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CHANGES IN ABUNDANCE AND DISTRIBUTION OF THE BARENTS SEA LONG ROUGH DAB, HIPPOGLOSSOIDES PLATESSOIDES (FABRICIUS) DURING THE PERIOD 1980-1992

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ABSTRACT

Abundance and biomass of long rough dab in the Barents Sea and adjacent waters were assessed from bottom trawl survey data from research surveys by Norway and Russia, during the period 1980-1992. Although there was no directed fishery for this species, with only a 1000-6000 ton bycatch by the Russian fleet, the population abundance and biomass were reduced by 50% of the long term average during 1986 to 1988. Subsequently the population began to increase to pre-1985 levels. We suggest that these fluctuations reflect changes in availability of the population to the survey gear, however the mechanism responsible is not clear.

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INTRODUCTION

Long rough dab, Hippoglossoides platessoides (Fabricius) is an arcto-boreal right eyed flounder of the Pleuronectidae family. It inhabits the shelf waters of the Barents Sea from the archipelagoes of Spitzbergen in the north, to Novaja Zemlja in the east, the coastal waters of northern Norway and Russsia, and the shelf edge along the western coast of Norway (Milinsky, 1944; Isaksen, 1977; Simacheva and Glukhov, 1986). There is no directed fishery for this species although it is frequently taken as by-catch in bottom trawl fisheries for cod, haddock, redfish, Greenland halibut, and shrimp, and generally discarded at sea. A limited amount of catch is taken by the Russian fleet and available catch statistics show that during the period from 1980-1987 landings ranged from 2.5 to 6 thousand metric tons and has decreased to less than 2 thousand tons in recent years.

Milinsky (1944) described Barents Sea long rough dab as both eurobathic and eurothermal in its distribution. It is found in depths of 50-550m and temperature ranges of -1.3 to 5.0 C (Milinsky, 1944; Isaksen, 1977; Simacheva and Glukhov, 1986). Although this species is generally considered fairly sedentary, with small movements generally associated with seasonal temperature changes (Powles, 1965; Pitt, 1969; Ntiba, 1989; Morgan & Brodie, 1991), the eastern Barents Sea populations have been reported to migrate to the western areas for spawning during the spring and return again during the summer months (Milinsky, 1944; Simacheva & Glukhov, 1986). It is not known whether the populations located in the north around Spitzbergen, Svalbard and Bear Island, join this spawning migration.

The purpose of this study is to update and add new information about population size and distribution of long rough dab in the Barents Sea during the period 1980-92, based on analysis of Norwegian and Russian data-bases. We will first estimate population size in the Barents Sea (ICES Subarea I and Division IIa and IIb). Then we will examine variations in distribution of this species and discuss these findings in relation to available oceanographic parameters.

MATERIALS AND METHODS

Random stratified trawl surveys have been conducted by Norway and Russia individually, in the Barents Sea since 1980 (Fig. 1). However, since long rough dab is not considered a valuable commercial species, statistics on various biological parameters and stock density have been collected but not on a systematic basis. For the purpose of analysis the Barents Sea was divided into two areas: the northern region denoted as Svalbard Area (ICES Div. IIb) and the southern area (Subarea 1 and Div. IIa)

denoted as Barents Sea. The purpose of this denotation is to make the Norwegian and Russian databases more comparable.

SURVEY DESIGN

The Norwegian surveys of the Barents Sea (Fig. 1) from 1983-1992 were conducted using a Campelen 1800 shrimp trawl with a 38 mm codend and either used 35 cm rubber disc (1983-88) or rockhopper (1989-92) bottom gear. No correction in the time series was made to account for differences in efficiency between the two footgear riggings. Standard towing time was 3.0 knots. The Svalbard Area (ICES Division IIb) was surveyed during August to October while the southern Barents Sea (ICES Subarea 1 and Division IIa) was surveyed during late January to March each year. In 1989 the Norwegian survey coverage was extended farther to cover distribution of Greenland halibut and as expected indices of abundance are not directly comparable for the 1983-1987 period.

The Russian surveys from 1980-1992 were conducted using a 25 meter trawl with an 8 mm codend liner. The bottom trawl is rigged with large bobbin footgear. Average standard towing speed was recorded as 3.2 knots. Surveys of the northern and southern Barents Sea were conducted during the same time period; April to May, 1980-1992 and October to December 1983-1992.

SAMPLING

Numbers and weight of catches were standardized to a tow duration of one hour in catches by Russia and 3 nautical miles by Norway (~ 1 hour). Length frequencies were grouped in 2 cm intervals for analysis. Age data was obtained from otoliths (Russia) and subsequent age-length keys were used in the calculation of stratified estimates of age composition in both time series. Due to irregular sampling of catches, population numbers at age from Russian surveys could only be estimated for the period 1988-92. However, age length keys from the Russian data for the period 1983-92 were used to convert Norwegian length base data to numbers at age.

RESULTS

RELATIVE ABUNDANCE

The populations of long rough dab in the Barents Sea and Svalbard Area appeared to be fairly stable during the beginning of the 1980's, reaching a peak in 1984 with abundance and biomass being equivalent in both areas. A systematic decline was evident from 1986 to 1988 and stock size was reduced to approximately half of

the long term average in both the Russian catch rates and in the Norwegian estimates of abundance and biomass (mean = 874.5 million fish; 104 thousand tons) (Fig. 2). Following 1989 the stock has increased in both areas to pre-1985 levels (Fig 2). Total stock biomass in 1992 ranged between 114 to 147 thousand metric tons based on both surveys, with a higher percentage in the Barents Sea than in Svalbard Area (Table 1). Total population abundance in 1992 ranged from 543 to 1563 million fish. The discrepancy in estimates is probably related to the catching efficiency of both trawls and it is expected that the Norwegian trawl is more efficient for smaller sizes than the Russian trawl.

TOTAL POPULATION DISTRIBUTION

Long rough dab were distributed throughout the range surveyed, from the North Kanin bank in the south eastern Barents Sea to the northwest top of Spitzbergen (Fig. 3 shows a typical year). Highest concentrations were found in the eastern Barents Sea associated with the several banks especially North Kanin Bank, Goose Bank, Central Bank and the Svalbard Bank (ICES Subarea 1 and Div IIb). On the western side of the Barents Sea (ICES Div IIb), and along the west coast of Spitzbergen, the population density is low but wide spread (Figs. 1 & 3).

JUVENILES AND ADULTS

Distribution of juveniles (<21 cm) and adults (>21 cm) showed a considerable overlap in distribution as seen in the 1992 density contour plots from the Russian surveys (Fig. 4). Catch rates are highest in the areas of the large banks in both the eastern Barents Sea and Svalbard Area, being similar to distribution of the total stock as illustrated in 1985 (Fig. 3).

