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ANALYSIS OF CHANGES IN BIOMASS OF FISH STOCKS IN THE SOUTH GEORGIA AREA IN 1976/77-1986/87

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Abstract

The swept area method was used to estimate biomass density changes in the stocks of five fish species (Champsocephalus gunnari, Chaenocephalus aceratus, Pseudochaenichthys georgianus, Notothenia gibberifrons and Notothenia rossii marmorata) in the South Georgia area in the seasons 1976/77-1986/87. In most of the seasons analysed, the estimates covered a near-bottom layer in about 1/6 of the area of the island shelf.

Assessment results point to considerable variations in fish biomass density, in the studied period. Estimates of fish stocks biomass ranged from 43 to 158 thousand tons. The changes in the biomass level are first of all a result of periodical fluctuations in the biomass density of C. gunnari stock. High biomass density appeared with 2-4 year intervals after recruiting an abundant year-class to the exploited stock. The biomass of other bottom species is more stable, especially in the case of N. gibberifrons. Recently, an increase in the C. aceratus stock has been observed and, at the same time, there has been a gradual decline in the P. georgianus stock.

Résumé

La méthode de l'aire balayée a été utilisée pour estimer les changements de densité de la biomasse dans les stocks de cinq espèces de poissons (Champsocephalus gunnari, Chaenocephalus aceratus, Pseudochaenichthys georgianus, Notothenia gibberifrons et Notothenia rossii marmorata) dans la zone de la Géorgie du Sud au cours des saisons 1976/77-1986/87. Dans la plupart des saisons analysées, les estimations portaient sur une couche proche du fond et couvraient environ 1/6 de la superficie du plateau de l'île.

Les résultats d'évaluation indiquent des variations considérables dans la densité de la biomasse ichtyologique pour la période étudiée. Les estimations de la biomasse des stocks ichtyologiques variaient de 43 000 à 158 000 tonnes. Ces variations sont tout d'abord le résultat de fluctuations périodiques dans la densité de la biomasse du stock de C. gunnari. Une forte densité de la biomasse est apparue à des intervalles de 2-4 ans après le recrutement d'une abondante classe d'âge dans le stock exploité. La biomasse des autres espèces de fond est plus stable, surtout dans le cas de N. gibberifrons. Une augmentation du stock de C. aceratus a récemment été remarquée alors que le stock de P. georgianus a connu une baisse graduelle.

Resumen

Se usó el método del área barrida para estimar los cambios en la densidad de la biomasa en las reservas de cinco especies de peces (Champsocephalus gunnari, Chaenocephalus aceratus, Pseudochaenichthys georgianus, Notothenia gibberifrons y Notothenia rossii marmorata) en el área de Georgia del Sur en las temporadas de 1976/77-1986/87. En la mayor parte de las temporadas analizadas, las estimaciones cubrieron una capa cercana al fondo en alrededor de 1/6 del área de la plataforma de la isla.

Los resultados de la evaluación apuntan a considerables variaciones en la densidad de la biomasa de los peces en el período estudiado. Las estimaciones de la biomasa de las reservas de peces variaron de 43 a 158 miles de toneladas. Los cambios en el nivel de la biomasa son ante todo el resultado de las fluctuaciones periódicas en la densidad de la biomasa de la reserva de C. gunnari. Una alta densidad de biomasa apareció con intervalos de 2-4 años luego de restablecer una abundante clase-año a la reserva explotada. La biomasa de las otras especies de fondo es más estable, especialmente en el caso de N. gibberifrons. Recientemente se ha observado un aumento en la reserva de C. aceratus y, al mismo tiempo, ha habido una gradual declinación en la reserva de P. georgianus.

Резюме

Для оценки изменений в плотности биомассы запасов пяти видов рыбы (Champsocephalus gunnari, Chaenocephalus aceratus, Pseudochaenichthys georgianus, Notothenia gibberifrons и Notothenia rossii marmorata) в районе Южной Георгии в сезоны 1976/77-1986/87 гг. использовался метод протраленных площадей. В течение большинства проанализированных сезонов проведенная оценка охватывала придонный слой примерно на 1/6 площади островного шельфа.

Результаты оценки указывают на существенные вариации в величине плотности биомассы рыбы в рассматриваемый период. Оценки биомассы рыбных запасов варьировались от 43 до 158 тысяч тонн. Изменения величины биомассы являются в первую очередь результатом периодических флуктуаций в

плотности биомассы запаса <u>C. gunnari</u>. Высокая плотность биомассы возникала с интервалом в 2-4 года после вхождения многочисленного годового класса в промысловый запас. Величина биомассы других придонных видов более постоянна, особенно в случае <u>N. gibberifrons</u>. Недавно наблюдалось увеличение запаса <u>C. aceratus</u>, и в то же время происходило постепенное сокращение запаса <u>P. georgianus</u>.

ANAYLSIS OF CHANGES IN BIOMASS OF FISH STOCKS IN THE SOUTH GEORGIA AREA IN 1976/77-1986/87

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1. INTRODUCTION

Beginning with the second half of seventies, a number of biomass estimates of fish in the Antarctic appeared in print. Three independent methods of calculation may be generally distinguished : (1) based on annual production of fish biomass in a selected area (Everson 1977) as well as on annual consumption of fish by Antarctic birds and mammals (Laws 1977), (2) based on swept area (Hureau 1979; Kock 1981, 1985; Mucha 1982; Ślósarczyk et al. 1985) and (3) based on Virtual Population Analysis (Anon. 1985, 1986). The swept area methods, widely-used, especially on fishing grounds exploited by the fishery, yield acceptable biomass estimates (Kock, Duhamel and Hureau 1985). This method was used to estimate the biomass of five species of fish caught by the Polish fishery in selected subdivisions of the South Georgia shelf in the 1976/77-1986/87 seasons. The present study is a follow-up to an earlier paper by Ślósarczyk et al. (1985) and, at the same time, offers a repeated analysis of these investigations from the 1976/77-1986/87 period. The authors' objective was to examine the changes in the stocks of fish inhabiting the near-bottom zone located in five statistical subdivisions (56, 57, 60-62 acc. to Everson 1984), exploited regularly by the Polish fishery, in the 11 years of observations (Figure 1).

2. MATERIAL AND METHOD

The biomass estimates of fish stocks in the 1983/84-1986/87 period were prepared, just like in the earlier period, on the basis of data collected by observers from the Sea Fisheries Institute on board the trawlers Taurus (1983/84 and 1984/85) and Carina (1985/86) as well as the analysis of fishing logs of the F.V. Manta (1986/87), supplemented by observations from R.V. Professor Siedlecki (1986/87) (Table I).

Due to the fact that the results of sample hauls of our research vessel are available for only two fishing seasons (1978/79 and 1986/87), only catch results of fishing vessels were used here. On the one hand, this reduces the range of possible conclusions from calculations based on such material, on the other it enables a comparison of changes in the size and structure of fish biomass in eight out of eleven fishing seasons in the period studied. Catch results of the research vessel Professor Siedlecki could not be used in this analysis because of distinctly lower CPUE's attained by this vessel as compared with a standard trawler of similar tonnage, engine power and trawl dimensions. This was especially visible in the 1986/87 season, when catch results of a trawler were much higher although both vessels fished at the same time and on the same fishing grounds. It was partly a result of the more extensive fishing experience of the trawler's master and a better knowledge of the local fishing grounds.

