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Capelin (*Mallotus villosus*) Biology and History of the
Fishery in the Northern Gulf of St. Lawrence, Div. 4RS

by

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Abstract

Capelin in the northern Gulf of St. Lawrence were observed in three distinct areas: 1) the St. Lawrence estuary, 2) east of Anticosti Island, and 3) the northeastern portion of the Gulf in the Esquiman Channel. Distribution maps plotted from groundfish, redfish and shrimp, and pelagic surveys demonstrated that capelin were aggregated in these areas throughout the year except in spring during spawning season. Further research is required to demonstrate whether the three groups are separate stocks. Growth has not varied greatly since 1976. Annual landings from the commercial purse seine fishery has varied from 1500 to 8200 mt in Div. 4R since 1977.

Résumé

On a observé des populations de capelan dans trois zones de la partie nord du golfe du Saint-Laurent : 1) l'estuaire du Saint-Laurent, 2) à l'est de l'île Anticosti et 3) la partie nord-est du golfe, dans le chenal Esquiman. Des cartes de distribution établies à la suite du recensement des poissons de fond, du sébaste et des crevettes ainsi que des espèces pélagiques ont montré que le capelan se concentrait toute l'année dans ces zones, sauf durant la période du frai, au printemps. Il faudra pousser davantage les recherches pour déterminer si ces groupes constituent des stocks distincts. Le rythme de croissance ne s'est pas modifié beaucoup depuis 1976. Dans la div. 4R les prises annuelles des senneurs commerciaux ont varié de 1 500 à 8 200 tm depuis 1977.

Introduction

Very little information has been published on capelin in the Gulf of St. Lawrence. The information available up to 1979 has been reviewed by Carscadden (1979). Since 1977 a commercial purse-seine fishery has been prosecuting prespawning capelin populations along the west coast of Newfoundland.

The purpose of this manuscript is to provide recent information on the seasonal distribution of capelin in the northern Gulf of St. Lawrence, to present biological data relating to age-compositions and mean lengths-at-age, and to examine the activities of the commercial fishery in Div. 4R.

Materials and Methods

The seasonal distribution of capelin in the northern Gulf of St. Lawrence was described by distribution maps prepared from seven groundfish, four redfish and shrimp, and six herring and capelin surveys from 1978-82, and one summer redfish and shrimp survey in 1976 (Table 1). To prepare the distribution maps, all catches of capelin were included in the analysis. Since bottom trawling gear other than shrimp trawls is not very successful in retaining capelin, occurrences of capelin in cod stomachs were also utilized to augment the observations from incidental catches. Systematic surveys for herring and capelin were conducted in January 1981, 1982 (Fig. 2a and b). All spring surveys were directed at pelagic species (Fig. 3a, b, c and d) employing acoustic surveys and midwater trawls. The 1981 sounder survey included the Esquiman Channel which had been ignored in previous spring surveys.

Age-compositions and mean length-at-age data were determined from samples collected in Div. 4R in May, June, and July, 1976-81. Samples were from purse-seine, beach seine, and cast net landings.

Trends in the west coast fishery were based upon statistics from Economic Services Branch and from logbooks maintained by purse-seiners.

Results and Discussion

Distribution:

The seasonal distribution of capelin in the northern Gulf of St. Lawrence is well-defined. Capelin were generally concentrated in the northeastern portion of the Gulf off Pt. Riche and throughout the Esquiman Channel, on the east coast of Anticosti Island, and in the mouth of the St. Lawrence estuary and west of Anticosti Island. The winter distribution varied slightly from 1978 to 1982. In 1978 capelin were observed in a few sets and in cod stomachs in the upper Esquiman Channel, east of Anticosti Island, at the mouth of the estuary, and east of the Magdalen Islands (Fig. 1a). However, the incidence of occurrence was very low despite good coverage. In 1979 capelin were located throughout the Esquiman Channel and east of Anticosti Island (Fig. 1b). No sets were made west of 63° longitude. In 1980 and 1981 the winter distributions were similar, but capelin appeared more abundant in 1981 (Fig. 1c and d). Capelin were present predominantly along the northern portion of the Esquiman Channel, between Anticosti Island and the north shore of Quebec, and in the St. Lawrence estuary. Herring and capelin surveys in January 1981 (Fig. 2a)

and 1982 (Fig. 2b) on the west coast of Newfoundland confirmed that capelin were absent in the lower Esquiman Channel and generally towards the area along the west coast of Newfoundland south of Pt. Riche.

Spring surveys from 1978 to 1981 utilized an echointegration system (1978-80) or sounder only (1981) to search for capelin and herring (Fig. 3a, b, c and d). The 1978 survey covered a small area on the west coast locating capelin near the Bay of Islands in a midwater trawl set (Fig. 3a). In 1979 concentrations of capelin were observed in the Bay of Islands (Fig. 3b). In 1980, the majority of capelin were observed in patches between Pt. Riche and the north shore of Quebec around the Mecatina Islands (Fig. 3c). Except for 1981, all spring surveys were restricted to the northeastern Gulf of St. Lawrence at depths less than 183 m. The hydroacoustic and sounder surveys failed to find any significant concentrations of capelin, whereas a bottom trawl survey in the Esquiman Channel and St. George's Bay in 1981 indicated that capelin were present throughout this area (Fig. 4). The inability of the hydroacoustic system to detect capelin at this time of the year may be attributed to their distribution and activity prior to spawning. Capelin were not present in large concentrations in the upper layers but appeared to be distributed in the deeper water close to the bottom as shown in Fig. 4. Some capelin may also have been closer to shore in preparation for spawning.

Summer distribution patterns in 1976 and 1978-81 corresponded very well to those described by the winter surveys (Fig. 5a, b, c, d and e). The 1976 (Fig. 5a), 1978 (Fig. 5b), 1979 (Fig. 5c), and 1981 (Fig. 5e) summer abundance levels as suggested by occurrences were high and similar for all four years. Capelin were caught in the estuary, around Anticosti Island, and along the Esquiman Channel. In 1980 (Fig. 5d) a slight deviation from the general pattern was observed. Capelin appeared to concentrate in smaller areas east of Anticosti Island and in the upper portion of the Esquiman Channel. The levels of abundance in the estuary in 1980 were similar to all other known years.

The fall distribution is probably similar to what has already been described from winter and summer surveys despite less intense coverage (Fig. 6a, b, and c). The 1978 (Fig. 6a) pattern generally reflected the observations from distribution maps for other seasons. However, the number of sets and their locations in 1979 (Fig. 6b) and 1980 (Fig. 6c) were much reduced. Nevertheless, on the strength of the few catches and the surveys in winter and summer, we assume that the general distribution trends previously described exist as well at this time of the year.

There are some deficiencies in the data which must be considered in interpreting the seasonal distribution pattern of capelin. The winter and fall distribution maps were plotted from groundfish surveys employing fishing gear not generally considered to be very efficient at catching capelin unless present in large numbers. Shrimp gear used in the summer and January surveys were probably more effective provided that capelin were near the bottom. The combination of catches and presence in cod stomachs helped to alleviate this problem since cod were probably more efficient at sampling capelin than were groundfish trawls. Another factor to consider is the depths which were fished. Capelin may have been in shallower water which was not surveyed during groundfish trips (Table 1). Therefore, there is some likelihood that capelin may have been present but were undetected throughout the inshore areas. The spring

surveys suggested that capelin may have been located in shallow water. However, the 1978, 1979, and 1980 surveys avoided the Esquiman Channel and did not observe any strong concentrations of capelin inshore. A comparison of Fig. 3d and 4 indicates that capelin were probably present throughout the Esquiman Channel but were either too close to the bottom or not sufficiently aggregated to be detected by the hydroacoustic system. It is also unlikely that maturing capelin were close to the spawning beaches at the time of these surveys which were four to eight weeks prior to actual spawning time. Moreover, the purse-seine fleet generally fishes capelin between St. George's Bay and Bonne Bay at depths which were covered in the spring surveys.

Relying upon the distribution maps, we can summarize that capelin in the winter, summer, fall, and probably spring were aggregated into three distinct areas: (1) the upper Esquiman Channel and northern area between Pt. Riche and the Mecatina Islands, (2) east of Anticosti Island to the Quebec shore, and (3) at the mouth of the St. Lawrence estuary towards the Gaspé Peninsula. These groups apparently maintained their integrity throughout the year except in late spring when mature capelin migrated inshore to spawn. Since the capelin activity prior to and during spawning is dynamic, this may explain why the spring hydroacoustic surveys have not succeeded in locating larger concentrations of capelin. Abundances based upon occurrence appear to fluctuate from year to year and among seasons, however, the locations of these groups were quite predictable at least from 1978 to 1981 and probably since 1976.

The results of previous studies (Sharp *et al.* 1978; O'Boyle and Lett 1977; Carscadden and Misra 1980) when taken together with the distribution maps support our general hypothesis concerning the presence of three concentrations of capelin in the northern Gulf and their seasonal distribution. Relying upon evidence from Jacquaz *et al.* (1977) and Hodder and Winters (1972), the location of gyres, and the results from larval surveys, O'Boyle and Lett (1977) hypothesized that four fall-winter feeding areas for capelin in the Gulf of St. Lawrence were located in the estuary, east of Anticosti Island, off Baie des Chaleurs, and east of the Magdalen Islands (Fig. 7). The areas we hypothesize support their conclusions for the estuary and east Anticosti Island groups, however, no evidence for the other two feeding areas was observed. We did not have any information from these surveys (Table 1) off Baie des Chaleurs, and except for one set in Fig. 1a no capelin were caught or observed in cod stomachs in the area east of the Magdalen Islands. Our study suggests that O'Boyle and Lett's (1977) fall-winter feeding areas in the northern Gulf of St. Lawrence may be considered year-round areas where capelin congregate except during spawning. In addition our study proposed a third concentration of capelin in the northeastern Gulf of St. Lawrence in northern Div. 4RS which probably corresponds to Carscadden's (1979) western Newfoundland stock.

Morphometric (Sharp *et al.* 1978) and meristic (Carscadden and Misra 1980) analyses also lend support to these groupings. Sharp *et al.* (1978) using morphometric characters were able to differentiate four populations located at Sept Iles, Natashquan, Grande Riviere, and Ile aux Coudres in the northern Gulf of St. Lawrence (Fig. 7). With respect to our distribution hypothesis the Sept Iles population may correspond to the estuary group and the Natashquan population to the east Anticosti Island group. The Grande Riviere population could relate to O'Boyle and Lett's (1977) feeding group off Baie des Chaleurs or to our estuary group since at various times the distribution of the latter expanded along the Gaspé Peninsula. Carscadden and Misra (1980) successfully

separated west coast of Newfoundland capelin samples from capelin stocks in the Southeast Shoal and inshore Atlantic stocks on meristic characters. No comparisons were made with populations hypothesized by Sharp *et al.* (1978). The capelin samples used by Carscadden and Misra (1980) probably were from the upper Esquiman Channel group and not from east Anticosti Island.

This study has not ruled out the possibility that capelin distribution may be homogeneous throughout the Gulf of St. Lawrence. The lack of coverage due to depths fished and gear selectivity may indicate that there were gaps in this analysis. However, on the strength of comparisons with classification analyses (Carscadden and Misra 1980; Sharp *et al.* 1978) and hypothesized fall-winter feeding areas (O'Boyle and Lett 1977), there is strong corroborative evidence for differentiating between the St. Lawrence estuary and east Anticosti Island concentrations. Distribution maps and the presence of juvenile and mature capelin in the northeastern Gulf of St. Lawrence all year round imply a third concentration is located there which probably spawns along the west coast of Newfoundland.

Biological Aspects

Carscadden (1979) reviewed the available information on biomass estimates, ichthyoplankton surveys, and age-compositions. He concluded that management of capelin stocks in the Gulf of St. Lawrence was dependent on having 'precise biological information' available. We appear not to be much further ahead.

Age-compositions from 1976 to 1981 (Fig. 8) revealed some interesting observations on the commercial catch compositions in Div. 4R. Generally the catch was dominated by three- and four-year-olds as has been observed for other capelin stocks (Carscadden 1979). Of significance was the domination of the 1973 year-class in the 1976 and 1977 catches in Div. 4R which paralleled the strong 1973 year-class in the northwest Atlantic (Carscadden 1979). In 1981 there was a predominance of age 4's and 5's in the catch which suggest a strong 1976 and 1977 year-classes compared to a very weak 1978 year-class in Div. 4R. This differed from Div. 4S capelin which was dominated by age 3's in 1981 (S. Labonté, pers. comm.).

Mean lengths-at-age for the corresponding years in Table 2 indicated that growth has not changed very much among years. There is some suggestion the age 4's and 5's in 1980 experienced lower growth. However, the mean lengths are within the range one would expect given sampling error and variation in natural populations albeit they are at the lower end of the range.