DEPTH AND TEMPERATURE

Maximum mean number and weight per standard tow reached a peak in the 151-200 meter depth interval in the Barents Sea. Generally, the major portion of the population biomass was located in depths between 100 to 350 meters (Table 2). Average bottom temperatures associated with these depth intervals ranged from 3.2 to 4.2 °C (min.: -1.9 °C; max.: 7.9 °C). In the Svalbard area the population was spread more evenly across several depth intervals from less than 50 m to 500 m. No apparent maximum catch rate was evident (Table 2). Average bottom temperature associated with these depths ranged from 1.6 to 3.0 °C (min.: -1.9 °C; max.: 12.4 °C).

SIZE COMPOSITION

Length composition (combined sexes only) of long rough dab catches in the Norwegian surveys indicated little difference in size between the Barents Sea and Svalbard Area populations (Fig.5). Fish sizes ranged from 2 to 56 cm in the Barents Sea and 2 to 48 cm in the Svalbard Area. Average length derived from standard tows showed smaller fish were found in depths less than 50 m in the Svalbard Area and less than 100 m in the Barents Sea, A further increasing trend in mean size with depth was not evident (Fig 6). Beyond 150 m, average size of long rough dab is larger in the Barents Sea population than in the Svalbard Area. Catch rates of juvenile and adult long rough dab in the 1992 survey showed that both size groups were distributed across all depth ranges (Fig. 7). Catch rates of juveniles were higher in the Svalbard Area than the Barents Sea beyond 100-150 meter depth interval.

AGE COMPOSITION

Population estimates of age composition of long rough dab in the Russian and Norwegian surveys did not show catches of fish younger than age 3 or older than age 16 in the Barents Sea or Svalbard Area (Table 3, 4 & 5). Fish from age 1 to 19 years had been caught, but their numbers were low. In the 1992 survey, the 1982 to 1984 year classes contributed the majority of the biomass in the survey.

During 1986-1988, the age composition in the Norwegian surveys showed a systematic decline in estimates of ages 3-8 (1987-88) in the Barents Sea and ages 3-9 in the Svalbard Area (1986-88). Estimates of these age groups were the lowest in the time series. Population estimates of older fish, age 10+ in the Norwegian time series for both the Barents Sea and the Svalbard Area also showed a reduction during the 1985-1989 period, followed by an increase in 1990-92.

Mean age of males and females in the Russian surveys showed a sharp decline in the Barents Sea and Svalbard Area populations, beginning in 1985 and continuing to 1989. Thereafter, mean age began to increase but still remains below the pre-1986 levels (Fig. 8). A similar reduction in average length of fish was seen in both populations in the Russian and Norwegian time series (Fig. 9).

DISCUSSION

DISTRIBUTION

Long rough dab in the Barents Sea are distributed from the North Kanin Bank in the southeast region, westward along the northern coast of Norway and north to the Svalbard Bank and coastal waters off western Spitzbergen. Concentrations are associated mainly with the banks along the eastern region from North Kanin Bank, Goose Bank, eastern edge of Central Bank, and widely along the Svalbard Bank. The habitat of long rough dab covers a large area which Leong (1989) describes as being influenced by three water masses: the Coastal and Atlantic waters, with temperatures generally greater than 2 °C, and the Arctic water with temperatures less than 2 °C. Where the Arctic and Atlantic water masses meet, a well defined polar front is formed (Dragesund and Gjøsæter, 1988). Long rough dab appear to be concentrated along the polar front, an area of high primary production. The position of the polar front may limit the northern extension of this species due to heat content of the water masses in various years. Year to year variation in spatial distribution is relatively low, being dependent on the position of the polar front and size of the population.

The consistent distributional overlap of juvenile and adult long rough dab in the same depth and temperature regions illustrates that the Barents Sea is utilized as a nursery and feeding grounds by this species. Offshore oceanic nursery grounds associated with frontal systems are also common in this species in the Northwest Atlantic (Walsh 1982; 1991).

ABUNDANCE

Survey results point to a drastic reduction in population size during the period 1986-1988. No directed fishery for this species exists. An insignificant bycatch amount has been landed in Russia during the 1980's and it is assumed that bycatch from other fisheries in the area are discarded at sea. Unfortunately, no data exists on the levels of this discard or its potential effects on population size. However, if we assume the level of fishing effort directed towards other species, thus the level of discards, has not appreciably changed during the decade, then we suggest this reduction in population size cannot be solely attributed to fishing mortality.

Reduction in population mean age, older fish (age 10+), and mean size, normally reflects a change in growth and removal of older fish, thus the decline by itself is not at first, particularly surprising. Simacheva and Glukhov (1986) reported that the proportion of large long rough dab (>40 cm) in the Barents Sea

during the 1967-1984 period was significantly lower than that found during the 1930's. However the subsequent increase in mean size and age from 1989 onward cannot be predicted from the population dynamic theories. Therefore it is suggested that what happened in the population during the 1986-1988 period may be unrelated to major changes in growth.

On the Canadian Grand Bank, reduced biomass estimates in research vessel surveys immediately followed years of unusually low bottom temperatures (Wells et al. 1988). In the Barents Sea, the second half of the 1970's through to 1982 were characterized by very low temperatures, warming during the 1982 to 1985 period, followed by a period of slightly below average temperatures (1986-1988) and again a warming period from 1989 to 1990 (Leong, 1991). Although the low levels of population size were recorded during this period of slightly below average temperature, it does not appear to be the regulating factor. If temperature was the regulating factor, then one would have expected a reduced population during the extreme cold period of the early 1980's. However, the survey catch rates in the Russian time series showed the population level to be fairly stable during this period.

During 1986-1988 there was no evidence of a major change in distribution of the population spatially. We suggest that the reduction in population size and subsequent changes in age composition reflects a change in availability of long rough dab during the time period. Changes in availability in Northeast Arctic cod in the Barents Sea also occurred during this same time period resulting in similar changes in stock size as recorded in the bottom trawl surveys. Cod became distributed more pelagically and as a result were less available to bottom trawls. This was due to a change in diet to pelagic amphipods as a response to a decline in caplin stocks (O. Nakken. Institute of Marine Research, Bergen; personal communication). Since we do not expect long rough dab to become pelagically distributed for three years, we suggest that a large segment of the population may have moved out of the survey area, possibly into deeper water, but the cause of this movement is unknown.

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Table 1. Comparison of abundance and biomass estimates of long rough dab from Norwegian surveys (expanded strata system) and Russian surveys for the period 1988-92.

Year	Abundance (10^{-6})			Biomass ('000t)		
	Barents Sea	Svalbard Area	Total	Barents Sea	Svalbard Area	Total
Norway						
1988	215.3	211.6	426.9	31.8	26.0	57.8
1989	537.0	516.9	1053.9	67.4	38.6	106.0
1990	709.8	711.1	1420.9	58.4	58.3	116.7
1991	919.7	818.9	1738.6	100.5	79.0	179.5
1992	737.4	824.7	1562.1	85.0	62.4	147.4
Russia						
1988	183.7	143.6	327.3	27.9	22.1	50.0
1989	162.7	62.2	224.9	27.6	14.0	41.6
1990	558.9	69.3	628.2	65.4	13.9	79.3
1991	359.0	122.2	481.2	66.1	27.6	93.7
1992	355.9	187.2	543.1	73.4	41.3	114.7

Table 2
Trends in distribution of mean catches (numbers and weight) of long rough dab by depth interval and temperature from Norwegian surveys, during the period 1983-92.