Fish stock biomass was estimated in three depth zones : 50-150, 150-250 and 250-500 m. Mean relative biomass density was calculated without additional density stratification, for each depth zone, separately in each statistical subdivision. This means that in comparison with our earlier estimates (Mucha 1982; Ślósarczyk et al 1985) our assumptions were more cautious when estimating the biomass, which was calculated only for those depth zones within the subdivisions, for which CPUE was known; the results were not extrapolated for a wider comparable area of the shelf. In most of the seasons analysed, the estimates covered about 1/6 of the area (6.3 thousand km^2) of the whole shelf of the island, where the majority of fishing grounds traditionally exploited by Polish fishermen are located and from which the results of our long-term observations come (Figure 1). Only results of catches made with a bottom trawl, a length of headline of 32 or 36 m and a horizontal opening of 17.5 or 24 m were used in the calculations (Table I). Hauls made with a midwater trawl, even towed near the bottom, were disregarded, since estimates based on those data are not comparable with the calculations based on bottom trawl hauls (Ślósarczyk et al. 1985, Annex 1). Because detailed published information about the catching efficiency of the bottom trawls is not available, a catchability coefficient of C = 1 was assumed.

3. RESULTS AND DISCUSSION

There has been a number of attempts to estimate the biomass of fish stocks off South Georgia with the swept area method (Anon. 1980; Kock 1981, 1985; Mucha 1982; Ślósarczyk et al. 1985). These estimates are in most cases incomparable with each other because of some differences in method used, the kind of information serving as the basis of calculations (research or commercial fishery catches) as well as differences in the interpretation of the results obtained. The present study attempts to evaluate the extent of changes in the size of fish stocks off South Georgia, calculated by the swept area method in the past eleven years, on the basis of homogeneous data coming from one type of vessel, one type of gear and one method of fishing.

According to our estimates, the size of the biomass of fish in the near bottom water layer of the South Georgia shelf, in the depth zone of 50-500 m, in subdivisions 56, 57, 60-62 fluctuated in 1977-1987 period from 43 to 158 thousand tons (Table II, Figure 2).

In the seasons of 1978/79, 1979/80 and 1982/83, from which information for calculations was not available, the size of the biomass could have been lower or higher than the range of values given above, judging by the level of total catches of fish on the South Georgia grounds (Anon. 1986). Our previous estimates of fish biomass from that area (Ślósarczyk et al. 1985) also exceed the 43-158 thousand tons range. This is a result of the fact that those estimates were based on a larger shelf area (over 12 thousand km^2) as well as a different extrapolation method of biomass density on the surface of individual depth zones.

Champsocephalus gunnari

Substantial influence on the results of biomass estimates for this species and total biomass was exerted by great changes in biomass density of *C. gunnari* in some subdivisions and some depth zones, as a result of which three distinct peaks of its biomass (Table III, IV; Figures 3,4) were observed within the past eleven fishing seasons. Most probably there was a fourth peak in the 1982/83 season, because of very large catches of C. gunnari (128.2 thousand tons) in this area (Anon. 1986). A decisive factor in the high estimate of total biomass in the 1976/77 season was the high biomass density of C. gunnari in subdivision 56, in the 150-250 m zone (94.2 t/km^2) as well as equally high density values in subdivision 57, depth zones of 150-250 and 250-500 m (Table IV, Figure 4). In the 1980/81 season relatively high density values for C. gunnari uniformly distributed in the wide zone of shallow waters (50-150 m) of subdivision 62 had a decisive influence on the size of total fish biomass (Table IV, Figure 4). Similarly, in the 1986/87 season, the high biomass density of C. gunnari in the shallow-water area (50-150 m), in subdivision 62, as well as relatively high density in the wide 150-250 m zone of subdivisions 61 and 62 (Table IV, Figure 4) influenced the high result of the total fish biomass estimate, as compared with the previous seasons.

In the 1976/77 season, when the first peak biomass level of C. gunnari was observed, the catches were composed mainly of fish belonging to age-groups IV-VIII, with a length of 35-42 cm. The structure of the exploited C. gunnari stock in two later seasons characterized by high biomass densities was quite different. In both of them, 3-year old fish predominated - with a length of 22-33 cm in 1980/81 (December-February, fish length measurement on board the fishing vessel), and a length of 21-30 cm in 1986/87 (November-December, data from research catches).

The periods of relatively low biomass of C. gunnari in our study comprise seasons 1977/78-1978/79, 1981/82 and 1983/84-1985/86. In the first period, this is an indirect result of the finding of abundant fishing grounds for C. gunnari and other Channichthyidae in the southern part of the Scotia Arc. and a decline in interest of the fleet in a search for concentrations of fish in the South Georgia area. It is thus likely that a sudden drop in the biomass level in our study between the 1976/77 and 1978/79 seasons was not exclusively caused by intensive catches in the first season. Low biomass estimates in relation to the size of world catches in the eighties result from the fact that our biomass estimate is based solely on bottom hauls (in order to render the data comparable in the whole period under study), while a substantial part of the catches of this species came from mid-water trawls, more efficient in taking fish out of reach of a bottom trawl. These differences are visible most of all in the 1981/82 and 1983/84 seasons (of Anon. 1986). A trial biomass estimate of the C. gunnari stock by the swept area method on the basis of data from a mid-water trawl, made in the 1983/84 season (Ślósarczyk et al. 1985, Annex 1) showed that such an estimate may be 2.5-3 times higher than a biomass estimate of C. gunnari based on bottom trawl data.

Chaenocephalus aceratus

Estimate results point to a gradual increase in the biomass of this species from a level of 3 thousand tons in the 1977/78 season to 18.5 thousand tons in the last season (Table III, Figure 3). A distinct increase in biomass density in most of the subdivisions was especially visible after the 1981/82 season (Table IV, Figure 5). This is reflected in the twofold increase of the estimated biomass between the 1981/82 and 1983/84 seasons (Table III). Only to a small degree could this be a result of new fishing tactics used. Both in the pre-1982/83 seasons (Ślósarczyk et al. 1985) and in the 1983/84-1986/87 period, fishing operations were directed mainly at C. gunnari. In the seasons in which mixed catches prevailed (1977/78 and 1984/85), when higher CPUE of C. aceratus could have been expected, higher biomass density may be observed only in the latter season (Table IV). In the first of them, despite high CPUE of P. georgianus and N. gibberifrons, occurring in the fishing ground along with C. aceratus, the CPUE of the latter was low and the level of the estimated biomass, the lowest among those observed in the eleven seasons (Table III).

Prior to the 1977/78 seaons, large fish with lengths of 30-65 cm, age-groups III-IX, predominated in the catch. In the 1978/79-1981/82 period the stock was visibly rejuvenated; strong year classes of 1976, 1977, and 1978 were recruited to the stock. At that time young fish, age-groups II-IV, with lengths below 45 cm, predominated in the catch. In the 1983/84 season, when the biomass density of C. aceratus increased distinctly, no fish below 30 cm in length were found in the catch

(Kompowski, unpublished). It consisted of large fish with lengths of 42-65 cm, mostly from age-groups V and VI (year classes of 1977 and 1978). Higher biomass density in 1984/85 may be a result of recruitment to the exploited stock of relatively strong year classes of 1981-1983, which appeared in the catch alongside fully exploited, abundant year classes of 1976-1978.

