ANALYSIS OF RESULTS FROM DEMERSAL FISH SURVEYS AT SOUTH GEORGIA, UNDERTAKEN BY THE UNITED KINGDOM AND THE USSR, JANUARY AND FEBRUARY 1990

(Report of a Joint UK/USSR Workshop, 23 to 27 July 1990)

Abstract

The report describes discussions and analyses of the data from a survey from MV *Hill Cove* in January 1990 and RV *Akademik Knipovich* in February 1990 around South Georgia. Both surveys were characterized by large numbers of small hauls interspersed with a few large catches. The small number of large catches cause a disproportionate increase in the estimated standing stock of *Champsocephalus gunnari*. The paper describes the ways in which these large hauls were considered in the analysis. No ideal method was found for incorporating the large hauls into the analysis.

Résumé

Ce rapport décrit les discussions et les analyses des données provenant d'une campagne d'évaluation effectuée à bord du navire marchand *Hill Cove* en janvier 1990 et du navire de recherche *Akademik Knipovich* en février 1990 autour de la Géorgie du Sud. Les deux campagnes étaient caractérisées par de nombreux petits chalutages entrecoupés de quelques captures importantes. Le nombre restreint de captures importantes cause une augmentation disproportionnée de l'évaluation du stock existant de *Champsocephalus gunnari*. Ce document décrit les différentes manières selon lesquelles l'analyse traite ces chalutages importants. Aucune méthode idéale n'a été décelée pour incorporer ces grands traits dans l'analyse.

Резюме

Настоящий отчет описывает обсуждение и анализ данных, полученных судном *Hill Cove* в январе 1990 г. и НИС *Академик Книпович* в феврале 1990 г., в районе Южной Георгии. Для обеих съемкок было характерно получение множества небольших уловов и лишь нескольких крупных уловов. Небольшое количество крупных уловов вызвало непропорциональное завышение оценки биомассы *Champsocephalus gunnari*. В данном документе описывается, каким образом данные по крупным уловам учитывались при анализе. Идеального метода включения данных по крупным уловам в анализ найдено не было.

Resumen

Este informe trasunta los debates y análisis de la información obtenida de una prospección realizada alrededor de Georgia del Sur por el BI *Hill Cove* en enero de 1990 y por el BI *Akademik Knipovich* en febrero de 1990. Ambas prospecciones se caracterizaron por la vasta cantidad de lances pequeños mezclados con pocas capturas voluminosas. Estas últimas fueron la causa de un aumento desproporcionado en la estimación de la biomasa permanente de *Champsocephalus gunnari*. Este documento describe como se consideraron estos lances voluminosos en los análisis, pero no se logró encontrar un método ideal para incorporar estos lances en los análisis.

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1. INTRODUCTION

The workshop was held at Renewable Resources Assessment Group, Imperial College, London from 23 to 27 July 1990.

The following participated in the workshop: I. Everson (Convener and Rapporteur), M. Basson, G. Parkes, M. Bravington (part of the time: C. Jones) from the UK and P. Gasiukov and K. Shust from the USSR. Interpretation was provided by Irina Kirillova and Alan Parfitt.

The Convener welcomed participants and outlined the general aims of the workshop which were to analyze the results from the UK survey using the trawler *Hill Cove* (January 1990) and the USSR research vessel *Akademik Knipovich* (February 1990) so as to provide biomass estimates for the major fish stocks at South Georgia.

Dr Shust reported that the *Akademik Knipovich* had only returned to Sevastopol at the end of May 1990 and this had left little time in which to prepare for this workshop. He and his colleagues in the USSR were very keen to see improved collaboration between the respective national groups and had worked very hard in preparation for the workshop. Data had been provided to the UK in the formats requested, in advance of the workshop, and a report describing the survey was tabled. Copies of survey logsheets were also available. The Convener, on behalf of the group, thanked Dr Shust and his colleagues for their efforts.

The data from the *Hill Cove* survey had been sent to USSR in advance of the workshop and a report, in preparation for the next CCAMLR Working Group on Fish Stock Assessment meeting, was abstracted to provide a description of the UK survey.

A draft agenda had been circulated in advance of the workshop and this was agreed with minor modifications. The agenda as adopted is given in Annex 1.

2. DATA

Data from both surveys were available for the workshop and were loaded onto computer. These data included station lists and positions, catch and sample data. No age data were available because samples had not been fully analyzed.

3. DESCRIPTION OF SURVEYS

Both surveys had been undertaken in accordance with the design submitted by Dr Everson in December to CCAMLR. The survey area was divided into 27 rectangles half a degree of latitude by one degree of longitude, as are the CCAMLR fine-scale reporting areas. The area was stratified into three depth strata: 50 to 150, 150 to 250, 250 to 500 metres. A description of the allocation of stations is given in Paper 2 and the planned survey design in Annex 2.

Even though nearly all the haul positions for this design were taken from previous surveys, it had been the experience of both ships that on arrival at these positions the ground was found to be unsuitable for trawling. Alternative locations within the same depth stratum were therefore fished. Both surveys had encountered a great deal of difficulty in the area to the southern part of the west shelf (squares 19 and 20).

The reports of the two surveys were discussed separately.

3.1 *Akademik Knipovich*

GRT	3 000 tonnes
Power	2 000 hp
LOA	89 m

Details of the trawl net used for the survey were not available at the workshop. These were to be forwarded to the Convener as soon as possible. The dimensions of the net had been measured during a previous cruise. These calibrations were used to estimate net dimensions during the survey. The width of the net was estimated to vary from 20 to 22 m and the headline height from 5 to 6.5 m.

All hauls were described as 'Control hauls'. These are not repeated hauls but normal hauls within the specified series.

All hauls were intended to last for 30 minutes at a speed of 3 to 3.5 knots. Hauls were frequently terminated early due to rough ground. Most hauls were made during daylight although, when time became short, some were made after dark.

Catches were sorted into species on board immediately following the haul. In the case of small catches, all the catch had been sorted. For large catches, greater than 2 tonnes, a sub-sample was taken for biological sampling while the remainder of the catch was processed in the factory. The total weight of each species was determined from the amount of frozen products produced in the factory.

Samples for length distribution and biological sampling were obtained from random sub-samples from the catch. Sex was not determined from fish used in the length frequency samples.

Three adjacent hauls in rectangles 17 and 12 were not part of the original design (Annex 2) and their purpose was questioned. Dr Shust suggested that the intended location may have been unsuitable and that one at least might be the only ground on which it was possible to trawl in the vicinity.

The large haul of 23 tonnes had been made on a known concentration, as implied in the text of Paper 1 and it was a random haul within the predetermined survey design.

