

Investigations on cod and haddock in the  
Barents Sea and adjacent waters in 1991



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ABSTRACT

Trawl-acoustic survey to evaluate stocks and to assess young cod and haddock was conducted in the Barents Sea and adjacent waters by Russian RVs "PINRO" and "MARTI" in October-December 1991.

Analysis of materials indicated the abundance of cod from 1989-1991 yearclasses to be lower than the long-term mean. The 1989 haddock yearclass is at a level of above the mean, the 1990 is rich and the 1991 - mean one.

In the early 1992 total abundance and biomass of cod over the Barents Sea shelf constituted about 500 mill.spec. and 1235 thou.t, respectively, of which 380 mill.spec. and over 1200 thou.t made up commercial stock. Total abundance and biomass of haddock reached 880 mill.spec. and 290 thou.t, respectively, of which 130 mill.spec. and 180 thou.t applied to commercial stock.

INTRODUCTION

The trawl-acoustic survey to assess juveniles and stocks of bottom fishes has been regularly carried out since 1984 in the Barents Sea and adjacent waters using echo-integrating systems. Traditional trawl survey for assessment of young bottom fishes in the first three years of life, conducted in autumn-winter period since 1948 (Trambachev, 1981), was taken as its basis. This allows to use a large number of

observations over the indices for cod and haddock abundance to evaluate the yearclasses strength (Melyantsev, Salmov, 1985) and to forecast a size of recruitment to commercial stocks. Acoustic methods applied in the second half of 80's to determine abundance of bottom fishes in pelagial, as well as trawl-acoustic ones - for fishes in a bottom 8-meter water layer (Zaferman, Serebrov, 1985) allowed, to a certain extent, to avoid disadvantages in methods for bottom fishes stock assessment used earlier. At present the method of instrumental trawl-acoustic survey for bottom fishes stock assessment is still improving (Dorchenkov, 1986) and the results are applied when regulating fishery in the Barents Sea.

#### MATERIAL AND METHODS

The trawl-acoustic survey to evaluate juveniles and to assess cod and haddock stocks has been carried out in the Barents Sea and adjacent waters by Russian RVs "PINRO" and "Professor Marti" in October-December 1991 (Fig.1). The investigations were conducted in the terms similar to those in 1990. In total 435 hauls with bottom trawl were done from 50 to 500 m depths and this allowed to estimate a strength of next yearclasses of cod and haddock at age 1-3 and a size of these fishes stocks. Methods of the survey and data processing (Shevelev, Dorchenkov, Shvagzhdis, 1989; Shevelev, Dorchenkov, Mamylov, 1990; Dorchenkov, 1991) make possible to estimate substantially bottom and pelagic components of fish aggregations.

Fishing areas adopted in ICES are used in the paper.

#### RESULTS AND DISCUSSION

##### Assessment of juveniles

Higher thermal state of water masses in late 1991, as in two previous years, did not favour the descending of young cod and haddock in bottom layers and, hence, its assessment with a bottom trawl. Nevertheless, the analysis of material elucidated an increase in relative indices for abundance of the 1989 cod yearclass compared to the estimates for 1989 and 1990 (Table 1).

In Subarea 1 the estimate for the 1990 yearclass occurred to be lower than that obtained in a previous year, what was, apparently, accounted for by underestimation of that yearclass at the second year of life because of incomplete juveniles descending in bottom layers.

Abundance of the 1991 yearclass at the first year of life is estimated to be lower than the long-term mean level and close to the abundance of the 1990 yearclass at age 0+. Bearing in mind that the 1991 cod yearclass was estimated as a rich one by the data from ichthyoplankton survey and 0-group survey (Anon, 1991), possible underestimation of fingerlings in trawl-acoustic survey is assumed. This reason, as well as conditions of survival of juveniles at the first and second years of life during wintering may affect an estimate for yearclass at older age.

The strength of the 1989 haddock yearclass at age 2, evaluated in the 1990 survey, increased slightly and allowed to estimate that yearclass as mean abundant. Due to incomplete descending of fish in bottom layers the 1990 haddock yearclass, as a similar cod one, possibly, was underestimated. Nevertheless, this yearclass remains to be rich with a reduction of relative indices for abundance at the 2nd year of life. According to the data from ichthyoplankton and 0-group surveys the 1991 yearclass was estimated as a rich one and mean abundant - by our data (Table 2).

