2005 ICES Annual Science Conference

Elasmobranch Fisheries Science (Session N) CM 2005/ N:11

Skates in the Barents Sea: stock status and catch by fishing fleet

by

Konstantin V. Drevetnyak, A.V. Dolgov, K.M. Sokolov, E.V. Gusev, and A.A. Grekov

Abstract

Annual trawl surveys conducted by Polar Research Institute of Marine Fisheries and Oceanography (PINRO) in the Barents Sea during 1998-2003 have been used for estimation of abundance and biomass of the five species of skates (Thorny skate, *Amblyraja radiata*; Arctic skate, *Amblyraja hyperborea*; round skate, *Rajella fyllae*; blue skate, *Dipturus batis*; spinytail skate, *Bathyraja spinicauda*). The paper presents estimation of total skate catch during international trawl and long-line fishery for demersal fish in the Barents Sea and adjacent waters. The estimation was based on a method used at PINRO to determine catch of demersal fish taken as bycatch. Initial data to estimate total catch of skates in the study area were official international landings of demersal fish and database on species composition of catches gathered by Russian research observers onboard fishing vessels. The estimated catch of skates showed to be much higher than the official landings, which indicated that a large proportion of the skate catch was not used for production but discarded back to the sea.

Keywords: abundance, Barents Sea, biomass, discards, landings, skates, survey.

Contact author:
Konstantin V. Dreventyak: Knipovich Polar Research Institute of Marine Fisheries and Oceanography (PINRO), 6 Knipovich Street, Murmansk, 183763, Russia [tel: +7 (8152) 47 22 31, fax: +7 (8152) 47 33 31, e-mail: drevko@pinro.ru].

Introduction

Seven species of skate (Rajidae) are listed for the Barents Sea; thorny skate, *Amblyraja radiata*, Arctic skate, *Amblyraja hyperborea*, round skate, *Rajella fyllae*, blue skate, *Dipturus batis*, spinytail skate, *Bathyraja spinicauda*, long-nosed skate, *Dipturus oxyrhynchus*, and shagreen ray, *Leucoraja fullonica* (Andriyashev, 1954). The first five species are the most common.

Elasmobranch populations around the world are mostly caught as a by catch of the world's fisheries targeting teleost species. Skate by-catch is often not recorded (Bonfil, 1994), or where it is recorded, the species composition is unknown. Unfortunately, this is also a case in the Barents Sea. Skates are taken as by-catch during fisheries for cod, haddock, saithe, Greenland halibut, plaice and redfish. Since the fishing is conducted on large scale and all the year round, the catch of skates appears to be significant. The fishermen are not interested in processing of skates due to low prices for skate products and limited marked demands. Therefore, almost all skates are discarded. No doubt that after sorting of the catch, that requires quite a long time, the skates are discarded in non-viable condition. Besides the actual size of skates by-catch often remains unregistered in the fishing documentation or catch of one species is registered as another species. It leads to a significant underestimation of catches of skates in official statistics and therefore to underestimation of fisheries effect of these species.

Material and Methods

Data for estimation of abundance and biomass of skates were collected from annual surveys in 1997-2003 conducted by PINRO in the Barents Sea from October to December. Standard research bottom trawl (type 2283, 25x8 m opening) with codend lined with 16 mm mesh net was used as a sampling gear. Duration of trawling was usually 1 hour. More details are described by Shevelev et al. (1990). Total length from the snout to the endpoint of the caudal fin was measured to the nearest 1 cm, sex identified and, in some cases, fish were weighted and biological analysis was undertaken.

The abundance of skates was estimated by applying the area method. To do this the average catch of skates of each species in 5 cm length interval and for each fishing area (Map of fishing areas in the Barents Sea, 1957) was estimated and then multiplied by the area of a given fishing area. For calculation purposes, the fishing efficiency for all skate species and size groups was assumed as 0.1. As there were no specific studies to determine the fishing efficiency of trawls for skates, the fishing efficiency was for other fish species, usually such as flatfish similar in body shape and behaviour to skates, was applied. For instance, Konstantinov (1977) assumed the fishing efficiency as 0.5. Vinther and Sparholt (1988) used the fishing efficiency estimated for plaice. However, they noted that only 1.33% of the total biomass of thorny skate was fished. According to T. B. Nikiforova and L. I. Serebrov (PINRO, unpublished data), on the basis of underwater observations the fishing efficiency for thorny skate by research trawl was established to be 5 times less than for long rough dab for which the fishing efficiency was, on the average, about 0.2. The total abundance of a species was determined as a sum of estimates for each individual fishing area.