Information was presented about the USSR research vessel *Anchar* which has conducted another bottom trawl survey. The survey design is based on different principles of stratification. Trawling was only undertaken during daylight. Detailed information will be presented at the 1991 meeting of the CCAMLR Working Group on Fish Stock Assessment.

3.2 *Hill Cove*

GRT	1 591 tonnes
Power	2 000 hp
LOA	60 m
Beam	13.1 m

The intended towing speed was 3 to 3.5 knots over the ground. This was not always possible due to wind and tidal effects. A few hauls were made at 4 or even 5 knots and it was questioned whether the net would have fished efficiently on the bottom at these speeds. It was confirmed that evidence from net damage and the seabed polishing the bobbins indicated that the net had fished efficiently.

Although most of the hauls were made during daylight a significant proportion were made after dark. It was suggested that this might have some effect on the catch rate as some species, particularly *Champsocephalus gunnari*, tend to migrate off the bottom at night.

The catch was sorted on the factory deck. Small catches, generally less than 2 tonnes, were sorted completely by species into baskets. All of these were analyzed unless there was a very large number of small fish of similar size in the catch in which case a minimum of 100 individuals was measured.

Sub-samples of several baskets were taken from large catches. These sub-samples were fully analyzed. The total catch was determined from the proportion of the fish in the sub-samples to the number of the baskets in the total catch.

It was agreed that the report of the *Hill Cove* survey to be tabled in 1991 at the meeting of the CCAMLR Working Group on Fish Stock Assessment, would include maps showing the species distribution over the surveyed area.

There was some discussion on Coefficients of Variation.

4. DISTRIBUTION OF MAJOR SPECIES

4.1 *Champsocephalus gunnari*

Summarizing results from the *Akademik Knipovich* survey Dr Shust reported that *C. gunnari* was widespread around South Georgia but was only present in dense concentrations at some locations. These areas of high concentration were on the northern side of the west end of the island, near the shelf break west-southwest of the Willis Islands and around Shag Rocks. Around South Georgia the largest catches tended to be in the 150 to 250 m depth stratum. Dr Shust felt that there was a tendency for smaller fish to be present in the shallower depth stratum (50 to 150 m).

Dr Shust mentioned the results from previous surveys and concluded that there had been some redistribution of major concentrations over the shelf during the past five years. He felt that there was some tendency for the fish to migrate within Subarea 48.3 with the larger fish moving over greater distances.

The results from the *Hill Cove* survey indicated a broadly similar pattern of distribution around the island.

Samples had been taken for electrophoretic analysis. Preliminary results indicated that there may be separate populations at Shag Rocks and also that there may be evidence of separate populations being present around South Georgia. This study, being undertaken by Dr G. Carvalho at Bangor University, is likely to be expanded next season.

Dr Shust drew the attention of the group to similar studies on krill undertaken by the USSR. Initial results had indicated the presence of several populations but subsequent research had shown this not to be the case.

The results from the *Hill Cove* and *Akademik Knipovich* surveys had shown an essentially similar pattern of spatial distribution with low concentrations being present over much of the shelf, but relatively few large concentrations. It was thought that the presence of concentrations at more or less the same location on the two surveys, one month apart, gave some support to the view that there may be more than one stable concentration present.

There was some discussion on the vertical migration patterns of *C. gunnari.*

Dr Gasiukov showed a series of echocharts, obtained by an AtlantNIRO ship on an earlier survey, that indicted that the fish were very close to the bottom during the day but tended to migrate clear of the seabed after dark. Mr Parkes and Dr Shust also reported seeing the same phenomenon on Furuno colour video displays. Dr Everson reported that he was hoping to quantify this effect during a future survey planned for January 1991.

It was agreed that survey results from Shag Rocks should be analyzed separately from those from the mainland of South Georgia. It was also agreed that time of day should be taken into account in analyzing the data.

4.2 *Dissostichus eleginoides*

Both surveys had indicated that this species is present around Shag Rocks. The *Hill Cove* survey had caught large numbers of small specimens and both vessels had caught larger specimens there. Isolated large individuals were found around South Georgia on the *Hill Cove* survey although *Akademik Knipovich* made a large catch in the vicinity of Clerke Rocks.

The main distribution of this species is known to extend down to at least 1 000 m and it is also known to be semi-pelagic, hence bottom trawl surveys are likely to grossly underestimate its biomass.

4.3 *Patagonotothen brevicauda guntheri*

This species was only caught at Shag Rocks. None have been reported from South Georgia on previous surveys and Dr Shust stated that commercial catches had only been made in the vicinity of Shag Rocks.

Dr Shust also noted that the largest concentrations were generally made earlier in the season in November to January.

4.4 Other Species

Notothenia gibberifrons, *Pseudochaenichthys georgianus* and *Chaenocephalus aceratus* were found to be widespread over the shelf on South Georgia. Few large catches were

reported. *Hill Cove* caught 600 kg of *C. aceratus* to the south-west of South Georgia; these may have been feeding on the small *C. gunnari* present at the same location. *Akademik Knipovich* had only two hauls of this species greater than 100 kg.

5. ESTIMATION OF BIOMASS

All analyses were undertaken in parallel by USSR and UK scientists at the workshop and the results cross-checked to ensure consistency. Major discrepancies are recorded in the narrative of the report.

5.1 Swept Area Method

It was agreed that the standard swept area method described by Saville (1977) would be used for the first analyses.

5.2 Estimation of Biomass of *Champsocephalus gunnari*

There was some discussion on the way in which data should be grouped for the analyses. It was agreed that Shag Rocks data should be treated separately to those from the mainland of South Georgia. The following other models were agreed:

Determine biomass

Model 1 within fine-scale rectangles and by depth strata. The biomass would then be the sum of all rectangle and depth stratum values.

Model 2 within fine-scale rectangles irrespective of depth.

Model 3 within each depth stratum over the whole of the two areas (South Georgia and Shag Rocks).

Results from applying model 1 are given in Table 1 (*Hill Cove*) and Table 2 (*Akademik Knipovich*). These are summarized below:

Ship	Shag Rocks		South Georgia	
	Biomass	N	Biomass	N
Hill Cove	111 459	9	74 271	59
Akademik Knipovich	71 700	13	1 301 588	70

Reference to Table 1 indicates that 65% of the estimated biomass at Shag Rocks from the *Hill Cove* survey is present in the shallowest depth stratum of grid square 3. This was due to a single haul of 40 tonnes. Similarly in Table 2, 92% of the estimated biomass at South Georgia from the *Akademik Knipovich* survey is present in the 150 to 250 m depth stratum of grid square 8. This was due to one haul of 23 tonnes. It was felt that these large hauls were exerting an excessive influence on the biomass estimate and therefore warranted different analytical procedures. This is discussed further later.

The small number of hauls within each depth stratum and grid square, in many cases only one, meant that for many combinations of grid square and depth it was impossible to estimate variance for this model.