Region	Depth Range (M)	Mean Temp (C)	Number Tows	Number Mean	Number SD	Weight (kg) Mean	Weight (kg) SD
Barents Sea	<50	3.0	29	102.8	147.8	14.2	27.8
	50-100	3.4	212	65.0	111.0	9.5	14.9
	101-150	4.2	292	375.0	638.9	45.3	82.0
	151-200	4.2	251	960.5	1879.3	100.9	203.4
	201-250	3.2	285	750.4	944.4	69.5	77.1
	251-300	2.9	270	536.3	893.3	42.3	53.8
	301-350	3.2	152	301.1	368.8	29.0	30.1
	351-400	2.9	209	168.4	193.8	20.7	19.2
	401-450	2.8	110	95.1	70.3	13.9	9.8
	451-500	2.7	115	77.8	69.3	12.4	10.7
	501-550	5.2	29	43.7	68.7	8.4	10.4
	551-600	5.3	11	7.9	5.1	1.0	0.9
Svalbard Area	<50	1.7	9	177.2	241.5	21.1	22.1
	50-100	2.3	19	298.8	362.0	8.2	19.5
	101-150	3.0	91	203.0	264.5	14.8	24.9
	151-200	2.2	332	254.8	334.3	28.0	55.9
	201-250	1.6	470	244.2	267.4	34.3	36.8
	251-300	2.0	788	231.9	283.4	36.6	39.9
	301-350	1.7	478	143.1	159.3	25.1	24.2
	351-400	1.8	274	114.4	133.7	22.8	23.9
	401-450	2.0	138	137.9	112.1	29.1	23.7
	451-500	1.7	26	257.1	126.1	52.4	23.8
	501-550	1.6	3	10.0	10.4	2.3	1.6
	551-600	1.9	1	16.0	0.0	2.7	0.0

Table 3. Population abundance and age composition of long rough dab from Russian surveys during the fall of 1988-1992 of the Barents Sea (ICES Sub area 1 & Div IIa) and Svalbard Area (ICES Div IIb)

Age	Barents Sea (Numbers x 10^6)					Svalbard Area (Numbers x 10^6)				
	1988	1989	1990	1991	1992	1988	1989	1990	1991	1992
3	29.7	14.1	95.0	71.0	20.3	24.6	8.0	16.3	4.5	9.9
4	42.5	40.6	150.6	64.4	65.5	31.7	12.9	16.7	28.9	28.3
5	40.1	36.5	163.7	69.3	61.3	30.3	12.5	15.3	44.2	21.8
6	27.7	29.7	60.5	30.9	42.9	21.2	5.9	11.6	17.4	14.1
7	8.4	17.8	27.1	40.0	26.3	6.8	9.1	5.5	10.6	17.1
8	13.4	12.2	20.6	34.9	30.4	10.3	5.8	2.4	9.8	24.5
9	12.2	6.5	19.3	22.4	39.9	9.8	2.7	1.3	3.6	22.2
10	6.2	1.9	15.0	10.2	36.6	5.4	2.2	0.1	1.3	12.2
11	1.3	2.4	4.1	3.3	19.8	1.3	2.5	0.1	0.9	6.3
12	0.9	1.0	2.8	2.4	11.0	0.6	0.5		1.0	1.1
13	1.1		0.1	0.1	1.2	0.9	0.1			0.1
14	0.4			0.1	0.2	0.5				0.1
15	0.4				0.1					
16					0.1					
Total	183.7	162.7	558.9	359.0	355.9	143.6	62.2	69.3	122.2	187.2

Table 4. Age composition (10^6) of long rough dab from Norwegian surveys during 1983-1992 in the Barents Sea (ICES Subarea 1 & Div. IIa).

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
3	3.7	7.9	6.7	3.5	1.0	1.1	3.0	5.8	9.6	8.8
4	4.3	7.0	9.0	4.9	1.6	1.7	3.8	3.9	9.6	11.5
5	5.1	8.3	1.1	3.1	2.2	2.4	7.8	5.7	10.8	16.9
6	3.9	6.4	6.3	5.0	2.1	2.6	7.5	7.3	7.6	9.6
7	4.5	7.3	8.2	6.5	2.7	3.1	6.3	6.1	6.3	6.6
8	3.8	7.2	9.6	4.3	2.7	2.9	3.4	3.3	7.4	4.3
9	2.9	4.9	6.1	1.7	1.9	1.9	1.8	2.0	3.7	6.1
10	1.3	2.1	2.4	1.1	0.7	0.7	0.3	0.8	2.8	3.6
11	1.2	0.9	1.5	0.7	0.3	0.3	0.4	0.3	1.6	1.4
12	0.7	0.5	0.9	0.3	0.2	0.2	0.4	0.2	0.4	0.8
13	0.8	0.2	0.4	0.2					0.1	0.2
14	0.2	0.1	0.2							
15	0.1	0.1								
10+	4.3	3.9	5.4	2.3	1.5	1.5	1.1	1.3	4.9	6.0
Total	34.3	58.6	64.3	36.8	16.1	18.1	45.5	46.4	65.6	71.1

Table 5. Age composition (10^6) of long rough dab from Norwegian surveys during 1983-92 in the Svalbard Area (ICES Div. IIa).

Age	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992
3	1.7	6.7	4.9	1.6	1.5	1.5	2.2	7.5	10.1	3.8
4	3.2	6.8	4.7	1.6	1.4	2.0	3.3	6.3	7.7	4.1
5	6.6	12.2	8.2	3.0	2.5	3.7	6.5	9.6	11.5	7.4
6	6.0	9.1	5.9	2.3	2.0	3.0	5.9	8.1	11.5	4.3
7	6.6	8.9	6.1	2.1	2.2	3.1	4.9	7.5	7.2	3.8
8	4.9	7.3	5.0	1.7	2.0	2.4	4.0	3.4	4.3	3.4
9	2.6	4.5	3.7	1.2	1.1	1.4	1.5	1.5	2.4	2.6
10	1.0	1.9	2.0	0.6	0.3	0.5	0.4	0.6	0.7	1.4
11	0.4	0.8	1.7	0.6	0.1	0.2	0.3	0.8	0.4	0.7
12	0.2	0.5	1.0	0.3	0.1	0.1	0.3	0.1	0.2	0.3
13	0.1	0.1	0.7	0.2			0.1	0.2	0.1	0.1
14		0.1	0.2	0.1						
15			0.1							
10+	1.8	3.4	5.9	1.8	0.6	0.7	1.1	1.7	1.4	2.4
Total	35.7	67.5	48.8	17.8	14.8	18.9	33.8	61.9	70.4	37.7

