REVISED ESTIMATES OF THE AREA OF THE SOUTH GEORGIA AND SHAG ROCKS SHELF (CCAMLR SUBAREA 48.3)

M. Belchier✉ and P. Fretwell
British Antarctic Survey
High Cross, Madingley Road
Cambridge CB3 0ET
United Kingdom
Email – markb@bas.ac.uk

Abstract

A new South Georgia Bathymetric Dataset (SGDB) was compiled from a variety of primary sources including multi-beam swath bathymetry. Sea floor area (km^2 <500 m depth) within CCAMLR Subarea 48.3 was calculated using this new dataset. Total sea floor area within the region closely matched existing estimates derived from nautical charts (and single-point sounding data). However, the reliability of existing sea floor area estimates was found to vary spatially and between different depth strata. The new dataset is considered the most accurate and reliable currently available and should be used for future assessments and for assisting with the stratification of surveys.

Résumé

Un nouveau jeu de données bathymétriques sur la Géorgie du Sud (SGDB, pour South Georgia Bathymetric Dataset) a été compilé à partir de diverses sources dont la bathymétrie multifaisceaux. Ce nouveau jeu de données a permis de calculer la surface de fond marin (km^2 <500 m de profondeur) de la sous-zone 48.3 de la CCAMLR. La surface totale de fond marin dans la région correspond de près aux estimations actuelles dérivées des cartes nautiques (et de données de sondage en un seul point). Il a toutefois été constaté que la fiabilité des estimations actuelles de la surface de fond marin variait spatialement et en fonction des strates de profondeur. Le nouveau jeu de données est considéré comme le plus exact et le plus fiable qui soit disponible actuellement et il devrait être utilisé dans les prochaines évaluations et pour faciliter la stratification des campagnes d'évaluation.

Резюме

На основании различных первоисточников, включая батиметрические данные широкополосного многолучевого эхолота, был составлен новый набор батиметрических данных для Южной Георгии (SGDB). Площадь морского дна (км^2 на глубинах <500 м) в пределах Подрайона 48.3 АНТКОМ была рассчитана с использованием этого нового набора данных. Общая площадь морского дна в пределах этого региона хорошо соответствует существующим оценкам, полученным по морским навигационным картам (и данным одноточечного зондирования). Однако было обнаружено, что надежность существующих оценок площади морского дна меняется в пространстве и между различными горизонтами глубин. Новый набор данных считается наиболее точным и надежным из имеющихся в настоящее время и должен использоваться для будущих оценок и для содействия при проведении стратификации съемок.

Resumen

Se compiló un nuevo conjunto de datos batimétricos de Georgia del Sur (SGDB) de varias fuentes primarias incluido los datos de batimetría en fajas con sonares de múltiples haces. Se calculó el área de lecho marino (km^2 <500 m de profundidad) dentro de la Subárea 48.3 de la CCRVMA utilizando este nuevo conjunto de datos. El área total de lecho marino calculada para esta región fue muy similar a las estimaciones actuales derivadas de las cartas de navegación (y con los datos de ecosondas de un solo haz). Sin embargo, se encontró que la fiabilidad de las estimaciones existentes del área de lecho marino varía en función del espacio y entre los distintos estratos de profundidad. Se considera que el nuevo conjunto de datos actualmente disponible es el más preciso y fiable y debiera ser utilizado en las futuras evaluaciones y para facilitar la estratificación de las prospecciones.

Keywords: South Georgia, swath bathymetry, *Champsocephalus gunnari*, CCAMLR

Introduction

The area of sea floor within different depth strata in the South Georgia and Shag Rocks (CCAMLR Subarea 48.3) region has previously been calculated from nautical charts (Everson and Campbell, 1990 and references therein). These data are used to scale-up trawl survey derived, swept-area estimates of density of mackerel icefish (*Champsocephalus gunnari*) in Subarea 48.3 for stock assessment purposes (see CCAMLR Fishery Reports: www.ccamlr.org/pu/e/e_pubs/fr/drt.htm) and to enable appropriate trawl survey stratification. The nautical charts used to obtain these estimates are known to be unreliable, particularly for the areas to the south of South Georgia, as they rely on limited sounding data, with some dating from the 1920s.

