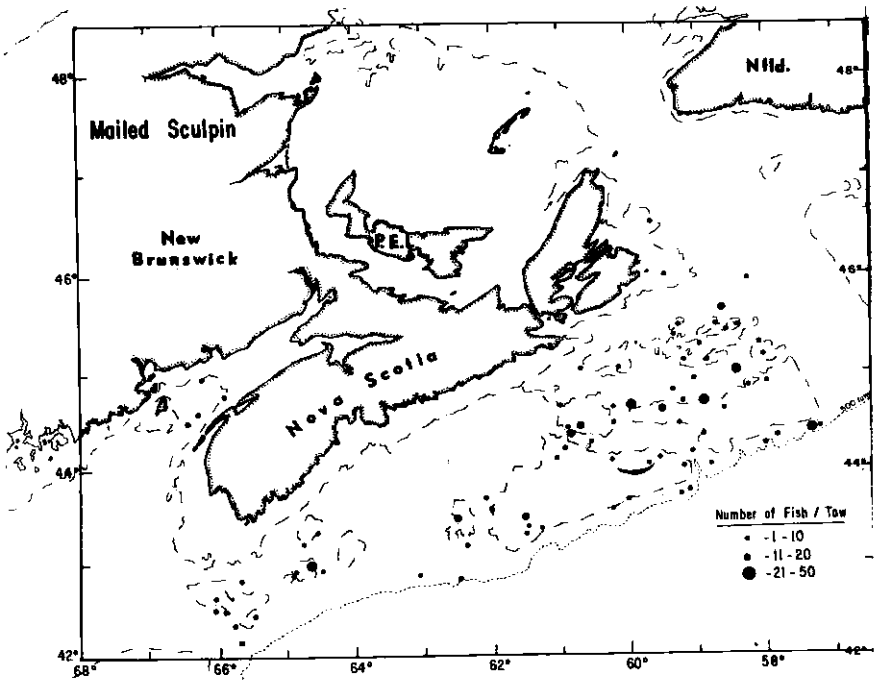

Fig. 17. Mailed sculpin (*Triglops murrayi*)

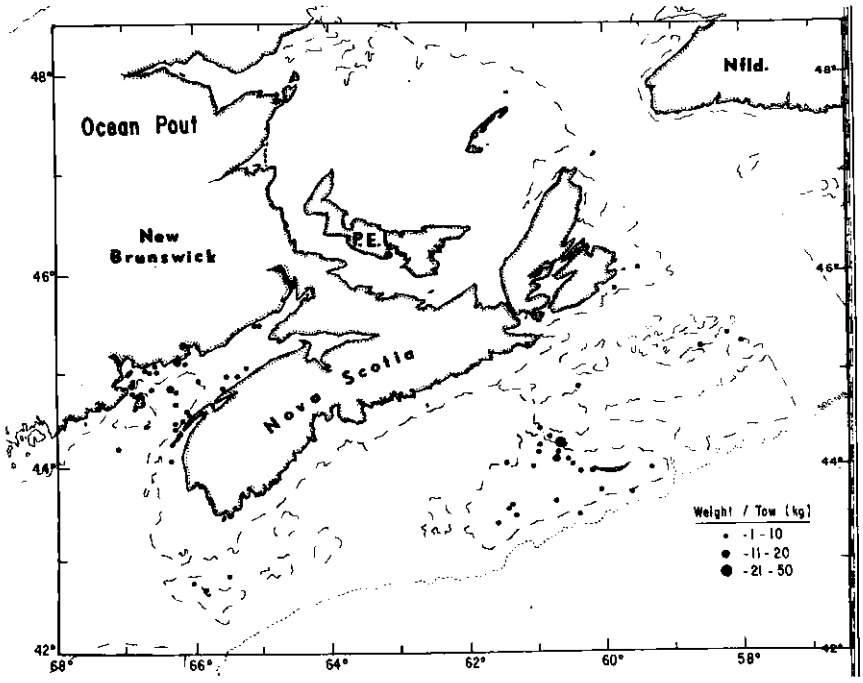

Fig. 18. Ocean pout (*Macrozoarces americanus*)

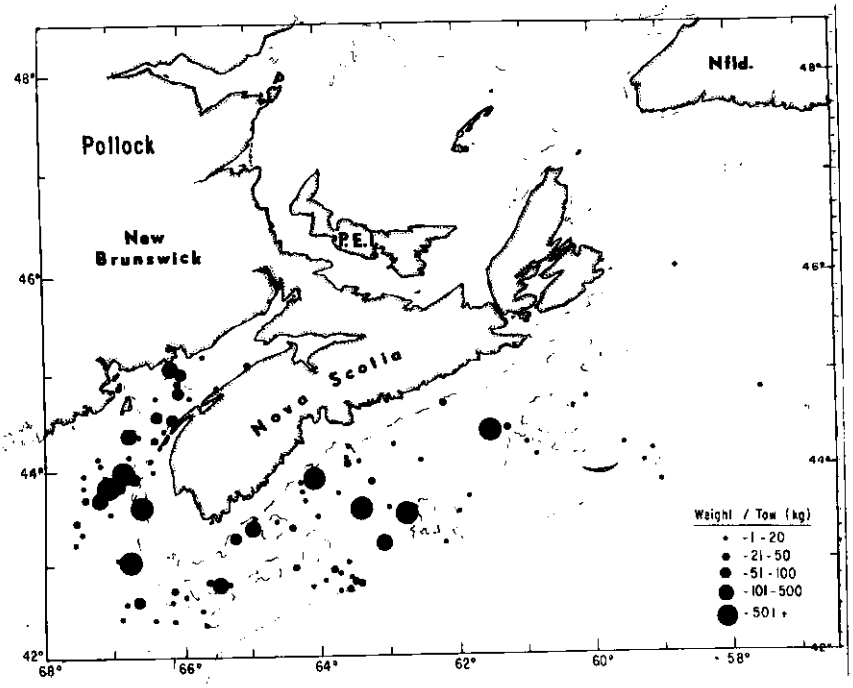

Fig. 19. Pollock (*Pollachius virens*)