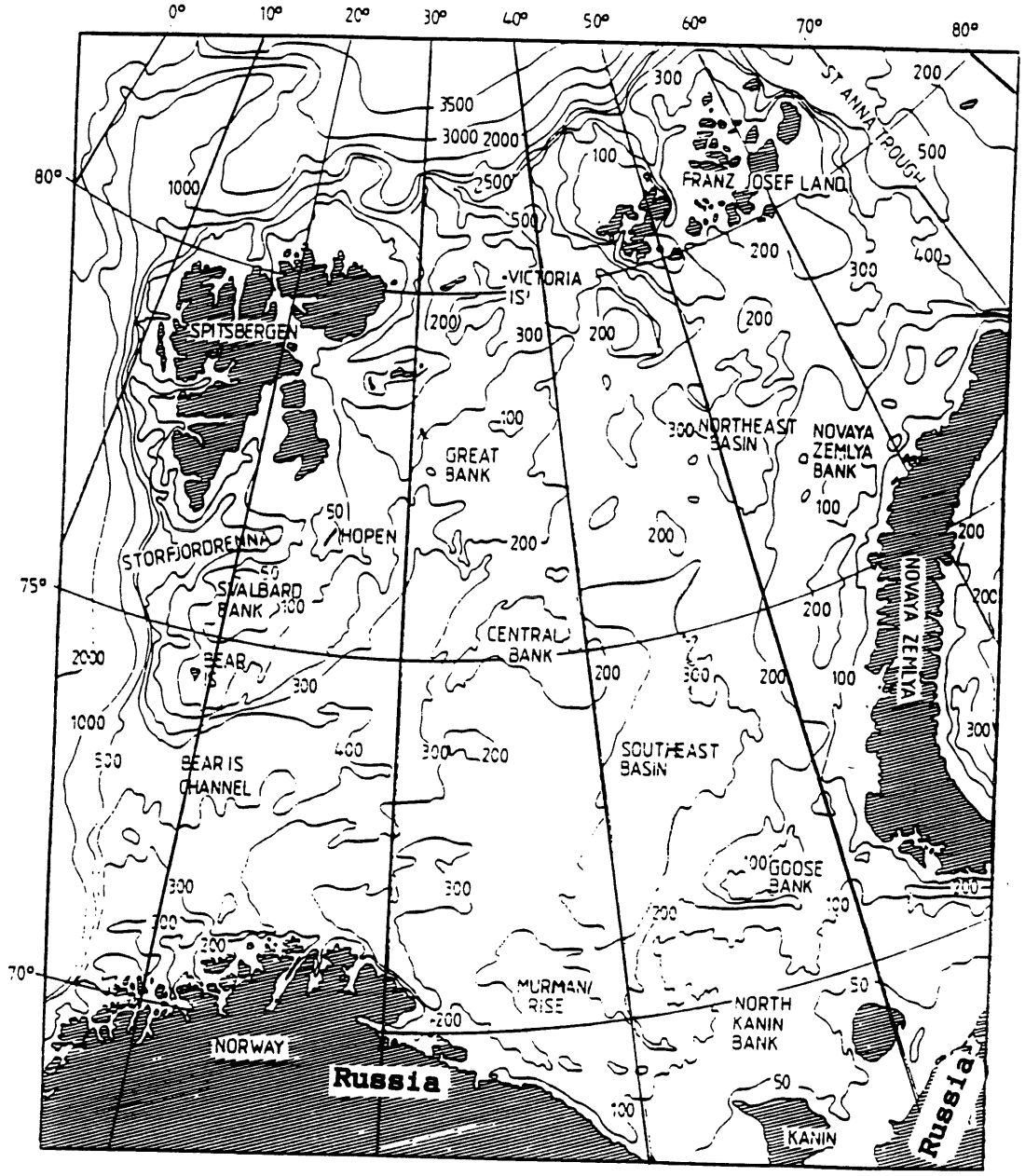


Fig. 1. Bathymetry of the Barents Sea (from Leong, 1989)