No biomass estimates have been considered for Div. 4R capelin since Carscadden (1979). Attempts have been made to apply a version of the SCAM models (Carscadden and Miller 1979) to Div. 4R capelin. However, there was insufficient knowledge from Div. 4R capelin to estimate mortality parameters for the model. Moreover, total catches have been quite low and the fishery has only been in existence since 1977. Hydroacoustic surveys have failed to provide any trends in relative abundance. As explained earlier this was probably due to the timing of these surveys in the spring when capelin distributions were more uncertain. It appears from the distribution maps that hydroacoustic surveys in winter or summer, when concentrations appear to be better defined,

may be more profitable. Because of the low catches by a small commercial fishery operating in Div. 4R, there does not appear to be an urgent need to determine biomass levels at this time.

Capelin Fishery in Div. 4R

Landings from the capelin fishery were small until 1977 when purse-seiners became involved (Table 3). Landings increased to their highest level in 1978 and have declined up to 1981. The low landings in 1981 were due to the premature closing of the fishery due to processing problems (J. Moores pers. comm.). In 1977 one purse-seiner prosecuted the fishery. This increased to eight vessels in 1978 and declined to six seiners in 1979 and 1980. In 1981 four vessels took part in the fishery. Catch/effort (Table 4) generally reflected the trends in landings despite concern over the use of catch/effort from purse-seine data (Powles 1981) for this purpose.

The purse-seine fleet has operated between St. George's Bay and Bonne Bay where most of the prespawning capelin are caught. Capelin were usually available to the seiners in late May and June. Despite the capacity to catch more catches were generally low. The division of the TAC into four statistical districts on the west coast of Newfoundland was recommended and implemented to prevent excessive fishing pressure on local stocks (CAFSAC 1981).

Conclusions

The distribution of capelin in the northern Gulf of St. Lawrence appears predictable. Capelin were observed at the mouth of the estuary, east of Anticosti Island, and in the upper Esquiman Channel. It appeared that the Div. 4R spawning component which is fished may originate from the Esquiman Channel group. The available evidence suggested that these groups may be discrete and that they are present throughout the year except during spawning. Meristic and morphometric studies (Carscadden and Misra 1980; Sharp *et al.* 1978) on beach spawning samples may imply that these groups are separate stocks. Further studies should test our hypothesis concerning the discreteness of the three areas and their presence year round. Classification analysis of samples from these three areas either in winter or summer when the aggregations were most distinct may be compared to the beach samples from Sharp *et al.* (1978) and Carscadden and Misra (1980) to determine if there is general mixing during the non-spawning period or if separate spawning populations remain discrete at other times of the year.

It is evident from the summary of biological data and the development of the fishery that advances in biological knowledge have been minimal. Growth appears unchanged since 1976. Age-compositions may reflect year-class fluctuations, however, the idea of parallelism among Gulf of St. Lawrence and northwest Atlantic capelin stocks may be in doubt except when very dominant year-classes are present. The fishery is small in comparison to the Div. 3L inshore fishery and landings do not appear to present any pronounced effects on the stock.

Understandably any advances in biology or analytical models to estimate biomass require much more data on several aspects of capelin population dynamics and life history. The information provided in this report on distribution lends support to other studies and further hypothesizes that these groups are present in the northern Gulf year round. Clarification and discrimination of capelin stocks and their distribution in the Gulf of St. Lawrence would be a significant step towards providing the biological advice required to manage these stocks. It would be especially valuable to obtain this information while fishing effort is relatively low.

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References

- CAFSAC. 1981. Advice on pelagic stocks. CAFSAC Advisory Document 81/4, 13 p.
- Carscadden, J. E. 1979. Capelin (Mallotus villosus) in the Gulf of St. Lawrence. CAFSAC Res. Doc. 79/24, 13 p.
- Carscadden, J. E., and D. S. Miller. 1979. Biological aspects of capelin and a sequential abundance model for the Division 3LNO stock. ICNAF Res. Doc. 79/II/33, 20 p.
- Carscadden, J. E. and R. K. Misra. 1980. Multivariate analysis of meristic characters of capelin (Mallotus villosus) in the Northwest Atlantic. Can. J. Fish. Aquat. Sci. 37: 725-729.
- Hodder, V. M., and G. E. Winters. 1972. Distribution size of larval herring and capelin, southern Gulf of St. Lawrence and southwestern Newfoundland, November, 1969 and 1970. Fish. Res. Board Can. Tech. Rep. No. 315, 25 p.
- Jacquaz, B., K. W. Able, and W. C. Leggett. 1977. Seasonal distribution, abundance, and growth of capelin (Mallotus villosus) in the St. Lawrence estuary and northwestern Gulf of St. Lawrence. J. Fish. Res. Board Can. 34: 2015-2029.
- O'Boyle, R. N. and P.F.K. Lett. 1977. Status of capelin (Mallotus villosus) stocks in the Gulf of St. Lawrence. CAFSAC Res. Doc. 77/4, 18 p.
- Powles, H. 1981. What does purse seine catch per unit effort measure? A simple fishery model. CAFSAC Res. Doc. 81/36, 27 p.
- Sharp, J. C., K. W. Able, W. C. Leggett, and J. E. Carscadden. 1978. Utility of meristic and morphometric characters for identification of capelin (Mallotus villosus) stocks in Canadian Atlantic waters. J. Fish. Res. Board Can. 35: 124-130.

Table 1. List of cruises with dates, fishing gear, and depths surveyed which correspond to specific capelin distribution maps.

Date	Trip	Fishing gear	Depth fished (m)	Distribution maps
<u>1976</u>				
July 25-Sept. 5	Beothic Venture	#36 shrimp trawl	140-340	Fig. 5a
<u>1978</u>				
Jan. 6-22	Gadus Atlantica 4	Engels high rise trawl	>91	Fig. 1a
May 1-10	E.E. Prince 197	Acoustic & midwater trawl	<183	Fig. 3a
July 18-Aug. 28	Beothic Venture	#36 shrimp trawl	140-340	Fig. 5b
Oct. 13-30	A.T. Cameron 283	41-5 Yankee trawl	>91	Fig. 6a
<u>1979</u>				
Jan. 6-15	Gadus Atlantica 16	Engels high rise trawl	>91	Fig. 1b
Apr. 28-May 15	E.E. Prince 219	Acoustic & midwater trawl	<183	Fig. 3b
July 18-Aug. 25	Beothic Venture	#36 shrimp trawl	140-340	Fig. 5c
Sept. 23-Oct. 9	A.T. Cameron 294	41-5 Yankee trawl	>91	Fig. 6b
<u>1980</u>				
Jan. 27-Feb. 11	Gadus Atlantica 31	Engels high rise trawl	>91	Fig. 1c
Apr. 14-28	E.E. Prince 236	Acoustic & midwater trawl	<183	Fig. 3c
July 17-Sept. 1	Beothic Venture	#36 shrimp trawl	140-340	Fig. 5d
Sept. 12-22	A.T. Cameron 309	41-5 Yankee trawl	>91	Fig. 6c
<u>1981</u>				
Jan. 7-30	Martin & Phillip	Sputnik 1600, #36 shrimp trawl	73-324	Fig. 2a
Jan. 29-Feb. 17	Gadus Atlantica 46	Engels high rise trawl	>91	Fig. 1d
Apr. 30-May 18	E.E. Prince 253	Sounder & midwater trawl Yankee 36	<300	Fig. 3d Fig. 4
July 29-Aug. 27	Vicki and Brothers	#36 shrimp trawl	140-340	Fig. 5e
<u>1982</u>				
Jan. 7-23	Gadus Atlantica 60	Sputnik 1600	>48	Fig. 2b

Table 2. Mean lengths of capelin sampled from the commercial fishery in Div. 4R, 1976-81.

Year	Sex	Ages				
		2	3	4	5	6
1976	Male	123	184	188	190	194
	Female	121	160	169	172	
1977	Male		181	191	185	
	Female	139	156	169	183	200
1978	Male	155	178	187	197	198
	Female	144	161	168	179	187
1979	Male	161	172	191	198	208
	Female	148	162	179	185	192
1980	Male	143	169	178	178	
	Female	145	157	165	166	173
1981	Male		171	189	193	193
	Female		160	174	180	187

Table 3. Landings (m tons) of capelin by month from Div. 4R, 1974-81.

Month	Year							
	1974	1975	1976	1977	1978	1979	1980	1981
April	42.4							
May	87.0			247.9	393.1	4712.2	2636	<.1
June	44.4	59.1	58.6	1209.9	7716.6	1018.0	2077	1986.7
July	5.6	9.1	32.8	49.0	93.8	6.8	61	101.4
August				6.8	0.5			75.8
TOTAL	179.4	68.2	91.4	1513.6	8203.8	5737.0	4774	2163.9

Table 4. Catch per operating day (CPUE_D), catch per set (CPUE_S), and mean number of sets per operating day (\bar{S}), for the purse-seine fleet and for a common fishing vessel.

Year	CPUE _D	CPUE _S	\bar{S}
<u>Purse-seine fleet</u>			
1977	61.2	44.8	1.5
1978	95.8	65.5	1.3
1979	125.7	66.0	2.0
1980	77.5	59.9	1.3
1981*	70.2	65.5	1.1
<u>Common fishing vessel</u>			
1977	61.2	44.8	1.5
1978	113.8	50.6	2.4
1979	148.5	74.2	2.2
1980	82.9	53.9	1.5
1981	70.2	65.5	1.1

* Logbook received from only one vessel.

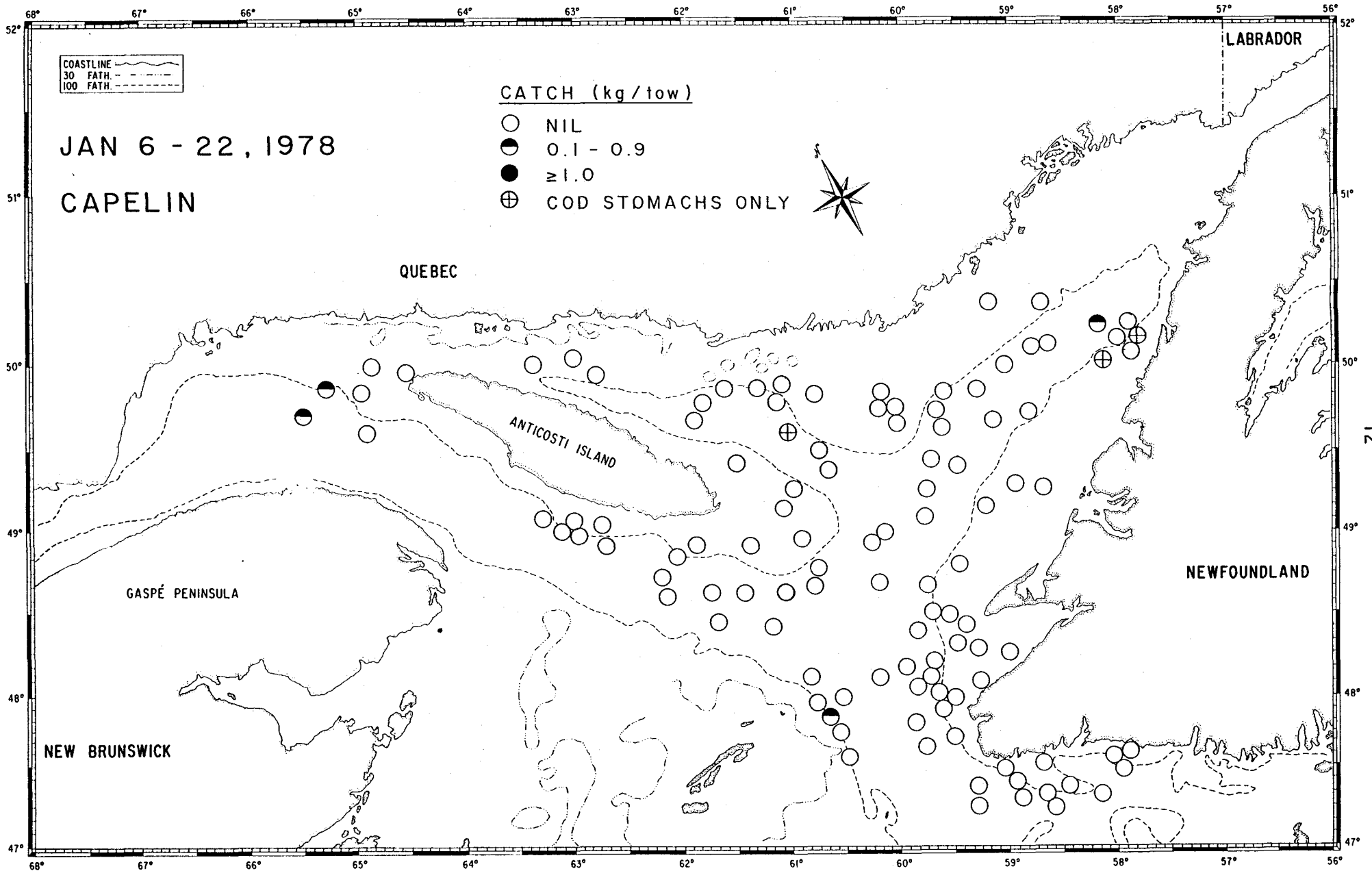


Fig. 1a. Winter distribution of capelin in 1978.