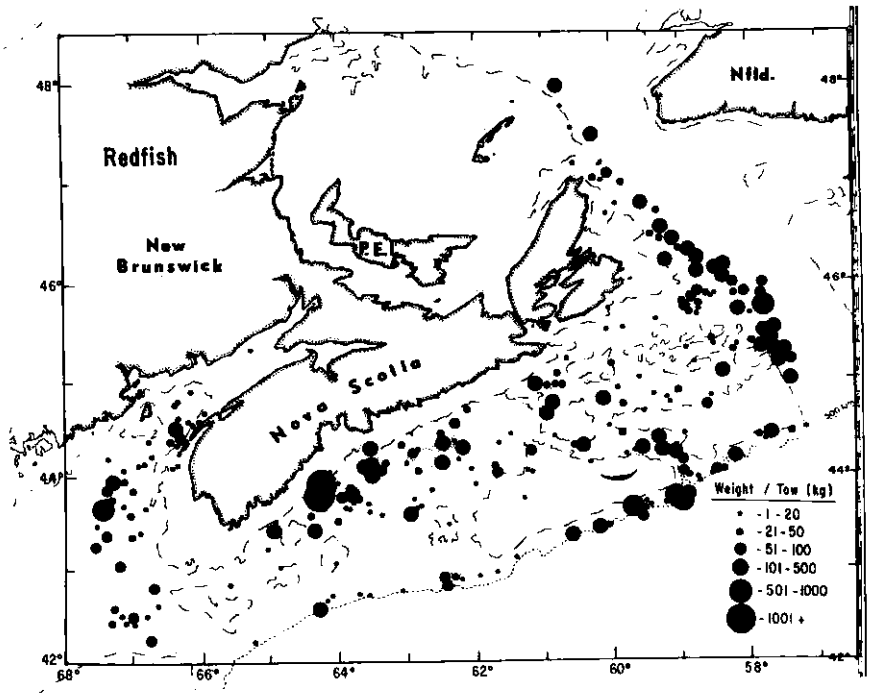

Fig. 20. Redfish (*Sebastes marinus*)

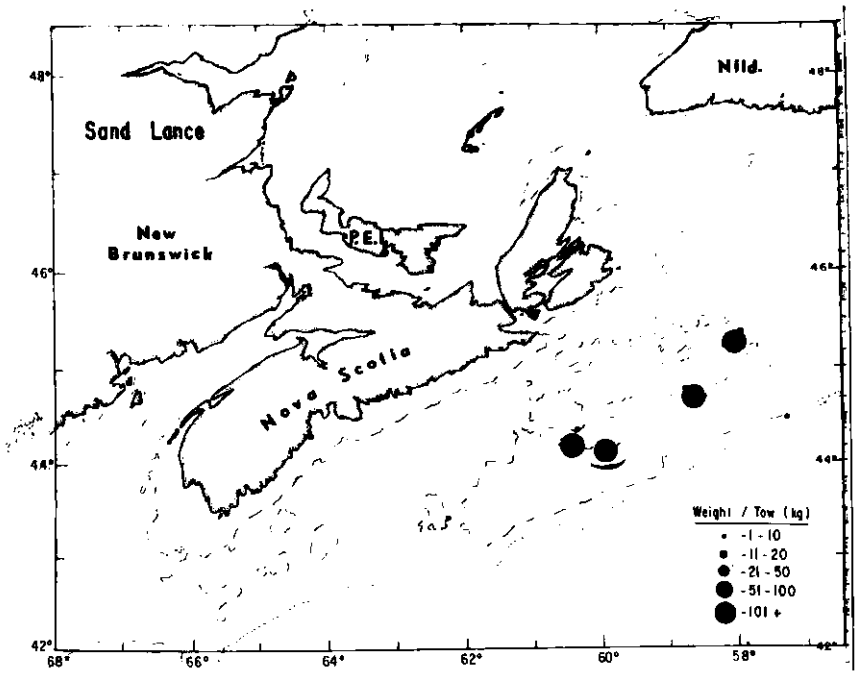

Fig. 21. Sand lance (*Ammodytes dubius*)

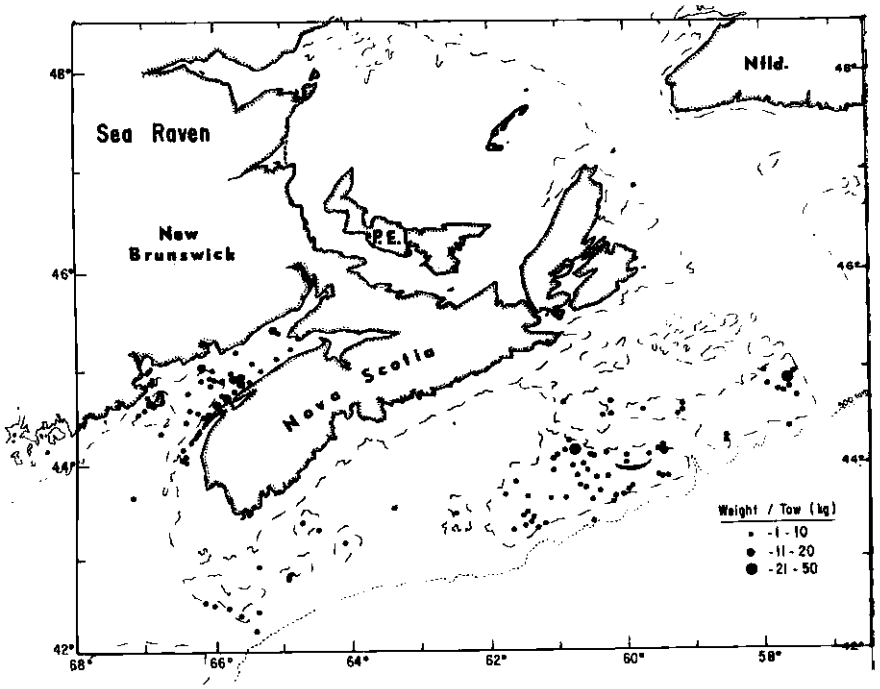

Fig. 22. Sea raven (*Hemitripterus americanus*)

