A REVIEW OF HYDROACOUSTIC SURVEYS CONDUCTED DURING WINTER FOR 2J3KL COD, 1987-1992

by

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Abstract

Hydroacoustic and fishing methods have been used, in one form or another since 1987, to obtain a better understanding of the distribution and abundance of pre-spawning and spawning concentrations of 2J3KL cod during winter. For the years 1987 to 1990 only qualitative data on distribution were obtained because of operational constraints and technical difficulties. During 1991 and 1992 hydroacoustic data were acquired electronically and estimates of fish density from the survey area were determined.

Résumé

Depuis 1987, on a utilisé des méthodes hydroacoustiques et des méthodes de pêche, sous une forme ou sous une autre, pour acquérir une meilleure connaissance de la distribution et de l'abondance des concentrations de morues juvéniles et adultes dans 2J3KL durant l'hiver. De 1987 à 1990, on n'a pu recueillir que des données qualitatives à ce sujet en raison de contraintes opérationnelles et de difficultés techniques. En 1991 et 1992, on a été en mesure d'obtenir des données hydroacoustiques par des moyens électroniques et de déterminer la densité approximative de poisson dans la zone étudiée.

INTRODUCTION

Total catches of cod in Divisions 2J3KL increased rapidly from the mid-1950's to the late 1960's (Figure 1). A peak catch of just over 800,000 t occurred during 1968. The largest proportion of the total catch in the 1960's and early 1970's was taken by non-Canadian fleets. As an example, a breakdown of the total catch of 2J3KL cod by country for 1968 is given in Table 1. Most of the non-Canadian catch, during the years prior to 1978, was taken by large trawlers from pre-spawning and spawning concentrations of cod on the seaward slopes of the offshore banks (Hamilton Bank, Belle Isle Bank, Funk Island Bank, North Cape of the Grand Bank) in all three divisions of the 2J3KL management unit (Figure 2). This fishery occurred mainly during the first half of the year.

The total catch declined in the 1970's as the stock declined. When Canada extended fisheries jurisdiction to 200 miles in 1978, quotas on cod restricted catches by foreign countries to levels lower than had been observed in the previous 20 years. The offshore fishery conducted by Canadian trawlers, as we know it today, began at this time and like the foreign fishery in the 1960's and 1970's, also occurred mainly in the first half of the year and on pre-spawning and spawning concentrations of cod on the seaward slopes of the offshore banks.

Beginning in 1987 DFO started a program of research, using a variety of hydroacoustic and fishing methods, to obtain a better understanding of the distribution and abundance of these pre-spawning and spawning concentrations of cod. This paper describes the sequence of events related to this research program as well as a description of results obtained to date.

1987

The purpose of this initial cruise was to define the boundaries of a concentration of cod that was being fished by the commercial fleet. The cruise was conducted by the GADUS ATLANTICA and the concentrations were delineated using the echo sounder on the vessel's bridge with its hull mounted transducer while steaming in a zig-zag pattern perpendicular to the slope of the banks. The technology used did not provide automated data acquisition, storage and analysis techniques. Instead, concentrations were identified by visual examination of the echograms.

A concentration extending from the north eastern portion of the Funk Island Bank to the eastern slope of the Belle Isle Bank was located and defined (Figure 2). Twenty-two commercial fishing vessels were observed fishing in this area. The aggregation covered an area of about 400 square nautical miles, being about 100 miles in length and between 3 and 5 miles wide. Forty fishing sets of 15 minutes duration using a lined codend were conducted within the defined boundaries. The average catch per tow was 1650 kg with the largest catch being 11,000 kg at a depth of 404 meters and a bottom water temperature of 3.3°C. This aggregation was in depths

of 300 to 500 meters with the southern most portion being more dense than the northern areas (Figure 3).

Several disadvantages were noted with this type of survey, including:

1) The sounder and transducer used were old and the echogram observations were not always consistent with the results of the fishing sets. It was noted at the time that in most cases, when echograms indicated dense aggregations, respective catches were large, but in some cases large fishing sets occurred with little or nothing observed on the echograms.