Thus, 3 recent yearclasses - the 1989 and, by preliminary data, 1990 and 1991 - are characterized by appearing of cod with abundance to be lower than the long-term mean. The abundance of haddock yearclasses continuously grows following the poor 1977 one, i.e. the 1988 yearclass is below the mean, the 1989 - above the mean and 1990 is a rich one. The 1991 yearclass is mean abundant by preliminary data. Thus, an upward trend in abundance of cod and haddock yearclasses has manifested. It is associated with a higher reproductive capability of cod and haddock spawning stocks and improving of survival conditions for juveniles at the turn of 80's and 90's.

## Peculiarities of cod and haddock distribution in October-December 1991.

Weather conditions favoured the cod and haddock stock assessment when conducting the survey in October-December 1991. Fish actively fed on capelin, with main aggregations being observed over the northern and northeastern margins of the area surveyed, in the areas of hydrographic front, as well as in the 1990 similar period (Shevelev, Dorchenkov, Lepesevich, 1991). Due to this, in autumn 1991, against analogous 1990 period, cod have been redistributed over the area investigated and no mass approach has been registered to the eastern shallows. Maximum catches were found over the Murman Bank slopes and in the Murman shallow (Subarea 1). In the Bear Island-Spitsbergen area cod abundance has nearly triplicated. In 1991 haddock were aggregated westwards compared to the similar 1990 period. Density of its aggregations has grown by nearly six times in Div.IIb, whereas in Subarea 1 and Div.IIIa it has decreased by 1.5 and 2 times, respectively. Higher thermal state of water masses, successful feeding, mass maturation predetermined earlier, compared to 1990, commencement of cod and haddock migration to wintering and spawning grounds. About 46% of cod and 48% of haddock have been recorded above 8-meter bottom layer over the area surveyed. Existence of migrating fish in pelagial favoured the assessment of gadoid species with trawl-acoustic method.

### Stock assessment.

Cod. Total abundance and biomass of cod on the Barents Sea shelf reached 500 mill.spec. and 1235 thou.t, respectively, of which 380 mill.spec. and over 1200 thou.t made up a commercial stock. Specimens from the 1984, 1983 and 1985 yearclasses constituted the bulk of cod catches (Tables 3 and 4). Compared to 1990 the stock abundance and biomass have increased by 1.4-1.5 times for most age groups. However, the reasons for this are not yet known. Possibly, in 1989-1990 stock assessment was insufficiently complete. It is possible that partially it was due to successful fishery regulation in 1990-1991, owing to which fishing mortality of the 1984-1989 yearclasses was at a low level.

Other probable reason for this phenomenon considered may be variations in cod acoustical reflectivity. These variations may result from inconstancy in fish biological characteristics. Thus, a trend towards mean weight growth of single-sized specimens is pronounced approximately by 10-15% in the period from 1989 to 1991, what is related to an improving of the Barents Sea nutritive base in these years. The target strength (TS) equation, obtained many years ago and adopted by ICES, is used in calculations:

$$Ts = 21,8Lg L -72,7 \text{ dB}$$

Acoustic data on cod target strength were obtained in trawl-acoustic survey. Preliminary analysis allows to judge of some real variations in this parameter.

Haddock. Specimens from the 1984, 1983 and 1988 yearclasses made up the bulk of haddock catches (Tables 5 and 6). Commercial stock abundance was much lower than the recruitment abundance, in which the 1990 and 1991 yearclasses were especially isolated (about 370 and 240 mill.spec., respectively). Total abundance and biomass of haddock over the whole area surveyed constituted about 880 mill.spec. and 290 thou.t, respectively, of which 130 mill.spec. and 180 thou.t of haddock refer to the commercial stock, and it is by 1.3-1.5 times lower compared to 1990. Possibly, the same reasons mentioned above for cod affect accuracy of haddock stock assessment.

On the whole, the estimates for stocks are well agreed with the ICES Working Group calculations on actual fishery for early 1992, what is indicative of their reliability.

## CONCLUSIONS

1. According to the data on juveniles assessment in 1991 the abundance of the 1989-1991 cod yearclasses is estimated to be lower than the long-term mean. The abundance of the 1989 and 1991 haddock yearclasses - to be lower than the long-term mean and 1990 one - to be rich.