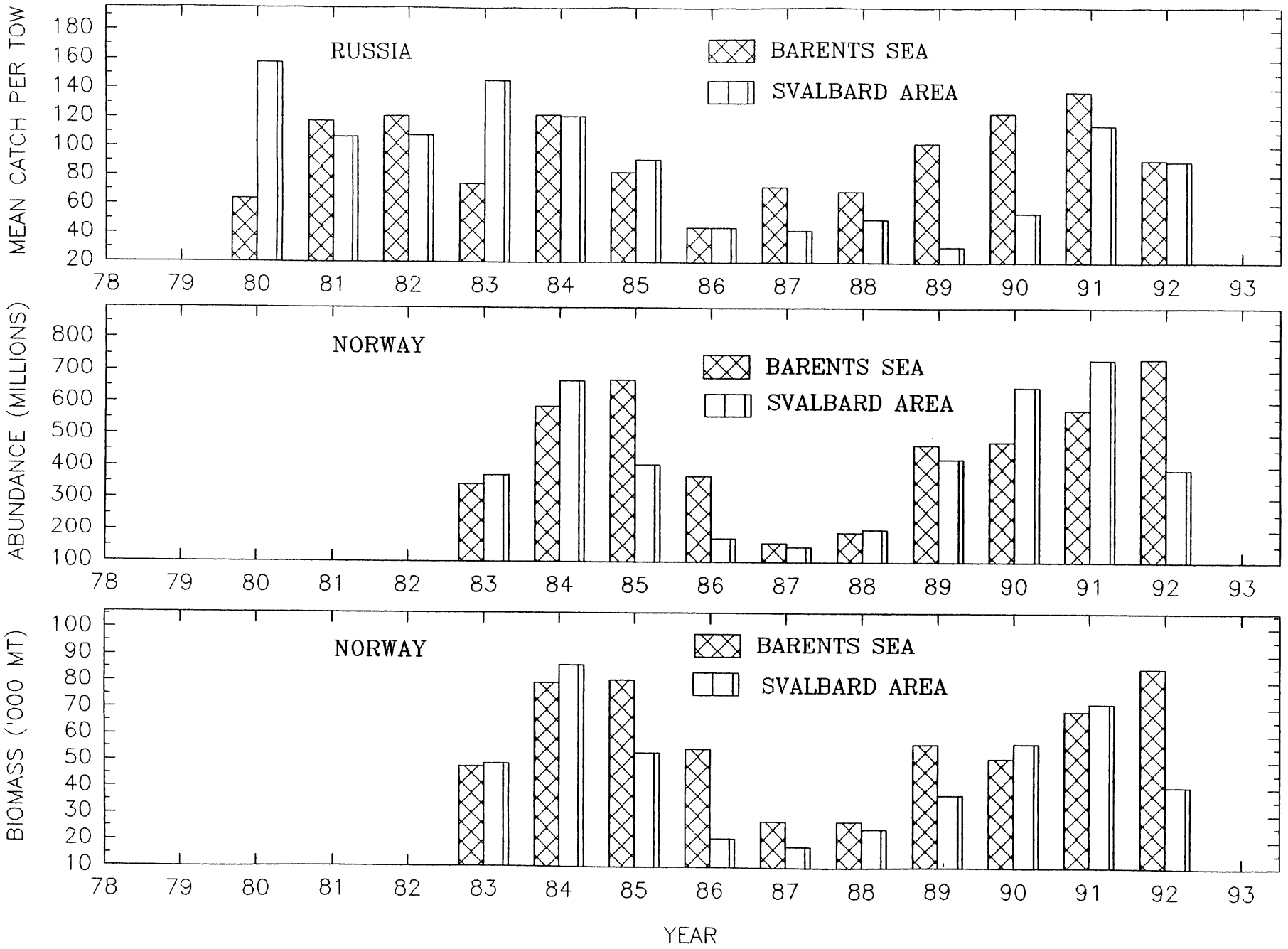


Fig. 2. Trends in abundance and biomass of long rough dab in the Barents Sea (ICES Subarea 1 and Div. IIa) and the Svalbard Area (ICES IIb) from Russian and Norwegian surveys.

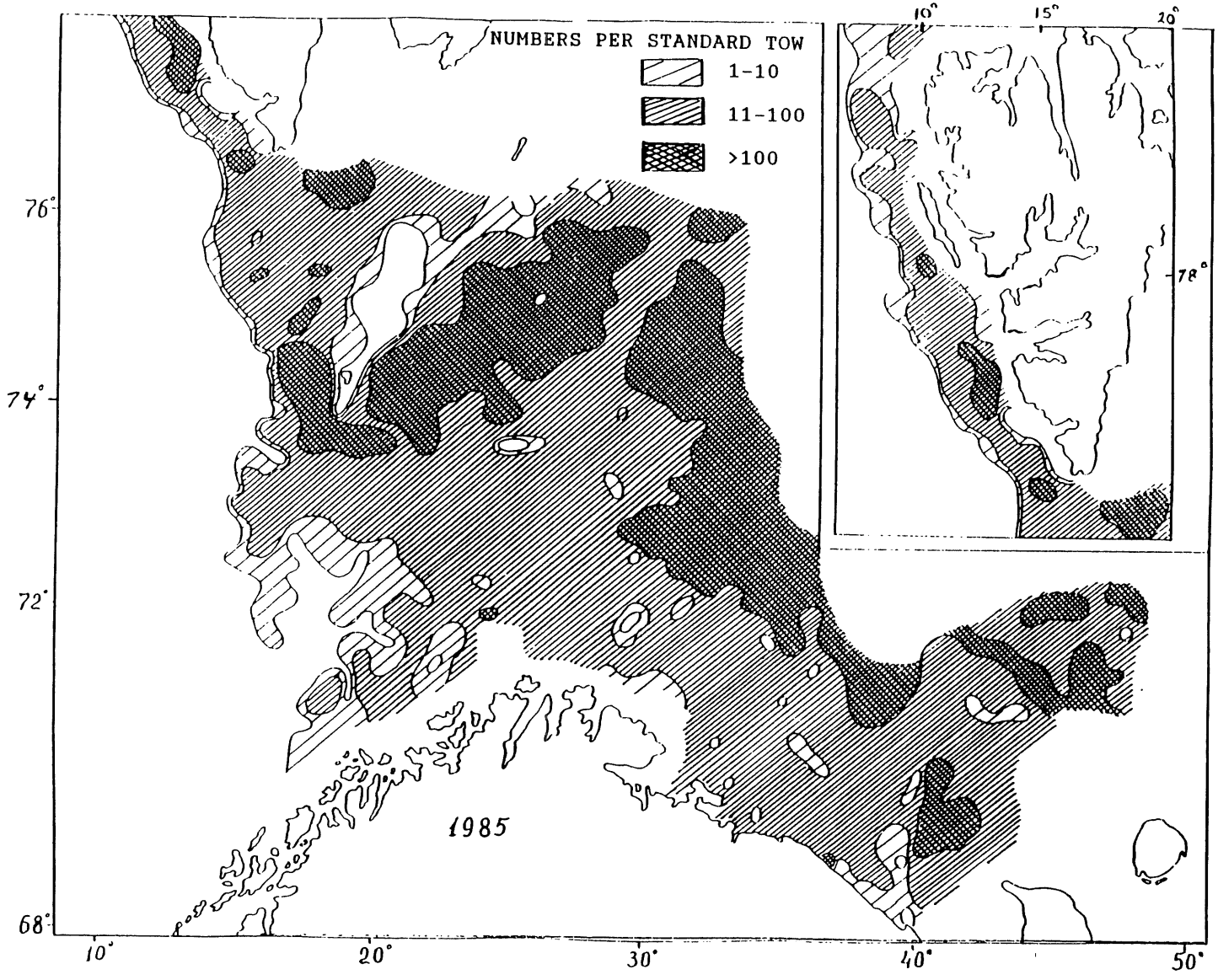
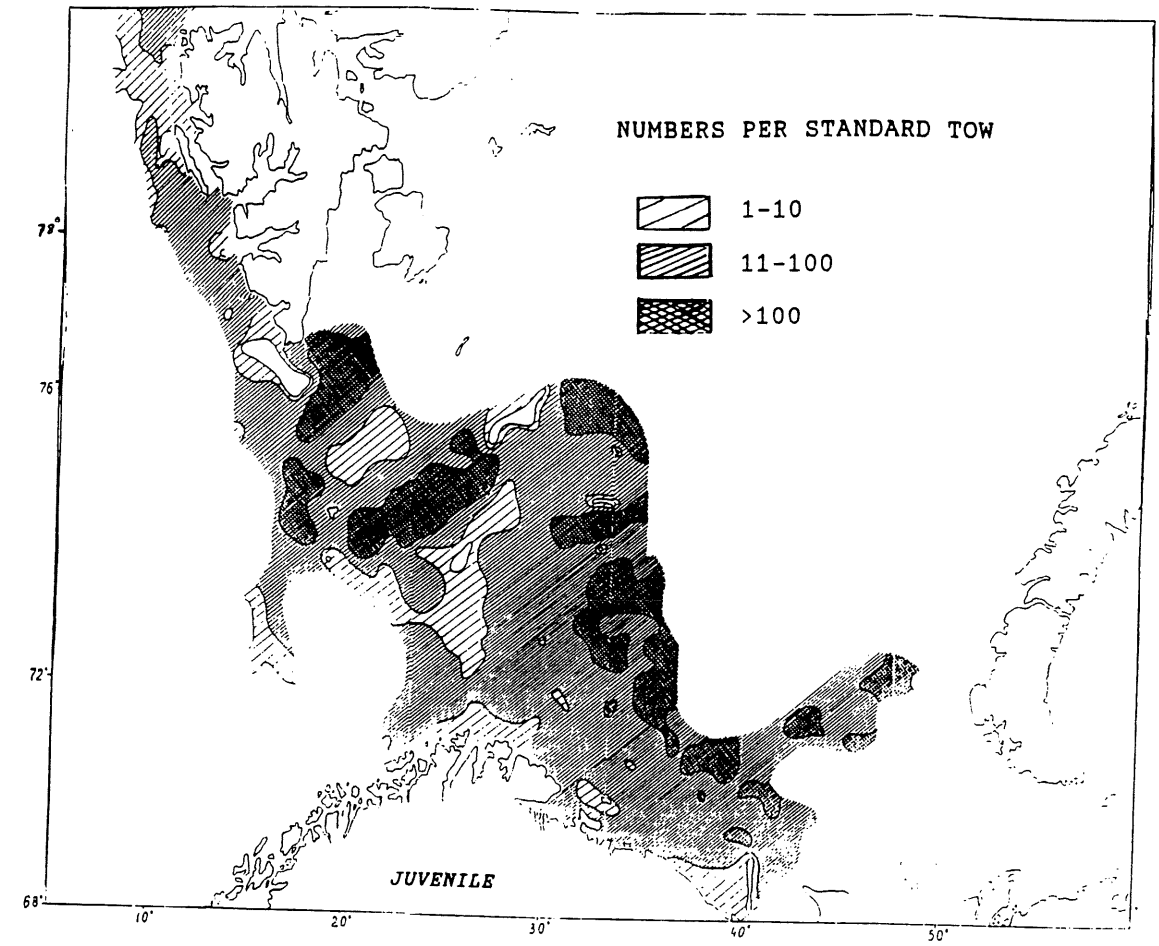