2) Aggregations observed via the echograms were quite dense and at times a high proportion of the biomass occurred above the headline of the trawl. Biomass estimates derived from fishing methods would therefore be underestimated.

3) There was a lag between the acoustic survey of the concentration and the trawl survey. In the interim, there was a possibility of movement or dispersion of the targeted concentration.

4) The method was very time consuming and limited the total area surveyed.

After the cruise was completed it was suggested future cruises with similar objectives use the Region's current hydroacoustic survey technology (i.e. HYDAS-Stevens 1986). It was noted that potential damage to wet-end hydroacoustic instrumentation (i.e. towing cable, towed body and transducer) caused by ice may be avoided if an alternate method of deployment of the towed body (from the stern) could be used.

1988-1989

During these two years, the research objective was to use the HYDAS system to conduct a hydroacoustic survey on the seaward slopes of the offshore banks in Divisions 2J and 3K and if time permitted Division 3L. Occasional fishing sets were to be completed for verification of the acoustic data and for the collection of biological samples.

The HYDAS wet-end instrumentation used for these surveys was composed of an unfaired towing cable and a 49 kHz transducer housed in a bomb shaped 4.5 ft. towed body. The towed body was constructed with an aluminum centre plate and frames which were covered with polycarbonate skins. A winch and crane were used to deploy and tow the towed body over the side of the vessel.

During 1988 a few survey transects were completed in about the same area the concentration of one year ago was observed. This was the first time DFO's wet-end

hydroacoustic hardware was subjected to the harsh winter conditions in the Northwest Atlantic. Problems were encountered with the towing cable and the tow termination. After about a week, the towing cable was hooked by a small pan of ice which caused the towed body to rise to the surface and collide with the ice pan. The collision rendered the towed body inoperable and the hydroacoustic portion of the trip was terminated.

Approximately the same scenario occurred in 1989. The side towing technique positioned the towing cable and towed body where they were very susceptible to collisions with pans of ice. As a result, the towed body was completely destroyed after several days of surveying and again the hydroacoustic portion of the trip was terminated prematurely.

During both years fishing sets and the vessel's bridge mounted echosounder indicated that the major commercial concentrations were located in northern Division 3K at depths of 300 to 500 meters. The area was marginally south of the aggregations observed in 1987, but the depth range was consistent with the first survey. The densest part of these aggregations occurred at about 400 meters.

1990

After two unsuccessful attempts at surveying with the HYDAS side towing instrumentation a decision was made to fund the development of a wet-end subsystem more suited to the severe winter conditions of the Northwest Atlantic. The resultant subsystem included a stainless steel towed body that could withstand a great deal more battering than the previous fibreglass models. More importantly, a method of stern deployment and towing was developed. This resulted in the cable being positioned in the wash of the ships propeller away from the pans of ice that previously caused damage. The new towed body was significantly heavier (approximately 1050 lbs.) and the towing cable was equipped with hard fairings. The combination enabled the transducer to be positioned at deeper depths (approximately 160 m) which improved discrimination of cod aggregations.

This new wet-end subsystem was first implemented during February of 1990. The deployment/retrieval and towing system worked beyond expectations, however, problems with computer hardware and electronic data transmission onboard the vessel caused a premature termination of the hydroacoustic survey.

Fishing sets and the vessel's bridge mounted echosounder indicated that commercial concentrations of cod were deeper than had been observed during the previous three February cruises to this area. Large catches of cod occurred at 550 meters in 1990, about 150 meters deeper than the largest catches in previous years. The major concentration in 1990 was also observed to be in the southern part of Division 3K compared to northern 3K/southern 2J in 1987-89.

1991-1992

The first successful hydroacoustic survey using the stern towing system occurred in 1991 (Figure 5).

TABLE FOR 1991

Division	Transect Distance (Nautical Miles)	Area surveyed (Sq nautical miles)	Fishing sets
2J	400	5000	9
3K	365	4000	12

A small area was also surveyed in the northernmost portion of Division 3L.

In Division 2J a small concentration was encountered on the south-eastern slope of Hamilton Bank. It was comprised of cod between 30 and 50 centimetres with the peak at 38 centimetres and was fairly evenly dispersed between the depths of 400 and 550 meters. A second concentration was located on the northeastern slope of Hamilton Bank between depths of 500 and 700 meters. No fishing sets were conducted in the northern area because of ice cover and a severe winter storm.

