Short Notes

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SURFACE AREAS OF SEABED WITHIN THE 500 M ISOBATH FOR REGIONS WITHIN THE SOUTH SHETLAND ISLANDS (SUBAREA 48.1)

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Abstract

Bathymetric maps of two major areas within the South Shetland Islands were generated using several integrated bathymetric databases. These areas comprise the lower South Shetland Island chain from King George Island to Smith Island, and the region around Elephant Island. From the integrated datasets, areas of seabed within the 500 m isobath for six levels of depth strata (0–50 m, 51–100 m, 101–200 m, 201–300 m, 301–400 m and 401–500 m) were computed. Areas were calculated based on planar and interpolated surface area of seabed incorporating seafloor slope. Differences in calculated seabed areas from previous studies were likely due to both improved methodology and georeferencing of contours.

Résumé

Création de cartes bathymétriques de deux régions étendues des îles Shetland du Sud au moyen de plusieurs banques de données bathymétriques intégrées. Ces régions sont formées du sud de la chaîne des îles Shetland du Sud, de l'île du Roi George à l'île Smith, et de la région de l'île Éléphant. À partir des jeux de données intégrées, des surfaces de fond marin, à l'intérieur de l'isobathe 500 m, sont calculées pour six strates (0–50 m, 51–100 m, 101–200 m, 201–300 m, 301–400 m et 401–500 m). Les surfaces sont calculées à partir des surfaces planes et interpolées de fond marin, compte tenu de la pente du fond de la mer. La différence entre ces calculs et ceux d'études précédentes résulte vraisemblablement, tant de l'amélioration de la méthodologie que de la détermination des coordonnées géographiques des courbes de niveau.

Резюме

На основе нескольких комплексных батиметрических наборов данных были построены батиметрические карты двух крупных районов Южных Шетландских о-вов. Эти районы включают нижнюю часть цепи Южных Шетландских о-вов от о-ва Кинг-Джордж до о-ва Смит, а также воды вокруг о-ва Элефант. На основе этих комплексных наборов данных были рассчитаны площади морского дна в пределах 500 м изобаты по шести горизонтам глубины (0–50 м, 51–100 м, 101–200 м, 201–300 м, 301–400 м и 401–500 м). Показатели площади были рассчитаны по плоскостной проекции и интерполированной площади поверхности морского дна с учетом уклона дна. Разница между рассчитанными площадями морского дна и результатами предыдущих исследований скорее всего связана с улучшенной методикой и с привязкой изолиний с использованием GPS.

Resumen

Se crearon mapas batimétricos de dos grandes áreas de las islas Shetland del Sur, mediante la utilización de varias bases de datos batimétricos integradas. Estas áreas comprenden la cadena inferior de islas Shetland del Sur desde la isla Rey Jorge/25 de Mayo a la isla Smith, y la región circundante a la isla Elefante. De los conjuntos de datos integrados, se calcularon las áreas de lecho marino hasta la isóbata de 500 m para seis estratos de profundidad (0–50 m, 51–100 m, 101–200 m, 201–300 m, 301–400 m y 401–500 m). Las áreas fueron calculadas en base al área superficial planar de lecho marino y al área resultante de la interpolación para incorporar la pendiente del lecho marino. Las diferencias observadas con las estimaciones de lecho marino de estudios anteriores posiblemente se deben al perfeccionamiento de la metodología y al uso de un sistema de referencia geográfica.

Keywords: seabed areas, bathymetry, South Shetland Islands, biomass estimates, CCAMLR

INTRODUCTION

Information on area of seabed within particular depth strata is important when calculating biomass estimates from bottom trawl surveys using 'swept-area' models. Errors or bias in computation of seabed areas can directly affect point estimates of standing stock. Early estimates of seabed areas within the FAO Statistical Subarea 48.1 were based on Admiralty Charts (Everson, 1987). In the Elephant Island region, Kock (1986) refined bathymetric information within the 500 m isobath by combining Admiralty Chart data with soundings collected during research cruises by the Federal Republic of Germany from 1977/78 to 1983/84. Estimates for the Elephant Island region were further refined by Kock and Harm (1995) using additional information collected during research cruises to 1992/93, and excluding the easternmost section of the King George Island shelf and the majority of a seamount to the south of Clarence Island.