Biomass was estimated as a sum of abundance of fish in each 5 cm length interval and mean weight of fish for this length group. Data on the mean weight of skates was provided by surveys data.

Since the survey area slightly differed between years, to derive comparable estimates of abundance and biomass, only selected locations, which had been covered by all surveys, were used. The total area surveyed was approximately 200 000 miles^2.

The actual Russian catch of skates in the Barents Sea was estimated applying the correction method for official catch data on fish species taken as by-catch in Russian fisheries for cod and haddock (Shevelev, Sokolov, 1997; Sokolov, Gusev, Drevetnyak, 2004). It was necessary due to large-scale fishery of these two demersal species since fishing is conducted all the year round and in the whole Barents Sea area. The major part of other demersal fish including skates taken as by-catch occurs in the fisheries for these fish species.

The data on species composition in catches collected by PINRO observers onboard fishing vessels is a basis for correction of catch of skates. Since 1996 our observers have covered the major part of fishing areas where Russian vessels operated. The calculations of actual catch of demersal fish taken as by-catch in Russian fisheries for cod and haddock have been carried out annually since 1996. Every year PINRO scientists take 3 500 – 6 000 samples of species composition in catches of fishing vessels before processing.

The catches are registered in catch documentation onboard factory trawlers by a responsible person (captain or navigator on duty) when the catch is processed. However, the fishermen register in catch documentation only main commercial fish species that are almost fully processed and some other high valued species taken as by-catch and further processed onboard. The catch of major part of fish that occur in by-catches is not registered in the catch documentation. PINRO observers make a precise estimation of species composition in catches by working with catches before sorting and processing.

The algorithm of corrected catch of skates by Russian fishing fleet can be described as follows. At the first stage, the data on catches collected by PINRO observers is used to estimate the proportion of a skate species in by-catch to cod or haddock that are main fish targeted by fishing vessels in the Barents Sea. For 1996-2003 this proportion was estimated separately for each year and ICES Divisions. Then, we assume that catch of cod and haddock in official catch statistics is estimated correctly and data on species composition in catches collected by PINRO observers corresponds to those provided by fishing fleet are generally identical and based on these assumptions we calculated the catch of skates.

International corrected catch of skates in 1996-2003 was estimated according to the following procedure. As mentioned above, we know the proportion of skates in Russian catches for each ICES division (I, IIa and IIb) and year in the period 1996-2003. Using this proportion of skates and international catch of cod and haddock for each year, the catch of skates by other countries except Russia for 1996-2003 was calculated.

Results

Estimated abundance of thorny skate over the period of research varied from 99 x 10^6 fish in 1997 to 167 x 10^6 fish in 1998, and averaged 142 x 10^6 fish and estimated biomass varied between 71 000 and 121 000 tons (average 98 090 tons). A decline in the abundance and biomass of practically all size groups of thorny skate from 1997 to 1999 should be noted, but the tendency of increasing of the abundance and biomass was observed in 2000-2003 (Fig. 1, 2).

Of the other skate species the most abundant were Arctic and round skate, with an average abundance of 2.4 x 10^6 and 2.6 x 10^6 fish, and an average biomass of 3 020 tons and 1 390 tons

respectively. The abundance of blue and spinytail skate was even less (0.55×10^6 and 0.73×10^6 fish), however, the biomass of blue skate was estimated at 2 920 tons due to the large size of fish, while the biomass of spinytail skate did not exceed 810 tons (Table 1).

Overall, thorny skate was the most plentiful of all skate species and constituted 95.8 % of catch in number and 92.3 % by weight.

According to official statistics in 1973-2003 the catch of skates in the Barents Sea and adjacent waters was approximately 34 500 tonnes. The major proportion of catch is taken by Russia (24 000 tonnes), Norway (5 500 tonnes), Germany (1 100 tonnes), France (610 tonnes) and UK (600 tonnes) (Table 2).

In 1973-2003 the minimum total catch of 224 tonnes was registered in 1974 and the maximum total catch of 4 637 tonnes occurred in 1987. In average the annual total catch of all skates was about 1 000 tonnes.

The major catch of skates by all countries was taken in ICES Division I, where annual catch of this fish is over 500 tonnes. The lowest catches of skates in 1973-2003 were registered in ICES Division IIb. The annual catch in this division made up to 200 tonnes (Table3).