A large concentration of commercial size cod (length > 40 cm.) was found in the southern most area in Division 3K between the depths of 600 and 850 meters. This concentration was most dense at 700-800 meters and extended into northern Division 3L. Another aggregation was found on the north-eastern slope of Funk Island Bank, again in depths of 600 to 850 meters. These cod were about the same size as those found in the initial concentration in Division 2J (30-50 centimetres, peak 38 cm).

Ice conditions in the area were less severe in 1992 than in 1991, especially in Division 2J, and consequently a larger area was surveyed in Division 2J (Figure 6):

TABLE FOR 1992

Division	Transect Distance (Nautical Miles)	Area Surveyed (Sq nautical miles)	Fishing Sets
2J	600	7800	13
3K	351	4000	7
3L	200	5300	1

About 14% of the proposed survey area in Division 3K could not be covered because of heavy ice and coverage in Division 3L was restricted because of time constraints. While ice condition did not severely restrict spatial coverage, it sometimes caused a reduction in survey speed as well as creating some difficulty making fishing sets. In many instances ice restricted fishing activities to the extent that sets were not always possible in the exact areas where the echosounder indicated the best concentrations. This problem also occurred in 1991.

No substantial aggregations of cod were found in Division 2J in 1992. Low densities were observed throughout the surveyed portion of the Division area with the highest abundance occurring in the Hawke Channel (between Hamilton and Belle Isle Banks) at depths greater than 400 meters. Length frequencies indicated that cod in Division 2J were generally in the range of 34 to 40 centimetres. No cod were observed greater than 55 cm.

In Divisions 3K and 3L cod were generally dispersed throughout the area in depths between 350 and 550 meters, however some fairly dense aggregations were seen in Northern Division 3L. Length frequencies indicated that most of the cod were in the range of 37 to 43 centimetres. No fishing sets were made on the densest concentrations in Division 3L because of a combination of: termination of the survey, bad weather and/or adverse ice conditions.

DETAILED RESULTS FOR 1991 & 1992

Acoustic data during 1991 and 1992 were obtained with techniques used for other species in the Newfoundland Region. Randomly selected parallel transects as recommended by CAFSAC in 1989 (O'Boyle and Atkinson, 1989) were not used. There is very little information on the distribution of cod in the survey area during winter so a more systematic suite of transects was employed. Estimates of mean densities for the survey blocks completed in 1991 and 1992 are presented in Table 2. Mean densities in 2J were all lower in 1992 than in 1991. This is inconsistent with the results of the autumn trawl surveys for autumn 1990 and autumn 1991 that show similar, but low, biomass levels for both years. Mean densities for 3K from hydroacoustics are similar in both years with densities for 3L lower in 1992 than in 1991 by

about 75%. The results for 3K and 3L are quite similar to those obtained from autumn RV surveys.

REFERENCES

O'Boyle, R.N., and D.B. Atkinson. 1989. Hydroacoustic Survey Methodologies for Pelagic Fish as Recommended by CAFSAC. CAFSAC Research Document 89/72. 12p.

Stevens, C.R., 1986. A hydroacoustic data acquisition system HYDAS for the collection of acoustic data from fish stocks. Can. Tech. Rep. Fish Aquat. Sci. 1520: v + 73 p.

TABLE 1. Catches of 253KL Cod by Country for 1968.

COUNTRY	REPORTED CATCH (t)
Portugal	152,473
Spain	130,972
Canada	123,320
Soviet Union	117,559
France	81,966
Poland	68,987
Federal Republic of Germany	47,868
United Kingdom	32,598
German Democratic Republic	27,393
Norway	16,057
Faroes	10,227
Japan	526
Iceland	68
Total	810,014

TABLE 2. Summary of results for cod from Hydroacoustic survey conducted during February of 1991 and 1992.