Updated estimates of the sea floor in Subarea 48.3 have many benefits such as helping to provide more refined biomass estimates of demersal fish species from trawl surveys and to assist with the appropriate depth stratification of such surveys. A better knowledge of the bathymetry of the South Georgia and Shag Rocks shelf would also assist with the development of fine-scale oceanographic models of the shelf region, helping to inform on areas such as egg and larval transport and distribution.

The advent of multibeam swath bathymetry systems deployed from research vessels has made it possible to collect high-resolution bathymetric data more quickly and cost effectively. This has led to the recent development by British Antarctic Survey (BAS) of the South Georgia Bathymetric Dataset (SGBD). The SGBD is a high-resolution gridded raster sampled at 150 m resolution with a geographical extent stretching between 34–44°W and 53–56°S.

This paper uses the SGDB to calculate seabed areas within 50 m depth strata for the South Georgia and Shag Rocks region. The new data are compared with estimates of seabed area derived from nautical charts by Everson and Campbell (1990).

Materials and methods

Several bathymetric data sources were used to compile the new SGBD grid. The primary dataset was high-resolution multibeam swath bathymetry obtained from research vessels. Secondary, single-beam echosounder data were obtained from a range of 'ships of opportunity', including fishing and research vessels, whilst tertiary data were derived from digitised hydrographic charts. Finally, in some areas GEBCO data (GEBCO, 2003) were used to supplement the dataset. These data were only used in the northeast of the region where the single-beam coverage is poor and the GEBCO data match well with the other inputs. Figure 1 identifies the coverage of relevant data sources. A nested hierarchy was used for the data with more accurate datasets given priority over poorer-quality data. A detailed description of data collection is provided in Fretwell et al. (2009).

Data processing

The various datasets were then brought into a GIS with the swath as a raster dataset sampled at ⅛ of a degree and the other data as point files. The swath data were further cleaned for spikes using slope analysis. All data were then re-sampled to 150 m (approximately ⅛ of a degree) and converted to points to ensure equal weighting of datasets. The TOPOGRID function in ArcGis was used to convert the final input data to one continuous grid with a cell size of 150 m. The resulting grid (Figure 2) is available as an ArcGis shapefile in LLC projection, or as an xyz ASCI file with latitude/longitude coordinates. Both grids are available to download from www.antarctica.ac.uk/bas_research/data/online_resources/sgbd/.

Data analysis

Revised sea floor area estimates within 50 m depth strata were calculated from the SGDB for the depths 0–500 m within 1° x 0.5° grid squares (Figure 3) for the South Georgia and Shag Rocks shelf regions. Data were compared with sea floor area estimates for the corresponding grid squares estimated from nautical charts by Everson and Campbell (1990).

Results

Seabed areas for 1° x 0.5° grid squares calculated from the new SGBD are shown at 50 m depth intervals (to 500 m) in Table 1. Total area of sea floor between 0–500 m at South Georgia and Shag Rocks (Subarea 48.3) was calculated at 44 018 km^2. Data were compared with estimates of sea floor area obtained from nautical charts (Table 2) from which total sea floor area (<500 m depth) was calculated as 42 311 km^2. For the older dataset, data were not available at 50 m depth intervals in the 250–500 m range but were pooled. The table indicates that overall there is good agreement between sea floor area estimates obtained from the two datasets. The best agreement was for grid squares to the north of South Georgia and predictably was better when sea floor area (<500 m depth) within a grid was large (Table 3). Agreement between the old and new datasets was worst between the estimates of sea floor area in the 100–150 and 250–500 m strata. There were few consistent spatial or depth trends in the discrepancies observed between the old and new area estimates. However, in regions where nautical charts were based on limited sounding data, discrepancies tended to be greater (i.e. to the southeast of South Georgia – grid squares 24–27) and in grids that contained only small areas of shelf area (<500 m depth – grid squares 1, 17, 23 and 27).