In view of these limitations to the analysis it was decided not to proceed further with this approach. The other two approaches provide for much larger sample sizes within each grouping and hence allow an estimation of variance to be made.

Applying model 2, analysis by grid square, gave the following summary results:

Analysis by Mr Parkes						
Ship	Shag Rocks			South Georgia		
	Biomass	N	CV (%)	Biomass	N	CV (%)
Hill Cove	278 431	8	83	75 576	59	79
Akademik Knipovich	121 680	13	34	597 424	70	79

Analysis by Dr Gasiukov						
Ship	Shag Rocks			South Georgia		
	Biomass	N	CV (%)	Biomass	N	CV (%)
Hill Cove	378 233	8	12	76 141	59	63
Akademik Knipovich	154 208	13	34	726 386	70	79

Discrepancies were noted between the results of the analyses performed by Mr Parkes and Dr Gasiukov using model 2. The source of this discrepancy was the result of differences in the interpretation of model 2. The equations that were used are given below:

Mr Parkes:

$$\hat{B} = \Sigma_s \hat{B}_s = \Sigma_s \left[\left[\sum_{i=1}^{n_s} C_i/A_i \right] A_s/n_s \right]$$

Dr Gasiukov:

$$\hat{B} = A \bar{x}_{st}$$

where $\bar{x}_{st} = \sum_{h=1}^{H} S_h \bar{x}_h / \sum_{h=1}^{H} S_h$

$$\bar{x}_h = 1/N_h \sum_{i=1}^{N_h} x_i^h/S_h i$$

The results after stratification into the three depth strata, model 3, are given in Table 3 and summarized below:

Ship	Shag Rocks			South Georgia		
	Biomass	N	CV (%)	Biomass	N	CV (%)
Hill Cove	278 937	9	83	95 405	59	63
Akademik Knipovich	108 652	13	31	877 817	70	69

Both model 2 and model 3 are strongly influenced by the large hauls mentioned above and it was concluded that they were responsible for the major difference between the biomass estimates from the two surveys. It was ageed that it would be desirable to develop alternative procedures for the analysis of these large hauls.

Table 3 indicates that biomass is strongly influenced by depth and it was agreed that, of the three models considered so far, model 3 provided the best estimator of biomass in the areas of moderate or low catch rates which predominated around the island.

At Shag Rocks there was a difference between the results from the two surveys, with the greatest biomass on the *Hill Cove* survey being present in the 50 to 150 m depth stratum whereas on the *Akademik Knipovich* survey the greatest biomass was in the 150 to 250 m stratum.

6. TREATMENT OF CLOSELY GROUPED HAULS

Concern was expressed that the three adjacent hauls in rectangles 17 and 12 as mentioned in section 3.1 may have been made on the same concentration of fish. If this were the case, it might mean that some form of replication had taken place. There were two schools of thought, one suggesting that the data from the three hauls should be summed and treated as being equivalent to a single long haul, the other that they should be treated as samples of equal status to all others in the survey.

In the absence of further information regarding these hauls it was decided to treat them as part of defined regions within the South Georgia area. This division was made in two ways, the first of which involved defining an area containing all hauls that appear to form a group. This was achieved by using data from four adjacent grid squares 12, 13, 17 and 18 within the 150 to 250 m depth stratum and analyzing these separately from the remainder of the South Georgia data. The second way was to divide the South Georgia area into two, a region of generally higher biomass west of 37° and a lower biomass region east of 37°.

The results from this comparison are set out below. The analyses were made using data from all hauls.

Akademik Knipovich survey, grouping data from grids 12, 13, 17 and 18 into one area and the rest of South Georgia into a second area; stratification by depth strata.		
Biomass of *Champsocephalus gunnari*		
	Grid 12....18	Remainder of South Georgia
150 to 250 m stratum	190 623 (N=12)	734 112 (N=21)
<u>Total biomass for South Georgia</u> 50 to 150 m stratum 150 to 250 250 to 500 Total	190 623 + 734 112	 2 740 924 735 9 363 936 838 N=70 CV=43%

Akademik Knipovich survey divided into east and west South Georgia regions		
East South Georgia		
50 to 150 m	2 030	N=8
150 to 250 m	12 103	N=17
250 to 500 m	4 818	N=12
Total	18 953	N=37 CV=38%
West South Georgia		
50 to 150 m	805	N=7
150 to 250 m	946 536	N=16
250 to 500 m	4 553	N=10
Total	951 895	N=33 CV=70%
South Georgia Total	970 848	N=70 CV=69%

The different systems of stratification do not change the results by more than 5 or 10%. These analyses include results from all hauls.

7. TREATMENT OF LARGE CATCHES

The very strong effect of the large hauls on the *Hill Cove* survey (40 tonnes at Shag Rocks) and *Akademik Knipovich* survey (23 tonnes at South Georgia) can be clearly seen from the results if they are excluded from the analysis. The following results duplicate those in section 6 with the exception that the large haul of 23 tonnes at station 16 has been excluded from the analysis, greatly reducing the estimated biomass.

Akademik Knipovich survey, grouping data from grids 12, 13 17 and 18		
Biomass of *Champsocephalus gunnari*		
	Grid 12....18	Remainder of South Georgia
150 to 250 m stratum	190 623 (N=12)	18 271 (N=20)
Total biomass for South Georgia		
50 to 150 m stratum		2 740
150 to 250 m	190 623 + 18 271	208 894
250 to 500 m		9 363
Total		220 997 N=69 CV=43%

Akademik Knipovich survey dividing survey into east and west South Georgia regions		
East South Georgia		
50 to 150 m	2 031	N=8
150 to 250 m	12 104	N=17
250 to 500 m	4 818	N=12
Total	18 953	N=37 CV=38%
West South Georgia		
50 to 150 m	805	N=7
150 to 250 m	296 861	N=15
250 to 500 m	4 554	N=10
Total	302 220	N=32 CV=49%
South Georgia Total	321 173	N=69 CV=46%

The above analyses exclude data from the large haul of 23 tonnes made at station 16.

A major difference in biomass estimates between the different methods of stratification was noted and it was agreed that this merited further attention.

One of the basic assumptions of the swept area method (SAM) is that the frequency distribution of catches is normal. Both surveys contained a large proportion of hauls where catches were less than 1 tonne and a much smaller number of larger catches with, in each case, one very large catch (Figure 1). It was agreed that for the small catches SAM was valid. It was not thought to be valid for the extremely large hauls. Its validity for the intermediate sized hauls, between about 1 and 10 tonnes, was also questioned.

There was much discussion on this subject and time prevented a full exploration of the possible analyses. However, it was accepted that all large hauls were valid and should be incorporated into the total biomass estimates. The following describes the general approaches that were discussed.