The corrected catch of skates in 1996-2003 by Russia and other countries as well as corrected total catch of skates is given in Table 4.

According to our calculations in 1996-2003 Russia exposed in official catch data only 44 % of skates catch and other countries registered 28 % of skates catch. The official total catch in 1996-2003 was 37 %.

In 1996-2003 the Russian discards of skates was over 4 600 tonnes (annual average was over 570 tonnes) and by other countries it was over 4 800 tonnes (annual average was over 610 tonnes). All countries executing fisheries for demersal fish in the Barents Sea and adjacent waters in 1996-2003 did not registered in official catch statistics over 9 500 tonnes of skates (annual average was over 1 100 tonnes).

Using skate species composition in Russian catches, the quantity of corrected skates catches by species were estimated (Table 5). In 1996-2003, the major part of skates in catches was thorny skate (76 % of catches of all skates), the proportion of Arctic skate was 23 % and that of other three species (round skate, spinytail skate, blue skate) was about 1 %.

Discussion

Estimates derived by us for thorny skate and round skate stocks practically remained unchanged over the period of research (1997-2003), which apparently suggests that their distribution area was covered rather well by surveys, and these stocks are in stable condition. Estimates derived for the stock of thorny skate in 1990-1996 (Dolgov, 1997) differed several times (from 34 000 to 116 000 tons), because the area covered by surveys in different years was not the same. Estimates of stock size for other species of skate appeared to be less realistic and could not be used for comparison of abundance and biomass dynamics of various skate species. For Arctic skate this was related to incomplete coverage by the survey of its distribution area, since a fraction of this stock was distributed between Spitsbergen and Franz Josef Land (Smirnov *et al*., 2000). For round and spinytail skate, it was due to a too small number of individuals assessed by surveys. Besides, unlike the first three species (thorny, arctic and round skates), for which the Barents Sea is a spawning area (Berestovsky, 1994; our field observations), blue and spinytail

skates do not spawn in the Barents Sea at all or the extent of spawning is small and their stocks are sustained through migrations of fish from more southern areas.

The major catch of skates in the Barents Sea and adjacent waters according to both official statistics and corrected catch was taken by Russia. Taking into account the fact that Russian and Norway according to the decisions of the Joint Russian-Norwegian Fisheries Commission devide the TACs of cod and haddock by 50 % for each Party, it seams strange that skates dominate in catches of one of the Parties. But if we look at cod and haddock fishing areas of Russia and Norway, such disproportion in catch of skates can be quite comprehensible.

The major part of skates catch is thorny skate that mainly distribute in ICES Division I and IIb and to less extent occur in ICES Division IIa (Dolgov *et al.,* 2005). Russian conducts fishery for cod and haddock in the areas with highest concentration of skates (ICES Division I and IIb). Norway mainly execute fisheries in its economic zone, which id ICES Division IIa.

It should be emphasized that over the fishing history catch of skates in Barents Sea has been dependent on cod and haddock fishery (Fig. 3, 4). While catches of cod and haddock increase, the by-catches of skates decrease. This relationship can be explained by the fact that when catches of main target fish species increase the fishermen lose practically all interest to by-catch fish including skates. If we look at the price-list of Norges Råfisklags/Norwegian Raw Fish Organisation (http://www.rafisklaget.no) dated 20.12.2004 we can see skates as species are not specifies in this list. Fishermen can land skates only as industrial fish at price of 0.25 NOK per kg, while cod heads that are used for drying can be delivered at price of 0.4 NOK per kg.

Considering estimates of skates stocks and their catches, we can calculate the fishing level of these populations. Let's take thorny skate as example. The average size thorny skate stock in 1997-2003 was estimated as 98 000 tonnes (Table 1) and the catch of this species in 1996-2003 was estimated as 1 400 tonnes (Table 5). Therefore, the annual catch of thorny skate has been about 1.5 % and such current level of harvesting is unlikely to cause a decrease of thorny skate stock since it is significantly lower than natural mortality of this species (M=0.22) (Frisk *et al.,* 2005).

References cited

ANDRIYASHEV, A. P. 1954. Fishes of the Arctic seas of the USSR. Guide to identification of USSR fauna of the Zoological Institute of the USSR Academy of Science, Acad. Sci. Press, No. 53 M.; L., 566 p. (in Russian).