Fig.3. Distribution of long rough dab in the 1985 Russian research survey of the Barents Sea.



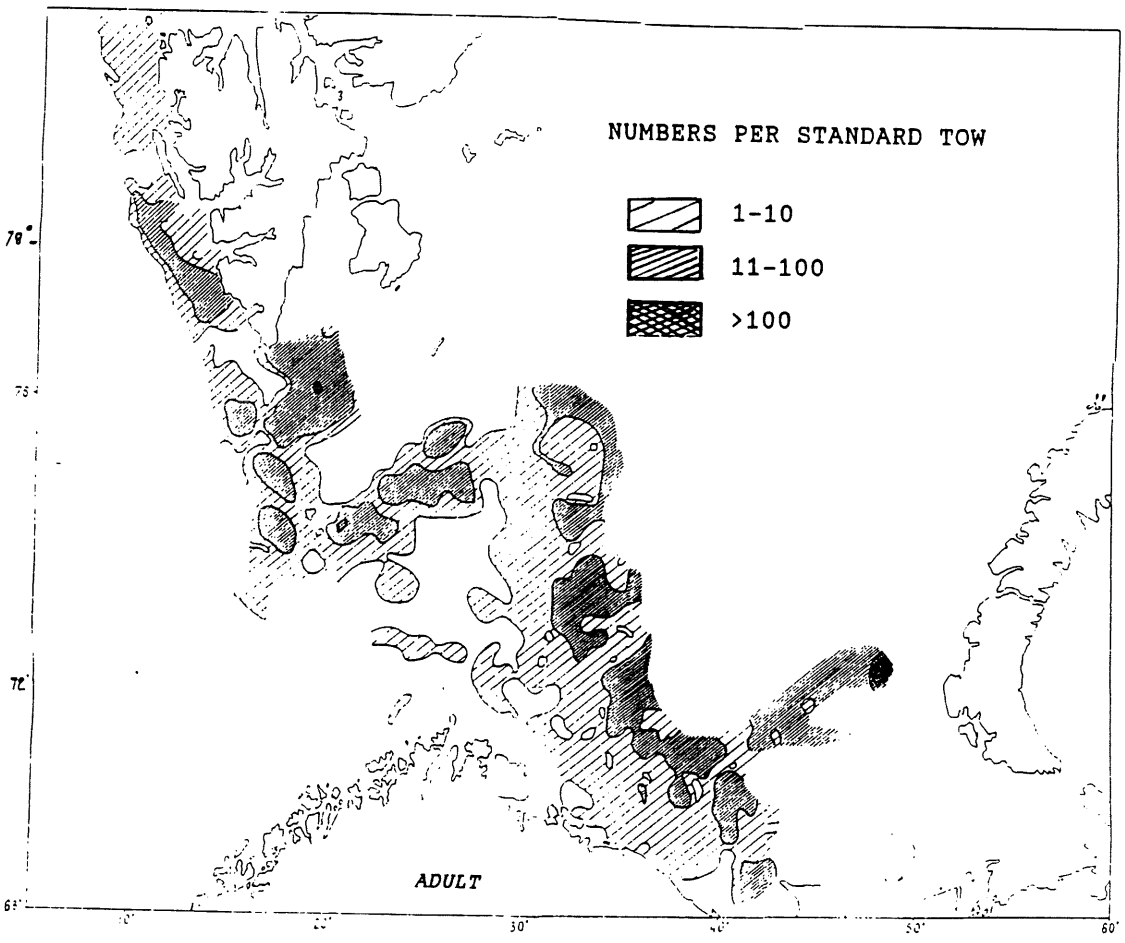


Fig. 4. Distribution of juvenile (<21 cm) and adult (>20 cm) long rough dab in the 1992 Russian research vessel survey of the Barents Sea.

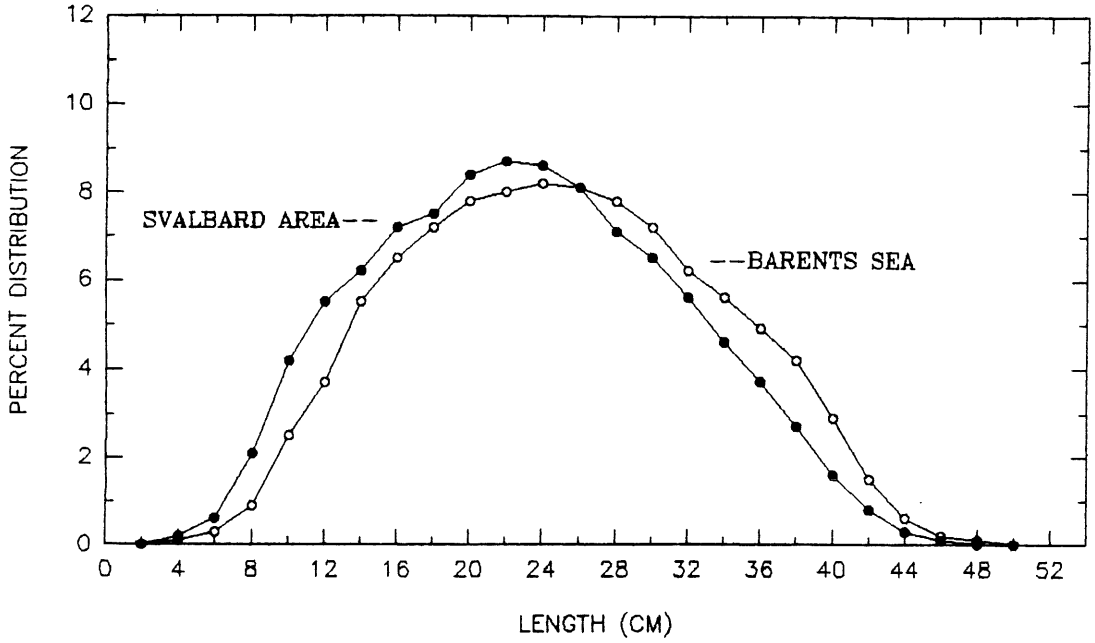


Fig.5 Length frequency distribution of long rough dab from Norwegian surveys,1983–87.