Density (kg/m2)							
		1991			1992		
Division	Block	Min.	Max.	Mean	Min.	Max.	Mean
2J	A	0	6.30	0.24	0	0.79	0.03
	B	0	7.37	0.81	0	0.26	0.11
	C	0	4.86	0.17	0	3.26	0.07
	D	0	6.92	0.24	0	1.55	0.04
	E	0	5.57	0.20	0	0.14	0.03
	R				0	0.15	0.02
	S				0	0.92	0.03
3K	F	0	8.72	0.70	0	2.84	0.01
	G	0	9.98	0.87	0	9.19	0.66
	H	0	4.26	0.90	0	8.61	1.32
	I	0	5.42	0.68	0	9.64	0.64
	T				0	0.15	0.04
	V				0	0.26	0.07
3L	K	0	7.89	1.38	0	9.15	0.33
	L	0	4.91	1.28	0	8.58	0.44
	M				0	1.80	0.10
	W				0	1.97	0.10

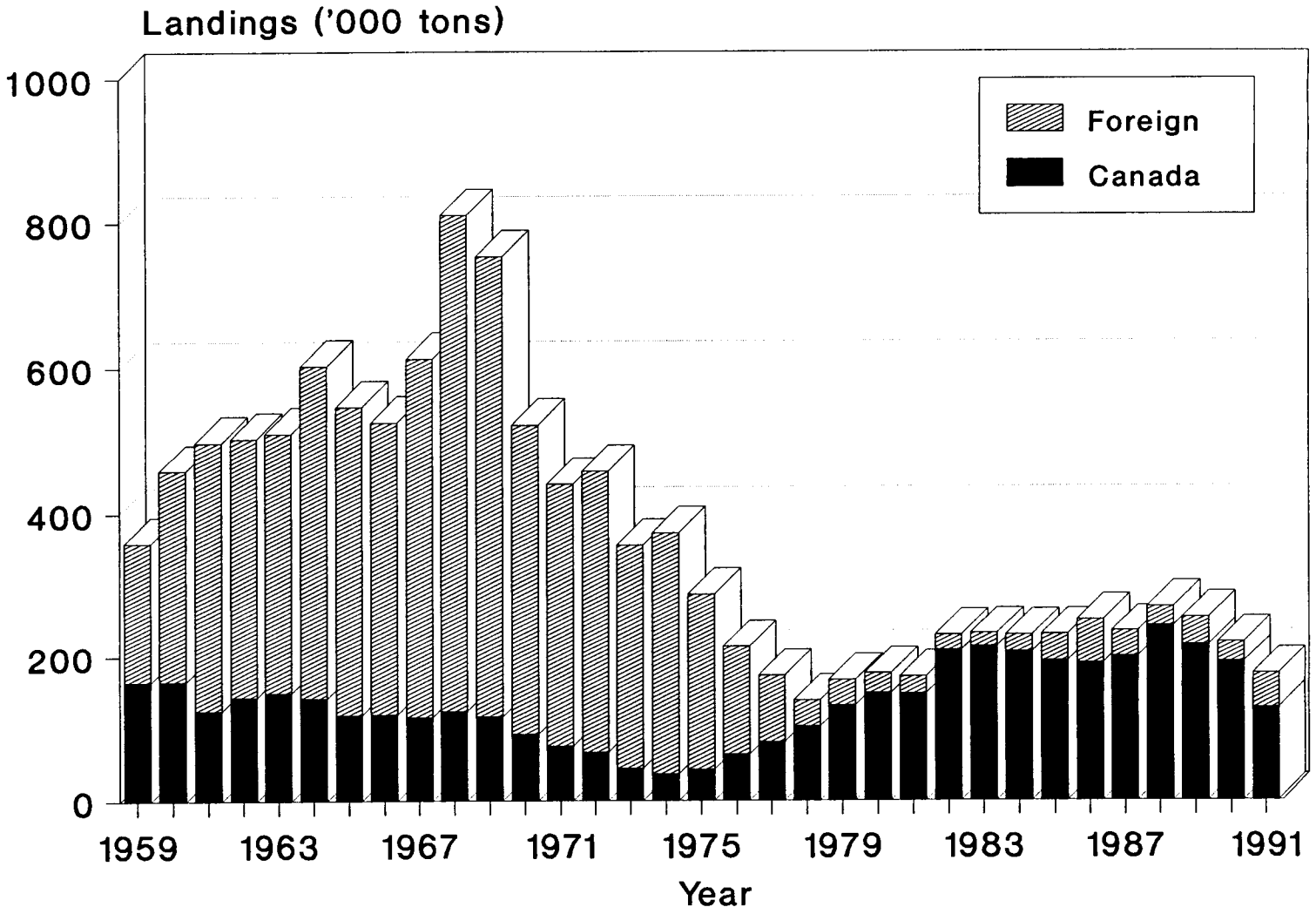

Fig. 1. Cod in Divisions 2J3KL: Landings by Canada and other countries.