2. In early 1992 total abundance and biomass of cod on the Barents Sea shelf reached 500 mill.spec. and 1235 thou.t, respectively, of which 380 mill.spec. and over 1200 thou.t made up commercial stock. Total abundance and biomass of haddock constituted about 880 mill.spec. and 290 thou.t, respectively, of which about 130 mill.spec. and 180 thou.t refer to commercial stock. Cod specimens from the 1983-1985 and haddock - from the 1983-1984 and 1988 yearclasses made up the bulk of catches.

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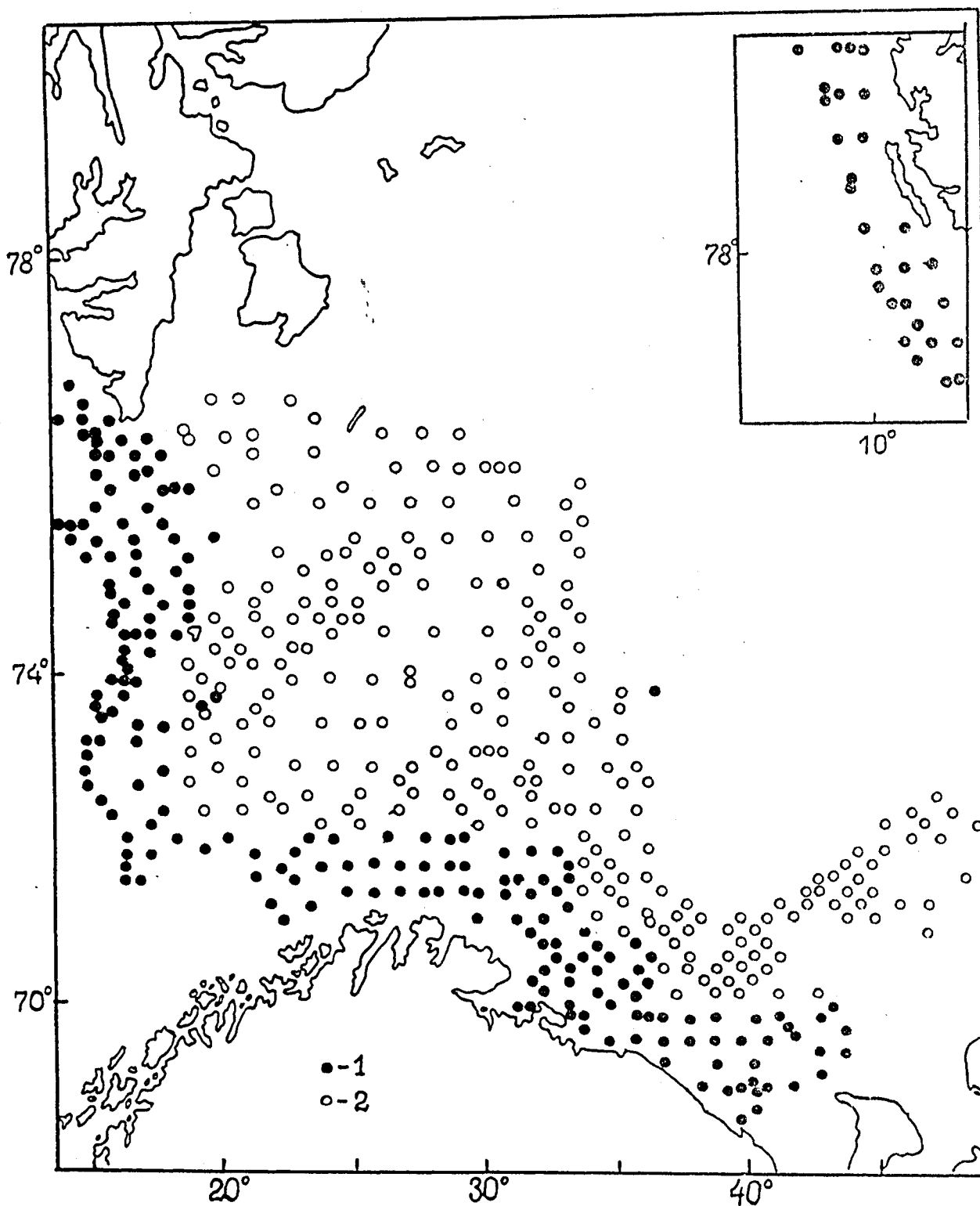