The simplest approach was to treat the highest values as freak occurrence which were not representative of the overall situation but rather represented a local very high biomass. To reduce the effect on the biomass estimate it was suggested that the value be reduced by an order of magnitude. However, it was thought that such an arbitrary reduction would be very unwise as it had no logical basis to support it and, furthermore, might be seen as questioning the techniques of those people engaged in data collection.

An alternative was to treat the extreme values as being unusual examples of hauls of moderate size. The extreme values were therefore replaced with the mean of all hauls greater than 1 tonne but excluding the largest value. The results from this approach are summarized below:

Akademik Knipovich Mean 'large haul' value = 6 393 kg over a towing distance of 1.75 nm		
South Georgia		
50 to 150 m	2 740	N=15
150 to 250 m	321 412	N=33
250 to 500 m	9 363	N=22
Total	333 515	N=70 CV=42%
Shag Rocks		
50 to 150 m	4 439	N=3
150 to 250 m	104 088	N=9
250 to 500 m	124	N=1
Total	108 653	N=13 CV=31%
Hill Cove Mean 'large haul' value = 4 029 kg over a towing distance of 2.0 nm		
South Georgia		
50 to 150 m	1 234	N=8
150 to 250 m	93 502	N=39
250 to 500 m	667	N=12
Total	95 405	N=59 CV=63%
Shag Rocks		
50 to 150 m	51 515	N=5
150 to 250 m	2 676	N=3
250 to 500 m	0	N=1
Total	54 193	N=9 CV=38%

The results, as expected, give a much reduced biomass estimate and also, since the largest values have been reduced, the coefficients of variation are also reduced. In the case of South Georgia this is from 60 to 42% and at Shag Rocks from 83 to 38%.

A second approach was to assume that the extreme hauls were unusual events, and to try to estimate how often such a concentration of fish might occur. Existing swept area methods were used to estimate biomass from all other stations, and then an adjustment was made by first finding the proportion of total swept area covered by the highest density in the middle stratum of western South Georgia, in which all the larger catches were made. This proportion was then multiplied by the density of the haul from station 16, and then by the total seabed area in the middle stratum of western South Georgia. A similar adjustment was made for the *Hill Cove* results at Shag Rocks, but using the whole of the shallowest stratum.

Results: South Georgia, *Akademik Knipovich* survey		
Adjustment for large haul		
Large haul adjustment (LHA): 216 264 = C * A * a16 / sum(a) (in tonnes)		
Catch rate in haul 16 (kg/sq. km)	1 036 036	= C
Seabed area, west South Georgia, 150 to 250 m	10 342.1	= A
Swept area, haul 16	0.0222	= a16
Total swept area, west South Georgia, 150 to 250 m	1.0999	= sum(a)

Akademik Knipovich
Grouping data from grids 12, 13, 17 and 18. Large haul analyzed separately.

Stratum	Grid 12....18	Remainder
150 to 250 m	190 623	18 271
	Total by Stratum	
50 to 150 m	2 740	
150 to 250 m	208 894	
250 to 500 m	9 363	
Total	220 997 (excluding large haul adjustment)	
LHA	216 264	
Total	437 261	

Akademik Knipovich
Survey divided into eastern and western South Georgia. Large haul analyzed separately.

Stratum	Eastern South Georgia
50 to 150 m	2 030
150 to 250 m	12 103
250 to 500 m	4 818
Total East South Georgia	18 951
Stratum	Western South Georgia
50 to 150 m	805
150 to 250 m	296 860
250 to 500 m	4 554
Total West South Georgia	302 220
Total	321 169 (excluding large haul adjustment)
LHA	216 264
Total	537 433

Results: Shag Rocks, *Hill Cove* Survey	
Adjustment for large haul (LHA):	
184 787 = (catch rate, haul 82)*(total seabed area in Shag Rocks, shallow stratum)*(swept area of haul 82)/(total swept area in Shag Rocks, shallow stratum)	
Hill Cove survey: Stratification by depth strata only, excluding haul 82	
Stratum	Shag Rocks, Total by Stratum
50 to 150 m	44 825
150 to 250 m	2 677
250 to 500 m	0
Total Shag Rocks	47 502 (excluding large haul adjustment)
LHA	184 787
Total	232 289

A third approach was to treat all samples as being part of a highly skewed distribution and apply a transformation to the catch rates in order to normalize the distribution. While having considerable merit as an approach, it was recognized some difficulty might be encountered in determining a suitable transformation to apply to the data.

8. DAY/NIGHT DIFFERENCES

It was accepted that the diurnal vertical migration pattern of *C. gunnari* was likely to influence the results from bottom trawl surveys, however time did not permit a thorough examination of the data to quantity the effect.

9. BIOMASS ESTIMATES FOR OTHER SPECIES

With the exception of *Dissostichus eleginoides* where one large haul was made during the *Akademik Knipovich* survey the distribution of catch rates for all other species did not vary widely. It was accepted that, in view of the high catches of *D. eleginoides*, the data from that species should be treated in the same way as those for *C. gunnari* described above. It was agreed that the standard swept area method should be appropriate for these analyses. The results from the two surveys are presented below.

Note: In each column the biomass is given with the percentage CV in brackets.

Species	South Georgia				Shag Rocks			
	Hill Cove		*Akademik Knipovich*		*Hill Cove*		*Akademik Knipovich*	
	Biomass	%CV	Biomass	%CV	Biomass	%CV	Biomass	%CV
C. aceratus	14 226	(37)	14 424	(26)	0		0	
P. georgianus	5 761	(28)	12 200	(28)	37	(73)	0	
N. gibberifrons	12 417	(28)	21 891	(23)	267	(39)	0	
N. rossii	1 481	(76)	3 915	(30)	0		0	
D. eleginoides	335	(39)	3 020*	(33)	9 631	(55)	1 693	(21)
P.b. guntheri	0		0		13 608	(90)	1 918	(45)
N. larseni	590	(23)	0		50	(85)	0	
N. nudifrons	129	(51)	0		46	(62)	0	
N. squamifrons	1 239	(59)	5 977	(98)	120	(44)	414	(55)
Other Species	2 877	(19)	606	(34)	338	(51)	67	(67)

* Excludes large catch from Clerke Rocks

The results, although in some cases showing quite large differences, do demonstrate a reasonable degree of concordance between the two surveys. The general trends in biomass indices between the surveys, with *Akademik Knipovich* providing generally higher values, is followed through the results. The presence of zero as a biomass value indicates that no catch was made of that species by the respective vessel for the area.

The results for *D. eleginoides* are strongly affected by the known distribution of the species as described in section 4.2. It was agreed that bottom trawl surveys should not be used in isolation to provide biomass estimates for this species.