Pseudochaenichthys georgianus

In the 1976/77 and 1977/78 seasons, when the biomass of P. georgianus was estimated at a high level of 11.3 and 25 thousand tons (Table III, Figure 3), large fish (exceeding 45 cm and belonging to age-groups V through XII) were mostly observed in the catch. In the following season (1978/79) an increased share of young fish (age-groups I-III) was observed in sample hauls of the R.V. Professor Siedlecki (Anon. 1978). In the 1980/81 season, the percentage of young fish with lengths of 32-40 cm was still quite high in the catch (no data from the 1979/80 season). Biomass densities in both the 1978/79 (Ślósarczyk et al. 1985) and 1980/81 seasons (Table IV, Figure 6) were among the lowest observed. In the following season, biomass density increased while a decrease in the share of youngest fish and a simultaneous increase of fish 41-49 cm in length in the catch structure was observed. In the period between 1983/84 and 1986/87 this process was repeated. In the first season of that period very high biomass densities of P. georgianus (Table IV, Figure 6) were noted, accompanied by a large share of older fish (similar to the 1976/77 season). The biomass estimate in the 1983/84 season was the highest of the whole study period (Table III, Figure 3) despite the small area of the shelf covered by fishing operations and estimates, as well as the fact that operations were directed at C. gunnari. In subsequent seasons biomass densities of P. georgianus generally decreased; at the same time, beginning with 1985/86, young fish with lengths of 34-40 cm reappeared in the catch. In the last season (1986/87) the above-mentioned species was not found in the analysed catches of F.V. Manta so we could speak of zero biomass density. However, P. georgianus was at the same time second in quantity (8.2%) component of C. gunnari by-catch on the second Polish fishing vessel on the South Georgia grounds. It was also observed at that time in sample hauls of the R.V. Professor Siedlecki on the same fishing grounds (Figure 3). It is thus difficult to evaluate to what degree a density and biomass estimate based on observations from a single vessel reflects the actual state of P. georgianus stock. When large concentrations of C. gunnari appear, the interest of fishermen in other species of demersal fish declines. This might apply to catches of P. georgianus in 1986/87 in the case of F.V. Manta, when the main species sought was C. gunnari.

Notothenia gibberifrons

N. gibberifrons is characterized by the most stable biomass density indices (Table IV, Figure 7). As a result, with the exception of the 1983/84 season, the results of biomass estimate of this species usually range between 9 and 11 thousand tons (Table III, Figure 3). The estimate made in the 1983/84 season is approximately two times lower than the remaining ones, because the shelf area covered by fishing operations and biomass calculation in that season was also two times smaller (Table III).

However, some changes in the biological structure of the N. gibberifrons stock were observed during the study period. In the first two seasons (1976/77 and 1977/78) 10-year old fish and older predominated in the catch. Their share gradually decreased in later years while the percentage of younger fish increased (Ślósarczyk et al. 1985). In the eighties, the highest frequency was observed in age-groups VIII-X (Skóra, unpublished). Mean lengths of fish dropped from 37 cm in 1976/77 to 32 cm in 1981/82 (Ślósarczyk et al. 1985), and then increased to 36 cm in 1984/85 (Skóra) and 38 cm in 1985/86 (Kreft and Szynaka, 1986). An increase in mean length of fish in the last season could have been affected by the closing for the fishery of the shallow-water near-shore zone, mostly inhabited by small fish, below a length of 30 cm.

Notothenia rossii marmorata

Differences in biomass estimates of this species are generally a result of its uneven distribution over the shelf. Most likely, only the localization of new concentrations of N. rossii accounts for the high biomass density indices in some seasons, among others in the 250-500 depth zone in subdivisions 56 and 60 in the 1981/82 season, in the 150-250 m zone in subdivision 60, and in the 250-500 m zone in subdivisions 60-62, in the 1984/85 season (Table IV, Figure 8). High biomass densities gave in effect high biomass estimates in those seasons (Table III, Figure 3), which - most likely - were not a result of very large one-time recruitment. Beginning with the 1985/86 season, a decline in the biomass level, estimated on the basis of catches of fishing vessels might be apparent only due to the introduction of first catch regulatory measures for this species.

In the second half of the seventies, a large share of young fish belonging to age-groups III-V was observed in Polish catches; it often exceeded 50% of the catch (in numbers of fish). Mean lengths of fish in catches gradually decreased at that time from 59 cm in 1976/77 to 43 cm in 1980/81 (Ślósarczyk et al. 1985), age-groups V-VIII began to predominate in catches. This is connected with a simultaneous, sudden increase of CPUE in the deeper zone (250-500 m) and may indicate that new concentrations of fish of this species were discovered. Another increase in the mean length of fish from 46.2 cm in 1983/84 to 48 cm in 1984/85 could also be related to the very high, unobserved earlier increase in biomass density in the deep water zone (250-500 m). Further increase in mean length of fish to 50.5 cm in the following season could only be a result of catch regulatory measures for N. rossii, most of all the closing by the CCAMLR of near-shore waters for the fishery.

4. MANAGEMENT ADVICE

In the majority of analysed seasons of the 1976/77-1986/87 period, C. gunnari constituted the basis of catches off South Georgia and it seems that this early-maturing species might maintain such a status in the future, provided numerous year classes are recruited to the exploited stock. In a period of predominance of age-group II fish in the catches, they appeared with 2-4 year intervals and until 1984 kept catches at a high level, each time for two subsequent seasons : the year class of 1978 (Ślósarczyk et al. 1985) in the 1980/81 and 1981/82 seasons (Anon. 1986), and the year class of 1980 in 1982/83 and 1983/84 (Anon. 1986). The abundant year class of 1984, observed in great numbers as age-group I in sample hauls taken in the 1985/86 season (Kreft and Szynaka 1986), brought about very high biomass density values in the 1986/87 season. It seems that, similarly to the previous years, this year class might keep catches in the 1986/87 and the following season at a high level. To reduce, however, fishing in the 1987/88 season on the first spawning 1984 year-class, catches should be limited, depending on the total catch in the previous season.

Turning our attention to other species, the biomass and stock structure of C. aceratus has been improving recently and limiting the catches of this species appears unnecessary. The situation of the P. georgianus stock is not clear and requires confirmation by an estimate made by a different method. The biomass of the N. gibberifrons stock is stable and it seems unlikely that catches should be limited. What is worth doing is improving its structure by restrictions on the catch of juvenile fish. Latest tendencies in the structure and biomass of the N. rossii stock cannot be discussed on the basis of the results of commercial catches because of severe restrictions imposed on its fishery.

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Table I   Information on time and location of catches, swept area and fishing gears.

Season	Month	Vessel	Place of capture /Division No.after Everson 1984/	Depth range /m/	Swept area /km²/	No.of hauls	Gear type	Horizontal openning of trawl/m/	Speed of trawling /knots/
1976/77	I-V	m/t"Gemini"	56,57,60,61,62	150-500	6 142	277	P-36/39	24.0	3.8
1977/78	XII-IV	m/t"Gemini"	56,57,60,61,62	150-500	6 737	218	P-32/36 P-36/39	17.5 24.0	3.8
1978/79									
1979/80									
1980/81	X-II	m/t"Libra"	56,57,60,61,62	50-500	9 302	464	P-32/36	17.5	3.2-4.0
1981/82	XI-II	m/t"Neptun"	56,57,60,61	50-500	4 686	285	P-32/36	17.5	3.6-3.8
1982/83									
1983/84	XI-I	m/t"Taurus"	56,57,60,61,62	50-500	3 665	96	P-32/36	17.5	3.8
1984/85	X-XI	m/t"Taurus"	56,57,60,61,62	50-500	7 147	154	P-32/36	17.5	3.5
1985/86	XI-I	m/t"Carina"	56,57,60,61,62	50-500	6 434	232	P-32/36	17.5	3.2
1986/87	XI-I	m/t"Manta"	56,61,62	50-500	6 246	73		17.5	3.0

Table II Fish stock biomass off South Georgia, within subdivisions 56, 57 and 60-62, in the near-bottom water layer estimated by the "swept area" method.