Fig. 1 Trawl stations made in October-December 1991

1 - RV "PINRO", Cruise 17

2 - RV "PROFESSOR MARTI", Cruise 21



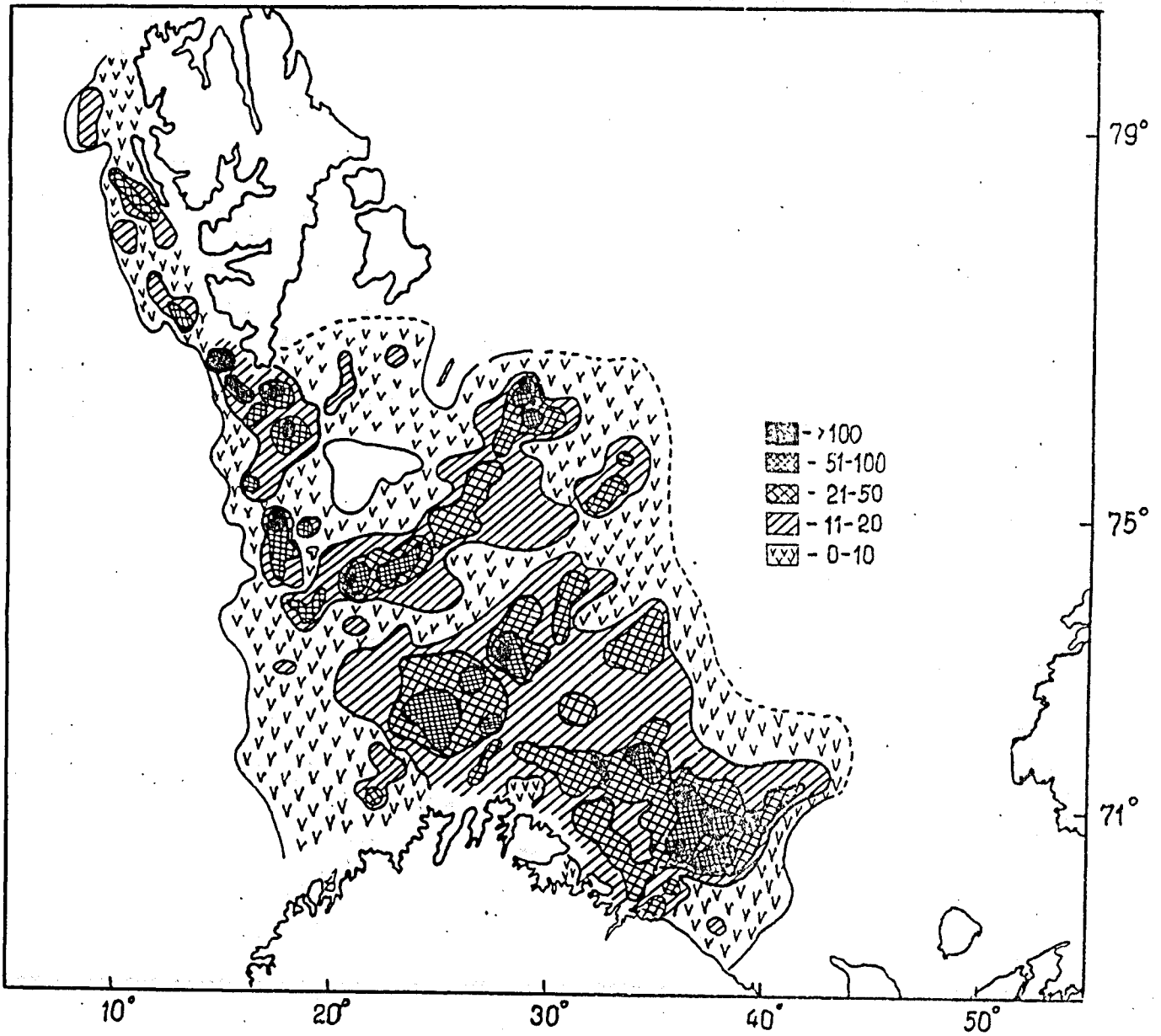


Fig. 2 Distribution of god echointensities in October-December 1991 ( $m^2/mile^2$ )