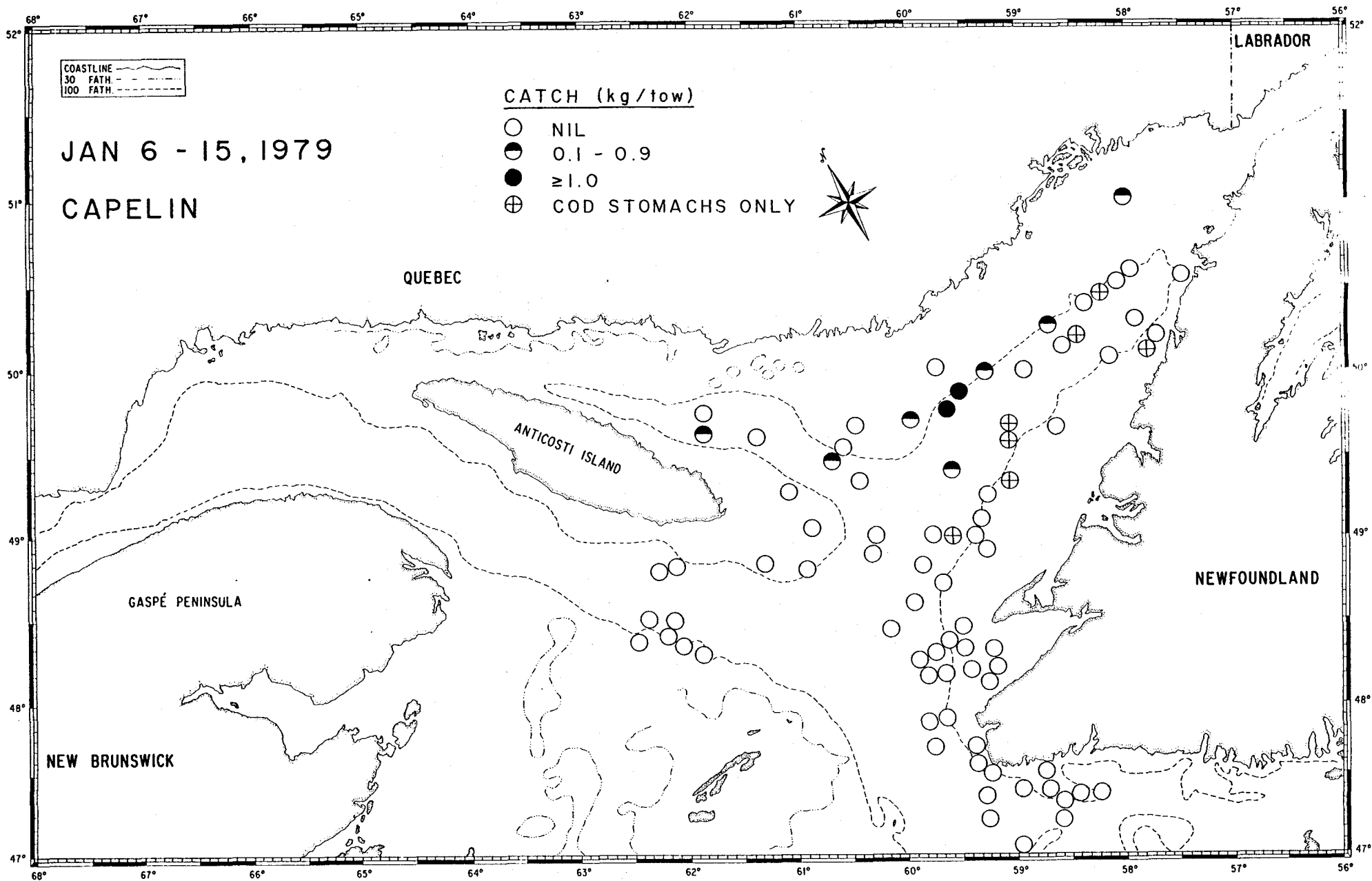


Fig. 1b. Winter distribution of capelin in 1979.

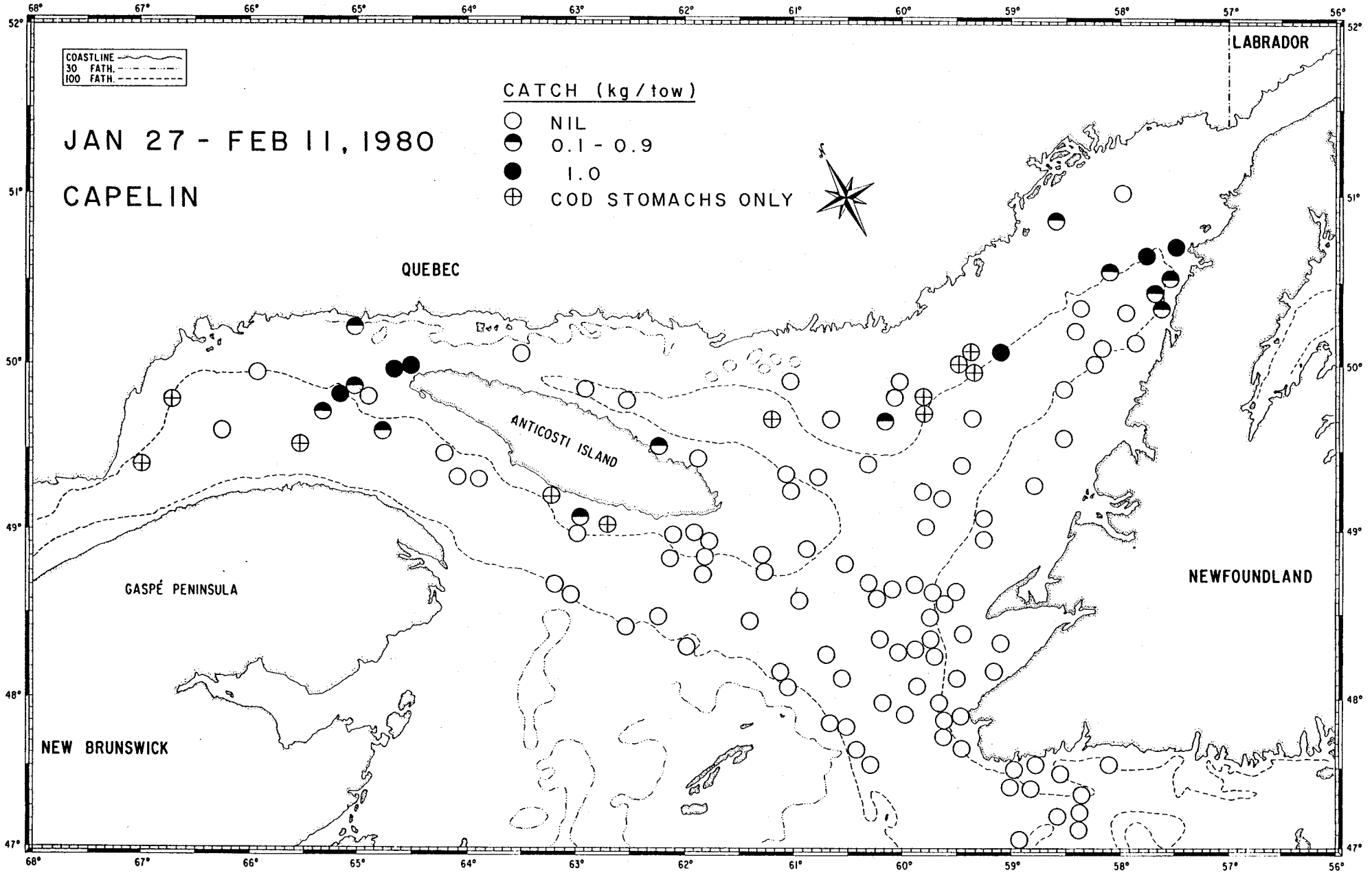


Fig. 1c. Winter distribution of capelin in 1980.

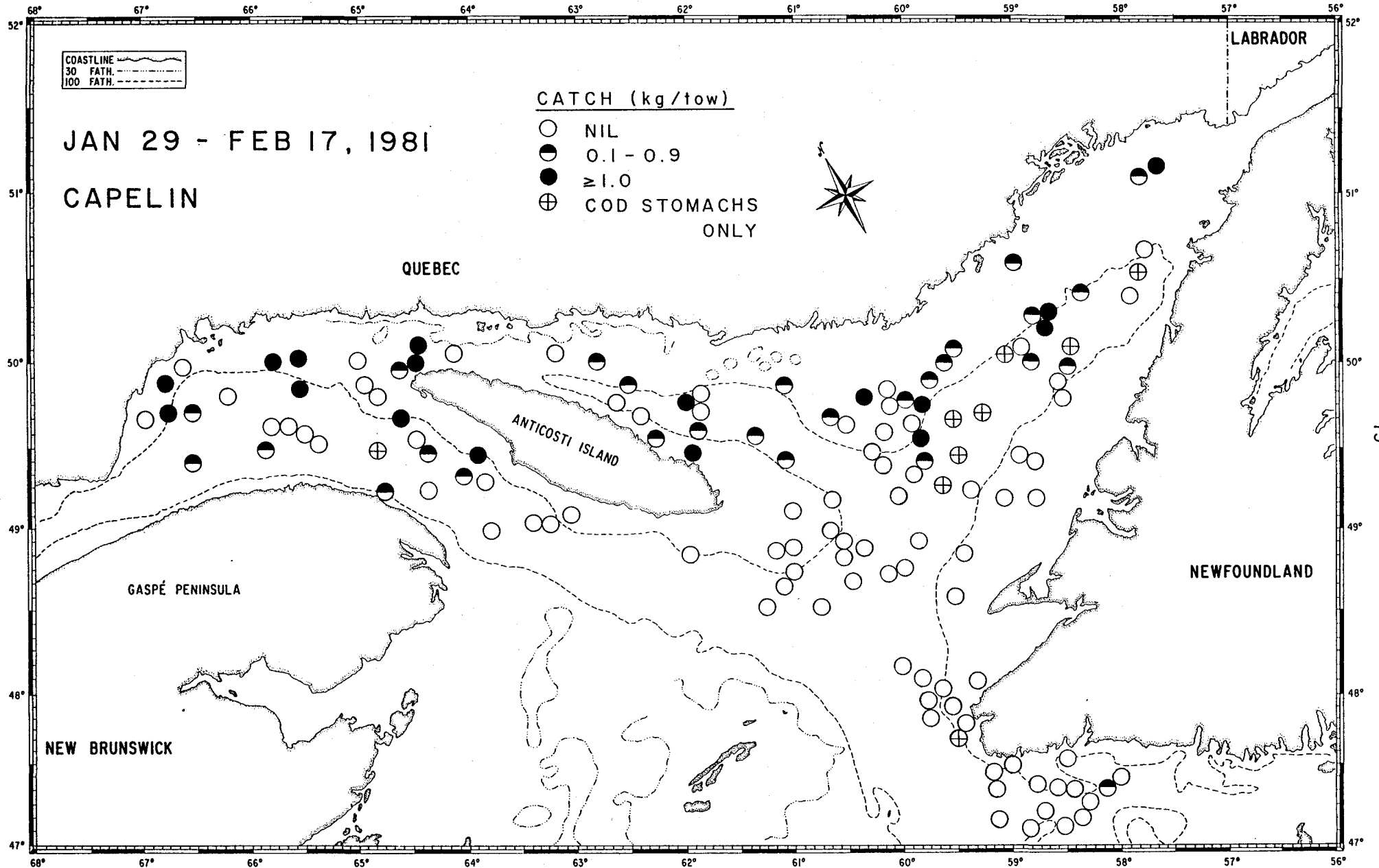


Fig. 1d. Winter distribution of capelin in 1981.