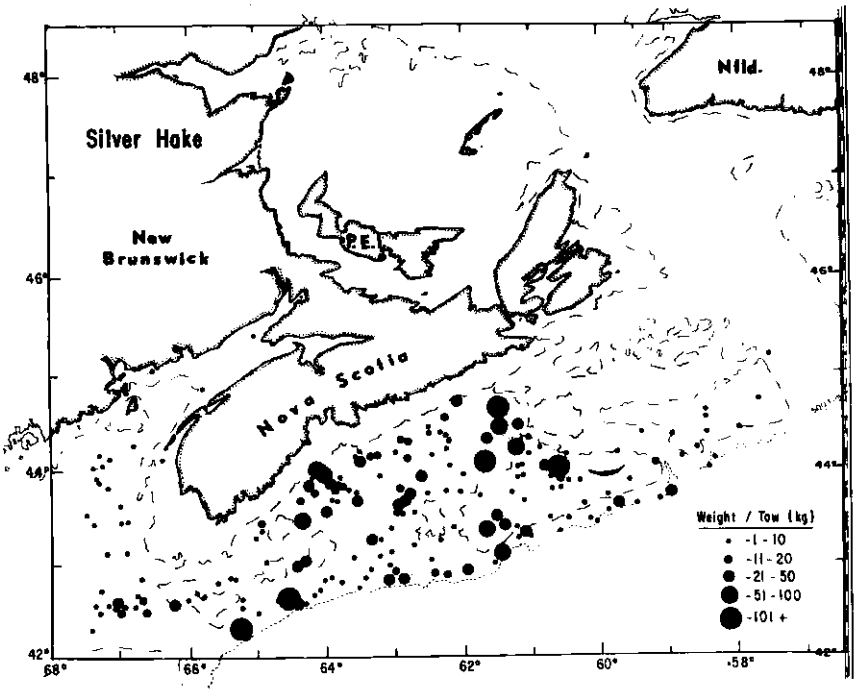

Fig. 23. Silver hake (*Merluccius bilinearis*)

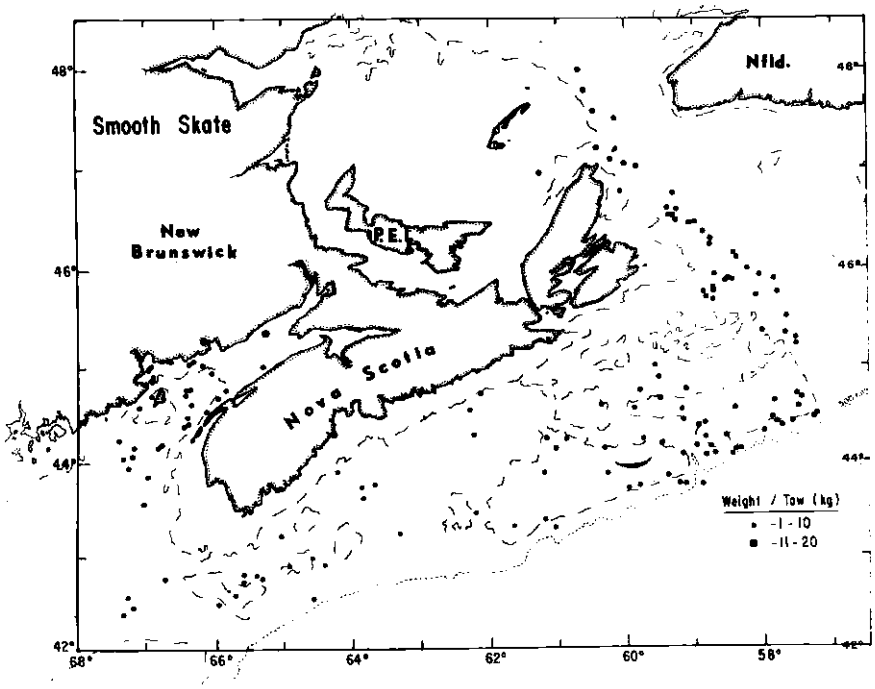

Fig. 24. Smooth skate (*Raja senta*)

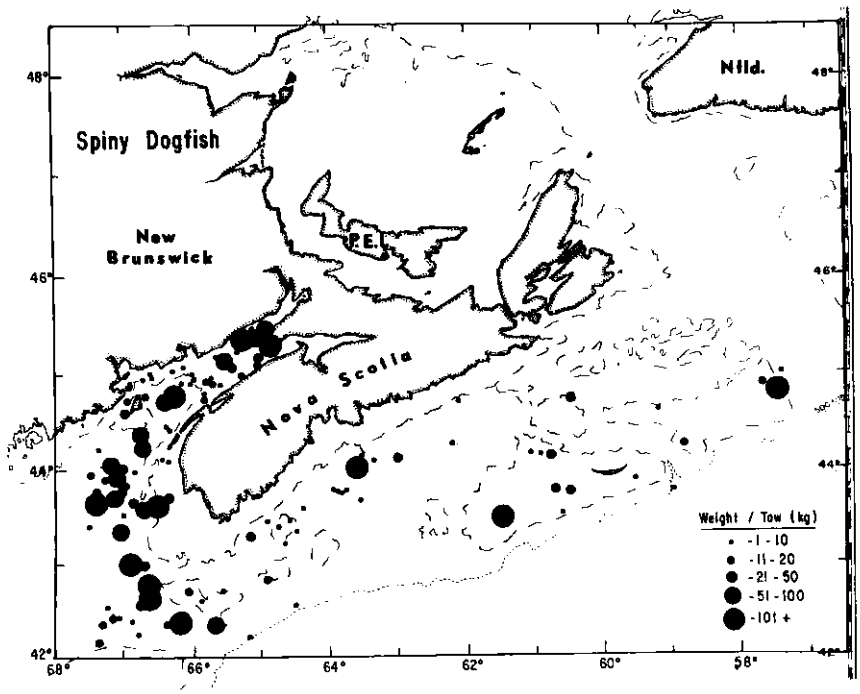

Fig. 25. Spiny dogfish (*Squalus acanthias*)

