SC-CAMLR-VI/BG/8

PREY MONITORING SURVEYS. A DISCUSSION OF THE CHARACTERISTICS NECESSARY IN PREY SURVEYS

I. Everson
(United Kingdom)

Abstract

The CCAMLR Ecosystem Monitoring Programme requires information on prey distribution to relate to changes in predator demography. The paper discusses the constraints imposed on such surveys and outlines some possible designs.

Résumé

Le Programme de contrôle de l'écosystème de la CCAMLR demande que les informations sur la répartition des proies soient relatives aux changements dans la démographie des prédateurs. Le document examine les contraintes qu'imposent de telles prospections et indique brièvement quelques types de prospections possibles.

Resumen

El Programa de CCAMLR de Control del Ecosistema requiere información acerca de la distribución de las especies presa para relacionar con los cambios en la demografía de los depredadores. Este documento trata los constreñimientos impuestos sobre tales prospecciones y reseña algunos diseños posibles.

Резюме

Программе АНТКОМа по мониторингу экосистемы требуется информация о распределении потребляемых видов для соотнесения ее с изменениями в демографии хищников. В работе обсуждаются ограничения, налагаемые на такие съемки, и описываются возможные схемы их проведения.

PREY MONITORING SURVEYS. A DISCUSSION OF THE CHARACTERISTICS NECESSARY IN PREY SURVEYS

Inigo Everson
British Antarctic Survey
Natural Environment Research Council
Madingley Road, Cambridge CB3 0ET
United Kingdom

INTRODUCTION

The CCAMLR Ecosystem Monitoring Programme (CEMP) has developed to the point where the implementation of monitoring of several predator parameters is believed to be praticable. Evaluation of the cause of changes in the values of these parameters is dependent on information being available on the availability of krill to the predators either before or during the monitoring period. This places an immediate constraint on the timing and duration of the prey monitoring studies.

The predator parameters may also be used to help define the geographical limits for the prey survey. Furthermore the diving ability of the selected predators defines the vertical stratum covering the amount of prey that is available to the predators. This is not synonymous with the total prey available as a significant amount, perhaps even all of the prey may be beyond the diving range of the selected predators at certain times. It is important to be able to distinguish between these two characteristics of prey distribution.

SURVEY CONSTRAINTS IMPOSED BY THE PREDATOR PARAMETERS

a. Predator Parameters

Eight penguin monitoring parameters have been identified and these are listed in Table 1 along with comments regarding the implied requirements for prey surveys. Three of the parameters (foraging trip

duration, chick fledging weight and chick diet) identify a restricted period during which an effect due to prey availability is likely to be recognised.

The remaining parameters require information on the availability of krill in an undefined region during a poorly specified period of time which includes part, at least, of the winter. These parameters, adult weight on arrival at breeding colony, length of first incubation shift, annual trend in size of breeding population, demography (annual survivorship, age at first reproduction, cohort strength) and breeding success, are therefore not suitable for comparison for interpretative purposes with quasi-instanteous surveys of krill abundance.

b. Survey Area

During the chick and pup rearing periods the predators are restricted to a relatively small area of the ocean. Precise information on foraging range is not available although from a knowledge of swimming speed, activity budgets and foraging trip duration a reasonable estimate can be made of the maximum radius of the 'foraging circle' relative to the breeding colony. Current best estimates are as follows :

Adelie Penguin	50 - 80 km (Max 100 km)
Chinstrap Penguin	40 - 60 km
Macaroni Penguin	50 - 100 km
Fur Seal	approx 100 km
Black-browed Albatross	approx 200 km

(Croxall pers comm.)

Taking the predator study colonies as the centre then prey surveys covering a radius of 100 km from the site should provide adequate coverage for penguins and fur seals while a 200 km radius may cover black-browed albatross foraging areas.

c. Depth Ranges

Fur seal and penguin diving activity patterns are concentrated within the range 0 to 100 metres from the surface. Albatrosses are unable to dive deeper than about 2 metres. These values indicate two sampling depth strata; further layers within these are desirable. It is also desirable to sample over the full depth range of krill.

INTEGRATED STUDY AREAS

a. Antarctic Peninsula Region

The area is indicated in Figure 1. The arcs of circles are of radius equivalent to 100 km and are centred on the study sites indicated in Table 1 of the report of the CCAMLR Ecosystem Monitoring Programme 1987.