BERESTOVSKY, E.G. 1994.Reproductive biology of skates in the Arctic seas. J.Voprosy Ichthyologii, v. 34, No. 2: 212-218 (in Russian).

BONFIL, R. 1994. Overview of world elasmobranch fisheries. *FAO Fisheries Technical Paper*, 341. 119p.

DOLGOV, A.V. 1997. Distribution, abundance, biomass and feeding of thorny skate, Raja radiata, in the Barents Sea. ICES CM 1997/HH: 04, p. 1-21.

DOLGOV, A.V., DREVETNYAK, K.V., and E.V.GUSEV. 2005. The status of skate stocks in the Barents Sea. J. Northw. Atl. Fish. Sci.Vol.35.: 249-260.

FRISK, M.G., T.J.MILLER, and N.K. DULVY. 2005. Life histories and vulnerability to exploitation of elasmobranches: inferences from elasticity, perturbation and phylogenetic analyses. J. Northw. Atl. Fish. Sci.Vol.35.: 27-45.

KONSTANTINOV, K.G. 1977. Revealing of species composition, abundance, biomass, horizontal and vertical distribution of skates as valuable raw material for food and technical production. In: Proceedings of the symposium on biological productivity of the Atlantic ocean. Moscow, p. 54-64 (in Russian).

MAP OF FISHING AREAS OF THE BARENTS SEA. 1957. Trudy PINRO, Murmansk, Vyp. 10, p. 281 (in Russian).

SHEVELEV, M.S., A.F.DORCHENKOV, and V.S. MAMYLOV. 1990. Soviet investigations of cod, haddock and redfish in the Barents Sea and adjacent waters in 1989. ICES C.M. 1990/G:8, 22p.

SHEVEKEV M.S., Sokolov K.M. On actual catch of demersal fish taken as by-catch in trawl fisheries in the Barents Sea in 1993-1995 // Rybnoe Hozyaistvo. – 1997. No. 3. Pp. 38-40 (in Russian).

SMIRNOV, O.V., A.V.DOLGOV, V.V.GUZENKO, Yu.M.LEPESEVICH, and Yu.B.OZEROV. 2000. New data on ichthyofauna and hydrological regime of waters off the archipelagos Spitsbergen and Franz Josef Land. In. Proceedings of the Final Session of PINRO Scientific Council by the results of researches in 1998-1999 (Ed. G.I.Nesvetova), Part 1. Pp.79-92 (in Russian).

SOKOLOV K.M, Gusev E.V., Drevetnyak K.V., Is catch statistics is real? New approach to estimation of by-catches in demersal fisheries in the Barents Sea. Fishing resources. – 2004 No. 2(7). Pp. 30-32 (in Russian).

VINTHER, M., and H. SPARHOLT. 1988. The biomass of skates in the North Sea. ICES C.M. 1988/G:48: 26 p.

Table 1. Estimated abundance (x 10^6 fish) and biomass (x 10^3 t) of various skate species in the Barents Sea in 1997-2003

Species		Year							Average
		1997	1998	1999	2000	2001	2002	2003	
Thorny skate	Abundance	99.55	167.00	130.57	135.62	140.32	161.31	160.58	142.14
	Biomass	71.71	106.32	88.68	91.56	95.42	121.68	111.29	98.09
Round skate	Abundance	1.00	2.50	0.33	4.18	3.21	3.38	3.81	2.63
	Biomass	0.51	1.34	1.26	2.26	1.24	1.45	1.68	1.39
Arctic skate	Abundance	2.30	1.86	0.78	6.18	1.46	0.83	3.23	2.38
	Biomass	2.49	2.73	1.35	7.42	2.32	1.57	3.28	3.02
Blue skate	Abundance	-	1.41	0.30	0.75	0.27	0.34	0.23	0.55
	Biomass	-	1.25	3.99	2.64	5.17	1.58	2.91	2.92
Spinytail skate	Abundance	-	-	0.05	1.06	0.51	0.98	1.07	0.73
	Biomass	-	-	0.01	1.44	0.41	0.88	1.33	0.81
All skates	Abundance	172.77	132.03	147.79	145.77	166.84	168.92	168.92	148.43
	Biomass	111.64	95.29	105.32	104.56	127.16	120.49	120.49	106.23

Table 2.