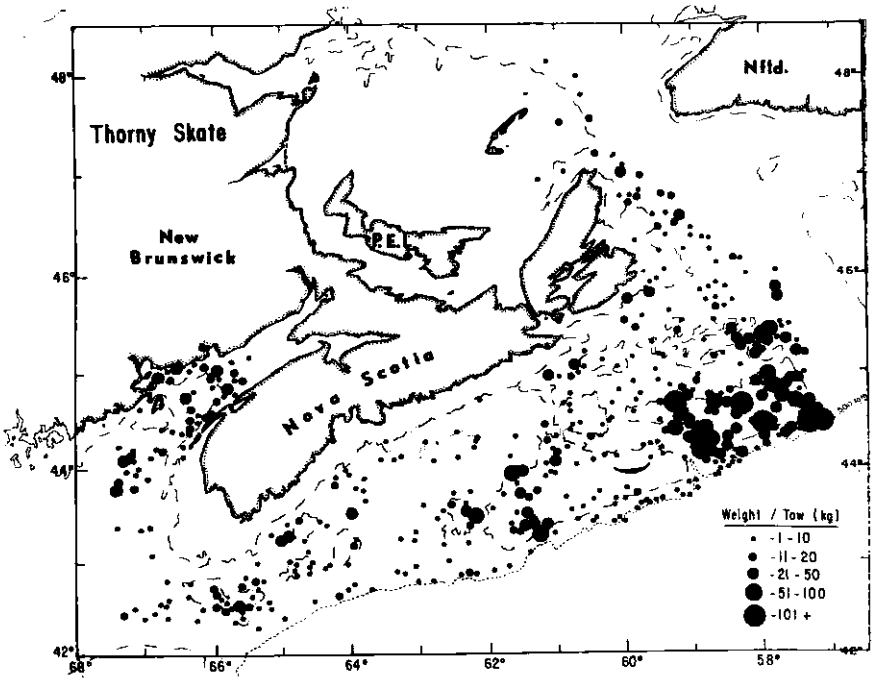

Fig. 26. Thorny skate (*Raja radiata*)

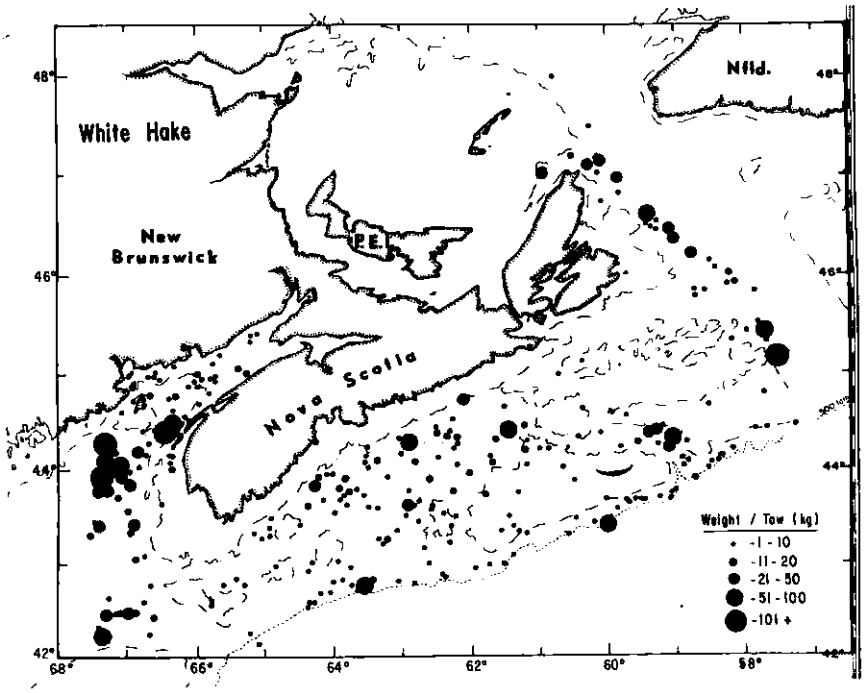

Fig. 27. White hake (*Urophycis tenuis*)

