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OUTLINE OF ECHO-SURVEY POLYGON USING SATELLITE INFORMATION

V. M. Vorobyov

Laboratory of electronic technique on sea investigations
AtlantNIRO, Kaliningrad, USSR

INTRODUCTION

The specific area called a polygon is used as an initial basis for acoustic surveys. To investigate this area, both a searching scheme of transects and a sampling scheme covering the given area are being planned. In practice, during echo surveys, the objectives of searching are often combined with those of representative sampling. Such a coincidence in time requires a thorough understanding of the two above-mentioned approaches to be planned and executed. If operative searching in a given area, to ensure effective results, (in the shortest time and with the minimum use of fuel) is given priority, then the methods of searching theory which determine the tactics of the latter, based for example, on parallel scanning with the characteristics given below, also gain priority: D - detection range, l - in between transect distance[1,6,8]. In this case, the samples of values of density characteristics of the population field are a non-random type, and, according to the sampling theory, are classified as "target selection" and are subsequently subject to a known statistical mechanism of accurate assessment.

If priority is given to biomass assessment in a given area, based on statistical investigation of the general assemblage by sampling part of the latter, then one of the techniques of sample selection is chosen based on statistical planning of the survey. The cost-expenditure factor is also considered in this case. However, it acts already within the framework of one of the techniques of planning the sampling scheme[3]. In both cases, the knowledge of the echo-survey polygon is essential as it enables an efficient solution of the problems of searching and quantitative biomass assessment. Currently, no method exists for defining the boundaries of the acoustic survey polygon, i.e. the distribution area of the main fish stock. It is held that the major part of the stock in shelf waters of coastal countries is concentrated in a certain area, the length of which is approximately that of the coastal line extension. The width is a distance between the shore and offshore part of the area, where the echo-sounder readings of fish aggregations indicate a lower frequency of their occurrence.

According to Shotton and Bazigos (1984)[5] theoretically "the offshore movement of the survey transect should be stopped at the point where the contributions to the MSE from the bias, caused by not covering the entire stock range, becomes less than the gain in precision obtained by increasing the number of applicates in the area where the major part of the stock is located. When offshore movement along a survey transect should be stopped, depends on the nature of the stock distribution. Procedures that allow this decision to be made quantitatively have not been established". Oeberst (1985)[4] recommends, "to outline the region of spatial distribution of a population, from the distribution of the sea bottom depth field above which the studied fish species usually occurs, as well as from the data of control catch and the commercial fleet catch statistics".

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METHOD

Until recently, the echo-survey polygon covered by the AtlantNIRO ships in various parts of the Atlantic Ocean has been suggested by the scientists, based on long-term observations made in the commercial fish species distribution areas and the commercial fleet catch statistics. In some cases, reconaissance acoustic - trawling, hydrological and ichthyological surveys were conducted to provide supposed contours of a biologically productive zone which was then taken as an echo-survey polygon for stock assessment. That was a time consuming procedure.

Since the end of the 1970's, the development of methods for remote ocean surface irradiation using satellite meteorological systems has provided a real possibility to radically improve the techniques of establishing the echo-survey polygon boundaries[9]. Satellite measured parameters of the surface temperature and chlorophyll content give a general idea of the most important characteristics of the investigated area in terms of its commercial value. This ensures a more precise establishment of the studied population habitat boundaries[6,9]. The outline of the echo-survey polygon using the satellite information becomes less time consuming, as even single satellite images received and processed in several hours may save some days of vessel time. The zones of high-temperature gradients are a good sign of a biologically productive area[2]. To establish the boundaries of biologically productive zones a new method has been developed in the AtlantNIRO in 1985 to demarcate the investigation are using maximum temperature gradients of the area. The realization of this method needs only limited means, namely the coloured sea-surface temperature (SST) fields. The principle of the method of the echo-survey polygon demarcation lies in that, the zone of maximum temperature gradients shown by an IR-image must be contoured with regard for the known temperatures in the domain of the biological species being studied.

RESULTS

The probability of the biologically productive zone coverage is assumed to be high as it is based on 90-100% agreement in co-ordinates of gradient zones shown in an IR-image and actual fish aggregations detected by the ships. So, the check of the SSTs from the satellite data for the Norway Sea (22 July 1985) showed a quite reliable agreement between maximum gradient regions and zones of near-surface mackerel aggregations (Fig. 1). Similar examples were also observed over the 1985 to 1988 period in the shelf waters of Namibia, West Sahara and in the Argentine area of the Southwest Atlantic from the results of the research carried out by the RV "Monocrystal" and "Ocher". Due to natural diversity of IR-Image structures, the operator deals with the material which is quite simple for demarcation purposes in some cases, i.e. separate colour parts are homogenous enough in hue permitting precise demarcation. In other more frequent cases, the picture of the coloured IR-image is littered with numerous tiny impregnations originating from colour admixtures contained in texture thus preventing precise demarcation. Therefore to produce the SST charts (to be used as the basic material for the survey polygon outline) the operator receiving the satellite information has to undertake preliminary processing of the received IR-images using special methods. Such a processing results in all SST chart for a 3-day period. A series of such SST charts makes it possible to summarize the picture of the distribution of zones of maximum temperature gradient. This allows for positive contouring of a potential biologically productive zone.