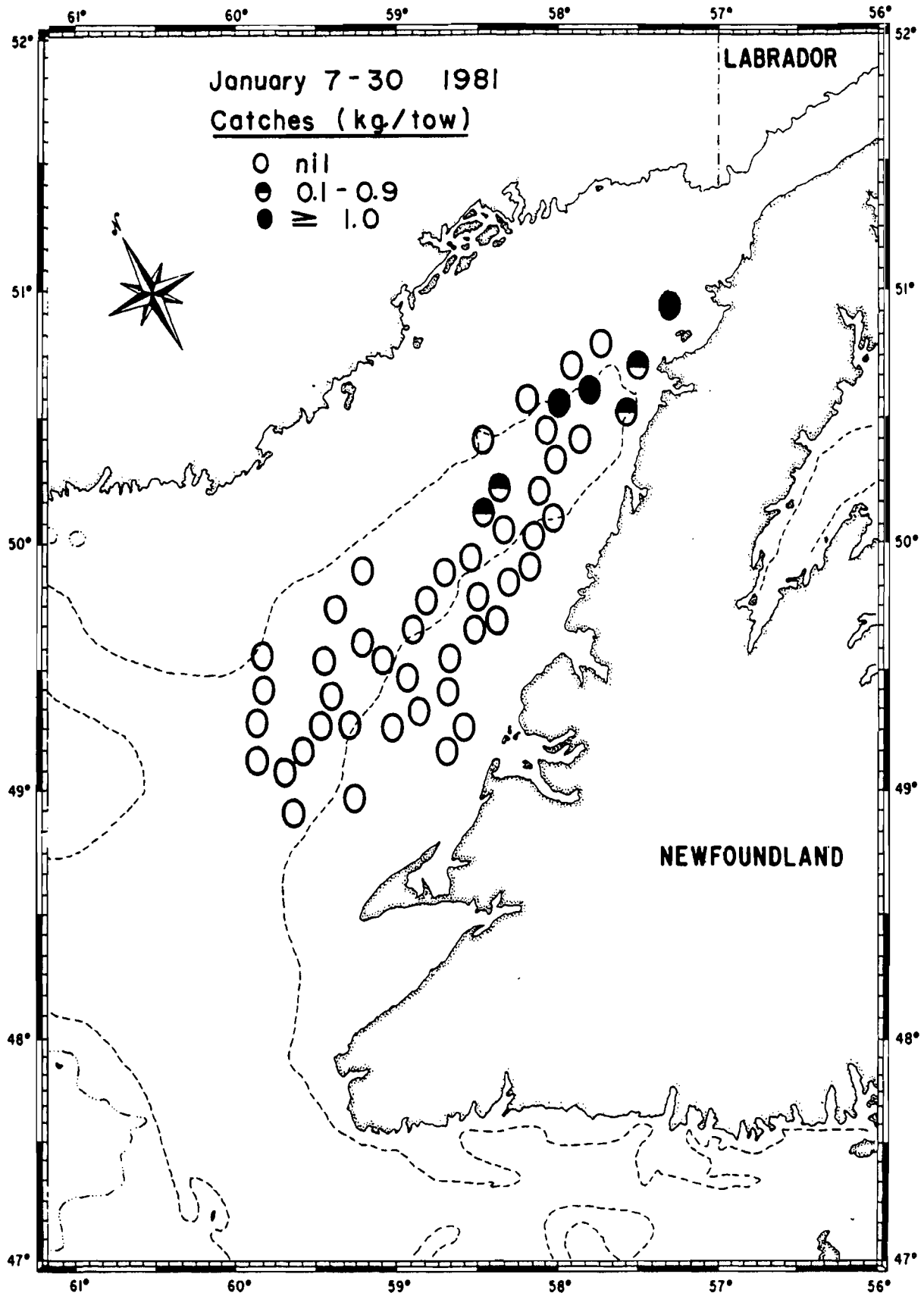


Fig. 2a. Winter distribution of capelin on the west coast of Newfoundland in 1981.

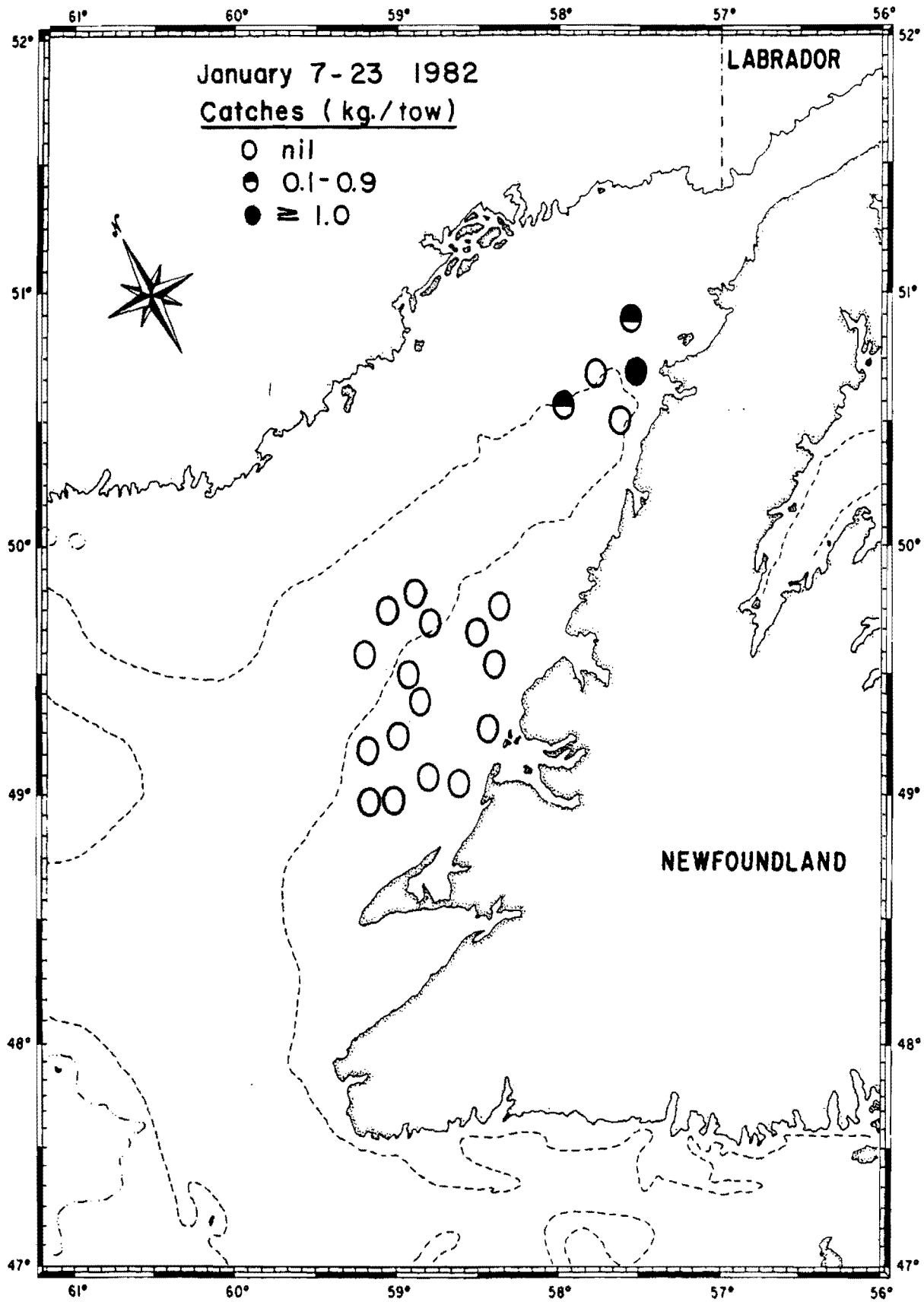


Fig. 2b. Winter distribution of capelin on the west coast of Newfoundland in 1982.

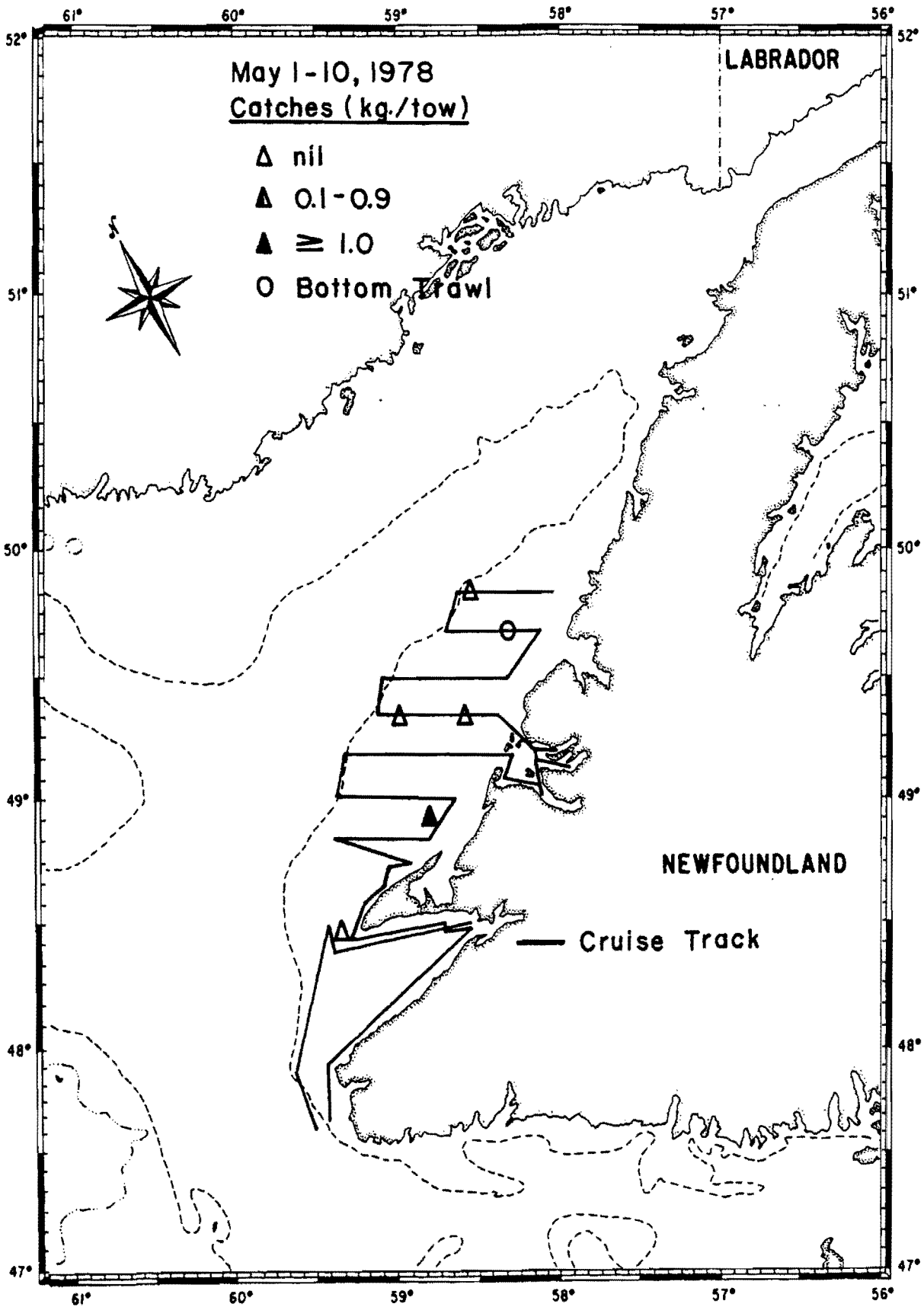


Fig. 3a. Spring distribution of capelin from acoustic survey in 1978.

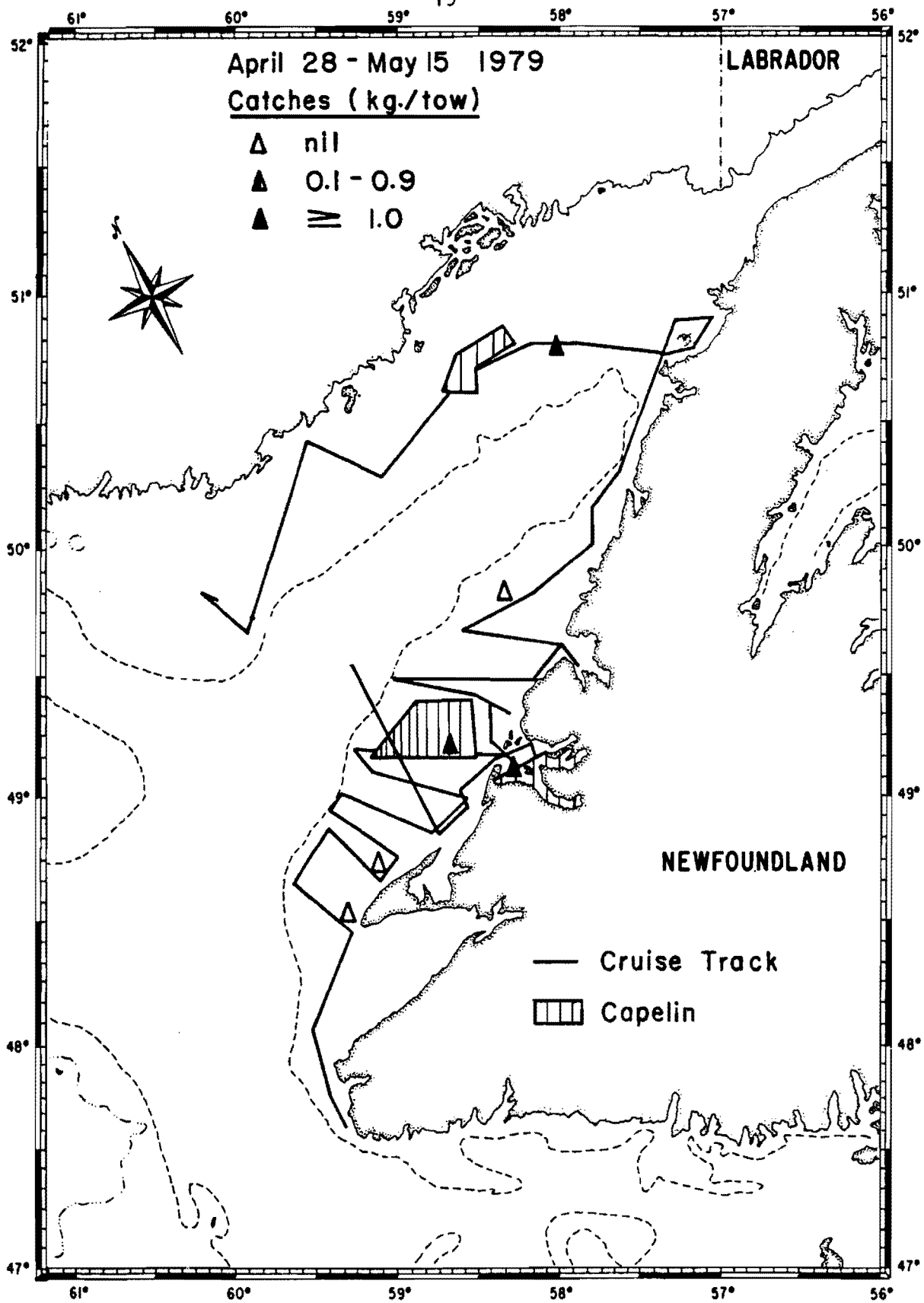


Fig. 3b. Spring distribution of capelin from acoustic survey in 1979.