Seasons	Depth range /m/	Subdivisions 56	57	60	61	62	Total
1976/77	50-150						
	150-250	73 136	2 905	7 238	17 014		100 293
	250-500	30 388	16 695	1 989	4 615	4 134	57 821
	Total	103 524	19 600	9 227	21 629	4 134	158 114
1977/78	50-150						
	150-250	4 463	864	1 739	11 236	6 537	24 839
	250-500	9 352		1 224	4 115	3 510	18 201
	Total	13 815	864	2 963	15 351	10 047	43 040
1978/79							
1979/80							
1980/81	50-150	586		7 968	2 633	33 298	44 485
	150-250	8 482	536	5 358	13 643	7 124	35 143
	250-500	7 701	1 410	1 714	3 225	4 524	18 574
	Total	16 769	1 946	15 040	19 501	44 946	98 202
1981/82	50-150				1 809		1 809
	150-250	5 803	630	3 666	16 051		26 150
	250-500	17 877		3 979			21 856
	Total	23 680	630	7 645	17 860		49 815
1982/83							
1983/84	50-150	457			1 316		1 773
	150-250	9 672	820		31 458		41 950
	250-500			2 845		7 020	9 865
	Total	10 129	820	2 845	32 774	7 020	53 588
1984/85	50-150	237			1 685		1 922
	150-250	4 539	567	5 734	20 385	8 296	39 521
	250-500	6 463	1 337	6 120	9 675	7 566	31 161
	Total	11 239	1 904	11 854	31 745	15 862	72 604
1985/86	50-150	696			2 275		2 971
	150-250	8 109	2 992		22 311	12 906	46 318
	250-500	5 227		1 438	3 392	6 786	16 843
	Total	14 032	2 992	1 438	27 978	19 692	66 132
1986/87	50-150	542			1 218	51 504	53 264
	150-250	8 630			22 150	17 011	47 791
	250-500				4 226	5 304	9 530
	Total	9 172			27 594	73 819	110 585
Area /km^2/	50-150	44		599	123	1 556	2 322
	150-250	744	63	470	1 605	838	3 720
	250-500	1 375	243	306	556	780	3 260
	Total	2 163	306	1 375	2 284	3 174	9 302

Table III Fish stock biomass off South Georgia by year, subdivision and species.

Seasons	Species*	Subdivisions					
		56	57	60	61	62	Total
1976/77	ANI	90 710	19 130	261	111		110 212
	SSI	2 216	86	247	667	468	3 684
	SGI	2 624	49	6 426	1 724	468	11 291
	NOG	5 499	262	1 209	2 223	1 716	10 909
	NOR	1 650		945	15 292	1 092	18 979
	MZZ	825	73	139	1 612	390	3 039
	Total	103 524	19 600	9 227	21 629	4 134	158 114
1977/78	ANI	212	13	31	538	503	1 297
	SSI	773	6	155	1 185	815	2 934
	SGI	8 190	800	1 660	9 342	5 025	25 017
	NOG	3 729	13	698	2 884	2 961	10 285
	NOR	911	32	419	1 402	743	3 507
	MZZ						
	Total	13 815	864	2 963	15 351	10 047	43 040
1978/79							
1979/80							
1980/81	ANI	11 627	1 131	12 168	13 814	38 566	77 306
	SSI	1 004	160	581	1 290	1 515	4 550
	SGI	1 141	208	612	1 414	1 827	5 202
	NOG	1 622	392	1 373	2 711	2 798	8 896
	NOR	1 100	49	245	111	156	1 661
	MZZ	275	6	61	161	84	587
	Total	16 769	1 946	15 040	19 501	44 946	98 202
1981/82	ANI	4 340	353	2 123	10 452		17 268
	SSI	1 283	69	529	1 840		3 721
	SGI	2 183	120	760	3 136		6 199
	NOG	5 631	88	1 588	2 432		9 739
	NOR	10 243		2 645			12 888
	MZZ						
	Total	23 680	630	7 645	17 860		49 815
1982/83							
1983/84	ANI	1 799	145	581	12 036	1 014	15 575
	SSI	1 238	101	520	5 999	312	8 170
	SGI	6 146	498	734	12 394	4 680	24 452
	NOG	565	44	459	2 345	1 014	4 427
	NOR	381	32	551			964
	MZZ						
	Total	10 129	820	2 845	32 774	7 020	53 588
1984/85	ANI	481	6	769	383	1 060	2 699
	SSI	2 428	543	1 489	7 204	2 751	14 415
	SGI	1 792	932	1 917	8 812	1 635	15 088
	NOG	1 582	423	1 098	4 070	4 164	11 337
	NOR	4 956		6 581	11 276	6 252	29 065
	MZZ						
	Total	11 239	1 904	11 854	31 745	15 862	72 604
1985/86	ANI	7 357	2 457	673	14 267	2 722	27 476
	SSI	3 570	214	214	4 710	1 959	10 667
	SGI	316	13	61	2 438	6 978	9 806
	NOG	1 992	176	245	4 420	4 308	11 141
	NOR	74			661	2 748	3 483
	MZZ	723	132	245	1 482	977	3 559
	Total	14 032	2 992	1 438	27 978	19 692	66 132
1986/87	ANI	6 790			22 000	51 551	80 341
	SSI	884			2 939	14 753	18 576
	SGI						
	NOG	1 498			2 655	7 203	11 356
	NOR					312	312
	MZZ						
	Total	9 172			27 594	73 819	110 585
Area /km^2/		2 163	306	1 375	2 284	3 174	9 302

* ANI - Champsocephalus gunnari, SSI - Chaenocephalus aceratus, SGI - Pseudochaenichthys georgianus, NOG - Notothenia gibberifrons, NOR - Notothenia rossii marmorata, MZZ - other marine fishes.

Table IV Biomass density of fish stocks off South Georgia by year, subdivision, depth zone and species.