Nominal catch of skates in Barents Sea and adjacent waters by countries (t) (ICES Fisheries Statistics 1973-2003, STATLANT Programme)

Year	Russia[1]	Norway	Germany[2]	United Kingdom[3]	France	Others	Total all countries
1973	-	201	-	145	-	-	346
1974	-	158	1	65	-	-	224
1975	-	89	52	64	-	101	306
1976	-	35	12	55	144	51	297
1977	-	102	59	163	108	42	474
1978	1428	86	114	19	61	1	1709
1979	267	134	84	14	2	3	504
1980	132	193	85	6	1	-	417
1981	3	139	53	-	12	-	207
1982	1	112	7	1	109	-	230
1983	-	97	2	-	2	28	129
1984	1100	160	112	5	6	-	1383
1985	880	115	124	1	5	17	1142
1986	3770	136	102	2	7	9	4026
1987	4285	228	95	8	21	-	4637
1988	3698	119	76	1	27	24	3945
1989	2102	152	32	2	8	-	2296
1990	908	434	104	2	28	84	1560
1991	-	240	-	-	11	-	251
1992	580	159	-	1	13	2	755
1993	502	315	-	-	9	23	849
1994	626	223	2	-	7	11	869
1995	-	248	-	1	8	10	267
1996	-	225	-	4	6	10	245
1997	476	172	-	-	8	32	688
1998	929	227	-	-	5	61	1222
1999	815	260	-	2	5	11	1093
2000	902	256	2	1	4	11	1176
2001	331	263	-	1	2	16	613
2002	211	144	2	3	-	18	378
2003	44	113	2	3	-	5	167
Всего	23990	5535	1122	569	619	570	32405
1973-2003	774	179	36	18	20	18	1045

[1] -1973-1991 USSR

[2] - 1973-1990 German Dem.Rep.+Fed.Rep.Germany

[3] – UK: Eng+Wales+N.Irl.+Scotland

Table 3.

Official catch of skates in the Barents Sea and adjacent waters by all countries in 1973-2003 by ICES Divisions in tonnes
(ICES Fisheries Statistics 1973-2003, STATLANT Programme)

Year	ICES Divisions			Total
	I	II a	II b	
1973	78	241	27	346
1974	46	170	8	224
1975	150	102	54	306
1976	129	114	54	297
1977	125	216	133	474
1978	1183	135	391	1709
1979	185	193	126	504
1980	99	265	53	417
1981	5	159	43	207
1982	4	222	4	230
1983	1	100	28	129
1984	573	190	620	1383
1985	630	232	280	1142
1986	2140	669	1217	4026
1987	2380	979	1278	4637
1988	2058	935	952	3945
1989	1239	800	257	2296
1990	494	846	220	1560
1991	5	215	31	251
1992	423	238	94	755
1993	420	382	47	849
1994	443	399	27	869
1995	16	204	47	267
1996	27	203	15	245
1997	403	206	79	688
1998	803	302	117	1222
1999	589	324	180	1093
2000	518	399	259	1176
2001	248	259	106	613
2002	199	134	45	378
2003	40	115	12	167
Total	15653	9948	6804	32405
1973-2003	505	321	219	1045

Table 4.

Official and corrected catch of all skates in the Barents Sea and adjacent waters by all countries in 1996-2003 by ICES Divisions (I, IIa and IIb) in tonnes

Year	Official catch by Russia	Corrected catch by Russia	Official catch by other countries	Corrected catch by other countries	Official total catch	Corrected total catch
1996	-	344	245	647	245	991
1997	476	844	212	692	688	1536
1998	929	1890	293	1352	1222	3242
1999	815	1665	278	1078	1093	2743
2000	902	1540	274	1111	1176	2651
2001	331	828	282	495	613	1323
2002	211	610	167	792	378	1402
2003	44	618	123	594	167	1212
Всего	3708	8339	1874	6761	5582	15100

Table 5.

Corrected catch of skates by species in the Barents Sea and adjacent waters by all countries in 1996-2003 by ICES Divisions (I, IIa, IIb), tonnes.