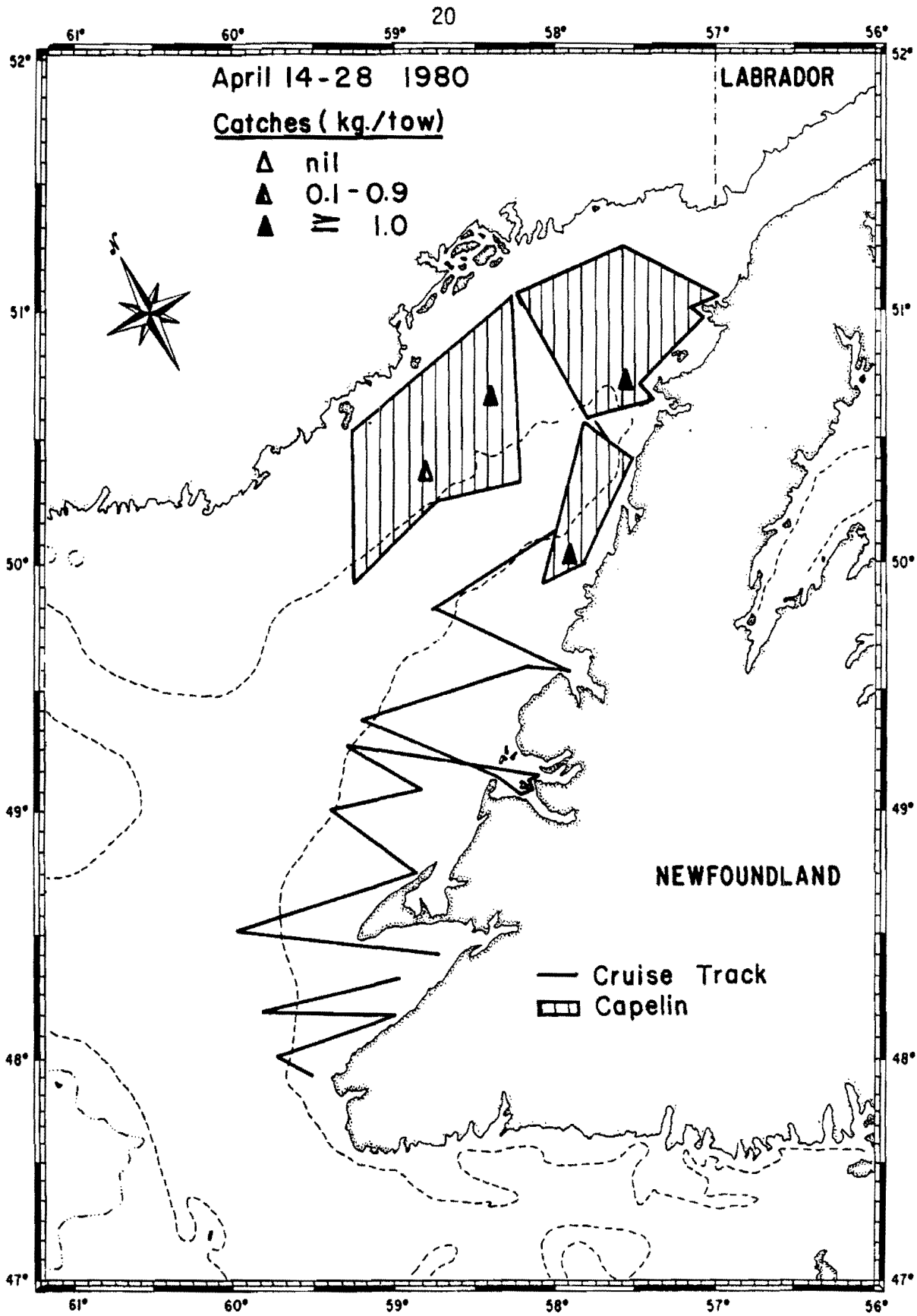


Fig. 3c. Spring distribution of capelin from acoustic survey in 1980.

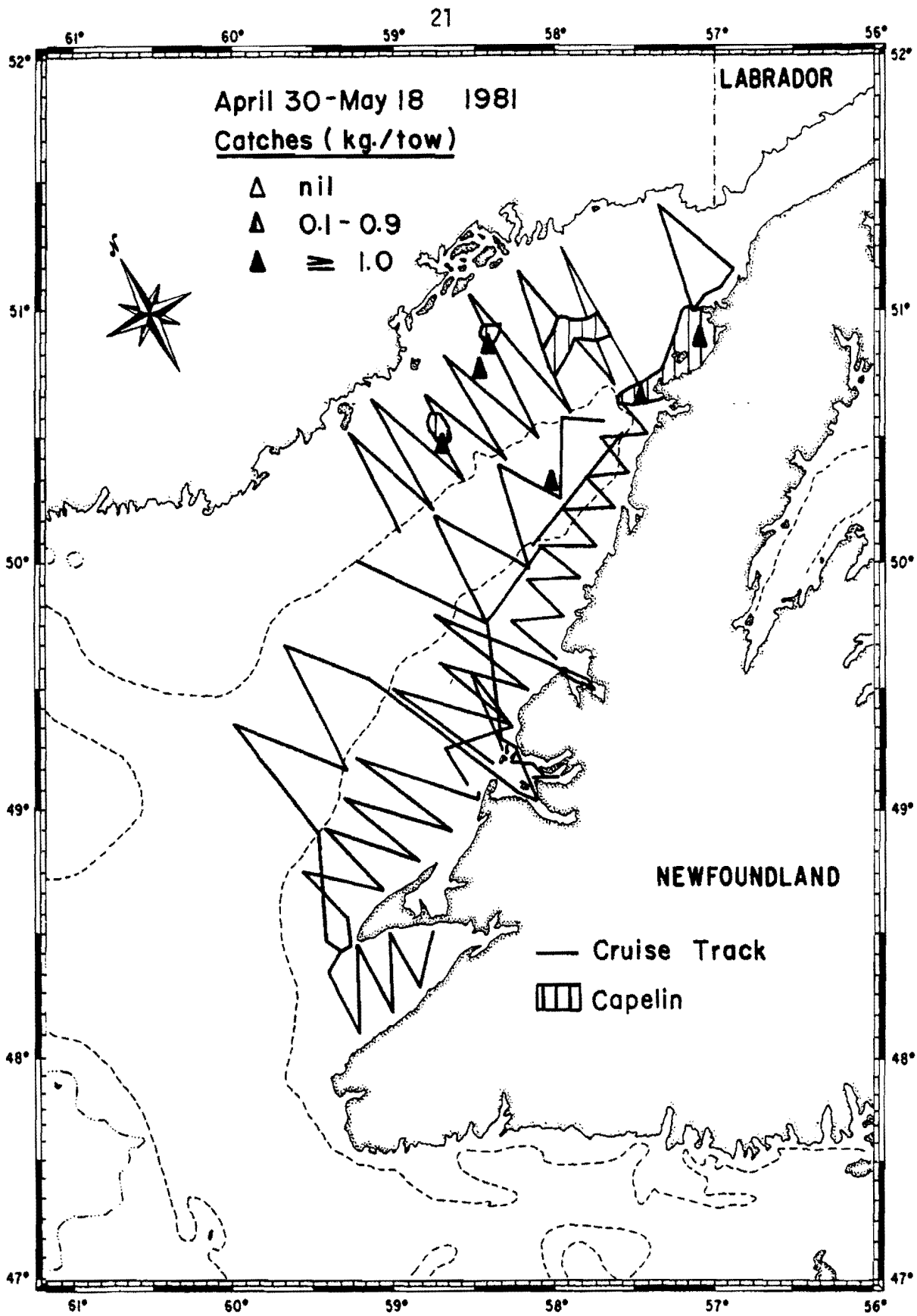


Fig. 3d. Spring distribution of capelin from sounder survey in 1981.

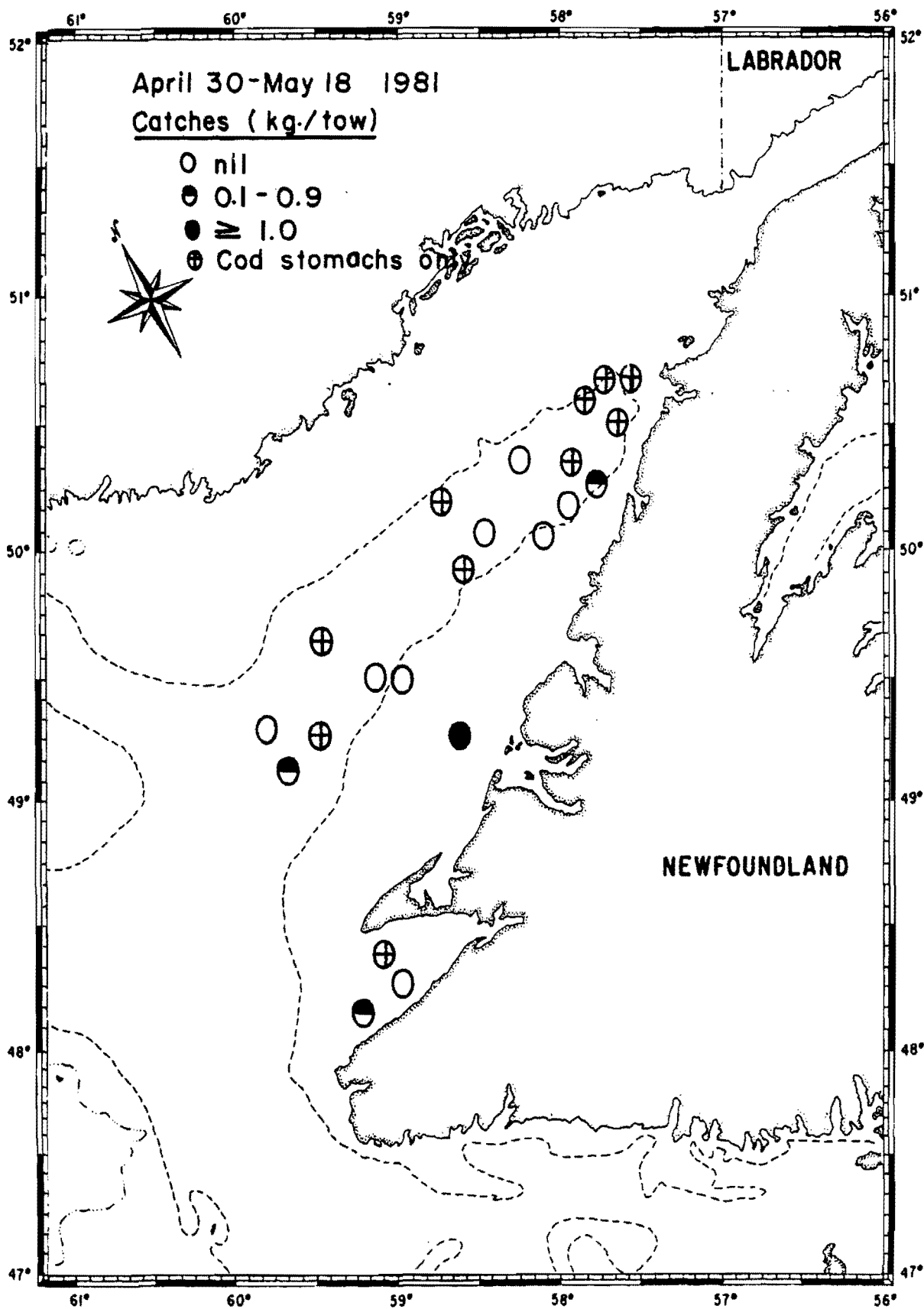


Fig. 4. Spring distribution of capelin in 1981 from bottom trawl sets.