The area to the south of Anvers Island contains a lot of foul ground and small islands and is unsuitable for establishing a survey. This area could form as much as half of the area available to foraging predators. Since such a large proportion of the area is unsuitable for survey further consideration needs to be given as to whether to continue to include this site as a primary monitoring site.

The sea areas close to the remaining sites are relatively free from foul ground and it would therefore be possible to undertake surveys in them. The timing of such surveys is constrained by the predator foraging periods; these are :

Adelie Penguin	23 Nov–13 Dec (guarding) or 2 Jan (creche)
Chinstrap Penguin	20 Dec–13 Jan (guarding) or 21 Feb (creche)

'Guarding' is the period when at least one adult of the pair is in attendance with the chicks. 'Creche' is when one or both of the adults are collecting food and chicks from the colony congregate into creches.

Although there is some overlap between the species the total period is about three months. In practical terms this is probably too long for a single survey, it is more likely that no more than one month is likely to be available. Some compromise may therefore need to be sought between the start of the Adelie and the end of the Chinstrap periods. A suitable compromise might be from 13 Dec to 13 Jan. Such a compromise would reduce the effectiveness of comparisons involving Chinstrap Penguin fledging weight. Any compromise decisions on the timing and duration of the survey can only be made on the advice of experts in the field of predator monitoring.

b. South Georgia

This is considered to be synonymous with Bird Island. The key predators are Macaroni Penguin, Fur Seal and Black-browed Albatross. A map showing the limits of the study area with circles of radius 100 and 200 km is shown in Figure 2. Very little of the area is unsuitable for survey.

Appropriate periods for predator monitoring are :

Macaroni Penguin	26 Dec - 19 Jan (guard) or 1 Feb (creche)
Fur Seal	12 Dec to 12 Jan

Rather than survey throughout this period a compromise of from about 20 Dec to 20 Jan would probably cover both species adequately. This would however raise the same compromise situation regarding comparison with chick weight at fledging.

c. Prydz Bay

It is not clear from the Report of the Working Group precisely where the predator monitoring sites are to be established. It is assumed that the main focus will be at Davis Station and this is indicated in Figure 3.

The main species identified for study is the Adelie Penguin which in this region begins feeding chicks about 13 Dec, the guarding phase is completed by about 2 Jan and creche phase by about 21 Jan. A survey timed to last for a month prior to 20 Jan would permit comparison with chick fledging weight but be less suitable for the early chick growth period.

SURVEY DESIGN

The primary aim of the survey is to determine how much krill is available to the predators during a defined critical period and within a defined range of the study colony. The area of the survey may therefore be considered to be contained within an arc. Seen in this way the study colony is effectively a point location from which foraging predators will search radially up to a distance of about 100 km. By analogy with predator foraging activity, the transects could be located along radii. Such a situation is shown in Figure 4 for a survey of ten transects.

It is likely that there will be some form of coastal water flow which could introduce systematic errors into the sampling. To overcome this the transects could be surveyed in pairs in a random sequence. If the pairs were selected so as to start at the study colony end then the time taken to travel between pairs would be minimised.

Assuming a constant survey speed of 10 knots (18.5 km/hr) for the hours of daylight (the time when krill are likely to be absent from the surface layer and hence be undetected) and that surveying closer than about 15 km to the colony is impractical, then about three transects per day could be surveyed. This would permit a set of 10 transects to be surveyed in about four days leaving the hours of darkness free for net sampling to determine the species composition in the zooplankton for predator dietary comparisons to be made.

Concentrating the survey phase during the hours of daylight reduces the likelihood of large amounts of krill being present in the near surface layer. Much predator feeding does however take place after dark so that

some consideration needs to be given to krill night depth based on daytime surveys. On balance it is probably better to survey during the day and apply such a correction than to continue at night using different techniques.

This survey is not suitable for Black-Browed Albatross due to the larger area and also because it requires estimation of krill at the surface. Further research on krill vertical migration may allow factors to be determined which convert daytime krill availability to that of surface availability during the day and night.

Several such surveys could be completed within a month and also allow some time between surveys in which to undertake additional studies aimed at investigating water circulation and the krill distribution outside this primary survey region.

No account has been taken of the likely effects of sea ice on the effectiveness of the survey. At South Georgia this is likely to be minimal. The South Shetland Island area is also generally free of ice during the December/January period. The Prydz Bay area is often congested with ice and this may mitigate completely against a survey of this type.