Previous approaches to estimating areas of seabed in this region relied on constructing isobaths by hand from available data sources, and subdividing areas into smaller rectangular subareas. These subdivisions were then converted to square areas by means of measuring the distances between isobaths and converting to square kilometres or nautical miles. Thus, these approaches estimated areas based on a planar projection of isobaths and not actual seabed area. Accounting for the slope and aspect of the seafloor may be important for accurately measuring the interpolated areas of seabed.

In this paper, we integrate several bathymetric databases, including acoustic measurements from the 1998 US Antarctic Marine Living Resources (AMLR) program bottom trawl survey, and compute bathymetric surface areas of seabed within the 500 m isobath for the region within the lower South Shetland Islands from King George Island to Smith Island (61°30'S–63°12'S, 56°30'W–62°36'W). The region around Elephant Island (60°48'S–61°36'S, 53°54'W–57°00'W) was also examined and revised areas of seabed are presented herein.

METHODS

Geographic information from several databases of regularly and irregularly spaced measured and estimated depths was merged to produce two large datasets for the study areas. Data used specifically for bathymetry consisted of the measured and estimated soundings from satellite altimetry and shipboard depth soundings (Smith and Sandwell, 1997), continuously collected acoustic measurements from the 1998 US AMLR bottom trawl survey, and US Defense Mapping Agency (DMA) hydrographic charts. Because no information was available on accuracy of soundings other than data collected during the AMLR 1998 survey, there was no weighting by data series, and any duplicate data points were averaged. Data used to more accurately tune (georeference) the positioning of coastlines were extracted from the CIA World Database II, DMA World Vector Shoreline (Wessel and Smith, 1996), and digitised DMA hydrographic charts.

The raw data points of the combined information base were gridded to a uniform ultra-fine scale matrix of latitude, longitude and depth using surface mapping software (Surfer). Gridding was accomplished by kriging the raw data points using a linear variogram model. The gridded information matrix consisted of 250 000 data points (0.0065 latitude x 0.0187 longitude resolution) for the lower South Shetlands, and 122 500 data points (0.0039 latitude x 0.0098 longitude resolution) for the Elephant Island region. These data points were reprojected from geographic (latitude/longitude) coordinates to a universal transverse mercator projection (UTM zone 20).

To compute surface areas, the fine-scale gridded data were converted by GIS software (Arc Info) to a triangular irregular network (TIN) data coverage. Data points within the TIN are connected by breakpoints to construct irregularly shaped, non-overlapping triangles which characterise topographical features of the surface. Standard contour lines were then calculated from the TIN and used as masks for extracting depth strata of interest. Six strata were considered: 0–50 m, 51–100 m, 101–200 m, 201–300 m, 301–400 m and 401–500 m. To estimate the area within a stratum, the TIN was further transformed into polygon coverage and divided into each of the six component depth strata. These coverages contained information on surface area, slope and aspect for each polygon (Table 1). Finally, seafloor areas were estimated by summing areas of polygons within each coverage. Interpolated surface areas of seabed were computed for each stratum separately.

RESULTS AND CONCLUSIONS

A map of the bathymetry around the lower South Shetland Islands was generated (Figure 1), as well as a revised chart of the seabed around Elephant Island (Figure 2). Regions in the lower South Shetland Islands not considered in the analysis of seabed areas are those outside the dashed line in Figure 1, including Low Island and the seabeds and bathymetric features adjacent to the Antarctic Peninsula. Estimates of seabed area in the lower South Shetlands for the strata examined were greatest in the 101–200 m stratum (Table 2). However, this area is exceeded when the 0–50 m and the 51–100 m strata are combined. The average slope of seabed, computed using mean polygon angles, ranged from 1.84 for the 0–50 m stratum to 3.37 for the 401–500 m stratum (Table 1). Due to limitations in topographic data, only planar areas of landmass were computed.