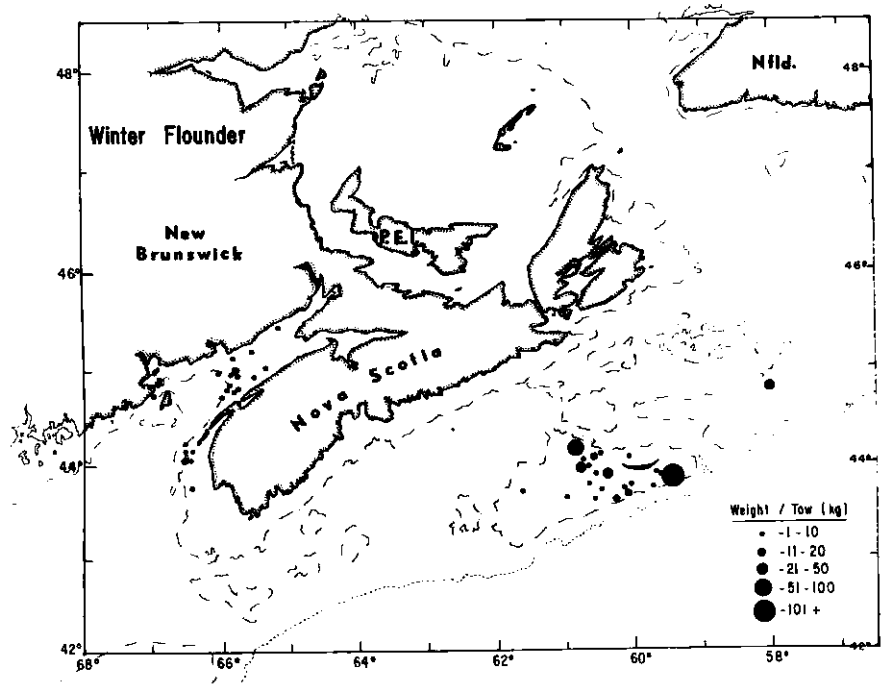

Fig. 28. Winter flounder (*Pseudopleuronectes americanus*)

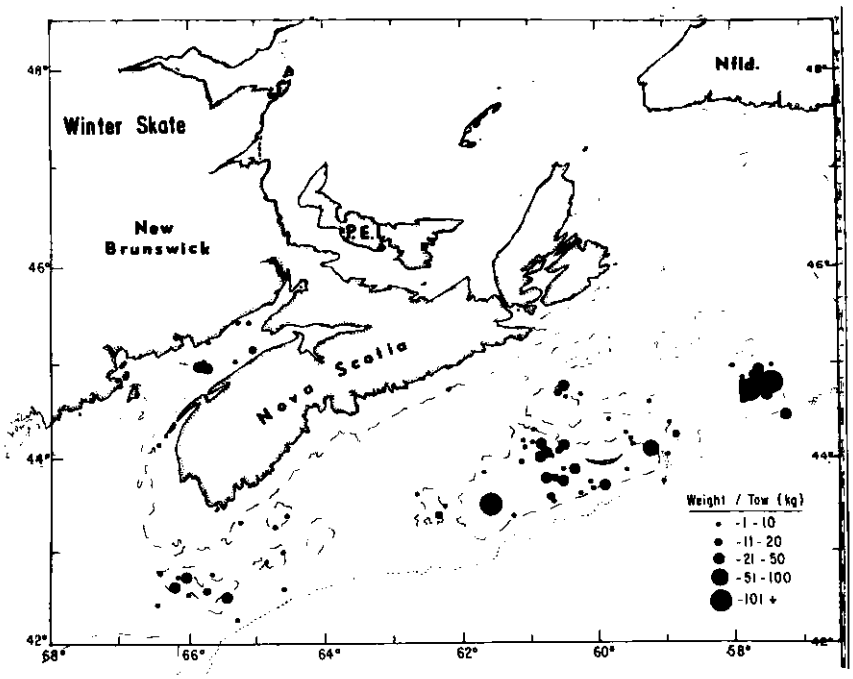

Fig. 29. Winter (eyed) skate (*Raja ocellata*)

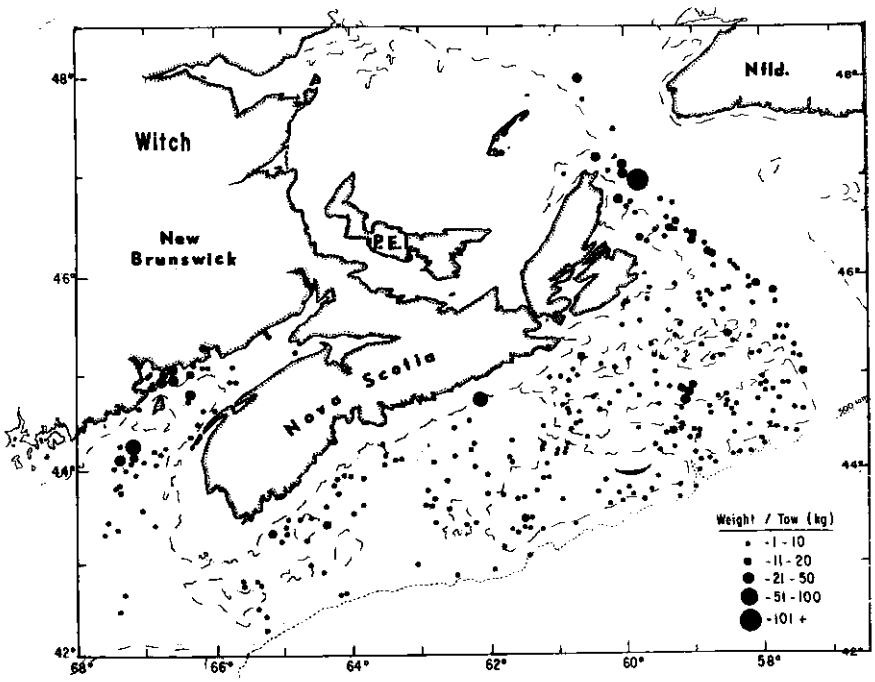

Fig. 30. Witch flounder (graysole) (*Glyptocephalus cynoglossus*)