The above is only one of the several options that could be employed and is primarily aimed at purely predator/prey interactions. Alternative designs that are as efficient for this purpose but more efficient for determining specific properties associated with krill are also possible. Before deciding on a particular survey it is essential that expert statistical advice is sought to refine the survey and take due consideration of the analyses to be undertaken on the resultant data.

CONCLUDING COMMENTS

The proposals outline a framework that could be used to monitor krill abundance locally and compare it with specific predator parameters. The area covered by such surveys and the level of interaction is only a small proportion of the total Southern Ocean. The level of coverage in the

South Shetland Island and South Georgia regions may be adequate for a monitoring exercise in those regions because the shore-based sites are sited in areas likely to be sensitive to variation over a wider area. This is not definite particularly if we wish to make comparisons involving integrated estimates of abundance over the year. The Prdyz Bay region is much more poorly known and for that region it may be advisable to undertake a coastal monitoring survey covering several study colonies.

Essentially, the unfortunate conclusion is that we have methods for monitoring prey locally but the logistics of mounting large scale surveys on an annual basis currently preclude direct estimation over the wider area. The difference between the few hundred square kilometres contained within the surveys described above and the 35 million square kilometres of the Southern Ocean is too great for simple extrapolation to apply.

ACKNOWLEDGEMENTS

I am grateful Dr J. Croxall for comments on an early draft of this manuscript.

Table 1. Consideration of predator parameters and the implied requirements from prey surveys

Predator Parameter	Required Prey Survey Characteristics	
	Duration and Timing	Area
Adult Arrival Weight	Unspecified duration during winter	Unknown but large
First incubation shift length	Unspecified duration early spring	Unknown may be large
Population Size	Unspecified duration	Unknown may be large
Demography	Unspecified duration during year	Unknown but large
Foraging trip duration	Approx one month in summer	Max 100 km from colony
Breeding success	Unspecified duration during year. Main survey in Spring and Summer	Unknown but may be large
Chick fledging weight	Approx two months during summer	Max 100 km range from colony
Chick diet	Approx one month	Max 100 km range from colony