In the Elephant Island region (Figure 2), the coordinates used in the area of seabed analysis were similar to those in Kock and Harm (1995). The overall appearance of bathymetric features around Elephant Island is similar to their map. However, there were several areas between the charts with discrepancies, as well as a distinct break in the 500 m isobath between Clarence Island and Elephant Island not described by Kock and Harm (1995). The refinement of computational procedures used to estimate seabed areas here resulted in differences of area estimates (Table 3) from 0.56 n miles^2 for the 201–300 m stratum to 213.55 n miles^2 for the 401–500 m stratum from that of Kock and Harm (1995). The discrepancy in the 401–500 m stratum was probably due in large part to the exclusion of a 401–500 m region south of Clarence Island, which may have been included in the estimates of Kock and Harm (1995). This region is associated with the northern edge of a seamount well to the south of Clarence Island (Kock, 1986). While Kock and Harm (1995) excluded the majority of this feature in their computations, all seabeds within a 500 m depth range of this seamount should be excluded from area computations of Elephant Island given a lack of information on fish distribution and abundance from available surveys.

The estimates of planar and bathymetric surface areas computed using the methodology described in this paper were very similar. In all cases, the differences were less than 1%. Therefore, differences in computed seabed areas between this study and that of Kock and Harm (1995) are due mostly to improvements in methodology and georeferencing of contour lines.

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Table 1: Summary of polygon coverage and average slope (degrees) by stratum for the lower South Shetland Islands and Elephant Island.

Strata	Lower South Shetland Islands		Elephant Island	
	No. Polygons	Average Slope	No. Polygons	Average Slope
0–50 m	8 661	1.84	6 945	2.21
51–100 m	9 447	2.05	8 708	2.25
101–200 m	16 320	2.11	14 926	2.46
201–300 m	13 818	2.94	13 718	3.76
301–400 m	13 274	3.31	13 408	4.50
401–500 m	13 184	3.37	15 144	4.24

Table 2: Summary of planar area and interpolated bathymetric surface areas of seabed (n miles^2) for the lower South Shetland Islands from King George to Smith Island. Exact lines of demarcation are specified in Figure 1. Area estimates of land masses were computed as planar area.

Strata	Planar Area	Surface Area
Land masses	852.39	*
0–50 m	834.07	834.54
51–100 m	695.84	696.38
101–200 m	1 347.68	1 349.04
201–300 m	1 051.07	1 052.90
301–400 m	997.35	999.48
401–500 m	996.93	999.17

Table 3: Summary of areas of seabed (nautical miles^2) for the region around Elephant Island. Exact lines of demarcation are specified in Figure 2. Area estimates of land masses were computed as planar area.

Strata	Kock, 1986	Kock and Harm, 1995	This Study	
	Planar Area	Planar Area	Planar Area	Surface Area
Land masses	167.68	167.68	177.97	*
0–50 m	226.33	201.72	157.91	158.08
51–100 m	232.47	207.23	223.14	223.35
101–200 m	461.50	378.30	421.47	422.10
201–300 m	500.00	360.85	359.25	360.29
301–400 m	736.50	351.91	336.22	337.65
401–500 m	1 012.10	604.70	389.53	391.15