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Figure 2, for example, depicts an averaged boundary of a biologically productive zone of the shelf waters of the West Sahara. It is the zone of maximum temperature gradients and divides the parts of two different colours of a quite homogenous hue, each in IR-images. In this case the echo-survey polygon can be determined as the surface contoured by lines of the territorial water and the maximum temperature gradient zone boundaries. The subsequent echo-survey based on sub-satellite acoustic Sv parameter records and executed within the polygon outlined will confirm that the most probable distribution area of the main stock is being covered.

COMMENT

The speculations on the problem of the outline of the echo-survey polygon can be concluded with the following comments:

- the echo-survey polygon is intended for searching activities (transect design) and planning the echo-survey using the methods of statistical exploration (sampling scheme) for quantitative biomass assessment;

- the outline of the echo-survey polygon by means of demarcation of potential biologically productive zones in coloured SST IR-images received from meteorological satellites is considered to be a modern operative method of planning ship's surveys.

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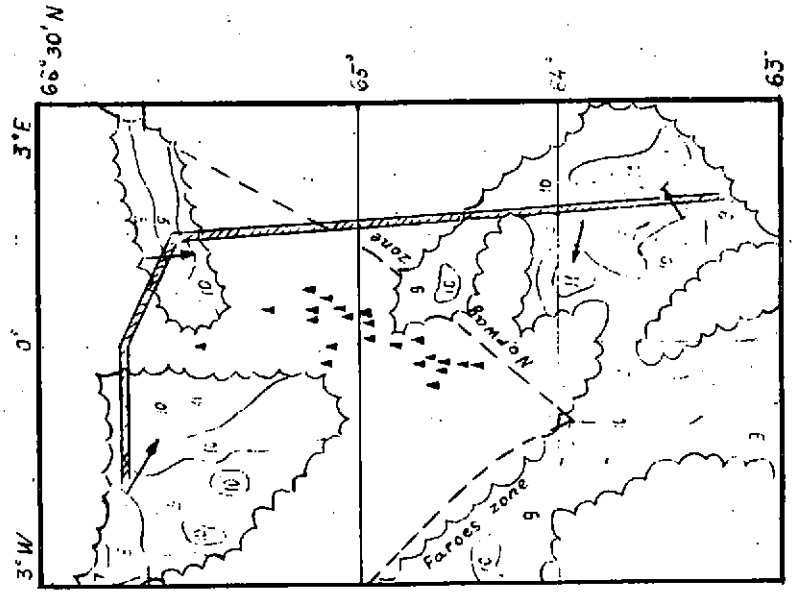

Fig. 1 Thermal structure of ocean surface and disposition of fishing flotilla (Norway sea, 22-24 July 1985).
- vector of a temperature gradient;
- fishing-boat;
- border of cloudiness;
- gradient zone.

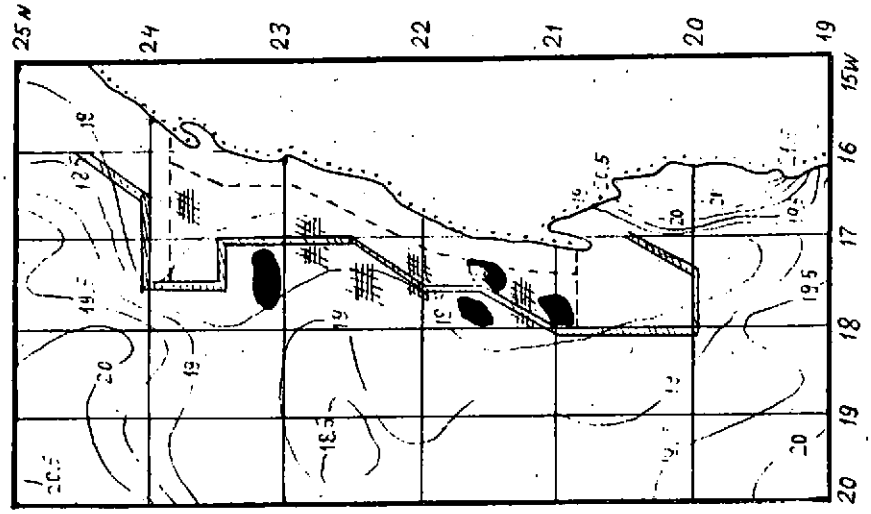

Fig. 2 Average chart-scheme of a raised temperature gradient zone (West Sahara, 21 May-2 June 1988).
- gradient zone;
- boundary of territorial waters zone;
- density (t/n.m.^{2}) more than 300;
- density from 100 to 300.