Year	Total	Thorny skate	Round skate	Arctic skate	Spinytail skate	Blue skate
1996	991	998	+	2	1	+
1997	1536	1370	+	166	+	+
1998	3242	2377	+	799	63	2
1999	2743	2503	+	163	+	77
2000	2651	1788	12	807	26	17
2001	1323	1022	1	298	+	2
2002	1402	739	3	655	4	+
2003	1212	649	2	549	5	8

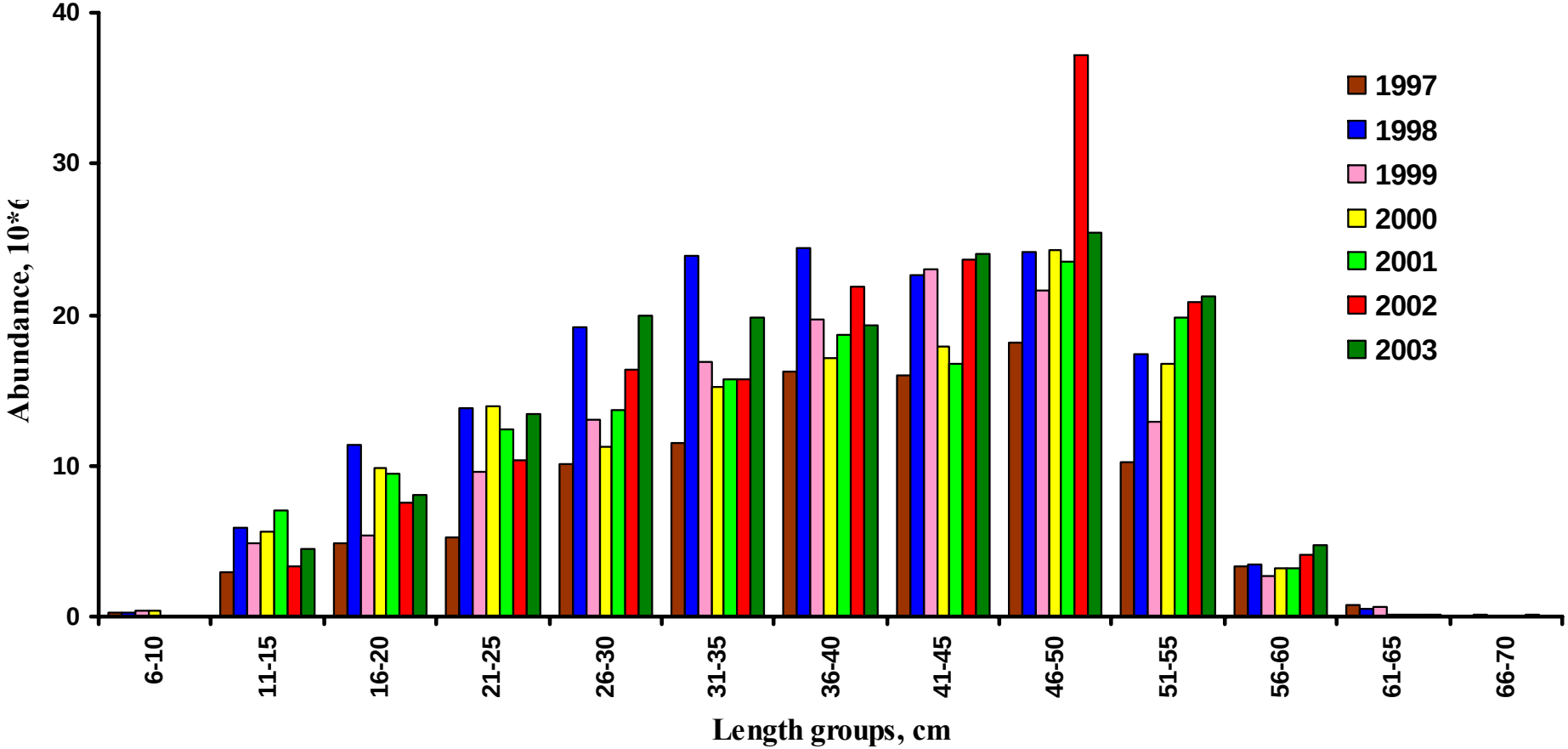

Fig. 1. Dynamics of abundance of thorny skate by size groups.