Seasons	Species*	Subdivisions														
		56			57			60			61			62		
	/m/	50-150	150-250	250-500	50-150	150-250	250-500	50-150	150-250	250-500	50-150	150-250	250-500	50-150	150-250	250-500
1976/77	ANI		94.2	15.0		45.6	66.9		0.1	0.7			0.2			
	SSI		1.5	0.8		0.2	0.3		0.2	0.5			1.2			0.6
	SGI		0.2	1.8			0.2		12.5	1.8			3.1			0.6
	NOG		2.4	2.7		0.3	1.0		1.4	1.8		0.9	1.4			2.2
	NOR			1.2					1.1	1.4		8.8	2.1			1.4
	MZZ			0.6			0.3		0.1	0.3		0.9	0.3			0.5
1977/78	ANI		0.1	0.1		0.2				0.1		0.3	0.1		0.6	
	SSI		0.3	0.4		0.1			0.2	0.2		0.6	0.4		0.6	0.4
	SGI		3.8	3.9		12.7			2.1	2.2		4.4	4.1		4.6	1.5
	NOG		1.5	1.9		0.2			0.9	0.9		1.0	2.3		1.3	2.4
	NOR		0.3	0.5		0.5			0.5	0.6		0.7	0.5		0.7	0.2
	MZZ															
1978/79																
1979/80																
1980/81	ANI	11.3	9.6	2.9	20.0	6.0	3.1	11.3	9.6	2.9	20.0	6.0	3.1	20.0	6.0	3.1
	SSI	0.4	0.4	0.5	0.4	0.6	0.5	0.4	0.4	0.5	0.4	0.6	0.5	0.4	0.6	0.5
	SGI	0.4	0.4	0.6	0.5	0.6	0.7	0.4	0.4	0.6	0.5	0.6	0.7	0.5	0.6	0.7
	NOG	1.2	1.0	0.6	0.5	1.2	1.3	1.2	1.0	0.6	0.5	1.2	1.3	0.5	1.2	1.3
	NOR			0.8			0.2			0.8			0.2			0.2
	MZZ			0.2		0.1				0.2		0.1				
1981/82	ANI		3.8	1.1	11.9	5.6			3.8	1.1	11.9	5.6				
	SSI		0.8	0.5	0.6	1.1			0.8	0.5	0.6	1.1				
	SGI		0.9	1.1	0.7	1.9			0.9	1.1	0.7	1.9				
	NOG		1.1	3.5	1.5	1.4			1.1	3.5	1.5	1.4				
	NOR		1.2	6.8					1.2	6.8						
	MZZ															
1982/83																
1983/84	ANI	2.0	2.3		2.0	2.3				1.9	3.9	7.2				1.3
	SSI	1.1	1.6		1.1	1.6				1.7	1.8	3.6				0.4
	SGI	6.1	7.9		6.1	7.9				2.4	4.2	7.4				6.0
	NOG	1.0	0.7		1.0	0.7				1.5	0.8	1.4				1.3
	NOR	0.2	0.5		0.2	0.5				1.8						
	MZZ															
1984/85	ANI	1.3	0.2	0.2	14.5	0.1			0.4	1.9	0.5	0.2			0.8	0.5
	SSI	0.5	1.2	1.1	0.5	0.9	2.0		1.8	2.1	4.1	3.1	3.1		1.7	1.7
	SGI		1.3	0.6	2.2	6.3	2.2		1.8	3.5	7.8	4.2	2.0		1.3	0.7
	NOG	0.3	1.0	0.6	0.1	1.7	1.3		1.1	1.9	1.2	1.3	3.3		3.2	1.9
	NOR	3.3	2.4	2.2	3.3				7.1	10.6	0.1	3.9	9.0		2.9	4.9
	MZZ															
1985/86	ANI	10.4	6.5	1.5	81.5	39.0				2.2	11.8	7.5	1.4		1.2	2.2
	SSI	2.8	2.6	1.1	6.6	3.4				0.7	3.3	2.3	1.1		1.5	0.9
	SGI	0.4	0.4		0.1	0.2				0.2	1.0	1.2	0.7		6.0	2.5
	NOG	1.4	1.3	0.7	4.8	2.8				0.8	1.7	2.0	1.8		3.0	2.3
	NOR		0.1								0.1	0.3	0.3		3.0	0.3
	MZZ	0.8		0.5	2.4	2.1				0.8	0.6	0.6	0.8		0.7	0.5
1986/87	ANI	8.9	8.6								8.7	11.1	5.6	24.3	15.0	1.5
	SSI	1.5	1.1								0.3	1.6	0.6	6.1	3.3	3.2
	SGI															
	NOG	1.9	1.9								0.9	1.1	1.4	2.7	2.0	1.7
	NOR															0.4
	MZZ															
Area /km²/		44	744	1375	-	63	243	599	470	306	123	1605	556	1556	838	780

*ANI - Champsocephalus gunnari, SSI - Chaenocephalus aceratus, SGI - Pseudochaenichthys georgianus, NOG - Notothenia gibberifrons, NOR - Notothenia rossii marmorata, MZZ - other marine fishes.

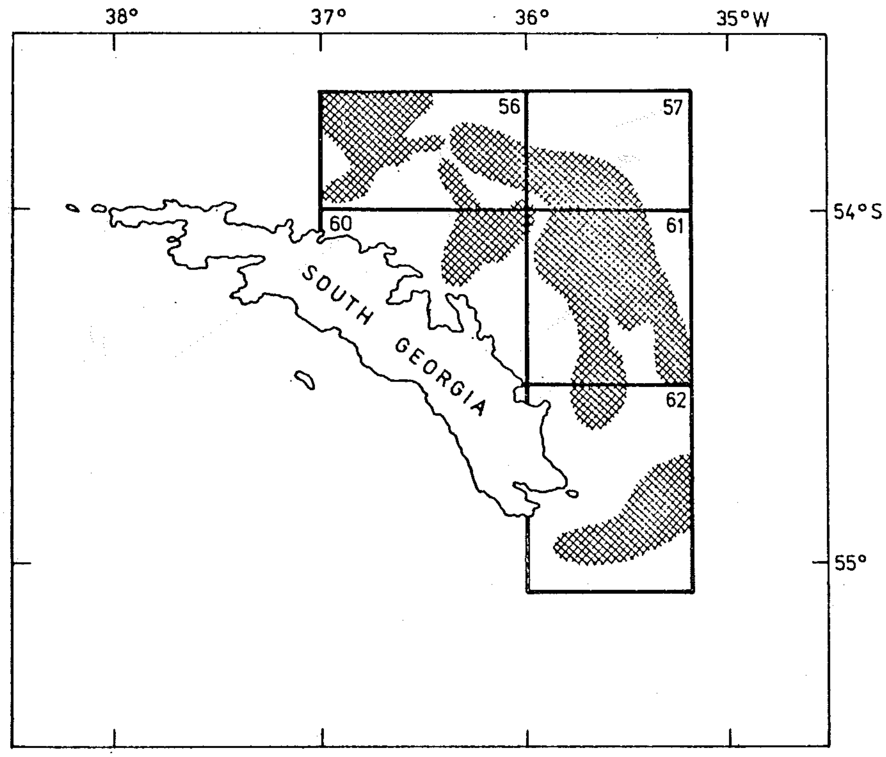

Figure 1 Area exploited regularly by the Polish fishery in the period 1977-1987 within statistical subdivisions 56, 57 and 60-62 (after Everson 1984).