Discussion and conclusion

The SGDB represents the most accurate information on the bathymetry of the South Georgia region currently available. Sea floor area estimates derived from this dataset are likely to be more accurate than those previously obtained from nautical chart data. In regions where single-point sounding data were abundant there was good agreement between the datasets but greater discrepancy exists where sounding data were limited. Although there was good agreement between the datasets with respect to total sea floor (<500 m) area in the South Georgia region, there was some discrepancy between seabed areas within different depth strata. The new data will assist with the design and development of appropriate stratified trawl surveys, enabling the most appropriate depth stratification and distribution of survey effort to be made. The new high-resolution dataset has recently been used to identify the glacial origin of many banks and ridges on the South Georgia shelf (Graham et al., 2008). It should therefore now be possible to identify different habitat types and accurately map the interaction of fisheries with sea floor topography at South Georgia.

Acknowledgements

Pete Morris for compiling the collection of single Beam data. Phil Leat for overseeing the BAS multibeam acquisition. All the officers and crew of vessels who collected the swath data.

References

Everson, I. and S. Campbell. 1990. Areas of seabed within selected depth ranges in CCAMLR Subarea 48.3, South Georgia. In: S*elected Scientific Papers, 1990 (SC-CAMLR-SSP/7).* CCAMLR, Hobart, Australia: 459–466.

Fretwell, P.T., A.J. Tate, T.J. Deen and M. Belchier. 2009. Compilation of a new bathymetric dataset for South Georgia. *Ant. Sci*., 21 (2): 171–174.

GEBCO. 2003. *General Bathymetric Chart of the Oceans*, digital edition: www.gebco.net.

Graham, A.G.C., P.T. Fretwell, R.D. Larter, D.A. Hodgson, C.K. Wilson, A.J. Tate and P. Morris. 2008. A new bathymetric compilation highlighting extensive paleo–ice sheet drainage on the continental shelf, South Georgia, sub-Antarctica. *Geochem. Geophys. Geosyst.*, 9, Q07011: doi 10.1029/2008GC001993.

Table 1: New sea floor area estimates (km^2) for CCAMLR Subarea 48.3 to depths <500 m derived from the South Georgia Bathymetric Dataset (SGBD). Grid no. corresponds to the 1° x 0.5° grid squares shown in Figure 3.

Grid no.	North east corner °S	°W	Depth bin (m)										
			0–50	50–100	100–150	150–200	200–250	250–300	300–350	350–400	400–450	450–500	Totals
1	53	43	0	0	0	0	0	0	0	0	4	4	8
2	53	42	0	0	1	112	287	208	162	134	128	91	1 123
3	53	41	0	0	68	129	42	17	9	12	15	8	300
4	53.5	42	2	3	58	272	95	67	49	30	14	25	615
5	53.5	41	4	19	1 023	776	434	143	103	87	58	58	2 705
6	53.5	40	0	0	33	59	76	69	84	110	135	92	658
7	53.5	39	0	0	0	76	131	118	184	178	125	82	894
8	53.5	38	16	126	389	813	354	270	186	144	60	36	2 394
9	53.5	37	75	141	1 193	633	296	378	142	15	17	26	2 916
10	53.5	36	0	0	176	711	804	371	63	44	65	54	2 288
11	53.5	35	0	0	4	44	117	133	18	18	14	17	365
12	54	39	0	0	0	124	537	301	146	74	56	59	1 297
13	54	38	38	46	135	656	2 274	396	9	5	1	2	3 562
14	54	37	598	321	541	613	317	172	115	5	0	0	2 682
15	54	36	465	264	427	452	339	220	0	0	0	0	2 167
16	54	35	2	30	273	385	1 125	467	35	30	28	31	2 406
17	54.5	39	0	0	0	15	57	47	26	20	12	8	185
18	54.5	38	0	0	19	634	690	282	130	92	63	76	1 986
19	54.5	37	28	30	270	847	1 090	448	114	38	30	23	2 918
20	54.5	36	384	251	248	690	817	284	45	7	2	0	2 728
21	54.5	35	167	444	871	660	429	450	198	14	5	7	3 245
22	54.5	34	0	78	249	98	151	111	63	79	65	73	967
23	55	37	0	0	2	23	15	11	8	7	5	14	85
24	55	36	0	4	9	337	182	164	39	36	85	78	934
25	55	35	0	14	1 229	860	694	206	135	83	67	33	3 321
26	55	34	76	130	292	153	143	149	55	51	57	35	1 141
27	55.5	35	0	0	0	0	14	34	25	25	10	20	128
Totals			1 855	1 901	7 510	10 172	11 510	5 516	2 143	1 338	1 121	952	44 018