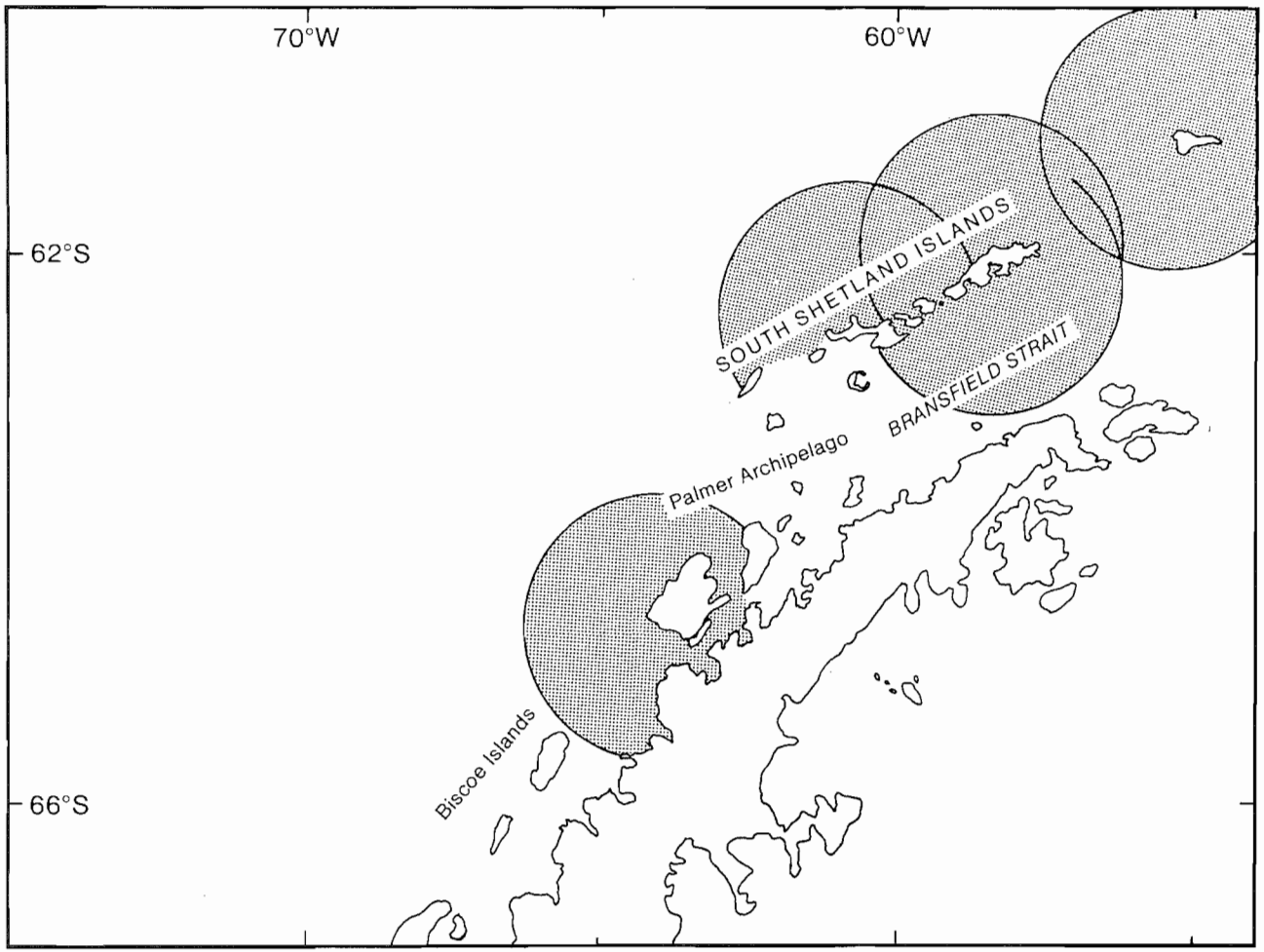

Figure 1 Peninsula Area. The shaded areas are approximately 100 km from the study sites.

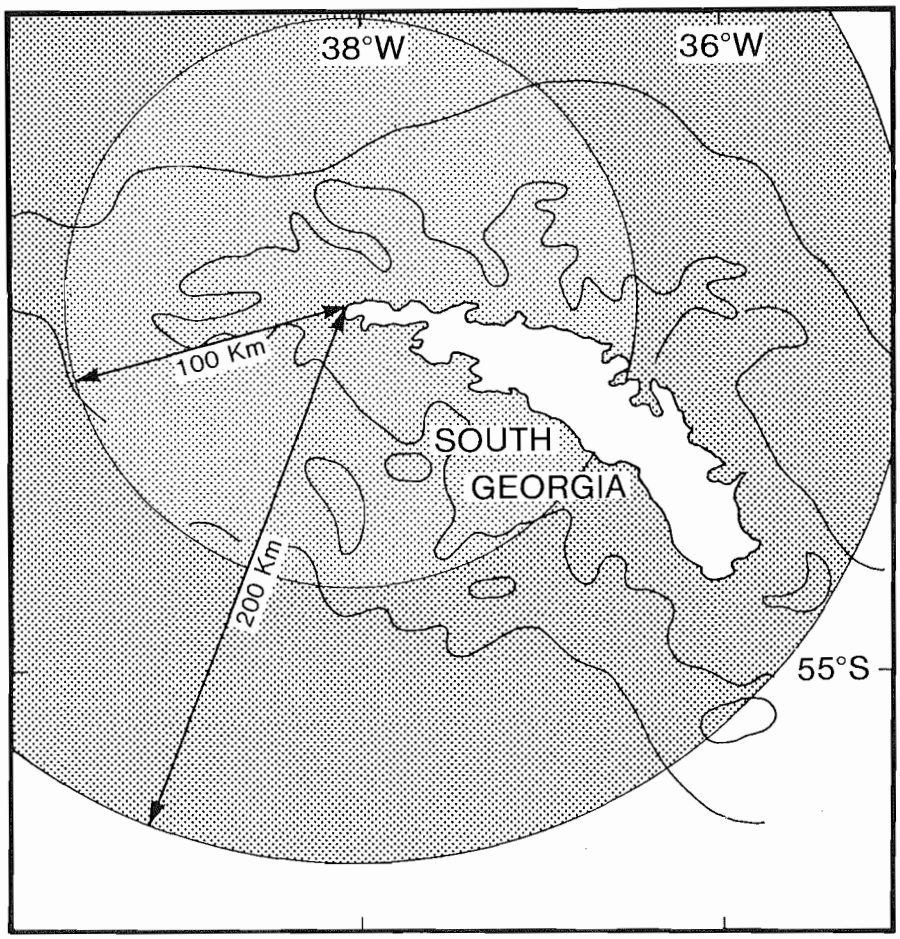

Figure 2 South Georgia Region. Circles represent 100 and 200 km from Bird Island.