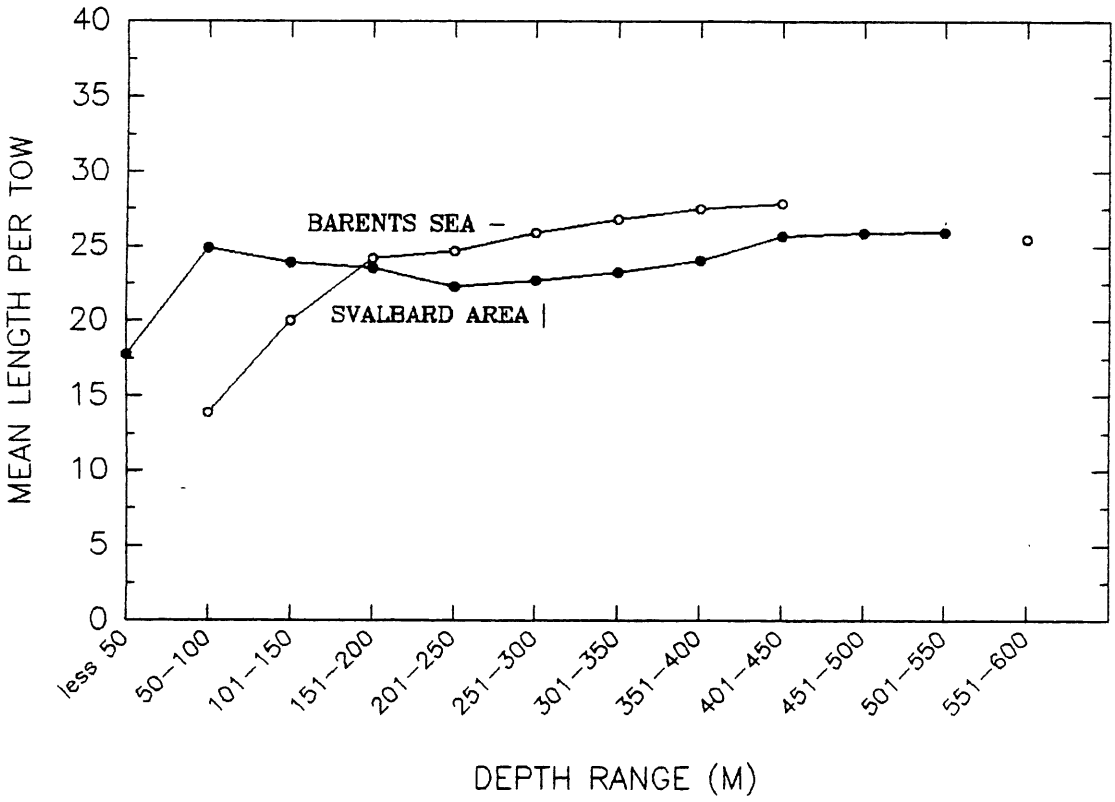


Fig. 6. Mean length of long rough dab per standard tow by depth range from Norwegian surveys, 1983–87.

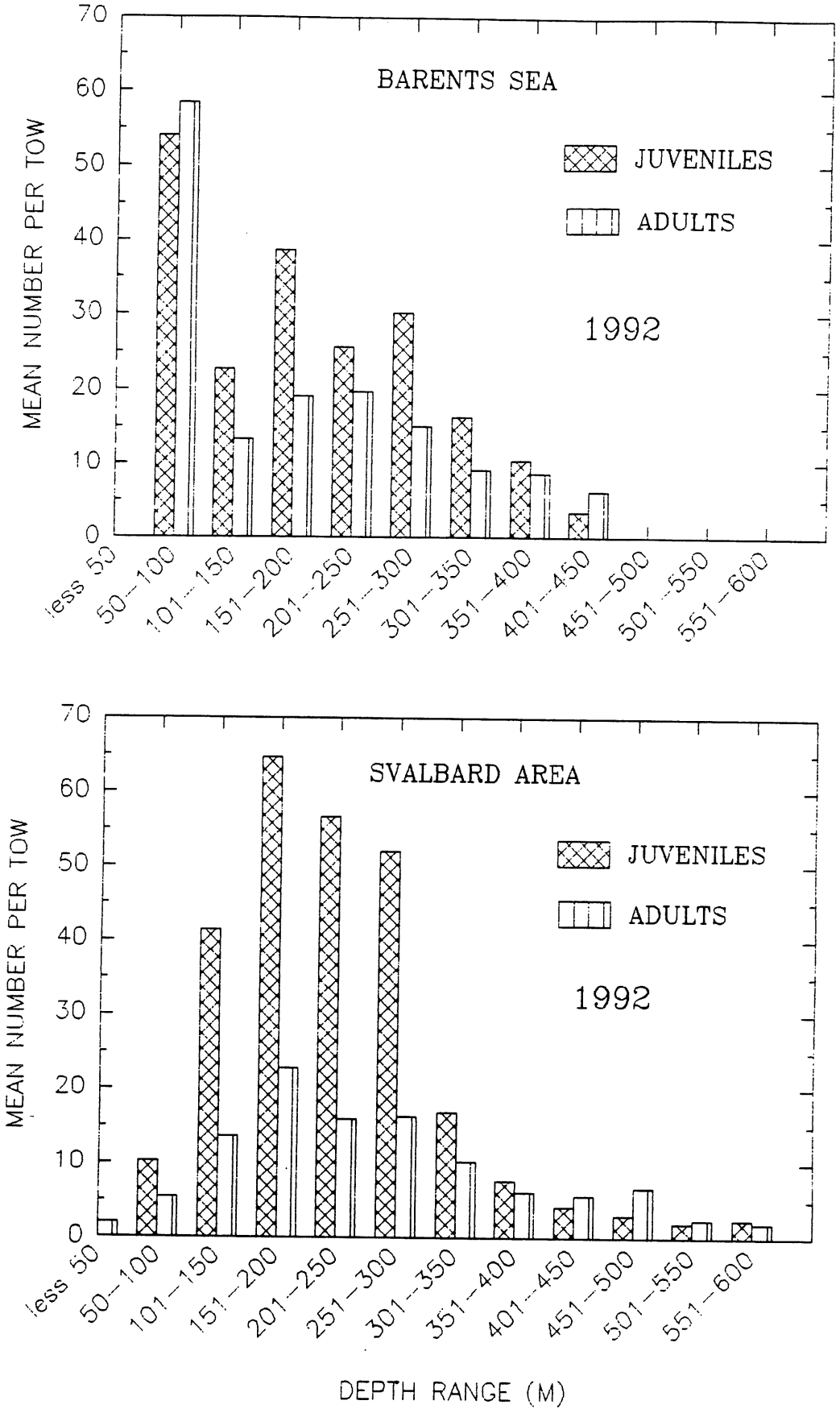


Fig. 7. Distribution of juvenile (<21cm) and adult (>= 21cm) long rough dab by depth interval from the 1992 Norwegian survey of the Barents Sea and Svalbard Area.