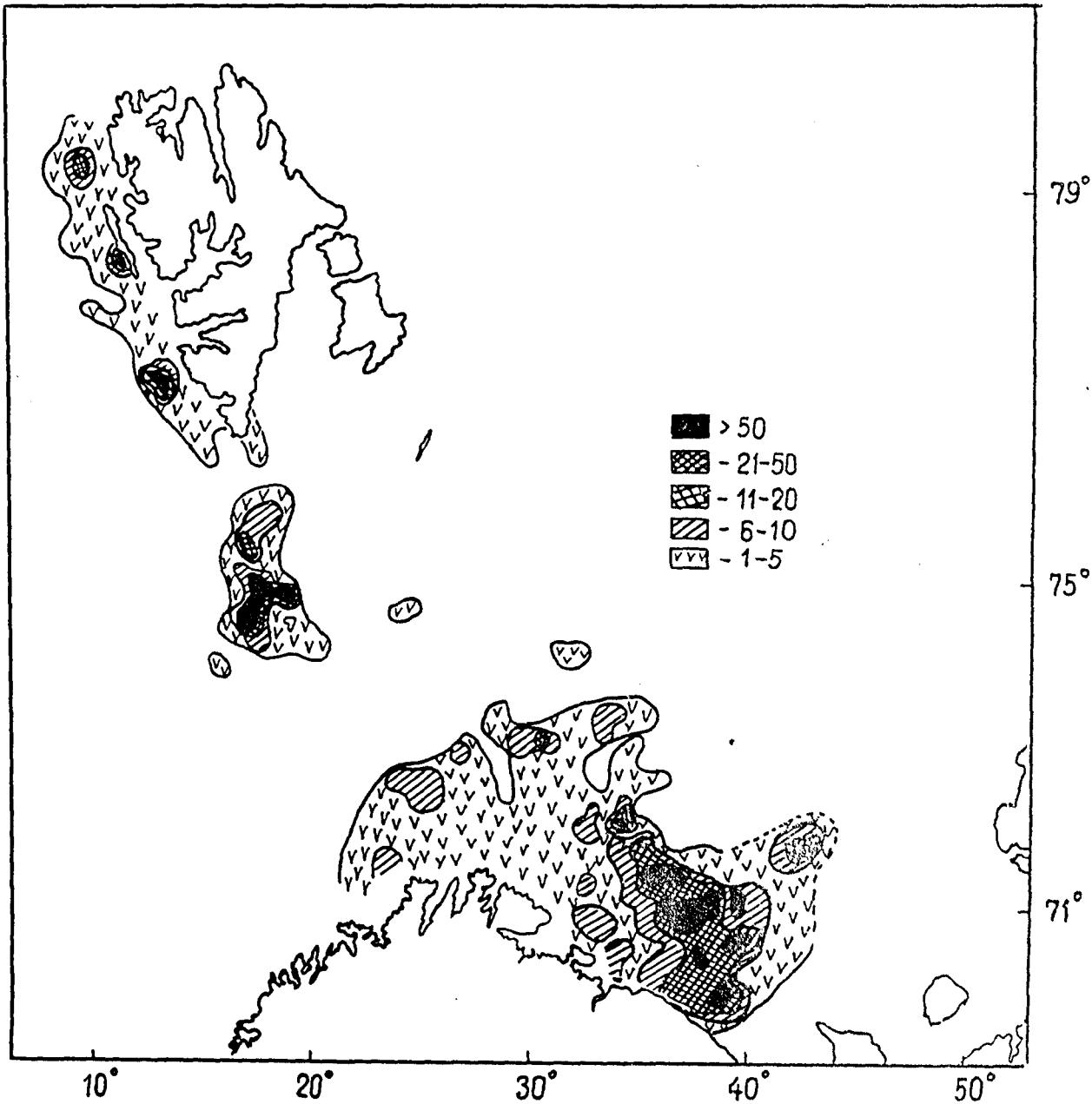


Fig. 3 Distribution of haddock echointensities in October-December 1991 ( $m^2/mile^2$ )

TABLE 1. Mean catches of young haddock at age 1-3 years in southern Barents Sea (1) and Bear Island-Spitsbergen area (IIb) in 1975-1991 (spec. per hour trawling)