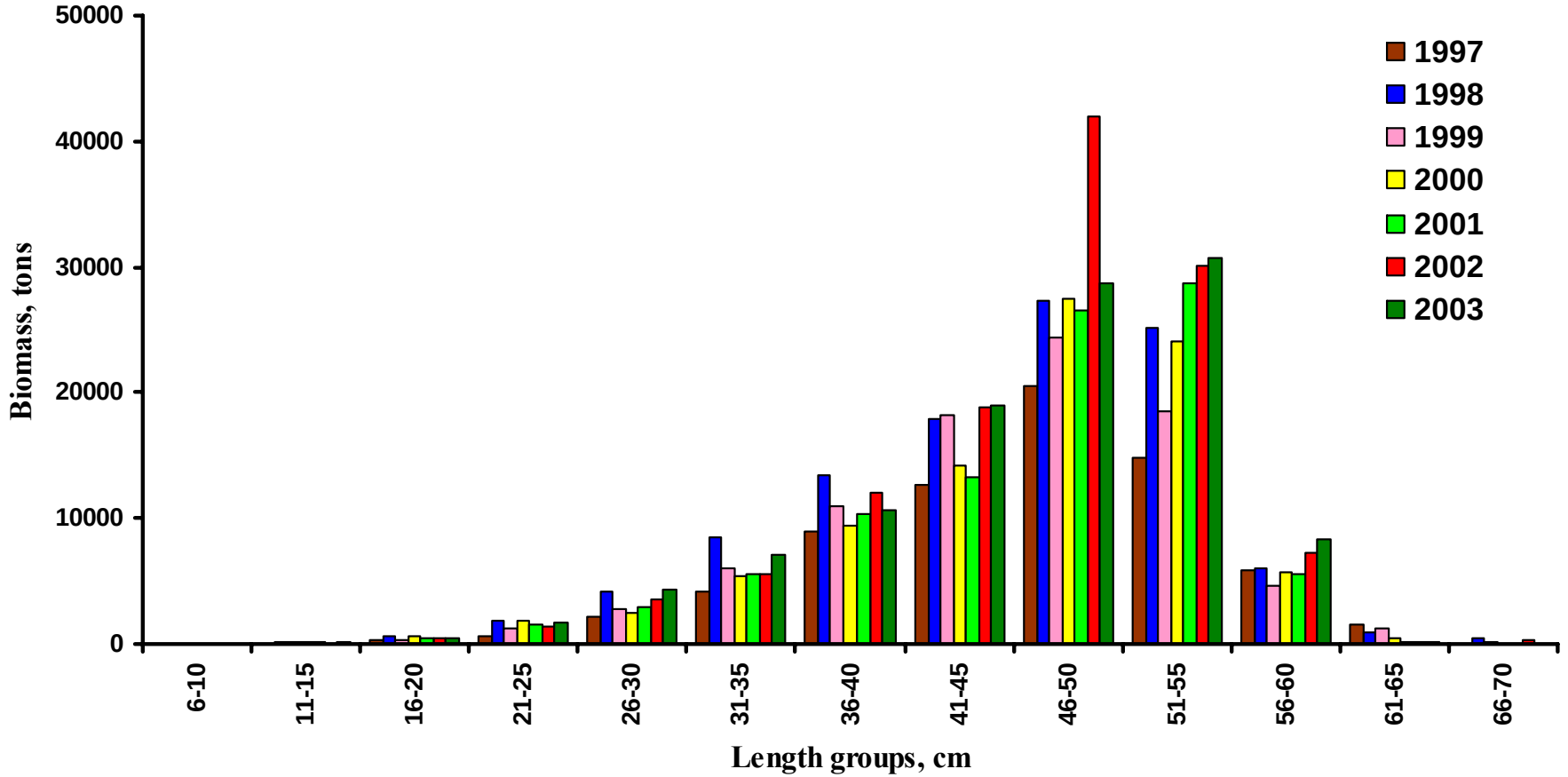

Fig. 2. Dynamics of biomass of thorny skate by size groups.