10. CONCLUSIONS

The group concluded that due to the highly skewed nature of the catch distribution it was difficult to determine a suitable index of abundance. The small number of large hauls had caused many analytical problems and the best way of dealing with them had not been finally resolved. Several methods which attempt to deal with these problems were considered. When these methods were applied it was possible to reduce the CVs of estimates of biomass. It was felt that the swept area method, stratified by depth, but excluding the very largest hauls would provide a useful minimum index of biomass. It should be remembered that the relative catching power of each vessel is unknown and therefore both survey estimates are of equal validity.

Possible further spatial stratifications were discussed including a north-south division along latitude 54°.

The evidence for diurnal vertical migration of *Champsocephalus gunnari* indicated that in future, bottom trawl surveys should be conducted in daylight when the fish are closest to the seabed.

The distribution of biomass between depth strata in the South Georgia area follows that of previous surveys, the greatest proportion being present in the middle (150 to 250 m) depth

stratum. It was suggested that a more appropriate depth division might be as follows:

50 to 100 m
100 to 200 m
200 to 300 m
300 to 500 m.

It was agreed that this should be investigated using the results from this and previous surveys.

It was agreed that the swept area method alone did not provide a good estimate of biomass for *D. eleginoides* and that for this species other methods need to be taken into consideration.

Lack of time had prevented the participants from investigating the relationship between coefficient of variation and sample size. It was agreed that such analyses should be undertaken so as to plan future surveys more efficiently. Further work was also required on sample sizes and the spatial distribution of sampling stations.

In spite of the short time between the completion of the surveys it was possible to undertake analyses of full datasets at the workshop. This was seen as a most welcome development. All the participants hoped that the cooperative analysis, established at this workshop, could be repeated in the future.

It was also agreed that there is a great deal of merit in collaborating on future surveys at all stages and it was felt that the two surveys this year leading up to this workshop demonstrated that such collaboration was useful not only for the two national groups present but also in the wider context of CCAMLR. The wish was further expressed that such collaboration might also include krill surveys.

11. RECOMMENDATIONS

The group recommended that the CCAMLR fine-scale grid squares should be used as a basis for designing surveys to ensure that the whole area of interest receives adequate coverage.

The group recommended that consideration should be given to designating grid squares within which surveys had suffered significant gear damage and to determining how necessary it was to obtain samples within them.

The swept area method is suitable for widely distributed species that are present in low density. Certain species, particularly *C. gunnari*, do occur in local dense concentrations and the group recommended that attention should be given to designing surveys and analyzing results to take account of this form of distribution.

The group recommended that analyses of survey data should be undertaken in the first instance by depth stratum and major area, such as Shag Rocks, South Georgia in total or in four quandrants.

The group recommended that particular attention should be given to methods of estimating biomass from surveys which contain a small number of unusually large hauls.

The group strongly recommended that collaborative links should be strengthened to allow joint work in the field and in analyzing results as this can only improve the quality of the results.

12. ADOPTION OF THE REPORT

The report of the workshop was adopted.

13. CLOSURE OF THE MEETING

The Convener thanked all participants for their cooperation and efforts and thanked Dr Beddington and the Renewable Resources Assessment Group (Imperial College, London) for hosting the workshop and providing secretarial assistance and computing facilities. He also thanked the interpreters and all colleagues of the UK and the USSR participants, who were involved in preparations for the workshop.

The Convener expressed the wish that similar workshops would be possible in the future and that the recommendations to cooperate and collaborate more fully in future would bear fruit.

Dr Shust extended his thanks, on behalf of the USSR participants, to all involved in the workshop and he supported the Convener's view that the workshop had been very successful.

The Convener closed the meeting.

PAPERS TABLED

1. KOZLOV, A.N. and K.V. SHUST. USSR Fish Stock Assessment Survey Made in Subarea 48.3 in February 1990.

2. PARKES, G. *Hill Cove* Survey Report. (Draft).

REFERENCES

SAVILLE, A. (Ed.). 1977. Survey methods of appraising fishery resources. *FAO Fish. Tech. Pap. 171*: 76.

Table 1: Results of the analysis by grid-square and depth strata (Model 1) of the *Hill Cove* survey.

	N	Biomass	%CV	Total
South Georgia	59	74 271	81	81
Shag Rocks	9	111 459	208	208
Total	68	185 730	208	208

	South Georgia *C. gunnari* Biomass	Shag Rocks *C. gunnari* Biomass
50-150 m		
3	0	72 520
5	0	36 803
8	0	0
9	0	0
14	349	0
15	4	0
21	465	0
25	43	0
25	13	0
150-250 m		
2	0	0
5	0	2 137
8	12 906	0
9	540	0
10	77	0
12	7 467	0
13	457	0
14	988	0
15	266	0
16	669	0
18	49 040	0
19	17	0
20	32	0
21	229	0
22	119	0
24	71	0
25	58	0
26	33	0

Table 1 (continued)

	South Georgia *C. gunnari* Biomass	Shag Rocks *C. gunnari* Biomass
250-500 m		
2	0	0
7	0	0
8	53	0
9	81	0
10	0	0
11	46	0
12	35	0
13	13	0
16	43	0
18	0	0
21	147	0
22	8	0
25	0	0
Total	74 271	111 450

Table 2: Results of the analysis by grid-square and depth strata (Model 1) of the *Akademik Knipovich* survey data.

	N	Biomass	%CV	Total
South Georgia	70	1 301 580	47	47
Shag Rocks	13	71 700	47	47
Total	83	1 373 287	47	47

	South Georgia *C. gunnari* Biomass	Shag Rocks *C. gunnari* Biomass
1.00		
5.00	0	3 645
8.00	77	0
9.00	22	0
13.00	44	0
14.00	576	0
21.00	489	0
22.00	4	0
25.00	169	0
26.00	682	0
2.00		
2.00	0	23 836
4.00	0	10 007
5.00	0	34 380
8.00	1 199 312	0
9.00	1 232	0
10.00	808	0
12.00	70 794	0
13.00	2 057	0
14.00	301	0
15.00	156	0
16.00	2 884	0
17.00	2 352	0
18.00	5 045	0
21.00	7 940	0
22.00	1 392	0
24.00	81	0
25.00	125	0

Table 2 (continued)

	South Georgia *C. gunnari* Biomass	Shag Rocks *C. gunnari* Biomass
3.00		
5.00	0	32
8.00	1 853	0
9.00	614	0
10.00	355	0
11.00	168	0
12.00	488	0
14.00	2	0
15.00	238	0
16.00	1 788	0
18.00	406	0
21.00	132	0
25.00	0	0
26.00	0	0
Total	1 301 580	71 700

Table 3: Results of the analysis by depth strata (Model 3) for the *Hill Cove* survey and for the *Akademik Knipovich* survey.