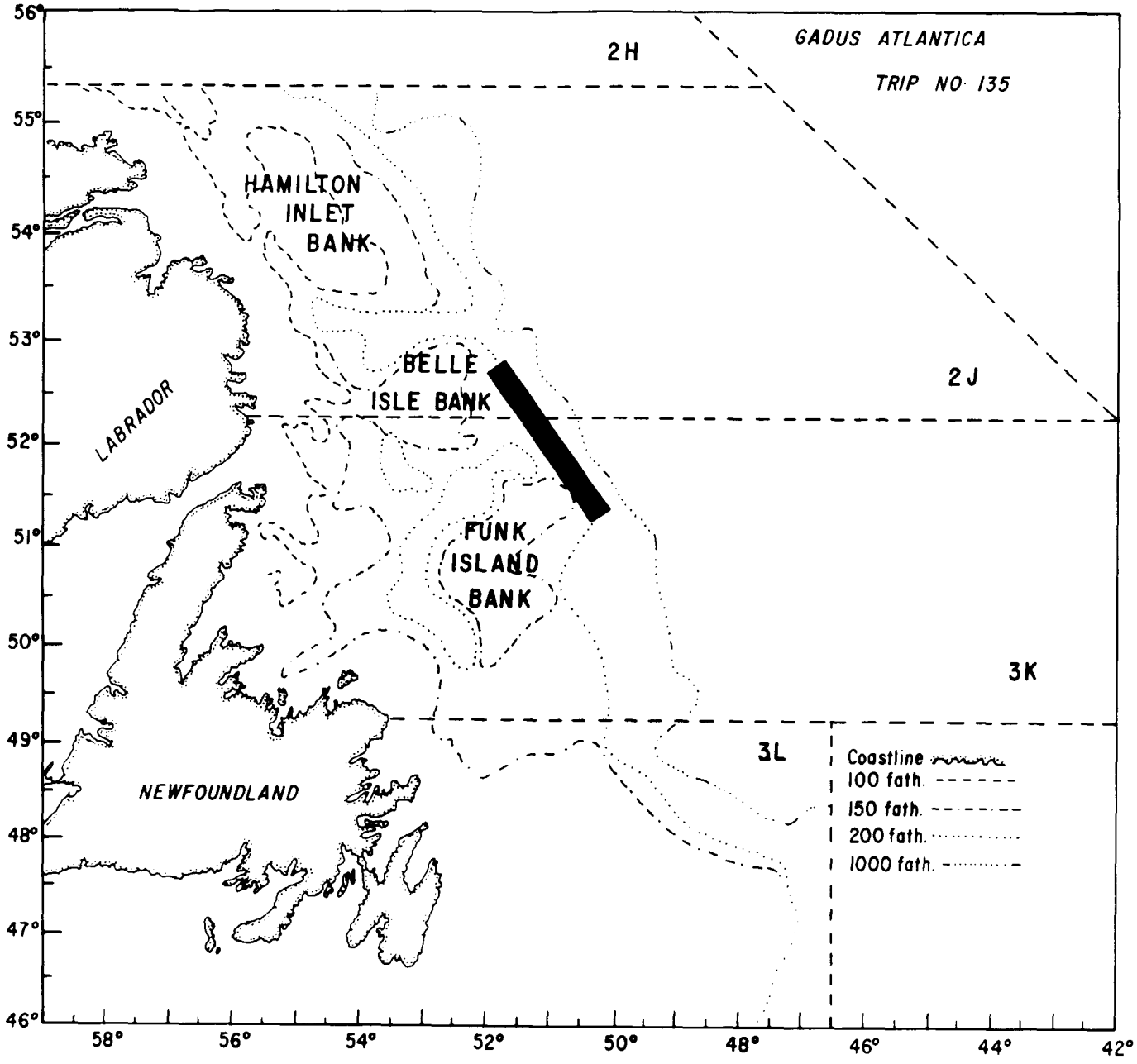

Figure 2. Map of Divisions 2J3KL showing offshore banks and location of concentration encountered during 1987 survey.