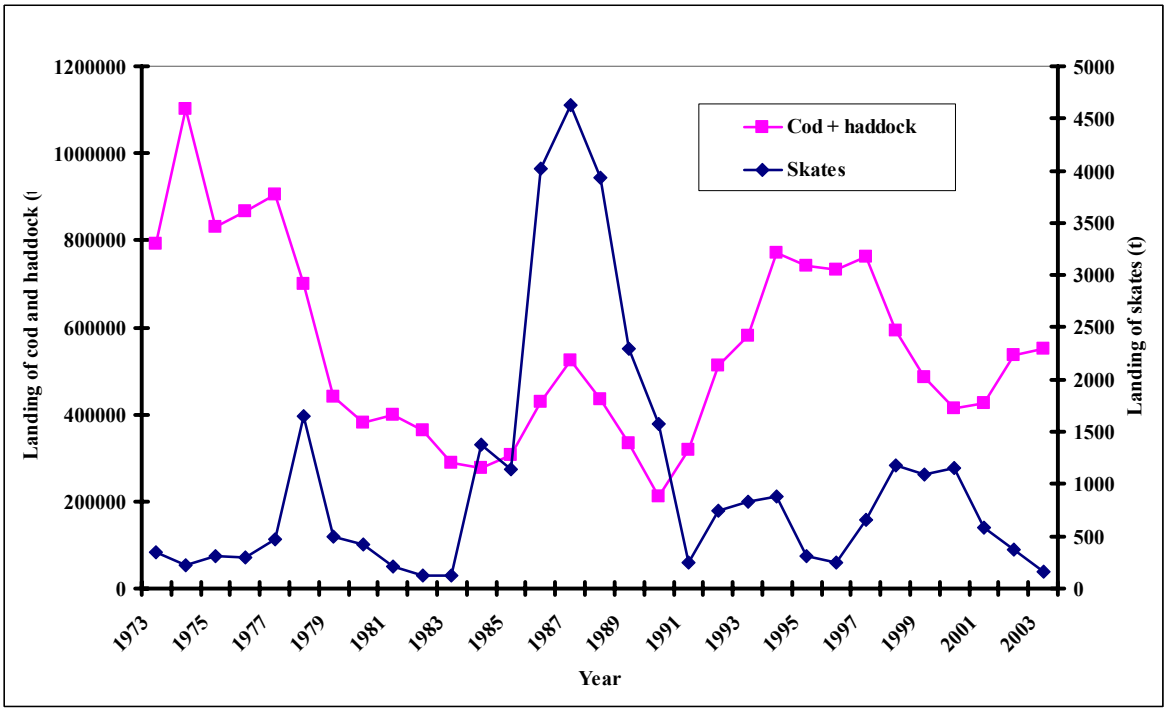

Fig. 3. Official landing of skates, cod and haddock, tonnes (ICES: I, IIa, IIb).

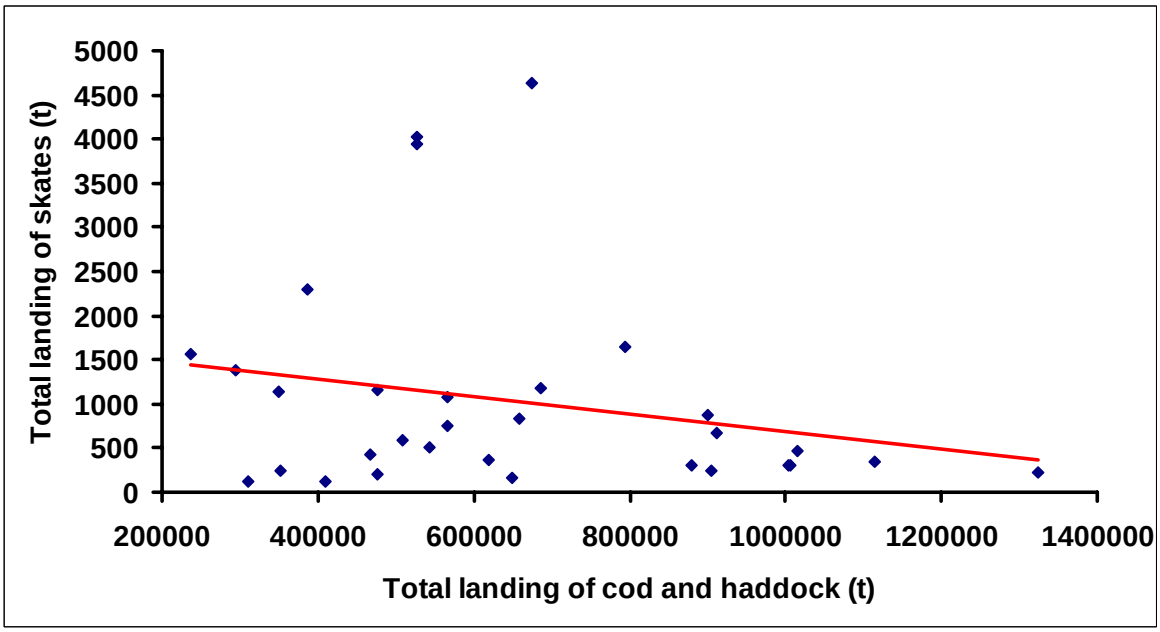

Fig. 4. Total landing of skates (t) plotted against total landing of cod and haddock (t) in 1973-2003 (ICES: I, IIa, IIb). Read line is trend.