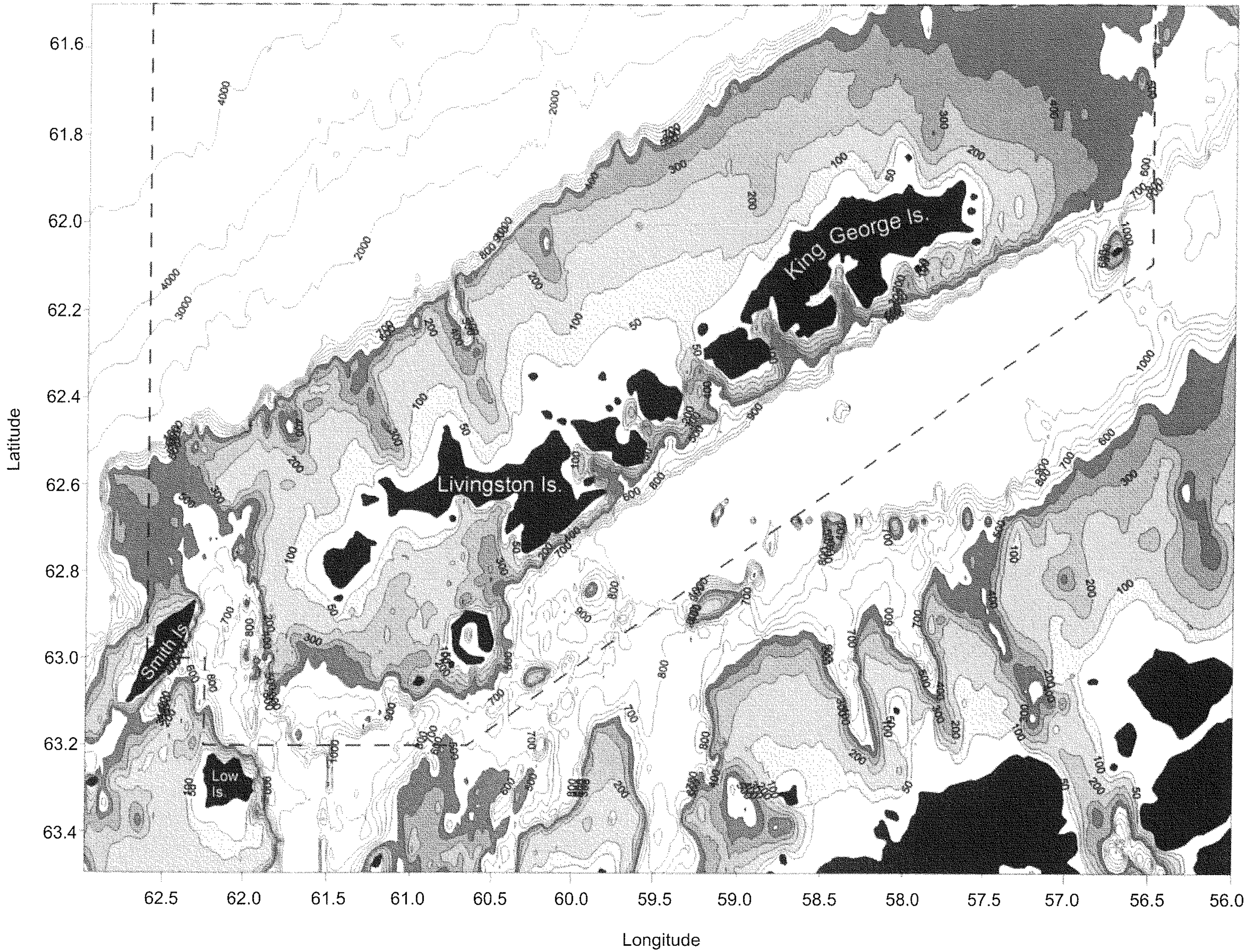

Figure 1: Bathymetric map of the lower South Shetland Islands from King George Island to Smith Island. Shaded regions within the dashed lines were used for seabed computations.