Table 2: Sea floor area estimates (km^2) for CCAMLR Subarea 48.3 to depths <500 m derived from nautical chart data (Everson and Campbell, 1990). Grid no. corresponds to 1° x 0.5° grid squares shown in Figure 3. (* denotes that data in the 250–500 m depth range were not available at 50 m depth intervals and were pooled.)

Grid no.	North east corner °S	°W	Depth bin (m)						
			0–50	50–100	100–150	150–200	200–250	250–500*	Totals
1	53	43	0	0	0	0	0	12	12
2	53	42	0	0	0	130	158	445	733
3	53	41	0	0	89	117	41	27	274
4	53.5	42	0	0	93	175	115	179	562
5	53.5	41	0	0	1 210	500	495	410	2 615
6	53.5	40	0	4	78	101	38	537	758
7	53.5	39	0	0	0	40	138	689	867
8	53.5	38	51	106	364	819	341	641	2 322
9	53.5	37	108	233	1 025	586	247	733	2 932
10	53.5	36	0	0	131	808	729	723	2 391
11	53.5	35	0	0	6	58	82	271	417
12	54	39	0	0	16	261	458	482	1 217
13	54	38	54	107	113	783	2 466	67	3 590
14	54	37	447	314	703	605	511	251	2 831
15	54	36	313	390	474	334	438	177	2 126
16	54	35	0	39	101	451	1 262	529	2 382
17	54.5	39	0	0	0	14	113	106	233
18	54.5	38	0	0	0	542	715	274	1 531
19	54.5	37	0	0	422	650	1 035	456	2 563
20	54.5	36	252	267	575	492	598	904	3 088
21	54.5	35	181	372	922	793	443	554	3 265
22	54.5	34	0	9	142	145	199	318	813
23	55	37	0	0	0	0	0	7	7
24	55	36	0	5	23	263	95	178	564
25	55	35	0	53	1 321	810	586	458	3 228
26	55	34	0	18	524	221	56	153	972
27	55.5	35	0	0	0	0	0	18	18
Totals			1 406	1 917	8 332	9 698	11 359	9 599	42 311

Table 3: Comparison of the South Georgia Bathymetric Dataset SGBD and nautical chart-derived estimates of sea floor in (a) different grid squares and (b) depth zones.

(a)

Grid no.	New area	Old area	Difference (new – old)	New area/ old area
1	8	12	–4	0.67
2	1 123	733	390	1.53
3	300	274	26	1.09
4	615	562	53	1.09
5	2 705	2 615	90	1.03
6	658	758	–100	0.87
7	894	867	27	1.03
8	2 394	2 322	72	1.03
9	2 916	2 932	–16	0.99
10	2 288	2 391	–103	0.96
11	365	417	–52	0.88
12	1 297	1 217	80	1.07
13	3 562	3 590	–28	0.99
14	2 682	2 831	–149	0.95
15	2 167	2 126	41	1.02
16	2 406	2 382	24	1.01
17	185	2 33	–48	0.79
18	1 986	1 531	455	1.30
19	2 918	2 563	355	1.14
20	2 728	3 088	–360	0.88
21	3 245	3 265	–20	0.99
22	967	813	154	1.19
23	85	7	78	12.14
24	934	564	370	1.66
25	3 321	3 228	93	1.03
26	1 141	972	169	1.17
27	128	18	110	7.11
Totals	44 018	42 311	1 707	1.04