Hill Cove

		N	Biomass	
	South Georgia			
	50-150 m	8	1 234.78	
	150-250 m	39	93 502.84	
	250-500 m	12	667.02	
	Shag Rocks			
	50-150 m	4	276 260.19	
	150-250 m	3	2 676.81	
	250-500 m	1	0.00	
Totals				
		N	Biomass	%CV
South Georgia		59	95 405	63
Shag Rocks		9	278 937	83

Akademik Knipovich

		N	Biomass	
	South Georgia			
	50-150 m	15	2 740.18	
	150-200 m	33	865 712.99	
	250-500 m	22	9 363.36	
	Shag Rocks			
	50-150 m	3	4 439.46	
	150-200 m	9	104 088.00	
	250-500 m	1	124.06	
Totals				
		N	Biomass	%CV
South Georgia		70	877 817	69
Shag Rocks		13	108 652	31

Please Note: The column sums in several tables are not identical to the given totals, due to rounding.

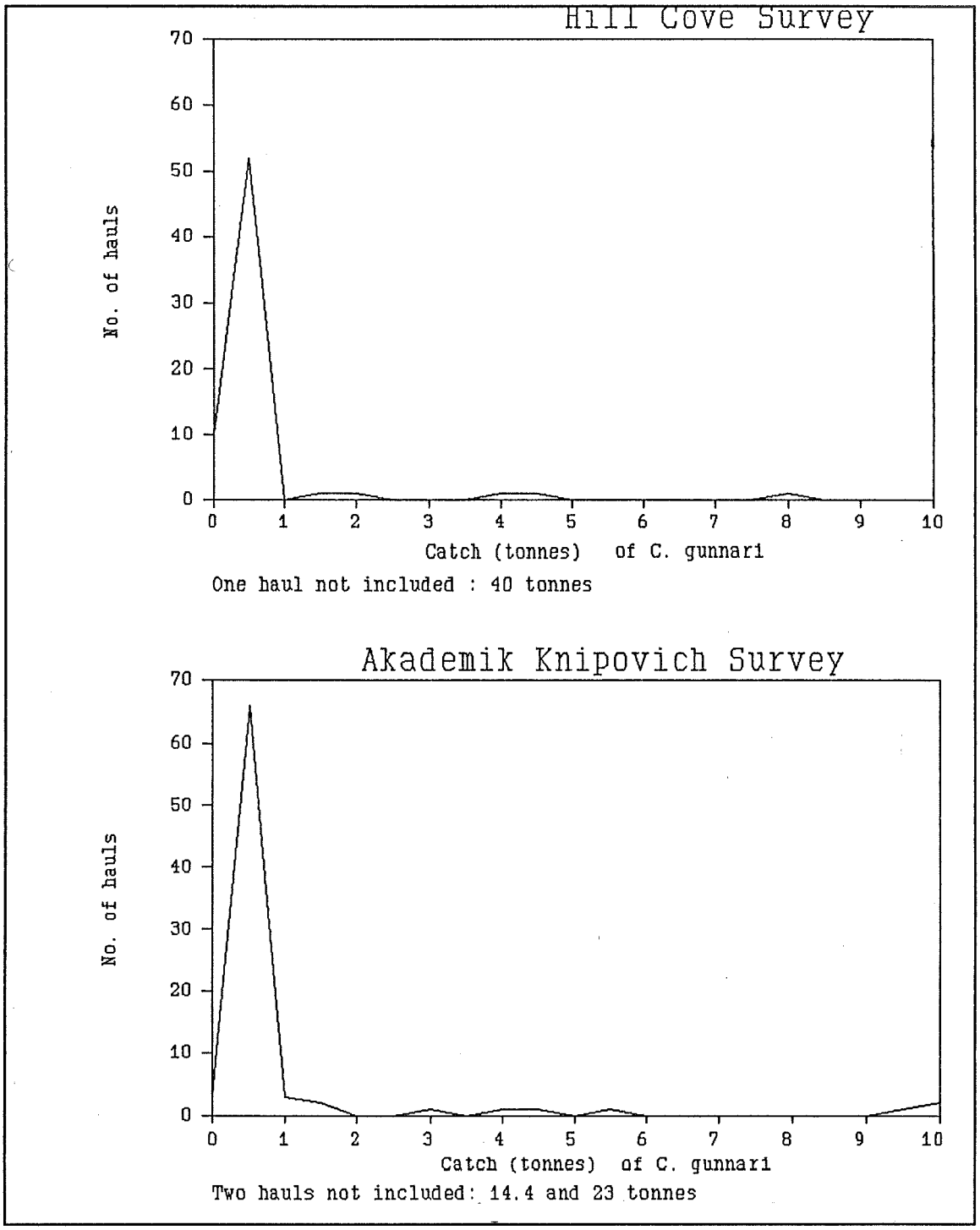

Figure 1: Frequencies (number of hauls) of catches by size (in tonnes) for the *Hill Cove* survey and the *Akademik Knipovich* survey. Note that, in both cases, the horizontal axis has been truncated for presentation; hauls not shown on the graphs are indicated below each figure.

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ANNEX 1

AGENDA FOR THE UK/USSR WORKSHOP
(23 to 27 July, 1990)

1. Appointment of rapporteur.

2. Check, load onto computer and validate data from both surveys against field data logbooks.

3. Provide a full description of both surveys.

4. Check cruise track data against UK and USSR hydrographic charts.

5. Determine biomass of major species within CCAMLR fine-scale reporting areas (half degree of latitude by one degree of longitude).

6. Determine population structure of the dominant species in the South Georgia area.

7. Assess the effectiveness of current survey techniques and recommend plans for future surveys.

8. Adoption of the report.

ANNEX 2

PROPOSED SURVEY DESIGN

(Submitted by United Kingdom)

1. Objectives

To estimate the standing stock of demersal fish in the vicinity of South Georgia.

2. Survey Design

The survey area has been divided into sampling rectangles according to the CCAMLR fine-scale data reporting format. These are half a degree of latitude by one degree of longitude and are specified by the coordinates of the rectangle nearest to the equator.

Previous surveys have stratified the sampling by depth within depth ranges 50-150, 150-250 and 250-500 m. The same approach has been adopted for this survey. The area of seabed within depth has been estimated and the values give in Table 1.

Sampling intensity has been determined based on the method of Francis (1984). The estimated values have been slightly adjusted to ensure adequate coverage of all rectangles with more than 200 sq. km of seabed within a depth range. The proposed sampling locations are shown in Table 2.

Depth strata where there is less than 200 sq. km of seabed within a rectangle will be assumed to have the same density as that within the most appropriate adjacent rectangle or rectangles. Decisions as to the most suitable adjacent rectangles to select have been based on the degree of continuity of the relevant depth contour into adjacent rectangles. The proposed system is outlined in Table 3.

3. Sampling Methods

Each sampling section will consist of one representative bottom trawl with the net fishing for 30 minutes on the bottom.