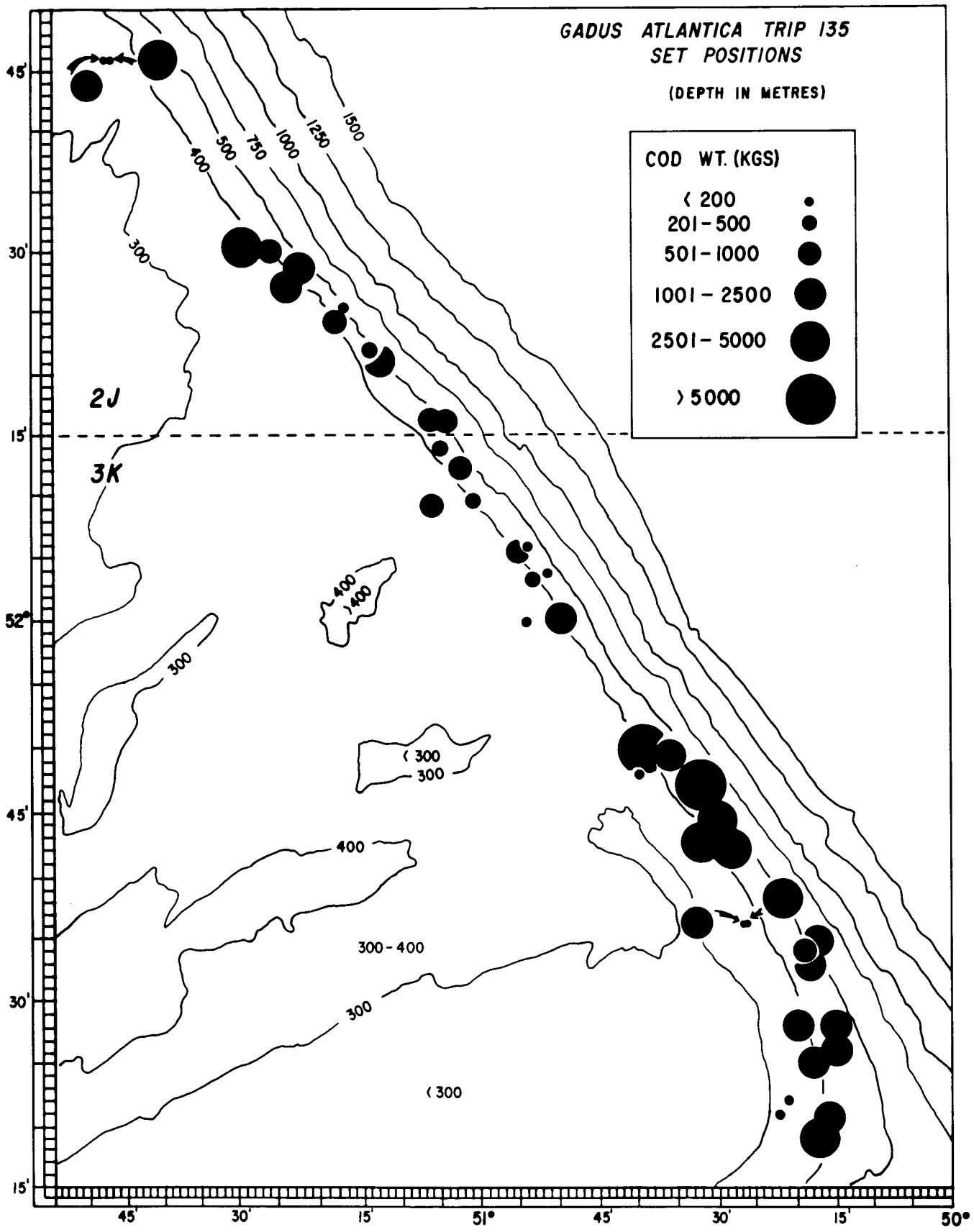

Figure 3. Results of fishing sets from the area of the concentration located during the February 1987 cruise.