(b)

Depth stratum (m)	New area	Old area	Difference (new – old)	New area/ old area
0–50	1 855	1 406	449	1.32
50–100	1 901	1 917	–16	0.99
100–150	7 510	8 332	–822	0.90
150–200	10 172	9 698	474	1.05
200–250	11 510	11 359	151	1.01
250–500	11 070	9 599	1 471	1.15
Totals	44 018	42 311	1 707	1.04

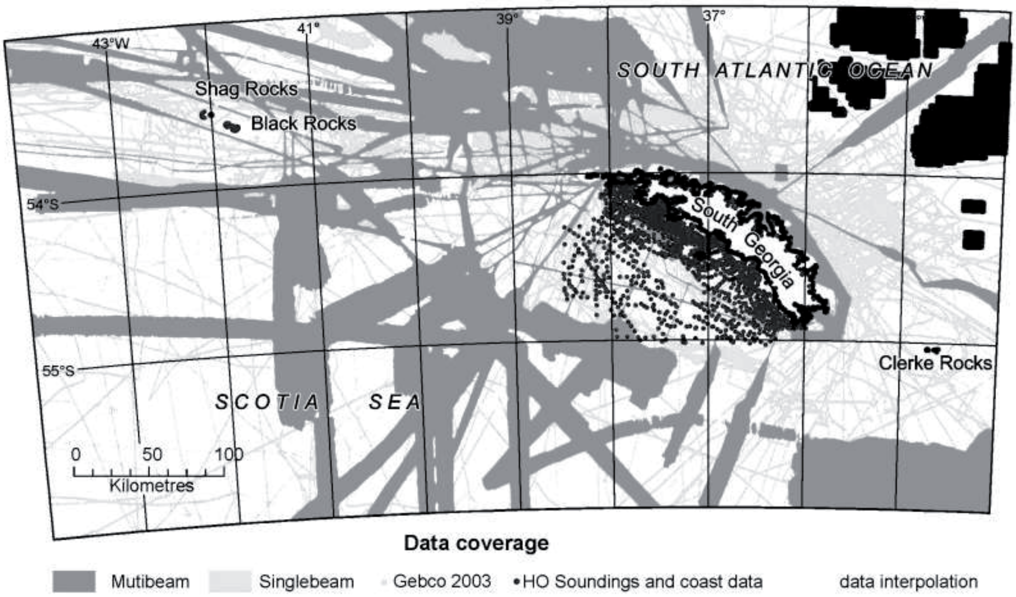

Figure 1: Origin of bathymetric data used to compile the new South Georgia Bathymetric Dataset (SGDB).

