METHODS OF INDEX CALCULATION AND PRESENTATION OF FISH ABUNDANCE DATA USING STANDARD COMPUTER PROGRAMS

by

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ABSTRACT

Standard 0-group indices and distribution maps are now produced based on hand-drawn maps using AutoCad with some additional procedures. This paper briefly describes the method. The paper further describes ways of importing coastlines and survey data directly into standard computer programs such as AutoCad and SAS. Standard methods are used for gridding data, producing isolines and further calculation of abundance indices and presentation of distributions. Interactive editing of distribution maps are made, which makes corresponding automatic updating of indices possible.

INTRODUCTION

In many cases a measure of abundance of fish is given both as an index of abundance and as an isopleth diagram of density distribution. In this paper we will present some methods to combine the two and to enhance the calculation of abundance indices.
Cod in the north-east Atlantic is one of the most important species and the abundance of fry in the first year of living (0-group fish) is used as an indication of recruitment.

0-group abundance indices are based on the number caught of each species and its area of distribution. The indices are estimated as the sum of areas of dense and scattered consentrations, with areas of high densities weighed by 10 (Haug and Nakken 1977). The criteria for discriminating between dense and scattered concentrations are given in Anon. (1980).

Until 1992 the calculations were based on a procedure placing a transparent "areafan" on the top of hand-drawn maps (Mercartor projection) and counting each square of the "areafan" falling inside each density, both whole and parts of squares, to get the sum of squares and thereby the total area of each density. This is a laboursome procedure and the hand-drawn maps had to be re-drawn for presentation purposes.

At Institute of Marine Research the computer program AutoCad (Anon. 1992) is used for presentation purposes. Since this program also has an area calculation part, a routine was developed, combining both the drawing of a distribution map and calculating the "old" area and density based indices.

A description of methods for producing distribution maps with isolines outside AutoCad (e.g. in SAS, Anon. 1993) and then importing them into AutoCad for calculation of "new" abundance indices are also given in this paper.

MATERIAL AND METHODS

Drawing of maps and calculating "old" indices in Autocad

The basic 0-group data is the catch in number per 1.0 nautical mile trawling. A hand-drawn map is prepared for each species, dense and scattered distributions are delimited by isolines. To ease the further work, we have given some standard values of the frame and coastlines. These standards were set when the map was digitized onto AutoCad. The standard 0-group map are within latitude 67° to 80° 30' N and longitude 4° to 57 E. In Figure 1 the standard 0-group map is shown.
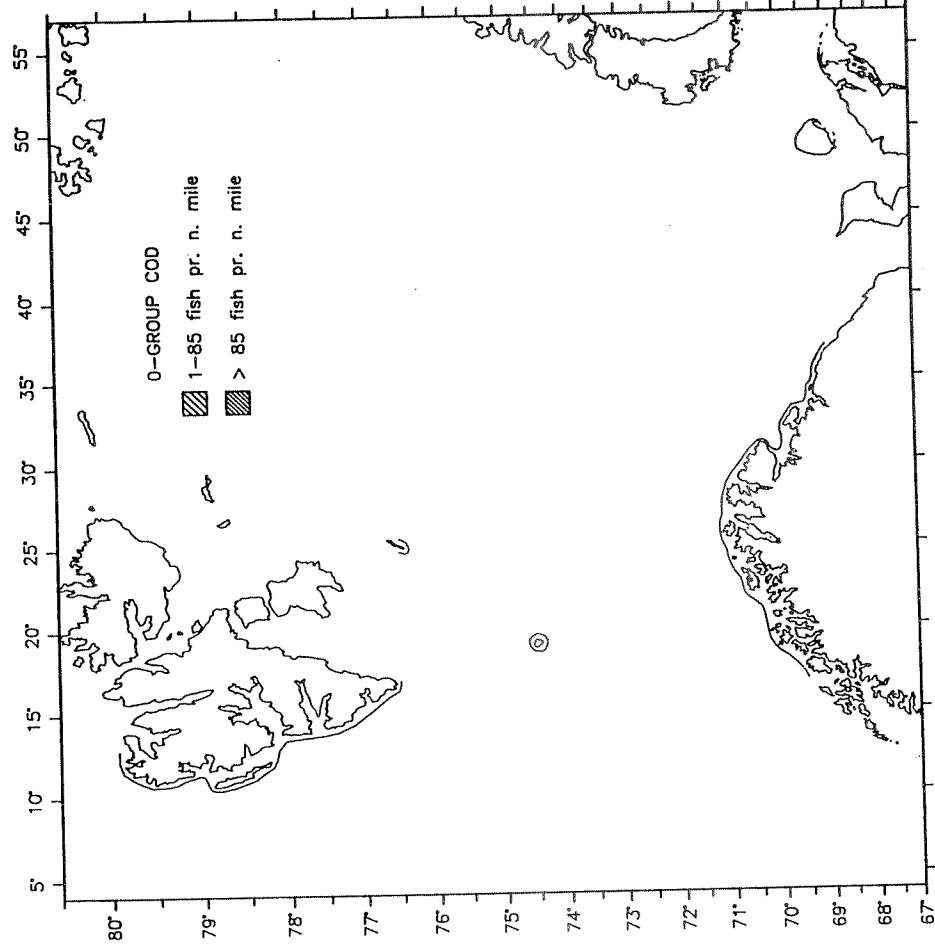

Figure 1.   Standard 0-group map.