The net used will be essentially the same as that used on the previous surveys undertaken by Poland in conjunction with USA and UK. This is a standard commercial bottom trawl 32/36 with a codend mesh of 80 mm and fitted with a 40 mm liner.

Estimates of total catch, by weight and number, will be made and the catch sampled to provide the length, age, weight and maturity stage composition for each species.

References

FRANCIS, R.I.C.C. 1984. An Adaptive strategy for stratified random trawl surveys. *New Zealand Journal of Marine and Freshwater Research, 18*: 59-71.

Table 1: Areas of seabed, South Georgia Subarea 48.3

The areas are presented as square kilometres and assume a total area within each rectangle of 3 548.2 km^2.

Coordinates of NE Corner		Areas of Seabed Within Depth Ranges (m)					
°S	°W	50-100	100-150	150-200	200-250	250-500	>500
53	43	0.0	0.0	0.0	0.0	12.4	3 536.1
53	42	0.0	0.0	217.8	264.2	507.8	2 558.8
53	41	0.0	26.7	129.2	36.5	52.2	3 303.9
53 30	42	0.0	153.9	215.8	114.7	221.0	2 841.1
53 30	41	0.0	1 049.1	586.4	483.2	310.2	1 118.3
53 30	40	0.0	6.5	59.4	71.1	401.8	3 009.7
53 30	39	0.0	0.0	0.0	170.5	710.1	2 667.9
53 30	38	334.4	340.3	430.8	574.4	420.3	1 448.4
53 30	37	133.4	527.3	781.9	307.7	1 085.0	713.2
53 30	36	0.0	0.0	134.4	1 402.5	885.8	1 125.8
53 30	35	0.0	0.0	0.0	59.7	320.6	3 168.2
54	39	0.0	0.0	114.1	940.3	579.4	1 914.6
54	38	124.9	171.3	1 332.4	1 103.2	797.2	0.0
54	37	181.6	121.9	12.2	11.0	0.0	0.0
54	37 so	250.5	270.6	660.7	485.2	214.5	0.0
54	36	329.2	270.8	391.2	481.9	191.7	0.0
54	36 so	88.2	48.7	29.2	11.0	0.0	0.0
54	35	17.8	83.6	138.1	1 782.5	388.3	1 138.2
54 30	39	0.0	0.0	0.0	245.8	124.1	3 178.6
54 30	38	0.0	0.0	663.0	866.4	418.5	1 600.6
54 30	37	107.9	362.9	732.3	755.0	1 102.4	481.2
54 30	36	355.9	181.1	201.8	1 049.0	362.8	0.0
54 30	35	500.7	527.6	397.4	788.6	1 065.8	95.1
54 30	34	0.0	100.1	259.7	100.1	430.6	2 657.9
55	37	0.0	0.0	10.4	26.0	56.0	3 456.2
55	36	0.0	79.6	171.9	458.7	167.3	2 670.9
55	35	0.0	1 234.8	548.1	960.7	770.3	34.6
55	34	0.0	484.1	183.9	140.6	240.7	2 495.5
55 30	35	0.0	0.0	0.0	0.0	137.8	3 410.7
TOTAL		2 424.5	6 040.76	8 402.15	13 690.5	11 974.6	48 625.4

Table 2: Proposed positions for sampling stations during South Georgia groundfish survey, January 1990.

2a - Sampling stations in vicinity of Shag Rocks

Fine-Scale Grid			Proposed Station Positions		
° Min	° Min				
South	West	Depth	Latitude	Longitude	
53 0	43 0	C	+++	+++	
53 0	42 0	B	53.38	42.30	*
		C	53.33	42.70	*
53 0	41 0	A	+++	+++	
		B	+++	+++	
		C	+++	+++	
53 30	42 0	A	+++	+++	
		B	53.52	42.40	*
		C	53.68	42.35	!
53 30	41 0	A	53.53	41.78	*
		A	53.72	41.57	*
		A	53.62	41.41	**
		B	53.80	41.68	*
		B	53.85	41.25	*
		B	53.77	41.33	**
		C	53.92	41.70	*
53 30	40 0	A	+++	+++	
		B	+++	+++	
		C	53.53	40.81	!

For explanation of symbols see notes following Table 2b.

Table 2 (continued)

2b - Sampling stations in vicinity of South Georgia

Fine-Scale Grid			Proposed Station Positions		
°Min	°Min				
South	West	Depth	Latitude	Longitude	
53 30	39 0	B	+++	+++	
		C	53.89	39.55	
53 30	38 0	A	53.91	38.47	
		B	53.72	38.03	
		B	53.75	38.36	
		B	53.77	38.61	
		C	53.72	38.45	*
53 30	37 0	A	53.80	37.17	
		B	53.68	37.58	
		B	53.70	37.08	*
		B	53.65	37.23	**
		C	53.89	37.27	
53 30	36 0	B	53.90	36.20	
		B	53.90	36.27	
		B	53.77	36.90	
		B	53.71	36.88	
		C	53.71	36.37	
53 30	35 0	B	+++	+++	
		C	53.93	35.83	
54 0	39 0	B	54.12	39.24	
		B	54.03	39.10	*
		B	54.30	39.23	!
		C	54.09	39.28	
54 0	38 0	A	54.11	38.04	**
		B	54.15	38.64	
		B	54.28	38.34	
		B	54.31	38.53	
		B	54.41	38.85	
		B	54.49	38.60	
		C	54.32	38.82	!
54 0	37 0	A	54.24	37.83	
		B	54.36	37.65	
		B	54.30	37.90	
54 0	36 0	A	54.18	36.32	
		B	54.04	36.37	
		B	54.22	36.43	*

Table 2b (continued)

Fine-Scale Grid			Proposed Station Positions		
°Min	°Min				
South	West	Depth	Latitude	Longitude	
54 0	35 0	A	54.99	35.44	
		B	54.10	35.68	
		B	54.15	35.77	
		B	54.30	35.85	
		B	54.47	35.65	*
		C	54.88	35.35	
54 30	39 0	B	54.58	39.17	!
		C	+++	+++	
54 30	38 0	B	54.73	38.57	
		B	54.67	38.35	
		B	54.61	38.07	
		C	54.84	38.33	
54 30	37 0	A	54.55	37.47	*
		B	54.77	37.25	*
		B	54.80	37.03	*
		B	54.85	37.18	**
		C	54.97	37.00	*
54 30	36 0	A	54.55	36.88	*
		B	54.94	36.21	**
		B	54.69	36.96	**
		C	54.97	36.10	!
54 30	35 0	A	54.89	35.69	
		A	54.72	35.54	
		B	54.62	35.21	
		B	54.51	35.83	
		B	54.68	35.31	**
		C	54.43	35.27	
54 30	34 0	A	+++	+++	
		B	54.90	34.98	
		C	54.82	34.90	
55 0	37 0	B	+++	+++	
		C	+++	+++	
55 0	36 0	A	+++	+++	
		B	55.17	36.22	*
		B	55.07	36.28	**
		C	+++	+++	