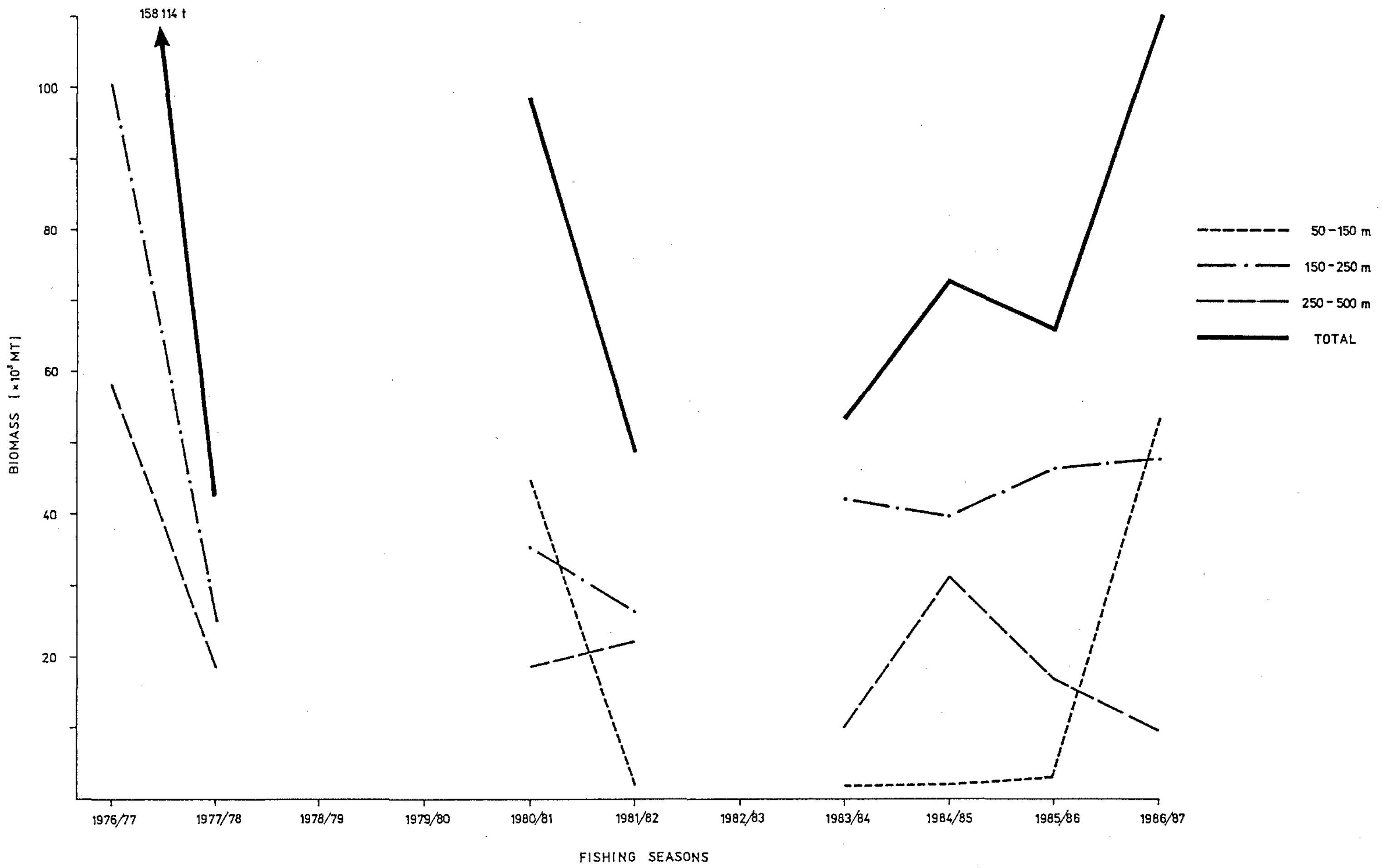

Figure 2 Changes in bottom fish biomass off South Georgia in 1977-1987 within subdivisions 56, 57 and 60-62, in three depth zones, estimated by the "swept area" method.

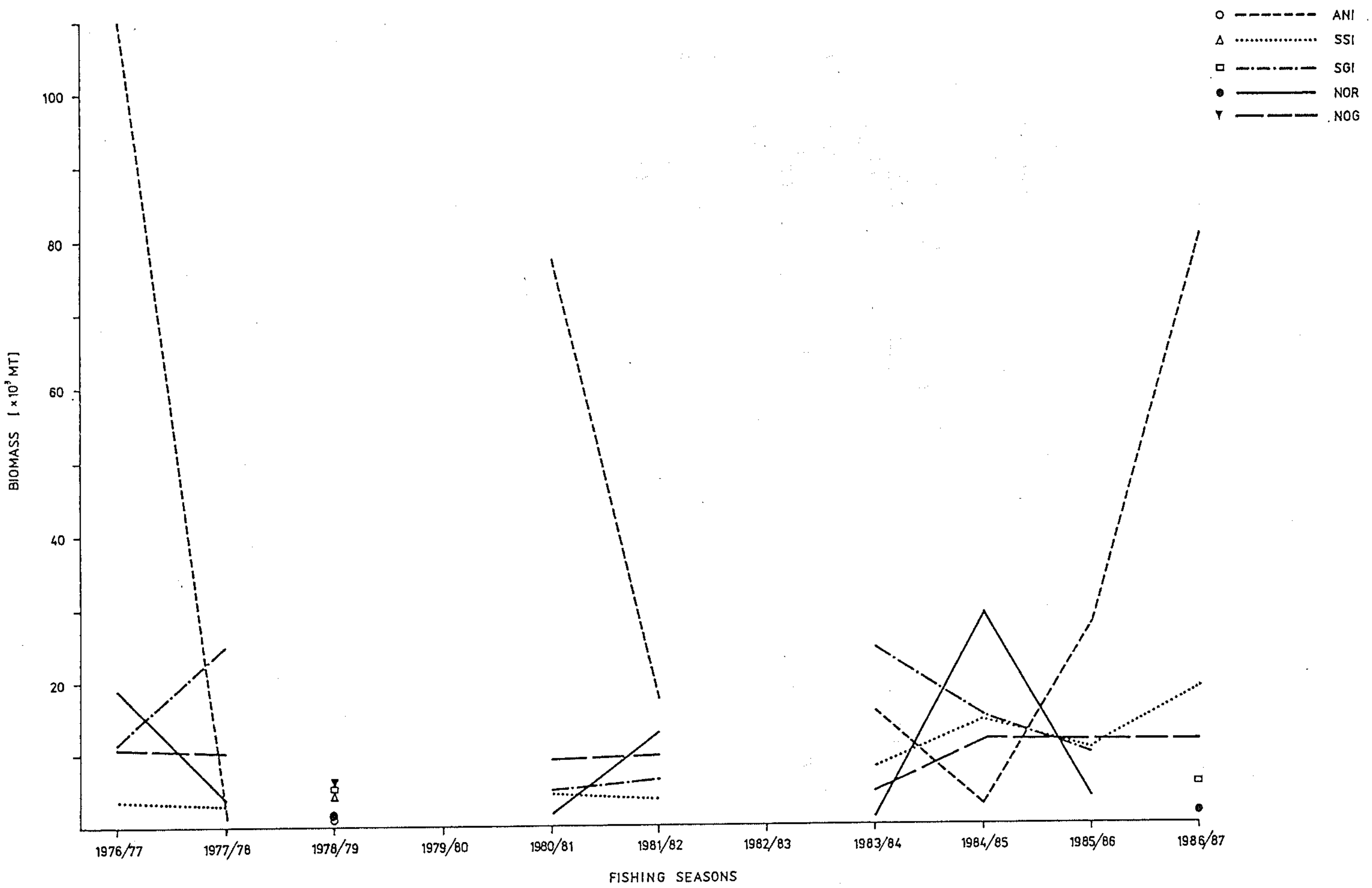

Figure 3 Changes in fish stocks biomass off South Georgia in 1977–1987 (ANI – Champsocephalus gunnari, SSI – Chaenocephalus aceratus, SGI – Pseudochaenichthys georgianus, NOR – Notothenia rossii marmorata, NOG – Notothenia gibberifrons).