The isolines from the hand-drawn maps are then digitized onto premade standard 0-group

maps in AutoCad, using an A3 digitizer. First the digitizer is calibrated to get a relation between the hand-drawn map and the corresponding map (i.e. standard 0-group map) in AutoCad. Each isoline is converted to a polygon and placed on AutoCad-layers, depending on its density value. The polygons can now be adjusted in AutoCad, stretched or joined with other polygons. The 0-line is finally drawn in AutoCad together with "0-islands" in the distribution.

Before calculating the area of different layers, the Mercartor map-projection has to be re-projected to a "true area" projection. This is done by a small extra routine (ACAD.LSP) written in programming language LISP and running in AutoCad. After the reprojection is done, the same routine automatically starts the area calculations in the different layers. The area of the layer representing dense concentrations is multiplied by 9 and not 10, because scattered distributions is supposed to cover the area including the dense ones. The area of "0-islands" in both densities is subtracted before the total area is calculated. Control calculations using the old counting method has given a deviation normally less than 5 %, except when the distributions are very small and far to the north.

Importing iso-, coast-lines and survey data directly into, and between, standard computer programs such as AutoCad and SAS

Up to now we have had no useful way to import a drawn map from SAS onto AutoCad. The map must be vectorized first and plotted in a readable format.

We have made an extra driver in AutoCad. This driver can import data as lines of ascii text corresponding to polylines, layers and coordinates (x,y,z) of each corner in the isolines (polygons). All z values in the 3D coordinates are set to zero. Thus, the map is actually drawn in 2D. AutoCad can now draw lines onto the specified layers. The layers are defined in the ascii file and may not exist before use, that means that the layers can be determined in the external program, e.g. SAS. Below is an example of such a file where longitude and latitude coordinates have been transformed into kilometre east and north.

Longitude	Latitude	Z-coordinates
POLYLINE		
LAG3		
405.3	7515.6	0.0
404.5	7516.3	0.0
405.4	7517.8	0.0
405.7	7517.6	0.0
405.5	7516.7	0.0
405.3	7515.6	0.0
POLYLINE		
LAG2		
416.0	7531.6	0.0
414.3	7530.1	0.0
413.6	7530.6	0.0
413.0	7529.5	0.0

Also the coastlines can be imported in similar ways. Standard maps can be made by digitizing

maps and by importing coordinates by lines. The example above is coastlines taken from a map of the Lofoten area.

Calculations of abundance indices

The index is calculated by multiplying the area of each layer by the value of density assigned to the layer. The layers are separated by levels of density. We therefore need an algorithm to handle layers, levels and values and their transform into indices. We also need an algorithm to compute true areas from mercartor projection.

Layers, levels and values

The ascii file representing layers, level and values may be edited. The name of the layers corresponds to identical name of layers in the map. No other layer would give any positive contribution to the calculation of the indices.

The standard chosen to set levels are as follows:An isoline is the drawn line at the density given by the level. The value associated with a level is the density representing the area between the isoline at the level and the isoline at the next level above. It is necessary to draw isolines in steps, that is you can't bypass an isoline without drawing it. An example of the levels and values in layers is given below.

Example: Import of ascii file which contains name of layer, level and value.

Layer	Level	Value
LAG1	1	1
LAG2	10	10
LAG3	100	100

How to calculate areas from polylines

The transformation from mercartor projection to a true area projection is explained elsewhere in the paper. The standard area calculation in AutoCad is used to compute the area inside a polygon. The isolines of a layer are converted to polygons by closing the polylines. The area computed are weighted with the values of the levels given in the asciifile.

The size of the areas can thus be transferred to summarised densities of fish.

Every layer corresponds to an antilayer with the same, but negative, density value associated to it. The antilayers are needed to eliminate inner polygons already counted for in other layers. If not, then "islands" within "islands" would be counted more than once. These layers and antilayers must be allocated and adjusted by the drawer before calculating the abundance indices.