Table 2b (continued)

Fine-Scale Grid			Proposed Station Positions		
°Min	°Min				
South	West	Depth	Latitude	Longitude	
55 0	35 0	A	55.19	35.39	
		A	55.08	35.35	
		B	55.27	35.92	
		B	55.31	35.37	
		C	55.12	35.92	*
			55.46	35.26	
55 0	34 0	A	55.07	34.96	
		B	55.27	34.85	*
		C	+++	+++	
55 30	35 0	C	+++	+++	

Notes:

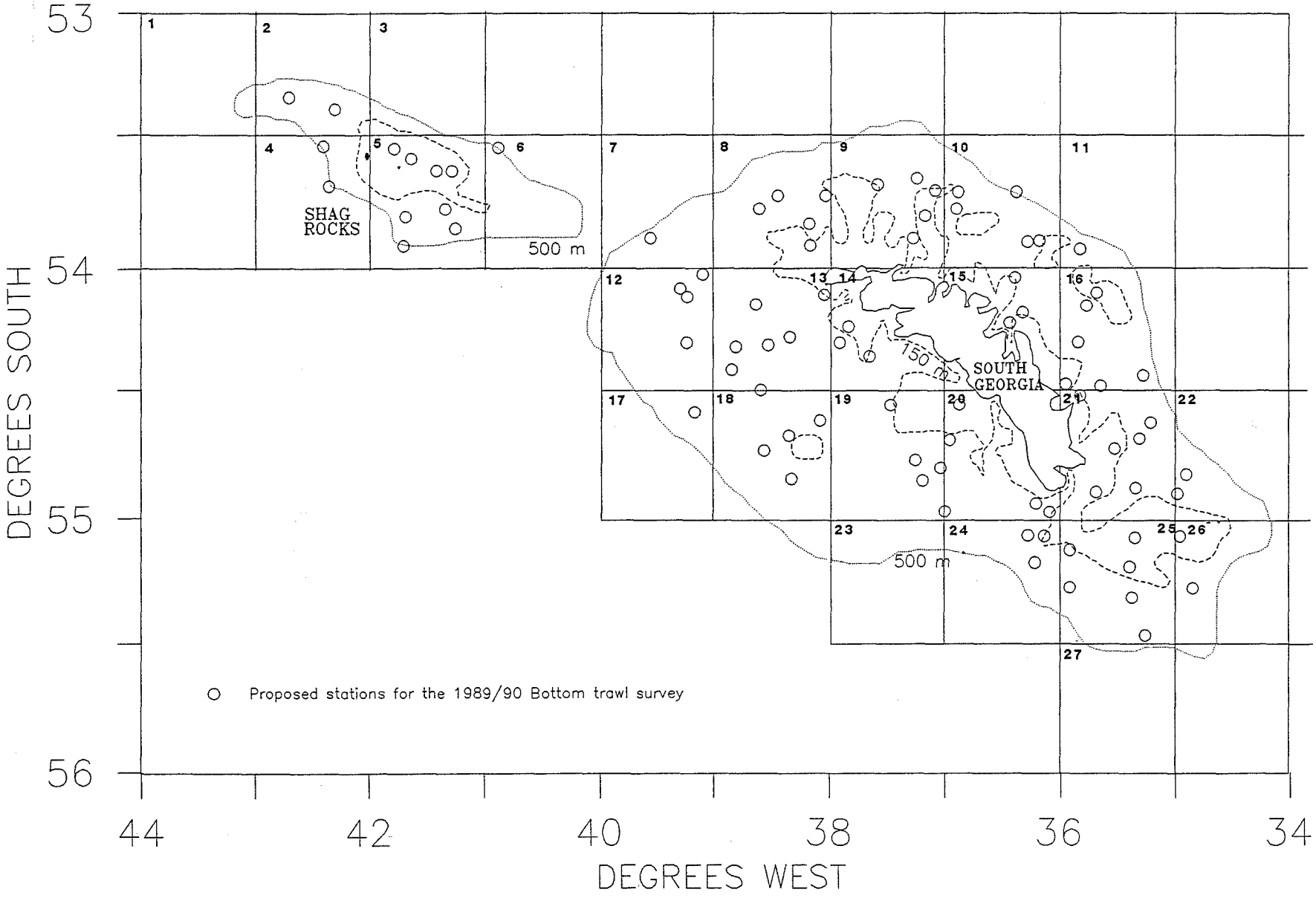
*	signifies that a position has been taken from the 1986/87 USA/Polish survey.
**	signifies that a position has been taken from the 1987/88 USA/Polish survey.
!	signifies that this position has not been sampled before.
+++ +++	signifies that there is some seabed within the depth range but this is insufficient to warrant allocating a sampling station. See Table 3.
	No indicator in the final column indicates that the station was sampled during the 1988/89 UK/Polish survey.

The depth ranges are:

A = 50-150 m
B = 151-250 m
C = 251-500 m

Table 3: Density estimates to be used in unsampled rectangles.

Unsampled Rectangle	Depth	Density Derived from:
53 00 43	C	Use value from 53°00'S, 43°W
53 00 41	A	Use mean value from 53°30'S, 41°W
	B	Use mean value from 53°30'S, 41°W
	C	Use value from 53°00'S, 43°W
53 30 42	A	Use mean value from 53°30'S, 41°W
53 30 40	A	Use mean value from 53°30'S, 41°W
	B	Use mean value from 53°30'S, 41°W
54 30 39	B	Use mean value from 53°30'S, 38°W
53 30 35	B	Use mean of all values in 53°30'S, 36°W and 54°00'S, 35°W
54 30 39	C	Use mean of all values in 53°00'S, 39°W and 54°30'S, 38°W
54 30 34	A	Use mean of all values in 55°00'S, 35°W and 55°00'S, 34°W
55 00 37	B	Use mean value from 54°30'S, 37°W
	C	Use mean value from 54°30'S, 37°W
55 00 36	A	Use mean value from 55°00'S, 35°W
	C	Use mean value from 55°00'S, 35°W
55 00 34	C	Use mean of all values in 53°30'S, 36°W and 54°00'S, 35°W
55 30 35	C	Use mean value from 55°00'S, 35°W


53
54
55
56
DEGREES SOUTH
44
42
40
38
36
34
DEGREES WEST
1
2
3
4
5
6
7
8
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10
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22
23
24
25
26
27
SHAG ROCKS
500 m
150 m
SOUTH GEORGIA
500 m
Proposed stations for the 1989/90 Bottom trawl survey