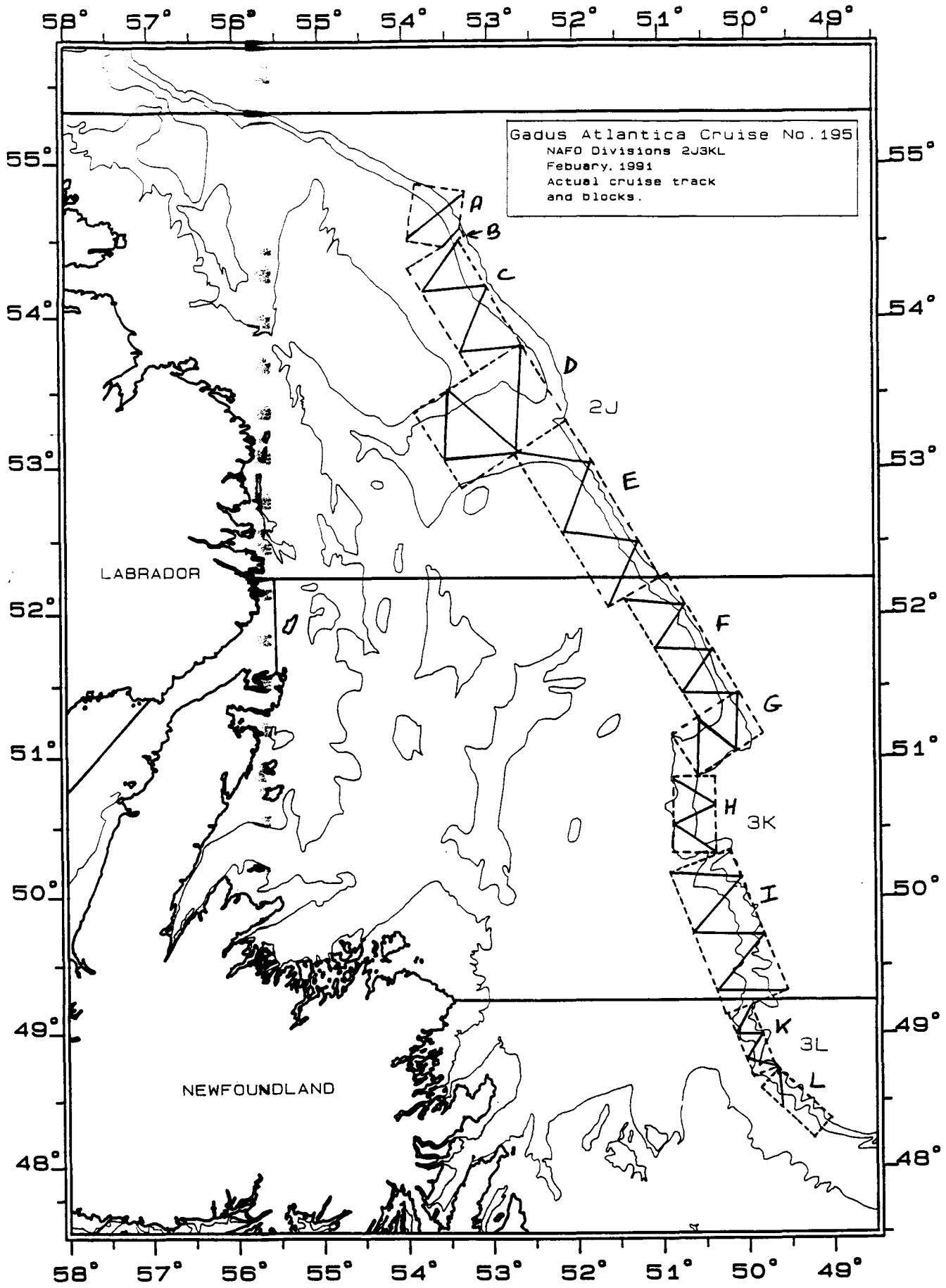

Figure 4. Area covered by February hydroacoustic survey during 1991.