The antilayers have the same absolute value as the layer itself, but a negative sign, and marks polygons of negative areas and therefore negative amount of indices. In Figure 2 there are three layers and the use of antilayers are shown in Figure 3.
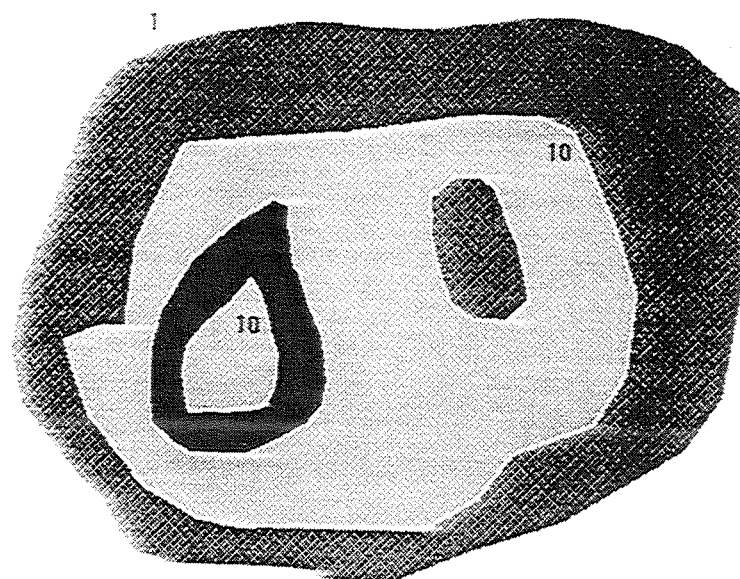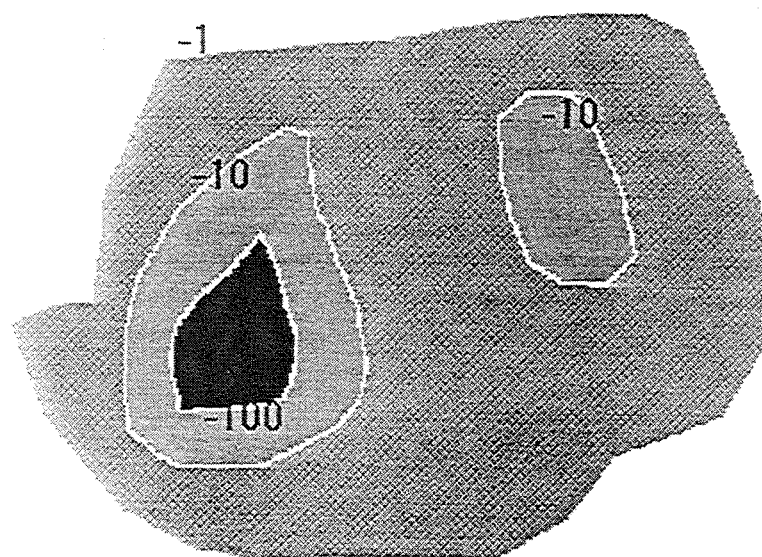
Figure 2.   A layer map.

Figure 3.   The corresponding antilayer map.