Year-class	Years of life										Mean catches at age 2-3 years		
	1			2			3			I	IIb	I+IIb	
	I	IIb	I+IIb	I	IIb	I+IIb	I	IIb	I+IIb				
1975	60	I	36	44	<I	29	93	4	62	68	2	45	
1976	I	I	I	I	I	I	4	<I	3	2	I	I	
1977	I	I	I	2	I	I	2	I	1	2	I	I	
1978	<I	2	<I	<I	<I	<I	I	3	2	<I	I	I	
1979	<I	I	<I	<I	<I	<I	<I	8	3	<I	5	2	
1980	<I	I	<I	<I	<I	<I	I	8	4	<I	4	2	
1981	<I	<I	<I	<I	<I	<I	4	4	4	2	2	2	
1982	I	8	4	8	13	10	8	10	9	8	II	9	
1983	4	9	6	II	7	9	45	4I	43	2I	20	20	
1984	I	I	<I	2	8	5	7	15	10	5	12	8	
1985	3	10	6	2	3	2	4	4	4	3	3	3	
1986	<I	2	I	<I	I	<I	2	5	3	I	2	I	
1987	<I	-	<I	I	<I	<I	<I	I	I	I	<I	<I	
1988	<I	<I	<I	<I	I	<I	7	I	4	3	<I	2	
1989	<I	I	<I	4	I	3	7	10	8	5	5	5	
1990	6	I	4	4	4	4							
1991	3	6	4										

TABLE 2. Mean catches of young haddock at 1-3 yr old in the Western, Central and Coastal areas of the Barents Sea in 1970-1991 (spec./trawling hour)

Yearclass	Years of life			Mean catches at 1-3 yr old
	1	2	3	
I970	I0	33	3I	32
I97I	3	3	9	6
I972	2	9	3	6
I973	I3	8	6	6
I974	I5	35	I4	24
I975	I63	96	59	77
I976	6	I3	4	8
I977	I	I	<I	<I
I978	<I	<I	I	<I
I979	<I	<I	<I	<I
I980	<I	<I	<I	<I
I98I	<I	<I	8	4
I982	23	59	63	6I
I983	40	79	239	I2I
I984	9	I9	I8	I9
I985	5	2	3	3
I986	<I	<I	I	I
I987	<I	<I	4	2
I988	2	3	2I	II
I989	3	25	30	28
I990	8I	67		
I99I	I7			
Mean for 1948-1991	I7	2I	28	22

Table 3

Abundance estimate of cod in the Barents Sea, 1988-91  
(number x 10<sup>6</sup>)

Area	Year of survey	Year class												Total	
		:1991	:1990	:1989	:1988	:1987	:1986	:1985	:1984	:1983	:1982	:1981	:1980		:1979+
I	I988*				+	+	II	56	50	I76	25	7	I	+	326
	I989*			+	+	+	7	29	4I	62	4I	4	+	2	I84
	I989			I	+	2	7	24	33	45	34	8	2	I	I56
	I990		28	2I	49	8	I9	23	52	63	26	5	I	+	295
	I99I	I0	I5	27	78	34	35	4I	44	27	3	+	+		3I5
IIa	I988*						II	35	I6	9	I	I	+	+	74
	I989*				+	+	I	5	7	II	7	+	+	+	3I
	I989				+	I	3	9	I3	39	39	I2	5	2	I23
	I990		+	+	+	+	I	2	4	4	4	I	+	+	20
	I99I	I	+	+	I	I	3	3	3	3	+	+			I5
IIb	I988*					+	2I	70	40	60	8	2	+	+	202
	I989*			+	+	+	I	6	8	I2	8	I	+	+	36
	I989			I	+	+	6	II	I0	I6	9	+	I	+	55
	I990			I	2	2	5	8	9	I8	I2	3	I	+	6I
	I99I	22	I3	26	23	8	I2	I4	22	2I	3	I	+		I64
I+IIa+IIb	I988*				+	+	43	I6I	I06	245	34	I0	2	+	602
	I989*			+	+	+	9	40	56	84	56	6	+	+	25I
	I989			2	+	4	I7	44	56	99	82	20	7	3	335
	I990		28	22	5I	I0	25	33	65	87	42	9	2	+	376
	I99I	33	29	53	I0I	43	50	58	70	5I	6	I	+		494

\*The survey was conducted in September/October (in other cases - in October-December)

Table 4

Biomass estimate of cod in the Barents Sea , 1988-1991  
(tonnes x 10<sup>3</sup>)