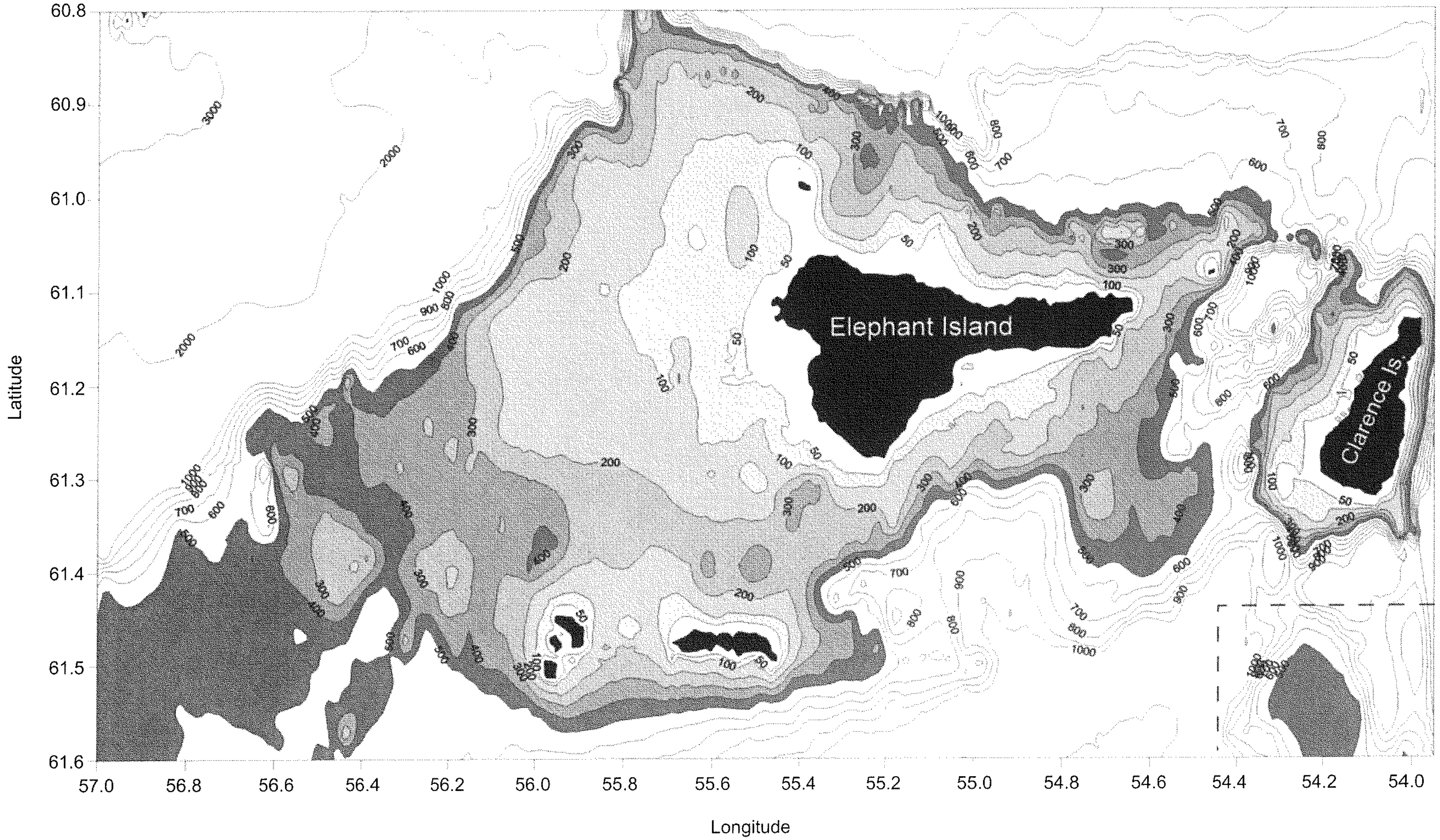

Figure 2: Bathymetric map of the Elephant Island area. The region within the dashed line south of Clarence Island was not used in seabed area computations.

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