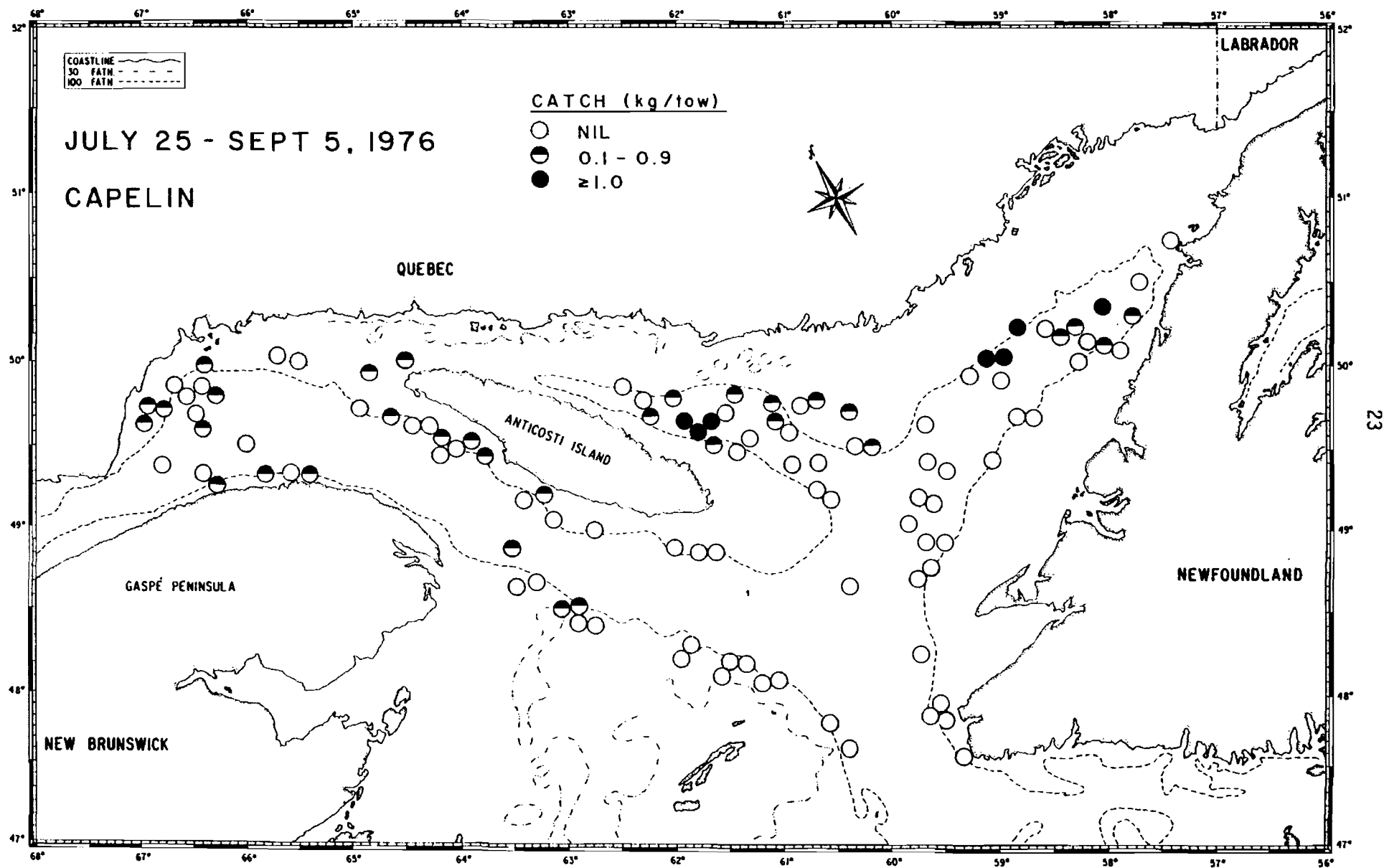


Fig. 5a. Summer distribution of capelin in 1976.

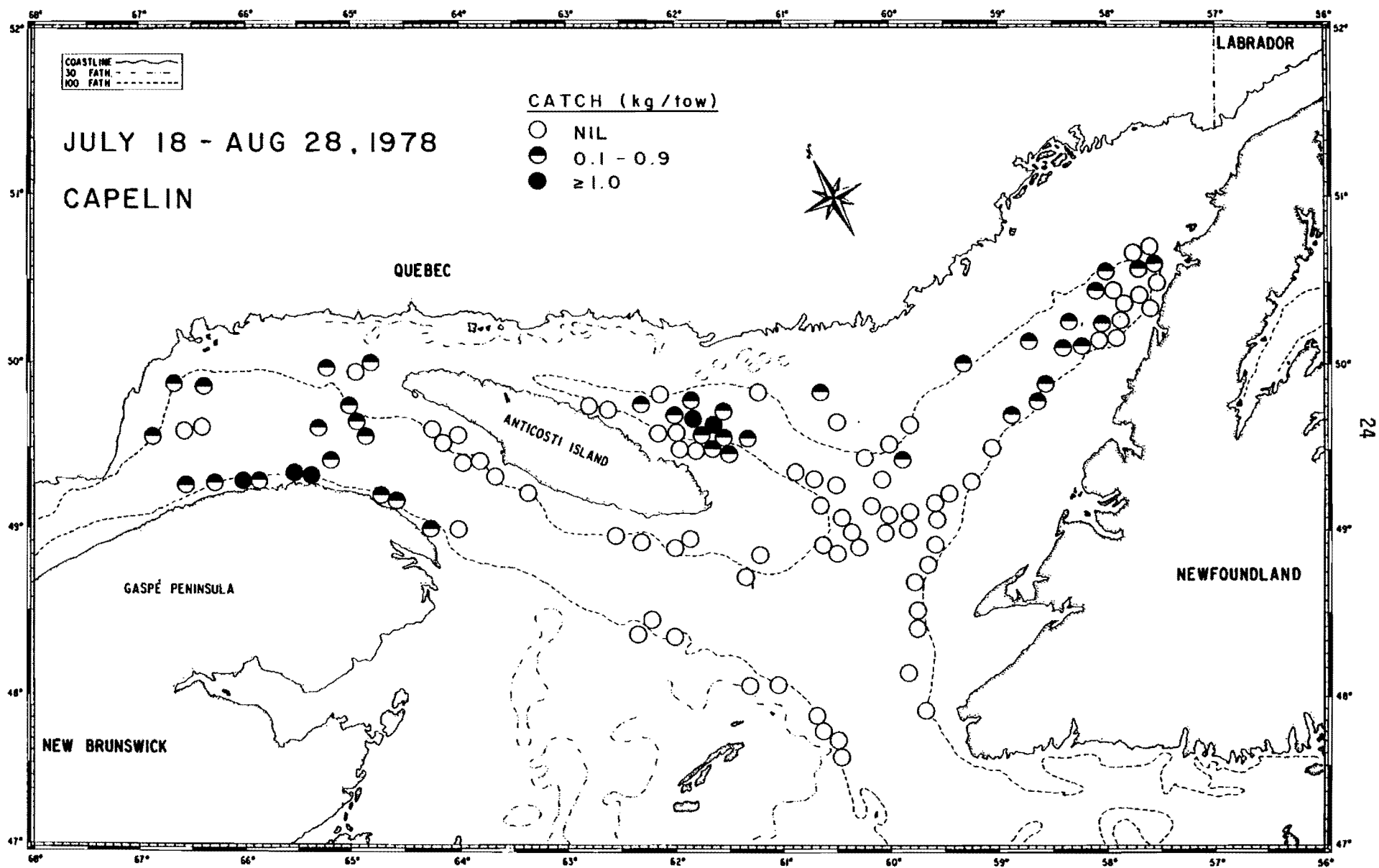


Fig. 5b. Summer distribution of capelin in 1978.

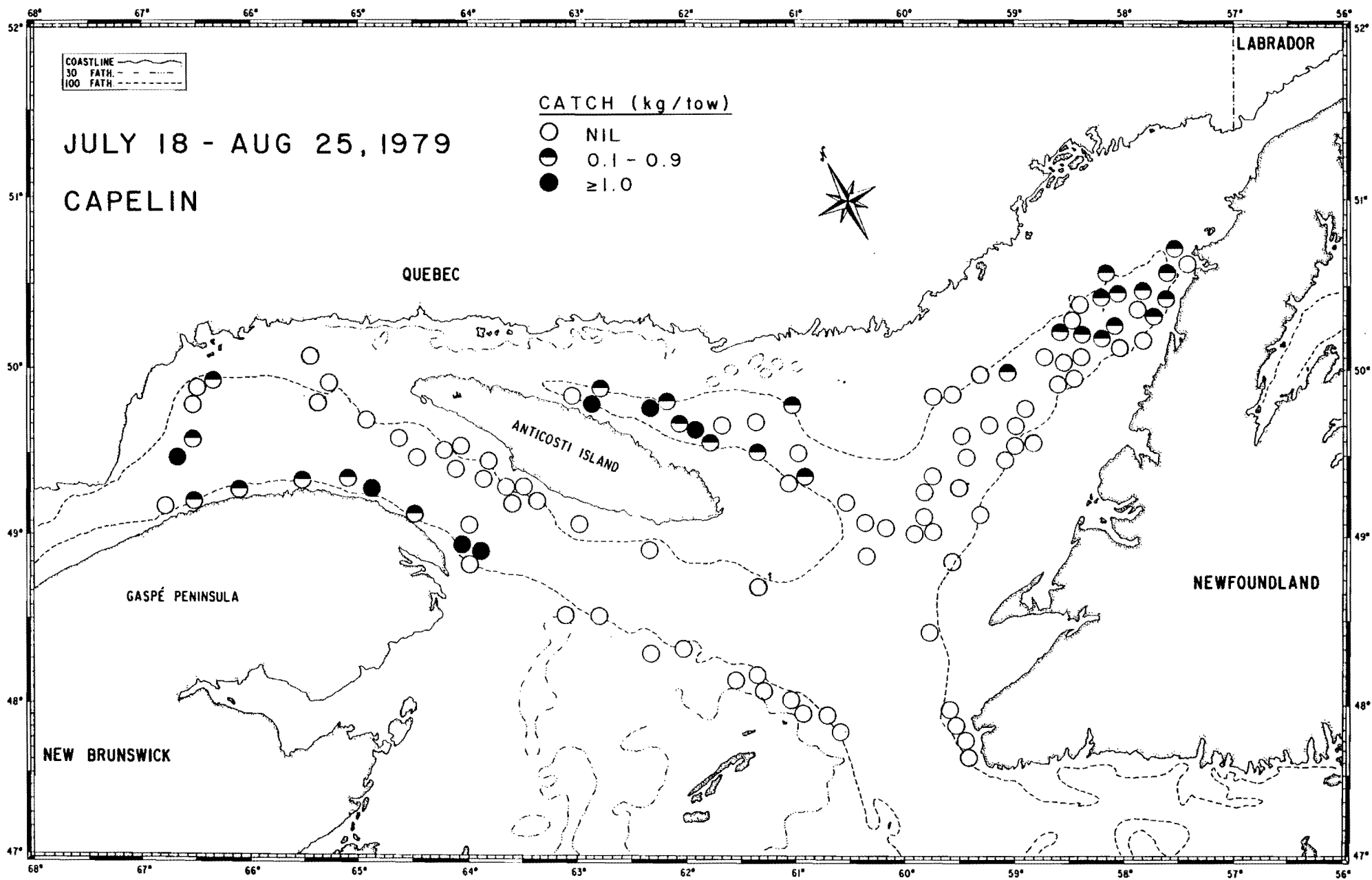


Fig. 5c. Summer distribution of capelin in 1979.