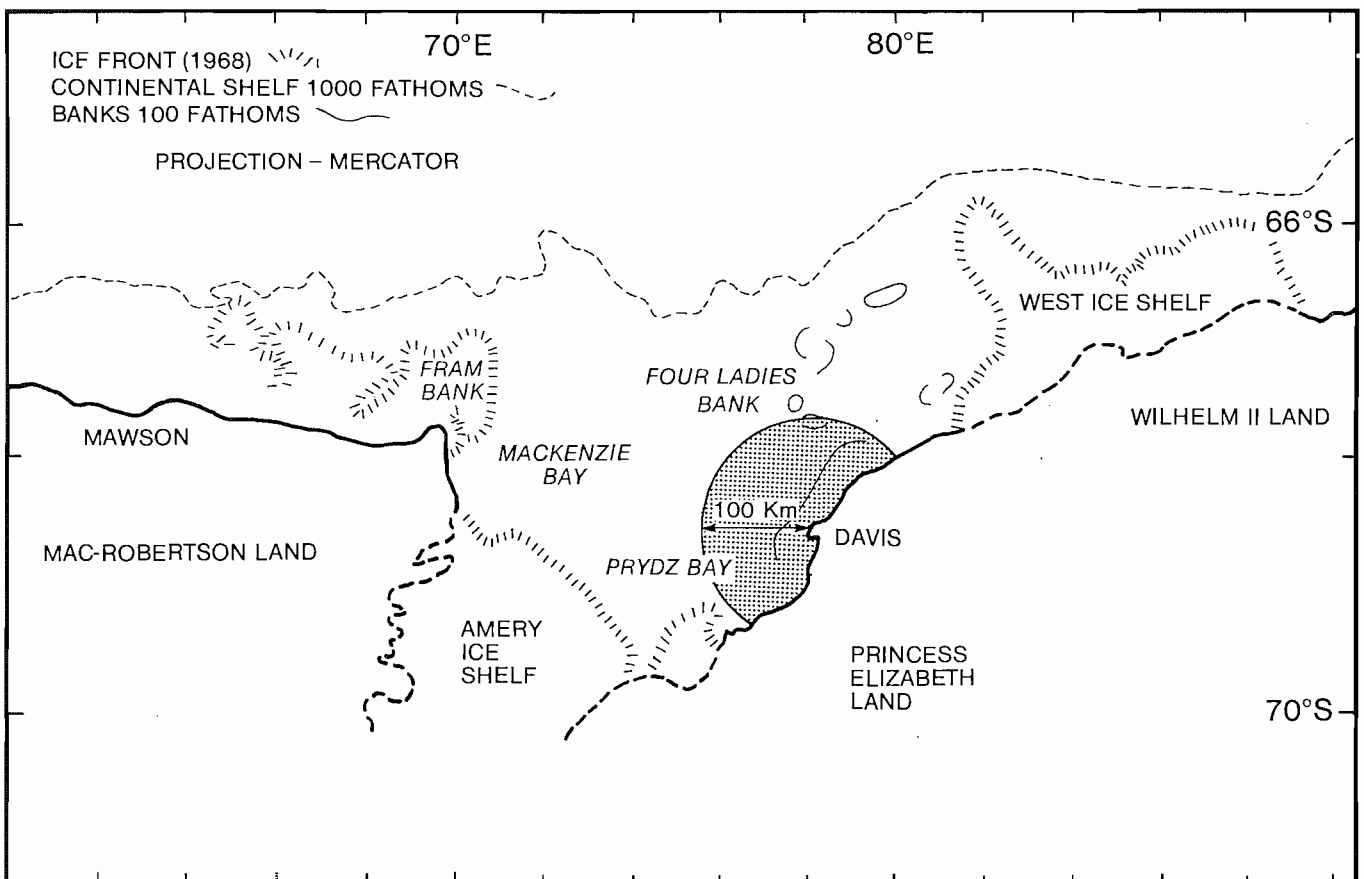

Figure 3 Prydz Bay Region. (Map reproduced from ANARE Research Notes No. 7, reprinted May 1985).