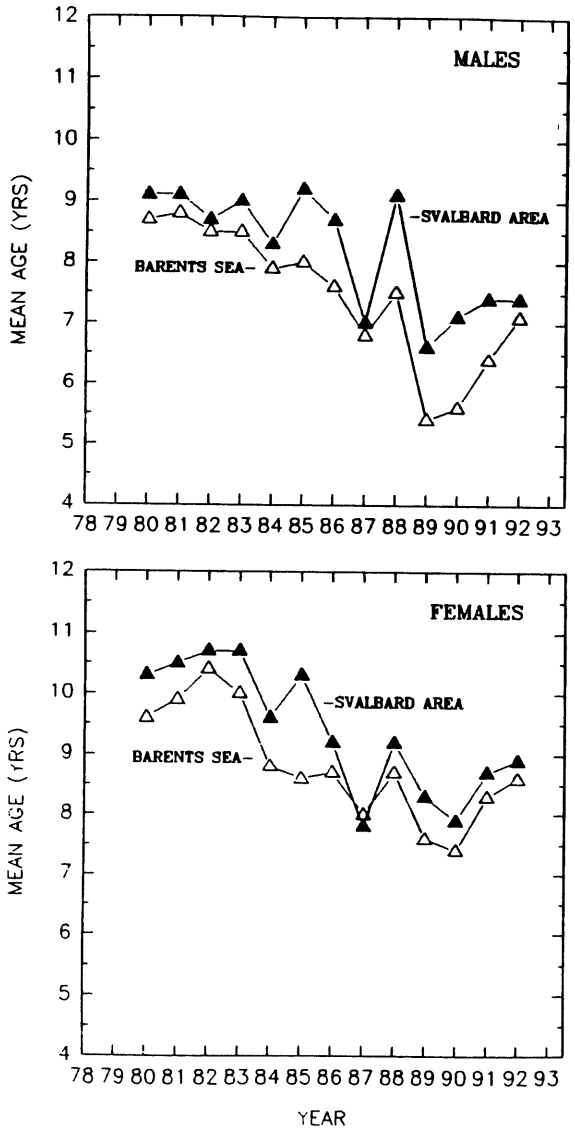


Fig. 8 Changes in mean age of long rough dab derived from Russian surveys of the Barents Sea and the Svalbard Area, 1980–92.

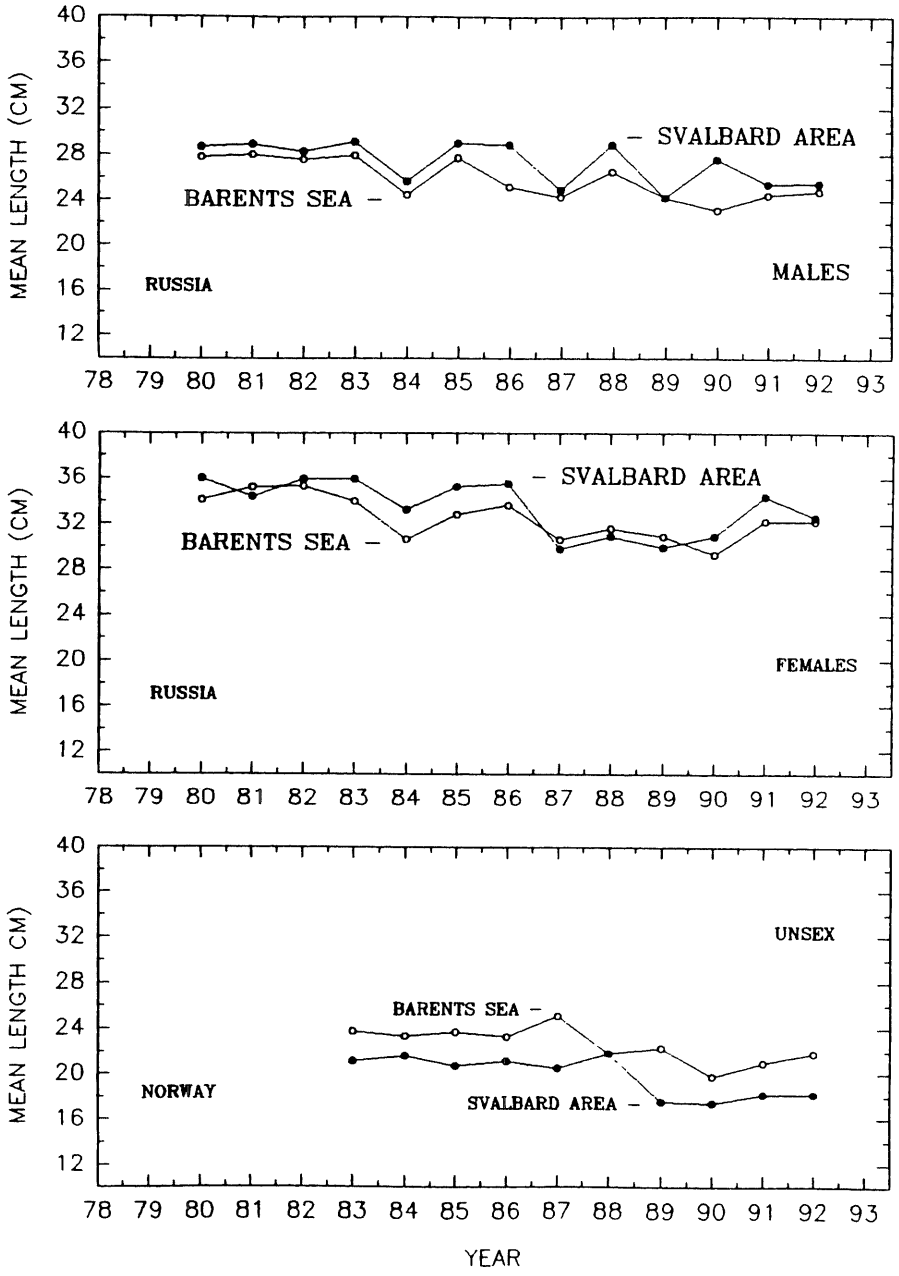


Fig. 9 Changes in mean length of long rough dab derived from Russian (1980–) and Norwegian (1983–92) surveys of the Barents Sea and the Svalbard Area.