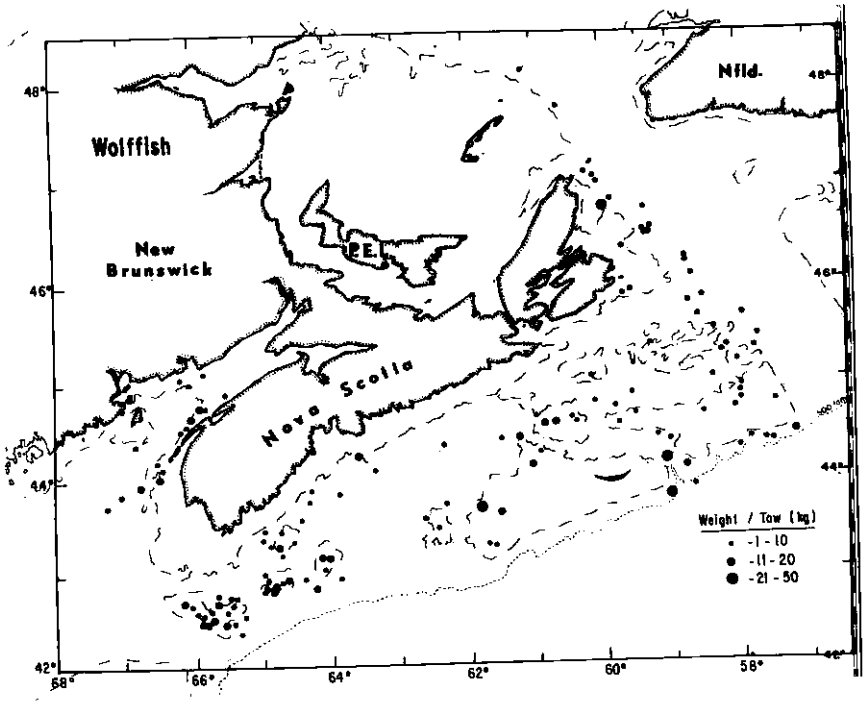

Fig. 31. Wolffish (*Anarhichas lupus*)

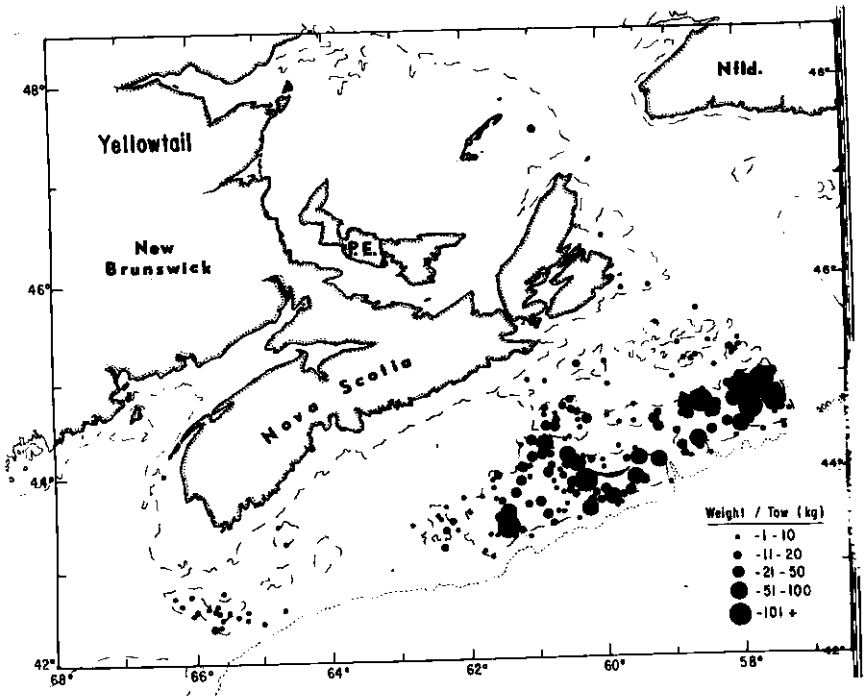

Fig. 32. Yellowtail flounder (*Limanda ferruginea*)

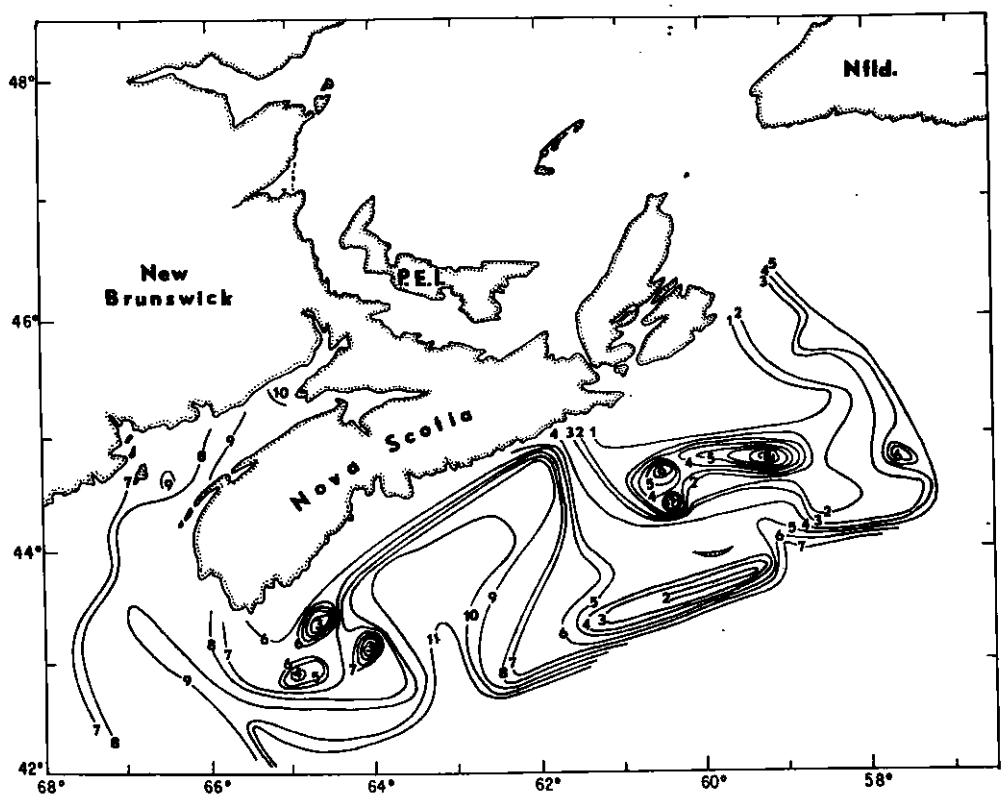

Fig. 33. Bottom temperature (°C) isotherms on the Scotian Shelf, July 6-31, 1970.