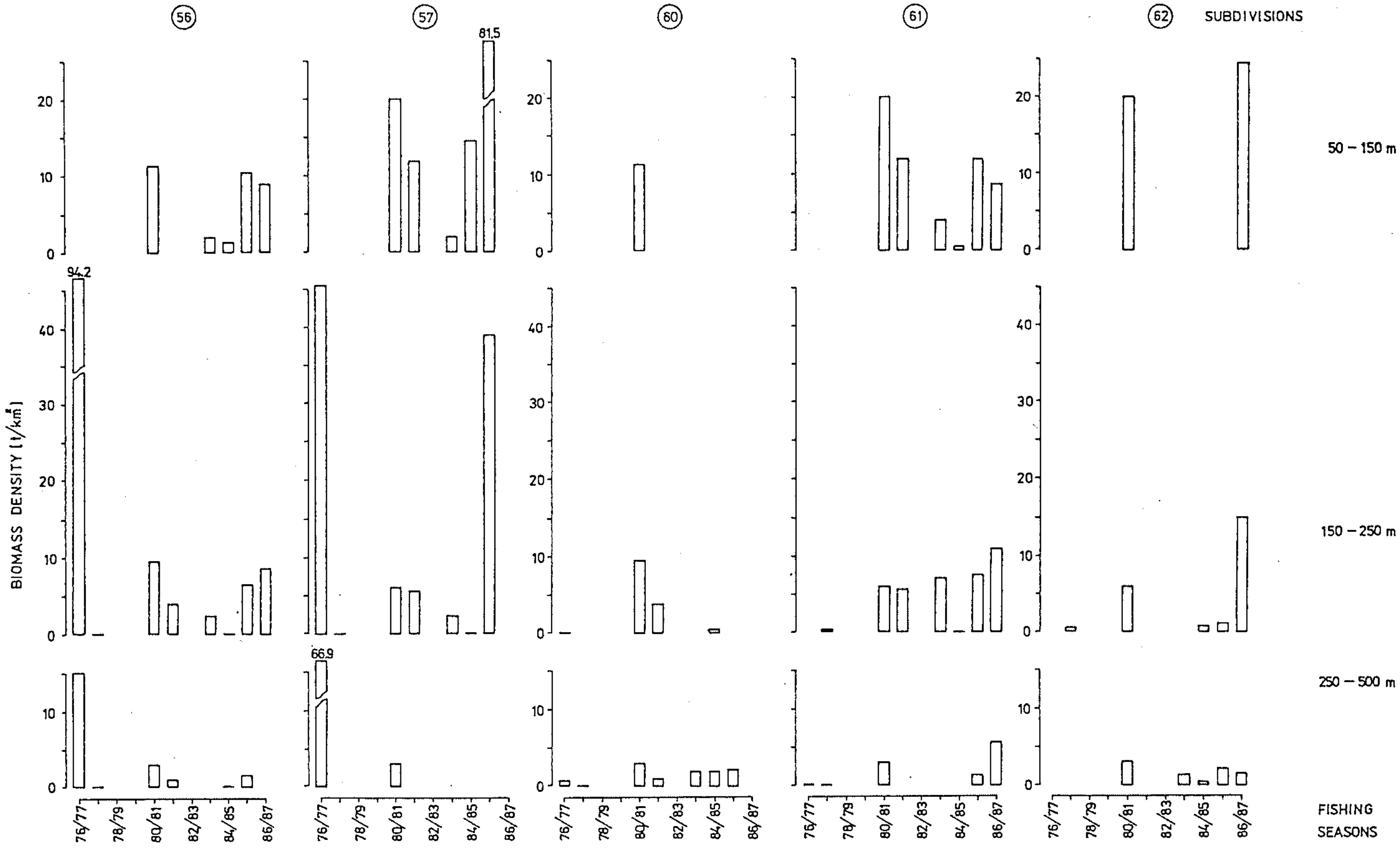

Figure 4 Biomass density of <u>Champsocephalus gunnari</u> by year, subdivision and depth zone.

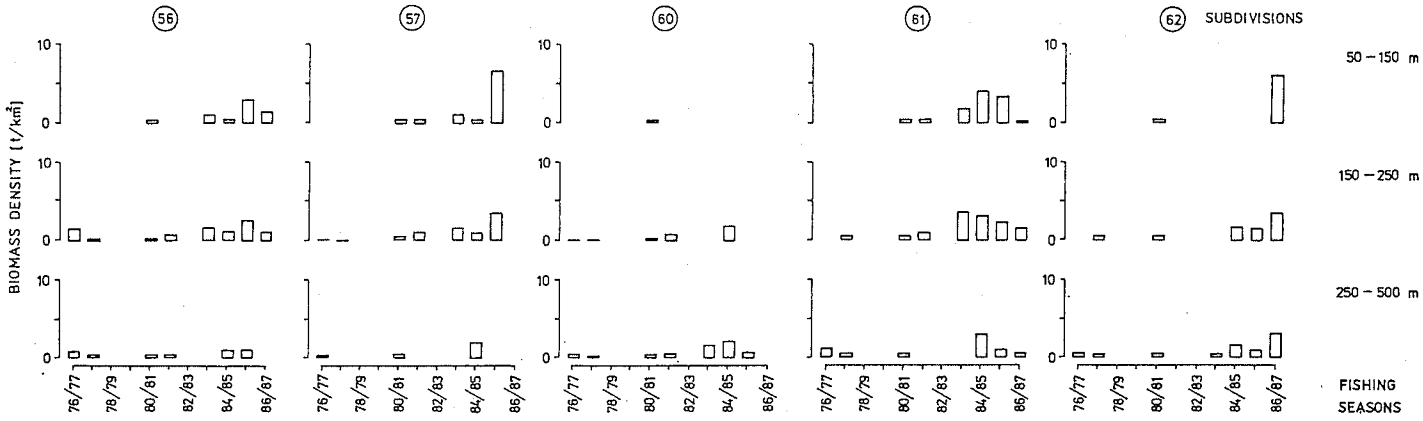

Figure 5 Biomass density of Chaenocephalus aceratus by year, subdivision and depth zone.

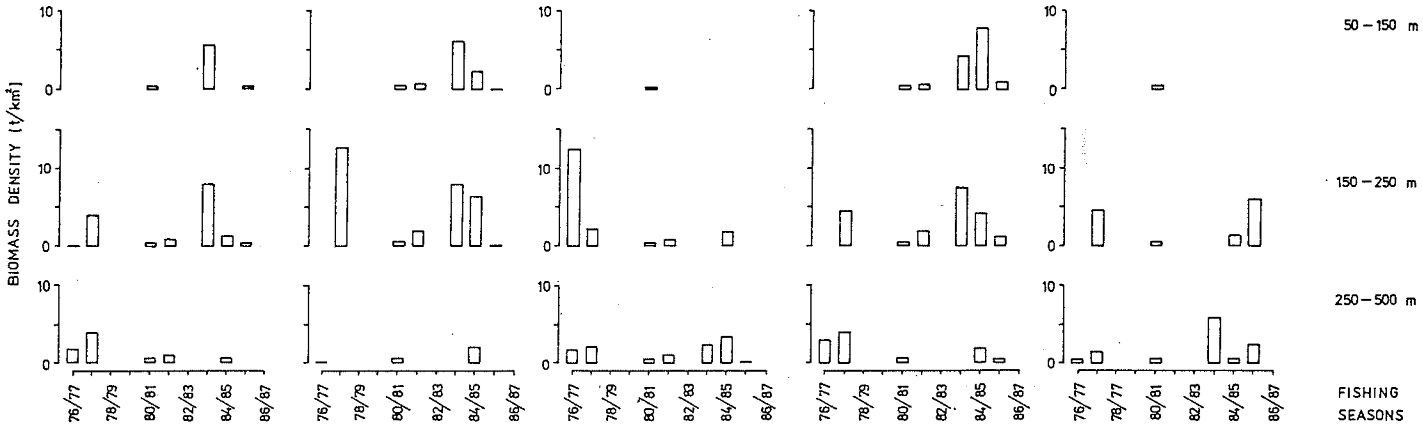

Figure 6 Biomass density of Pseudochaenichthys georgianus by year, subdivision and depth zone.