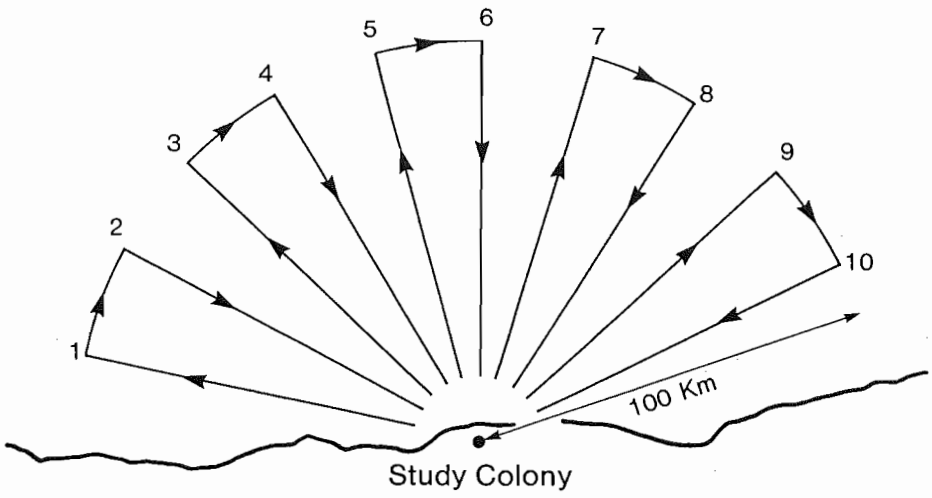

Figure 4 Radial transect survey design. The outer limit of each transect would be 100 km from the study colony. The length of each transect would therefore be between 85 and 90 km. Pairs of transects could be surveyed in random order so as to minimise bias, e.g. 9+10, 5+6, 1+2, 3+4, 7+8.

Légende du tableau

Tableau 1 Considération des paramètres des prédateurs et impératifs implicites relatifs aux prospections des proies.

Légendes des figures

Figure 1 Zone de la Péninsule. Les régions hachurées se trouvent à environ 100 km des sites d'étude.

Figure 2 Région de la Géorgie du Sud. Les cercles représentent 100 et 200 km à partir de l'Ile Bird.

Figure 3 Région de la Baie Prydz. (Carte reproduite d'après ANARE Research Notes No. 7, réimpression mai 1985).

Figure 4 Modèle de prospection par sections transversales radiales. La limite extérieure de chaque transect se trouverait à 100 km de la colonie étudiée. La longueur de chaque transect serait donc de 85 à 90 km. Les paires de transects seraient prospectées au hasard afin de minimiser tout biais, par ex. 9+10, 5+6, 1+2, 3+4, 7+8.

Encabezamientos de las Tablas

Tabla 1 Consideración de los parámetros de los depredadores y los requerimientos que sugirieron las prospecciones de las especies presa.

Leyendas de las Figuras

Figura 1 Area de la Península. Las áreas sombreadas se encuentran aproximadamente a 100 km de los sitios de estudio.

Figura 2 Región de Georgia del Sur. Los círculos representan 100 y 200 km desde la Isla Bird.

Figura 3 Región de la Bahía Prydz. (Mapa reproducido de las Notas de Investigación ANARE N^{O} 7, reimpresas en mayo de 1985).

Figura 4 Diseño de prospecciones de secciones transversales radiales. El límite exterior de cada sección transversal estaría a 100 km de la colonia de estudio. Por lo tanto, cada sección transversal tendría entre 85 y 90 km de longitud. Podrían prospectarse pares de secciones transversales en orden aleatorio a fin de minimizar el sesgo, por ejemplo 9+10, 5+6, 1+2, 3+4, 7+8.

Заголовки к таблицам

Таблица 1 Обсуждение параметров хищников и вытекающие из этого требования к съемкам потребляемых видов.

Подписи к рисункам

Рисунок 1 Антарктический полуостров. Заштрихованные районы находятся примерно в 100 км от изучаемых участков.

Рисунок 2 Регион Южной Георгии. Окружности - расстояние в 100 и 200 км от острова Берд.

Рисунок 3 Регион залива Прюдс. (Карта переснята из "ANARE Research Notes" №7, переиздано в мае 1985 г.)

Рисунок 4 Схема съемки по радиальным разрезам. Внешняя граница каждого разреза в 100 км от изучаемой колонии. Таким образом, длина каждого разреза - между 85 и 90 км. Чтобы свести к минимуму погрешность измерений, съемки пар разрезов могут производиться в произвольном порядке, напр., 9+10, 5+6, 1+2, 3+4, 7+8.