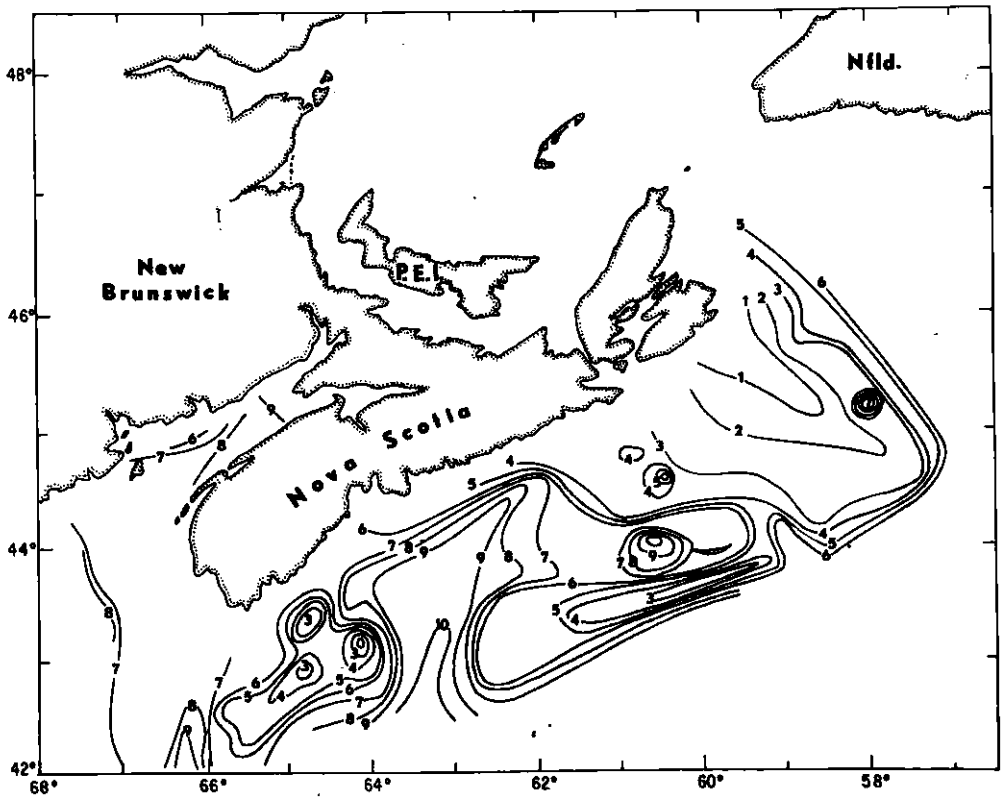

Fig. 34. Bottom temperature (°C) isotherms on the Scotian Shelf, June 29-July 22, 1971.

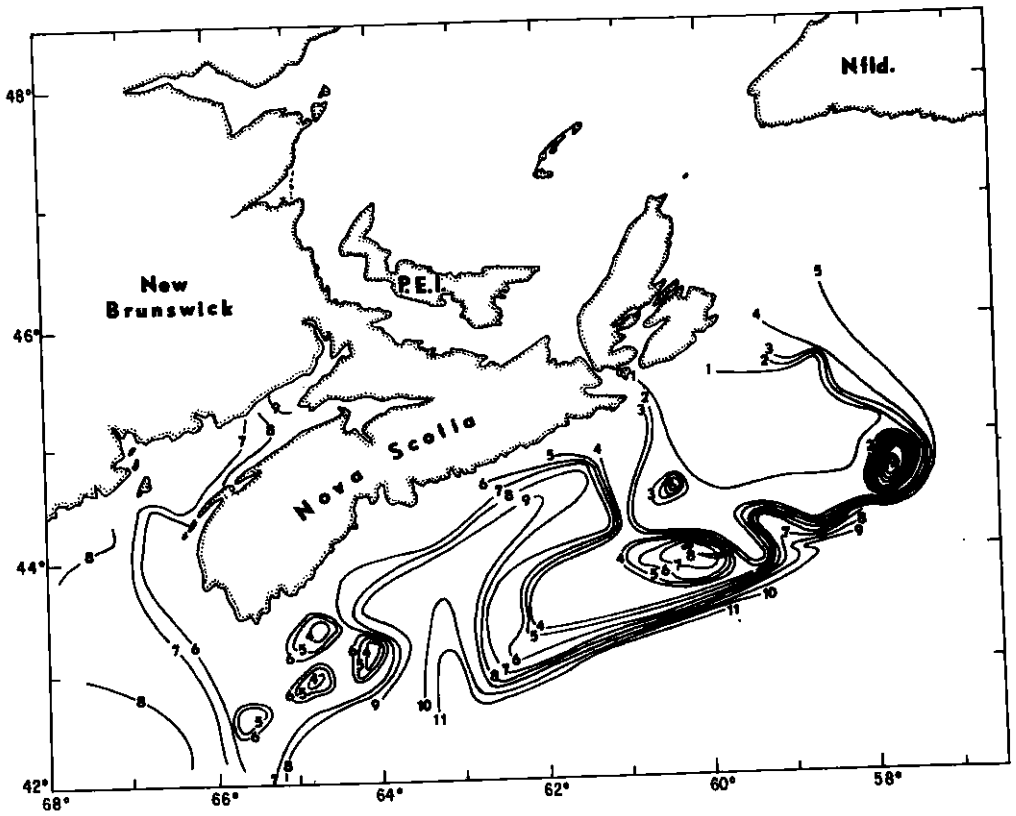

Fig. 35. Bottom temperature (°C) isotherms on the Scotian Shelf, June 23-July 19, 1972.