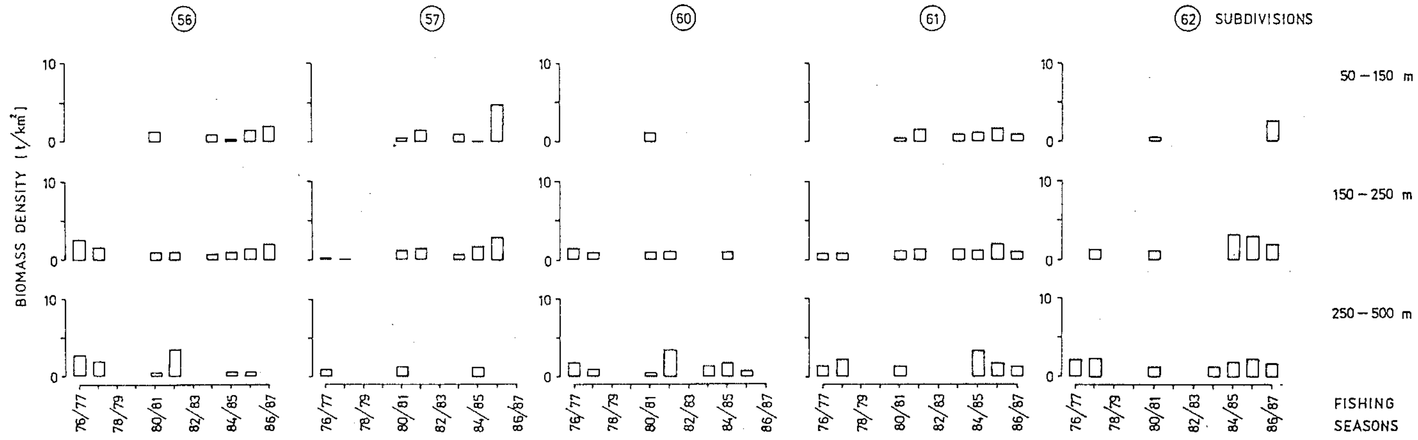

Figure 7 Biomass density of Notothenia gibberifrons by year, subdivision and depth zone.

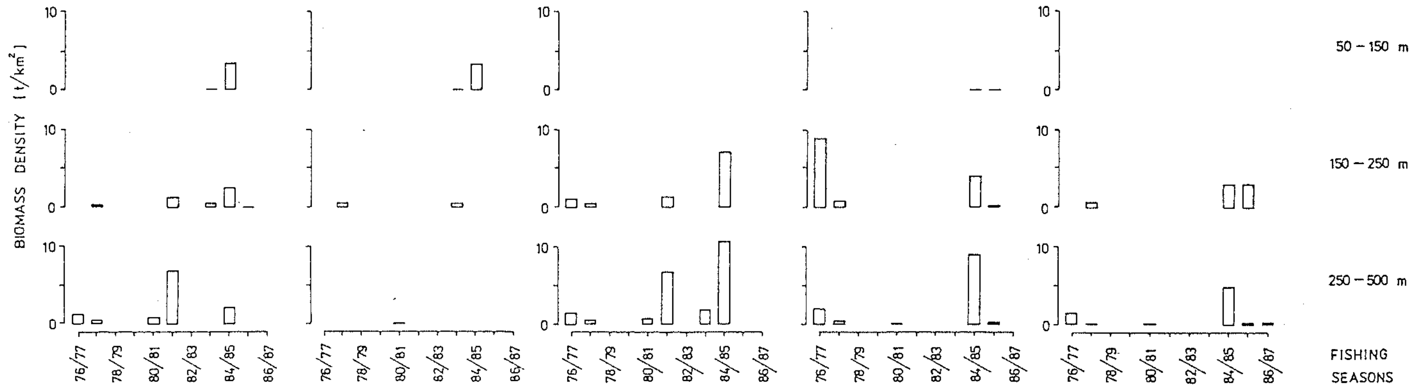

Figure 8 Biomass density of Notothenia rossii marmorata by year, subdivision and depth zone.

Légendes des tableaux

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Tableau II — Biomasse du stock ichtyologique au large de la Géorgie du Sud, au sein des subdivisions 56, 57 et 60-62, dans la couche d'eau située près du fond; estimation effectuée d'après la méthode d'"aire balayée".

Tableau III — Biomasse du stock ichtyologique au large de la Géorgie du Sud par année, subdivision et espèce.

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Figure 2 — Changements dans la biomasse des poissons de fond au large de la Géorgie du Sud en 1977-1987 au sein des subdivisions 56, 57 et 60-62, dans trois zones de profondeur; estimations effectuées d'après la méthode d'"aire balayée".

Figure 3 — Changements dans la biomasse des stocks ichtyologiques au large de la Géorgie du Sud en 1977-1987 (ANI - Champsocephalus gunnari, SSI - Chaenocephalus aceratus, SGI - Pseudochaenichthys georgianus, NOR - Notothenia rossii marmorata, NOG - Notothenia gibberifrons).

Figure 4 — Densité de la biomasse de Champsocephalus gunnari par année, subdivision et zone de profondeur.

Figure 5 — Densité de la biomasse de Chaenocephalus aceratus par année, subdivision et zone de profondeur.

Figure 6 — Densité de la biomasse de Pseudochaenichthys georgianus par année, subdivision et zone de profondeur.

Figure 7 — Densité de la biomasse de Notothenia gibberifrons par année, subdivision et zone de profondeur.

Figure 8 — Densité de la biomasse de Notothenia rossii marmorata par année, subdivision et zone de profondeur.

Encabezamientos de las Tablas

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Figura 3 — Cambios en la biomasa de las reservas de peces aguas afuera de Georgia del Sur en 1977-1987. (ANI - *Champsocephalus gunnari*, SSI - *Chaenocephalus aceratus*, SGI - *Pseudochaenichthys georgianus*, NOR - *Notothenia rossii marmorata*, NOG - *Notothenia gibberifrons*).

Figura 4 — Densidad de la biomasa de *Champsocephalus gunnari* por año, subdivisión y zona de profundidad.

Figura 5 — Densidad de la biomasa de *Chaenocephalus aceratus* por año, subdivisión y zona de profundidad.

Figura 6 — Densidad de la biomasa de *Pseudochaenichthys georgianus* por año, subdivisión y zona de profundidad.

Figura 7 — Densidad de la biomasa de *Notothenia gibberifrons* por año, subdivisión y zona de profundidad.

Figura 8 — Densidad de la biomasa de *Notothenia rossii marmorata* por año, subdivisión y zona de profundidad.

Заголовки к таблицам

Таблица I — Информация о времени и месте взятия уловов, протраленных площадях и рыболовных снастях.

Таблица II — Сделанные с помощью метода "протраленных площадей" оценки биомассы рыбных запасов в придонном слое воды в районе Южной Георгии с разбивкой по подучасткам 56, 57 и 60-62.

Таблица III — Биомасса рыбных запасов в районе Южной Георгии - по годам, подучасткам и видам.

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Рисунок 4 — Плотность биомассы у *Champsocephalus gunnari* - по годам, подучасткам и горизонтам.

Рисунок 5 — Плотность биомассы у *Chaenocephalus aceratus* - по годам, подучасткам и горизонтам.

Рисунок 6 — Плотность биомассы у *Pseudochaenichthys georgianus* - по годам, подучасткам и горизонтам.

Рисунок 7 — Плотность биомассы у *Notothenia gibberifrons* - по годам, подучасткам и горизонтам.

Рисунок 8 — Плотность биомассы у *Notothenia rossii marmorata* - по годам, подучасткам и горизонтам.