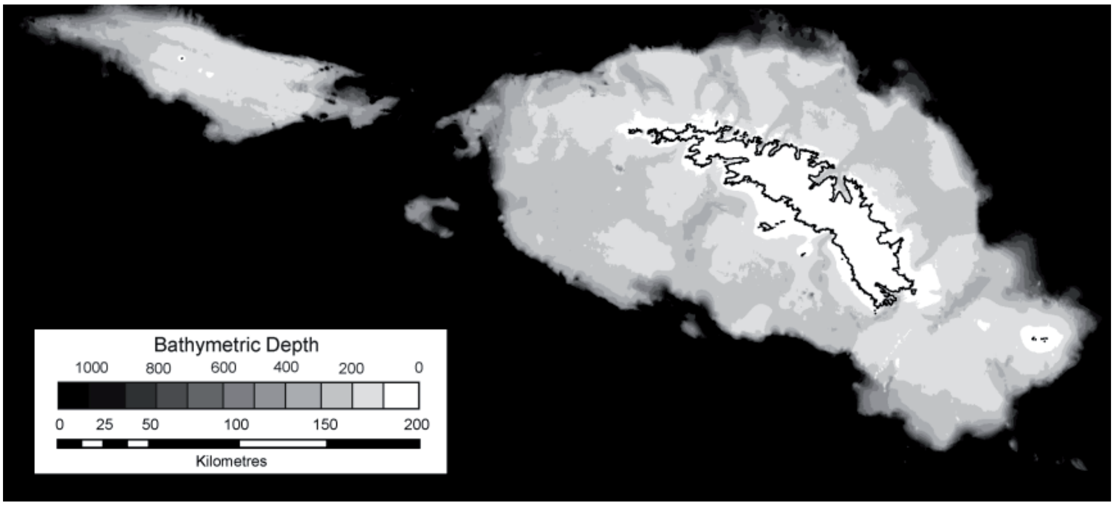

Figure 2: The new SGBD map.

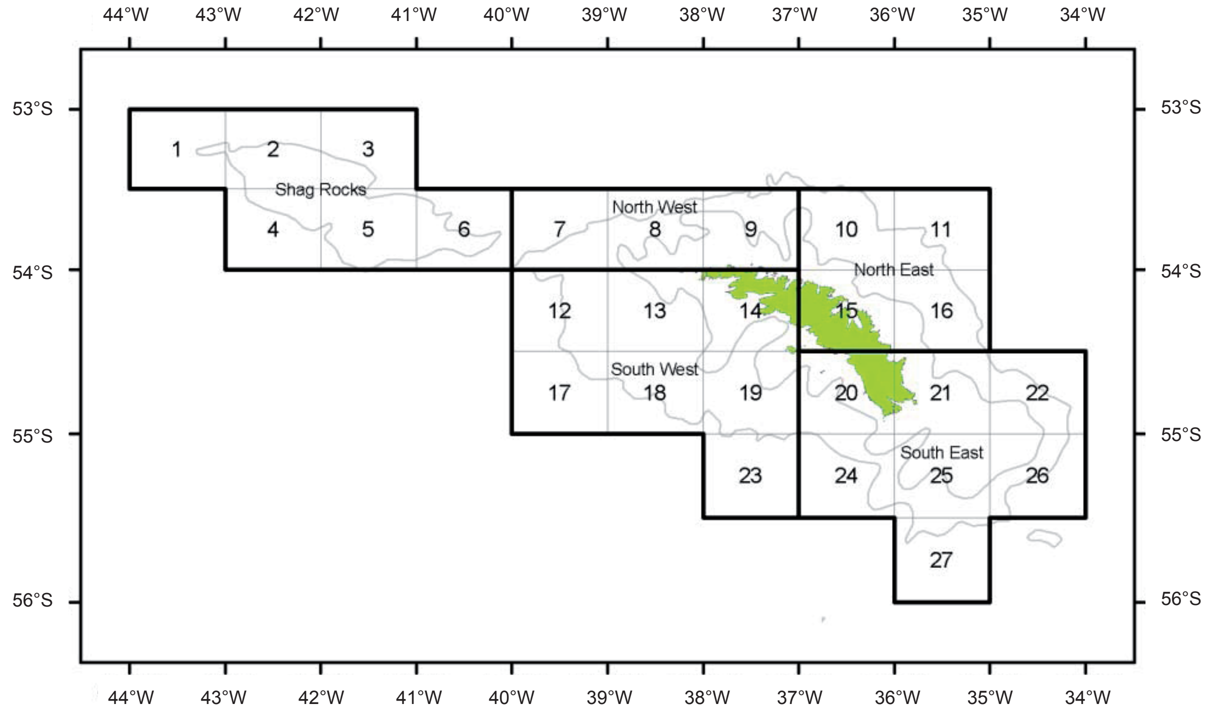

Figure 3: Distribution of 1° x 0.5° grid squares (1–27) used in sea floor area analyses.

Liste des tableaux

Liste des figures

Список таблиц

Список рисунков

Lista de las tablas

Lista de las figuras