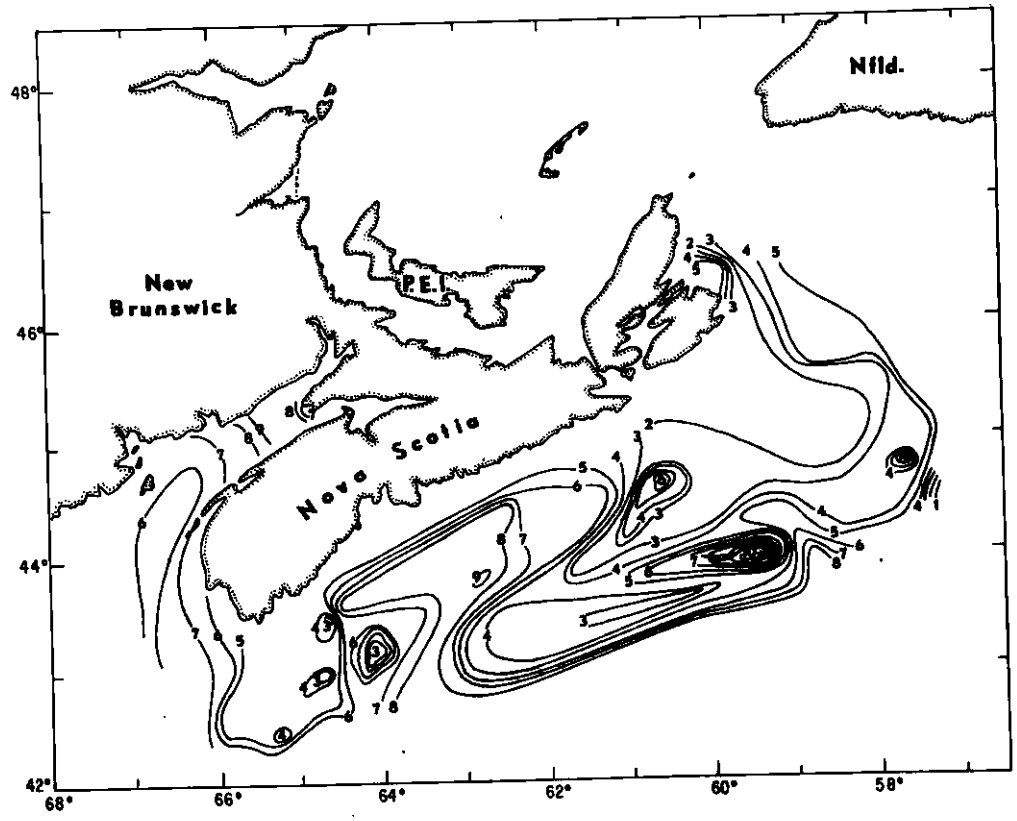

Fig. 36. Bottom temperature (°C) isotherms on the Scotian Shelf, July 9-August 3, 1973.

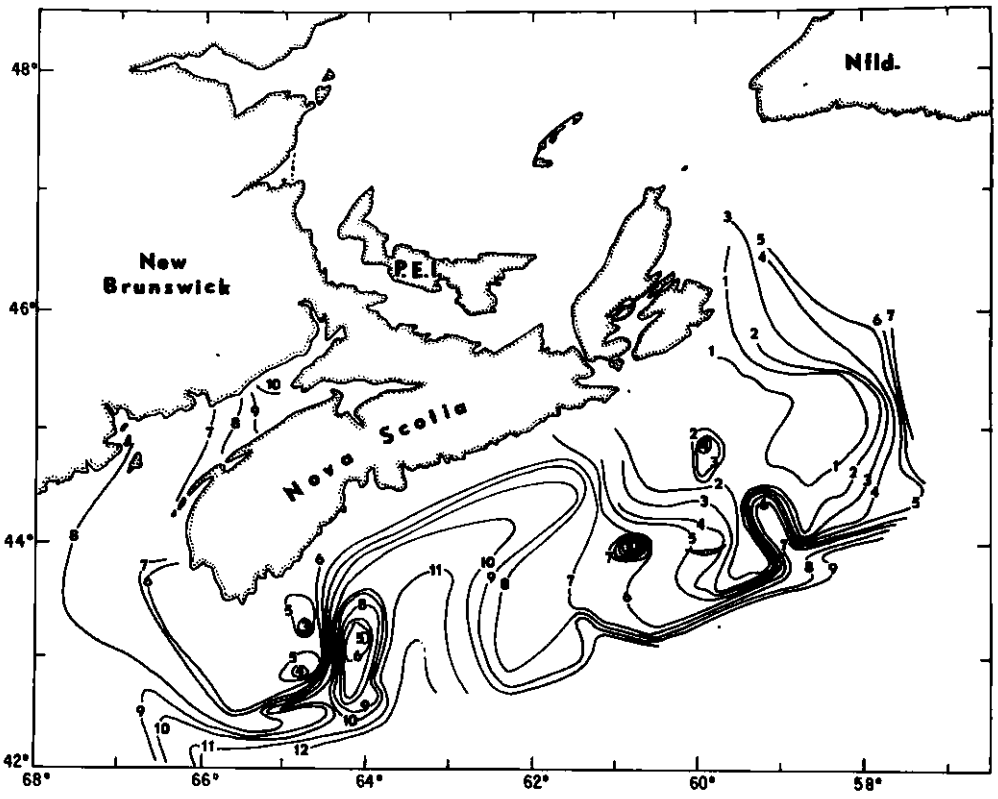

Fig. 37. Bottom temperature (°C) isotherms on the Scotian Shelf, July 8-August 3, 1974.