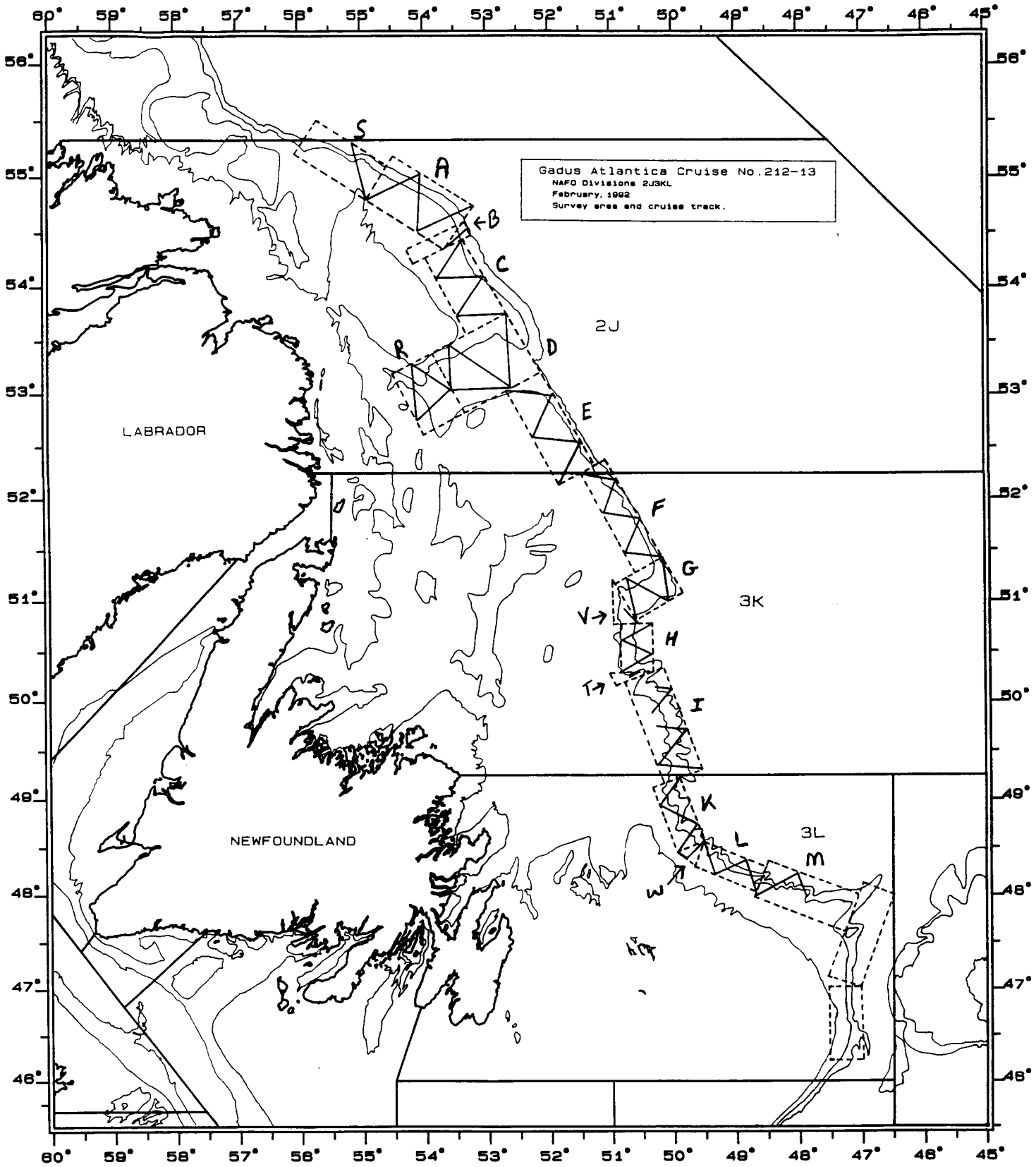

Figure 5. Area covered by February hydroacoustic survey during 1992.