Area	Year of survey	Year class												Total	
		I991	I990	I989	I988	I987	I986	I985	I984	I983	I982	I981	I980		I979+
I	1988*				+	+	2	21	35	249	61	30	5	3	406
	1989*			+	+	+	5	33	62	134	119	16	+	1	371
	1989			+	+	+	3	23	49	103	108	41	12	8	347
	1990		I	I	II	3	15	32	114	208	128	37	8	5	563
	1991	+	I	6	41	44	75	152	235	193	25	4	1	-	777
IIa	1988*						2	12	10	11	3	2	1	1	42
	1989*				+	+	1	5	11	23	20	2	+	+	62
	1989				+	+	1	8	19	80	123	53	23	18	326
	1990		+	+	+	+	1	3	9	20	21	8	+	3	65
	1991	+	+	+	1	2	6	9	16	19	4	1	+	-	57
IIb	1988*					+	4	26	25	82	20	8	3	1	169
	1989*			+	+	+	1	6	11	26	23	3	+	+	70
	1989			+	+	+	2	10	13	35	26	4	5	+	95
	1990			+	+	1	5	12	22	69	65	21	8	3	206
	1991	+	2	8	13	10	27	47	101	158	28	6	2	-	401
I+IIa+IIb	1988*				+	+	8	59	70	342	84	40	9	5	617
	1989*			+	+	+	8	44	84	183	162	21	+	1	503
	1989			+	+	1	6	41	81	218	257	98	40	26	768
	1990		I	I	II	4	21	47	145	297	214	66	16	11	834
	1991	I	3	14	55	56	108	207	352	370	57	10	3	-	1235

\* The survey was conducted in September/October (in other cases - in October-December)

Table 5

## Abundance estimate of haddock in the Barents Sea, 1988-1991

(number x 10<sup>6</sup>)

Area	Year of survey	Year class												Total
		1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981	1980	
I	1988*				I	I	3	I8	64	I68	25		+	280
	1989*			+	20	39	I	2	22	36	4			I24
	1989			9	9	I0	2	7	20	40	5	+	+	I02
	1990		536	I56	68	27	I6	23	42	43	4	I	+	9I7
	1991	96	240	I20	63	II	4	6	2I	I7	2	+		580
IIa	1988*				+			+	I6	III	I8			I46
	1989*				I7	35	I	I	3	4	I			6I
	1989			3	20	75	+	3	3	3				I07
	1990		27	4	4	+	+	+	I	I	+			40
	1991	II	8	I	+	+	+	+	+	+	+	+		20
IIb	1988*				+			+	3	22	3			28
	1989*							+	+	+	+			+
	1989			29	4	8	+	4	I2	25	4	+		86
	1990		30	I4	2	+	+	+	+	+	+	+		48
	1991	I33	I20	22	I	+	+	+	+	+				277
I+IIa+IIb	1988*				2	I	3	I8	83	30I	46		+	454
	1989*			+	37	75	3	2	24	40	4			I85
	1989			4I	32	94	2	I4	35	67	9	+	+	293
	1990		594	I76	75	28	I7	23	43	44	4	I	+	I004
	1991	240	368	I43	65	II	4	7	2I	I7	2	+		878

\* The survey was conducted in September/October (in other cases - in October-December)

Table 6

Biomass estimate of haddock in the Barents Sea, 1988-1991  
(tonnes x 10<sup>3</sup>)

Area	Year of survey	Year class											Total		
		1991	1990	1989	1988	1987	1986	1985	1984	1983	1982	1981		1980	1979+
I	1988*				+	+	1	7	41	160	35				246
	1989*			+	3	6	2	4	26	39	7				87
	1989			9	1	2	1	7	25	61	9	1	1		117
	1990		37	22	19	19	21	35	75	96	12	3	+		339
	1991	8	32	29	39	17	7	13	47	42	6	1			241
IIa	1988*				+			+	13	112	24				150
	1989*				2	6	1	+	3	6	+				18
	1989			3	2	12	1	3	4	5					30
	1990		2	1	2	+	+	+	1	2	+				8
	1991	1	1	+	+	+	+	+	+	+	+	+			2
IIb	1988*				+			+	2	22	5				29
	1989*							+	+	+	+				+
	1989			2	+	8	+	4	15	38	7	+			74
	1990		2	3	1	+	+	+	1	1	+	+			8
	1991	12	19	12	1	1	+	+	+	+					46
I+IIa+IIb	1988*				+	+	1	7	57	294	64		2		425
	1989*				5	12	2	5	29	45	7				105
	1989			+	3	22	2	14	44	104	16	1	1		221
	1990		41	26	23	19	21	35	76	99	12	3	3		355
	1991	20	52	41	40	18	8	13	48	42	6	1			289

\*

The survey was conducted in September/October (in other cases - in October-December)