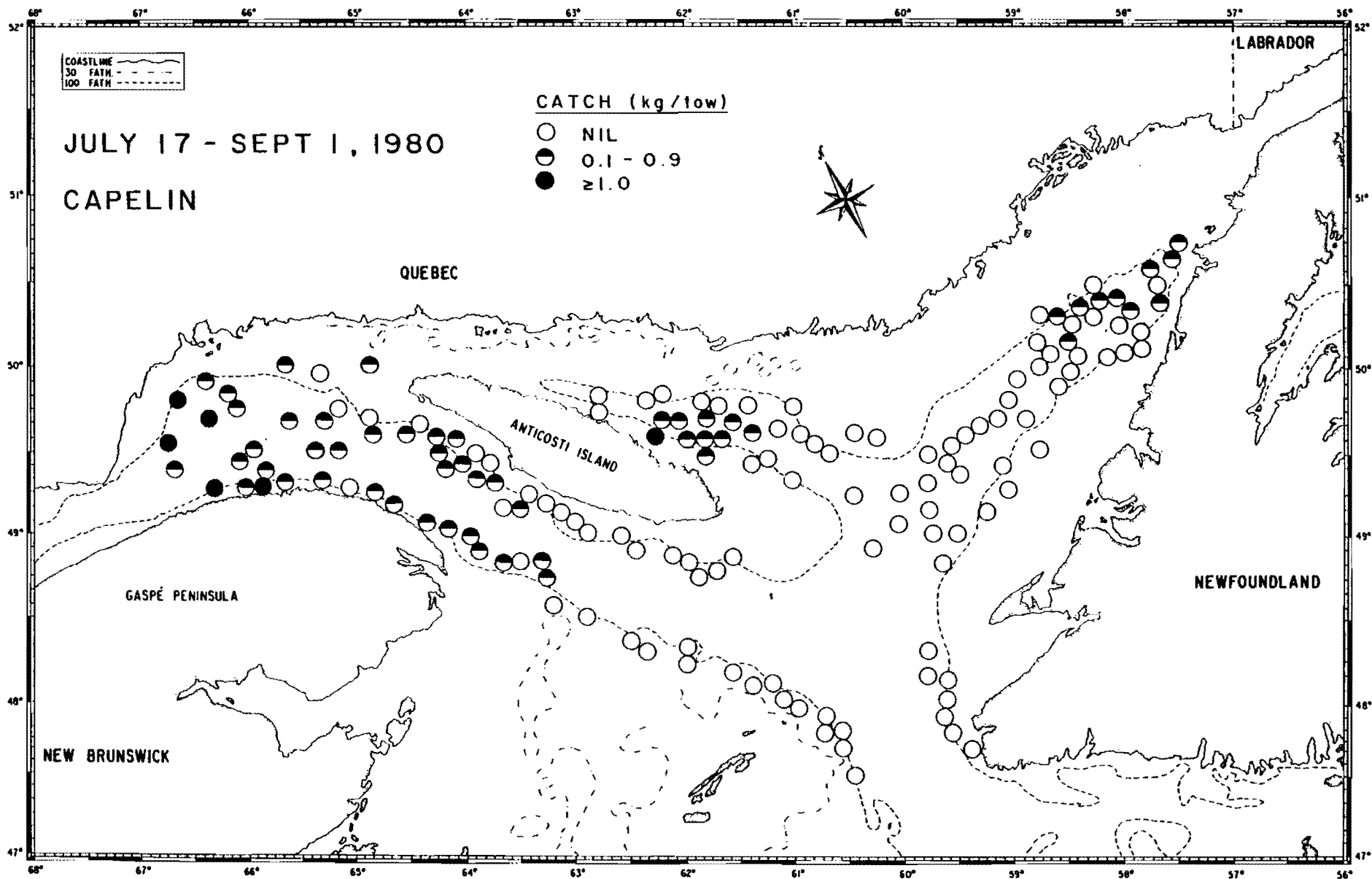


Fig. 5d. Summer distribution of capelin in 1980.

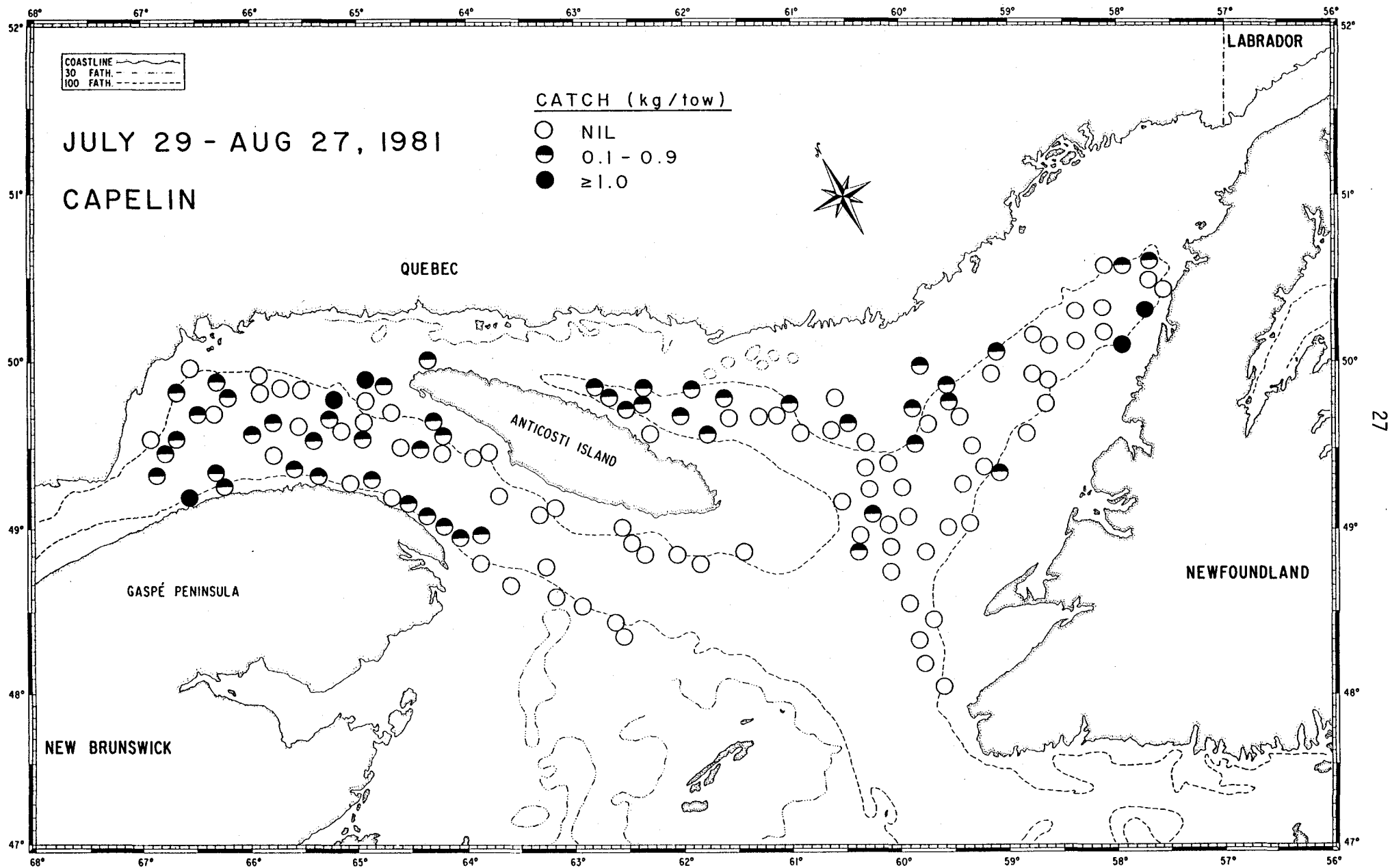


Fig. 5e. Summer distribution of capelin in 1981.

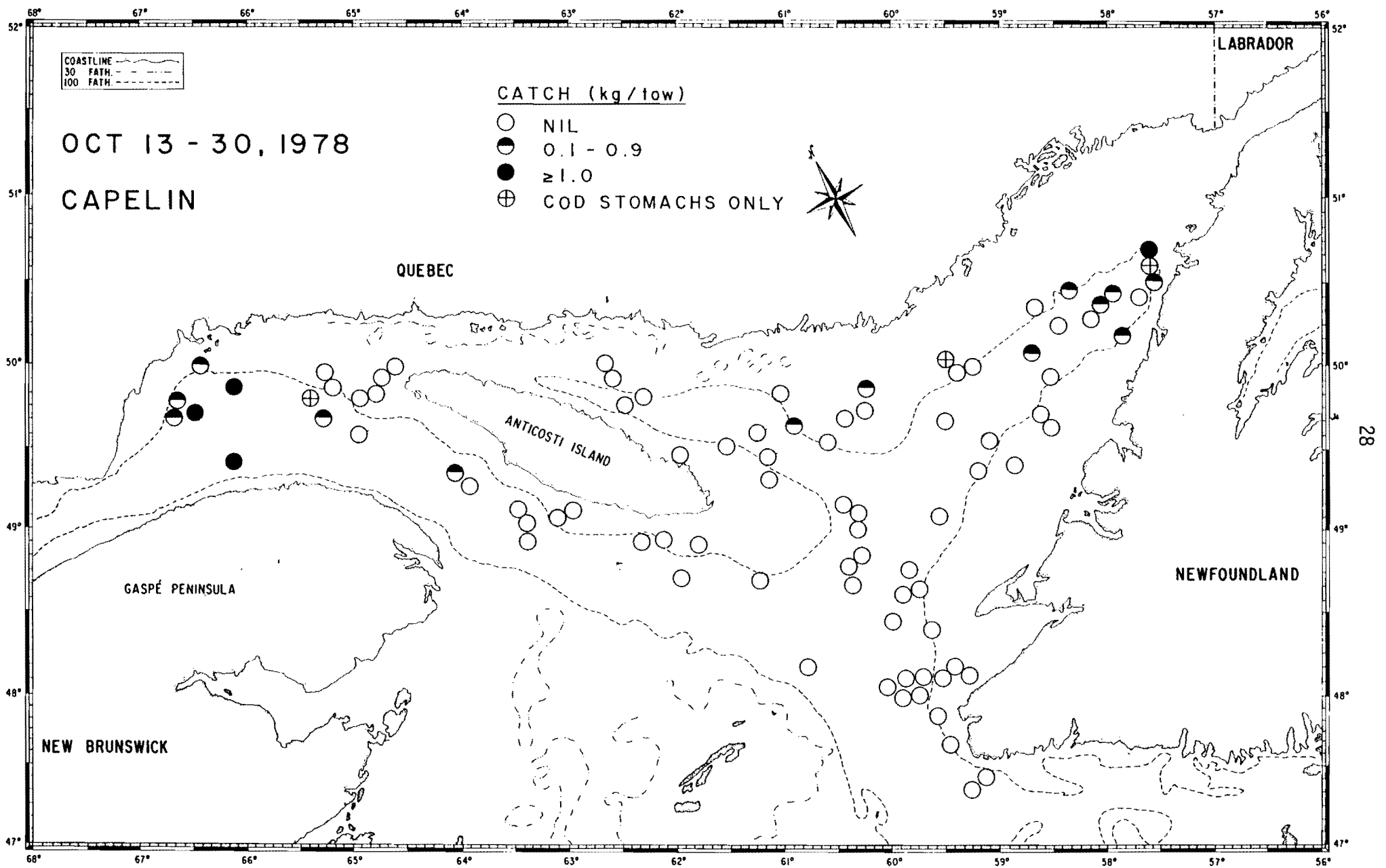


Fig. 6a. Fall distribution of capelin in 1978.

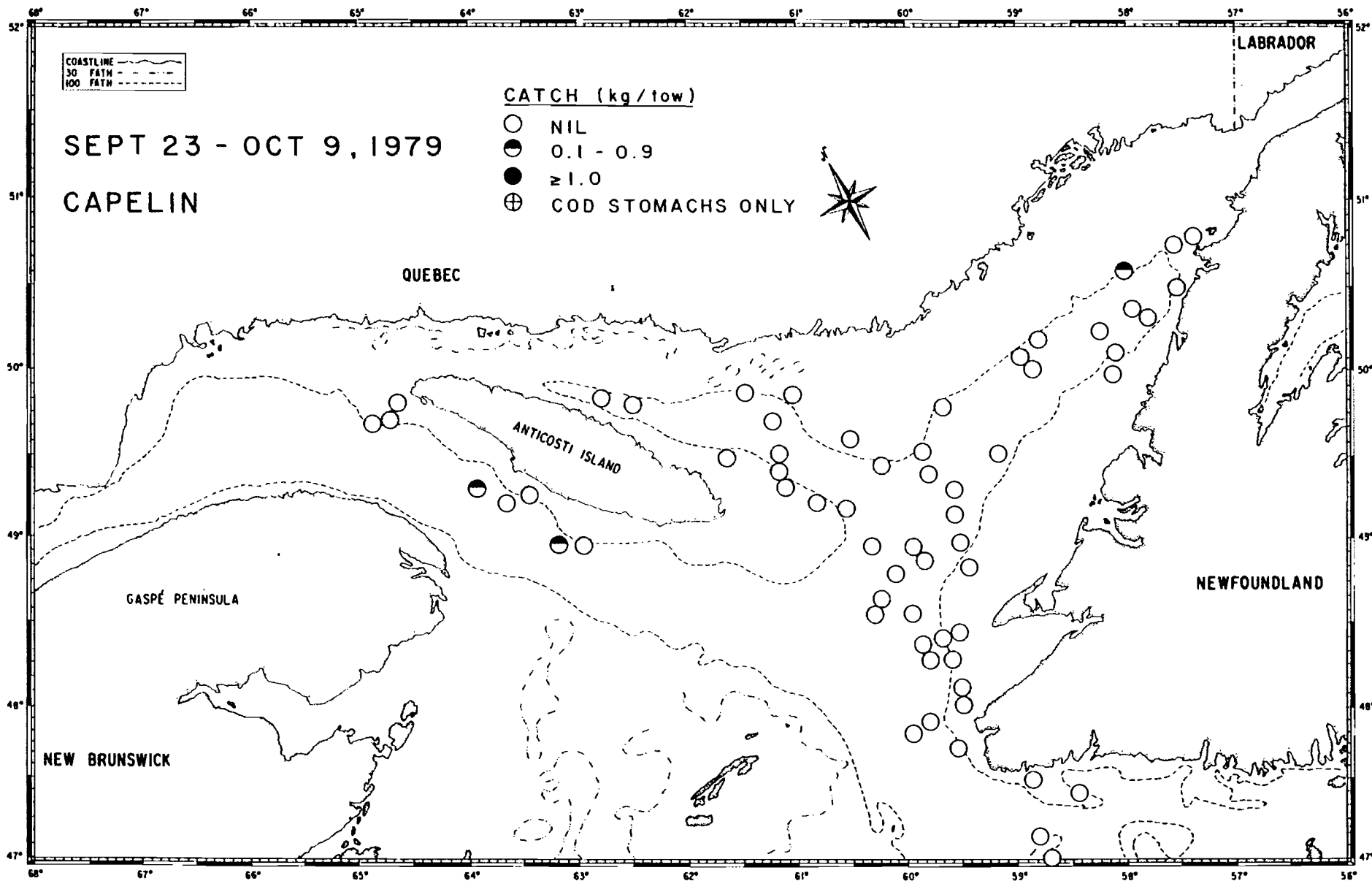


Fig. 6b. Fall distribution of capelin in 1979.

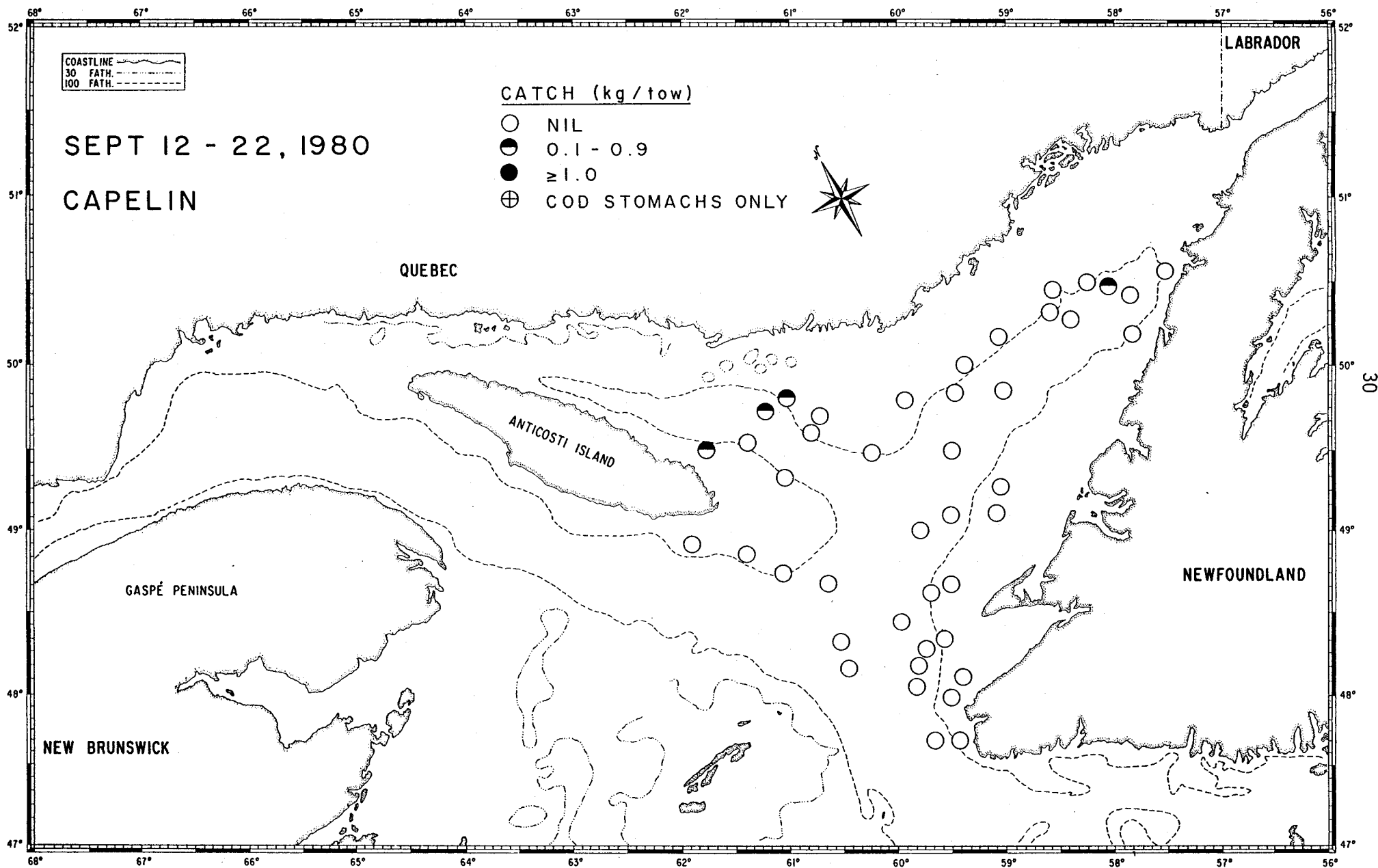


Fig. 6c. Fall distribution of capelin in 1980.

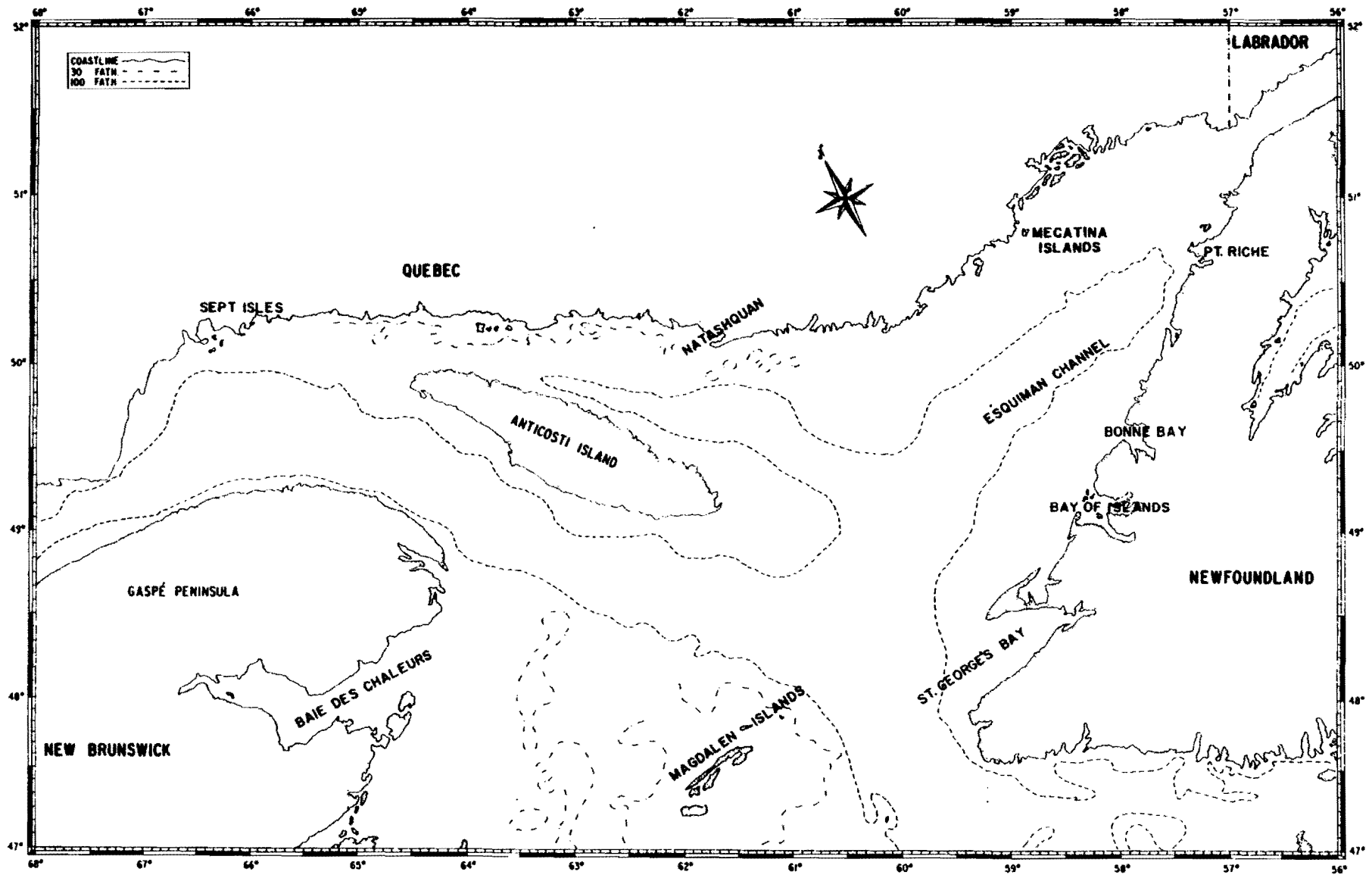


Fig. 7. The Gulf of St. Lawrence.

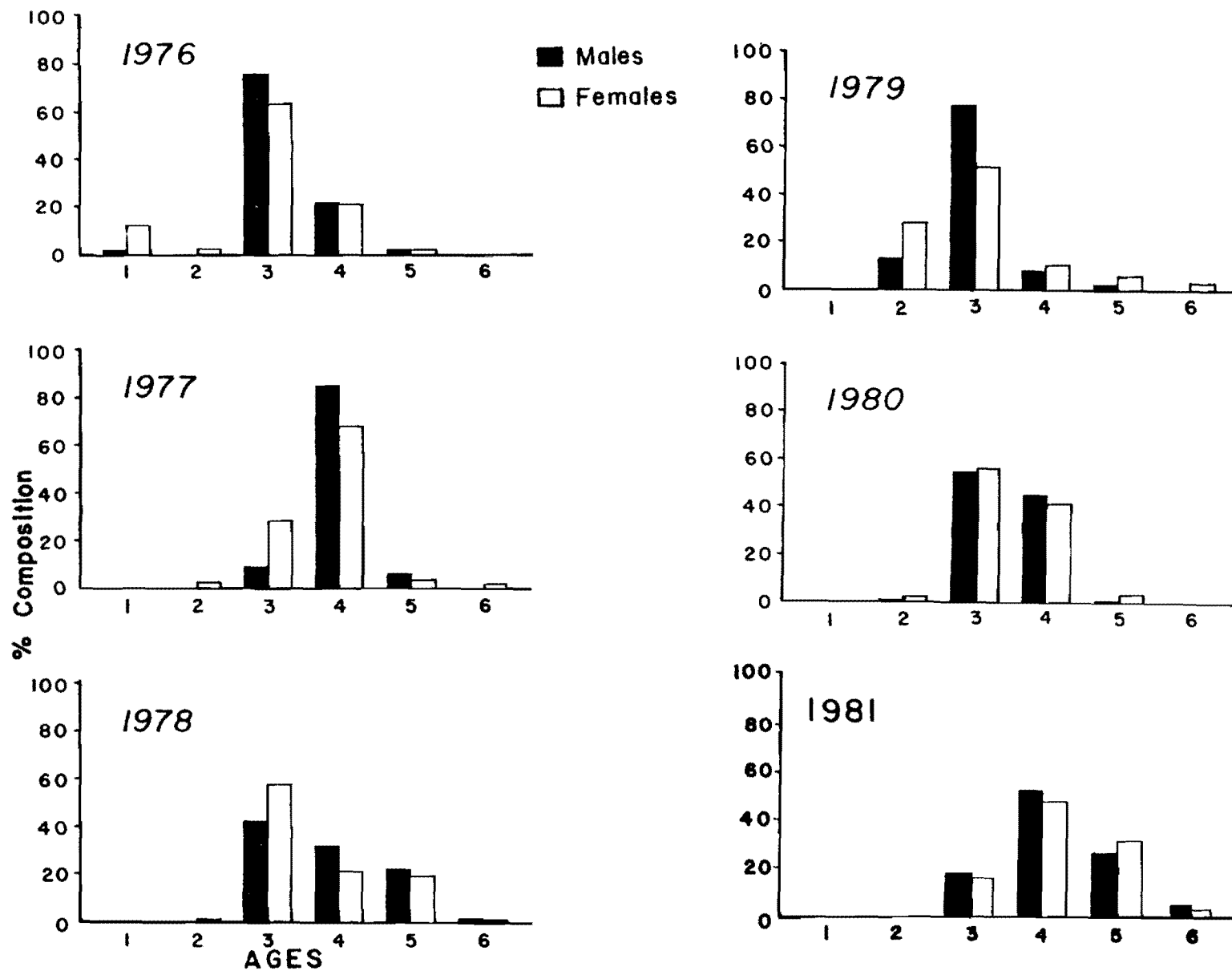


Fig. 8. Age-composition of capelin in Division 4R, 1976-81.