RESULTS

To verify the method we selected the distribution of 0-group cod in 1991. The index was counted to 766 (Anon. 1991). We used both AutoCad methods described in this paper. The first AutoCad-draw method, which was restricted to the use of layers "en" and "ti" with values 1 and 9 respectively, gave the result of 788, indicating a deviation from "areafan" method of 2,8%. The drawn map is shown in Figure 4 and the detailed results in Table 1.
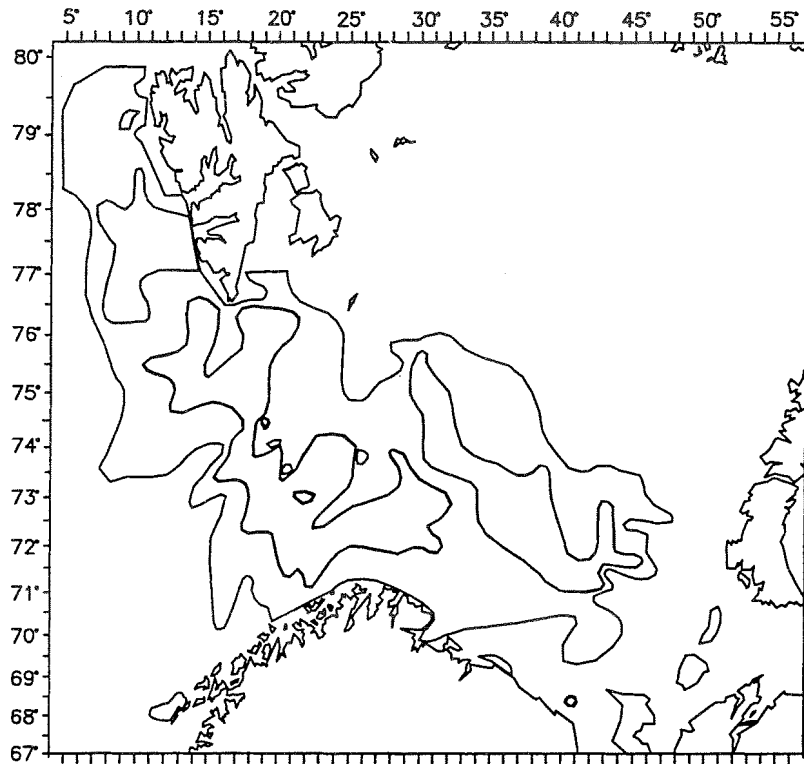
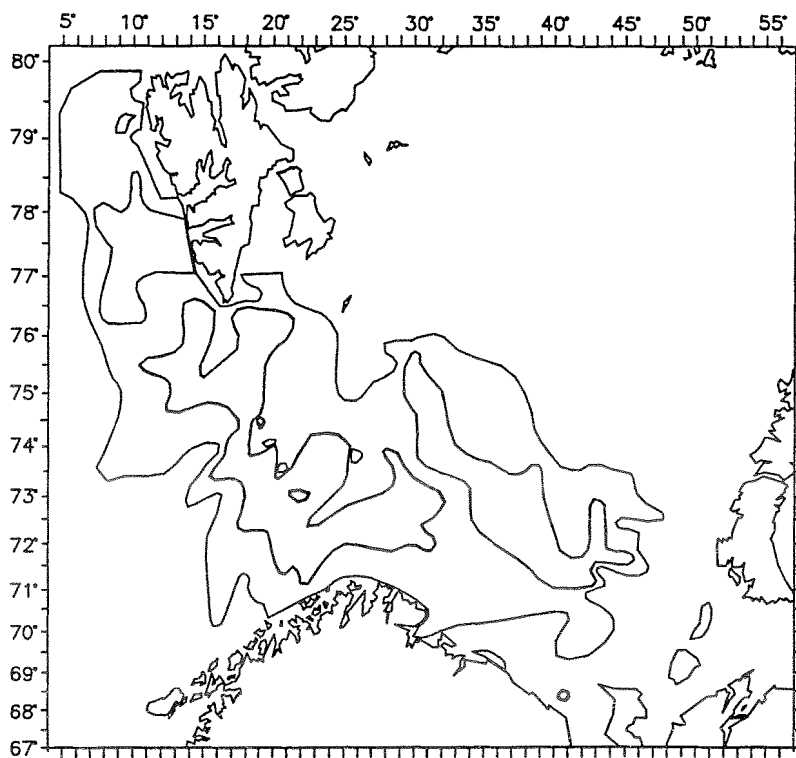Figure 4. Distribution of 0-group cod in 1991 (AutoCad drawn).

Figure 5. Distribution of 0-group cod in 1991 (AutoCad drawn). This method use the layers "LAG1" and "LAG2" and the antilayers "ANTILAG1" and "ANTILAG2". The original drawn map (Figure 4) used only two layers. This is no limitation any longer, but as a demonstration that the computer routine (acad.lsp) could reproduce the same result, we did not split the two layers in more and narrower levels.

The newly computerized method in which layername, levels and values can be set freely, and up to 8 layers may be used was applied on a similar map. The result is shown in Figure 5, both layers and antilayers are drawn. Since only 2 layers are use, the figure is identical with Figure 4. In Table 2 we have split the result from each polyline in the specified layers. The total value of the indices was computed to 783, indicate a deviation of 2,2% from the "aerafan" method.

Table 1.   Indices split on two layers. Layer to contribute ten times layer one.

Layer	Value	Area	Weighted area	Result
One	1	194,15	194,15	
Ten	9	65.98	593,82	788,0

Table 2.   The contribution of each polyline in the layers.

Layer	Level	Value	Area	Weighted area	Result
LAG1	10	10	37,754	377,537	
ANTILAG1	1	1	6,5798	-6,5798	
LAG1	1	1	191,46	191,463	
LAG1	1	1	1,2555	1,2555	
ANTILAG1	1	1	37,808	-37,8077	
LAG2	10	10	6,579	65,7895	
LAG2	10	10	0,1264	1,2641	
ANTILAG1	1	1	0,1264	-0,1264	
LAG1	1	1	0,4587	0,4587	
LAG2	10	10	0,1506	1,5064	
LAG1	1	1	0,2099	0,2099	
ANTILAG1	1	1	0,1507	-0,1507	
LAG1	1	1	0,7339	0,7339	
ANTILAG1	1	1	21,17	-21,1701	
LAG2	10	10	21,18	211,796	
ANTILAG1	1	1	0,0797	-0,0797	
ANTILAG1	1	1	0,0892	-0,0892	
ANTILAG2	10	10	0,2353	-2,3531	
ANTILAG1	1	1	0,2012	-0,2012	
LAG1	1	1	0,2012	0,2012	
ANTILAG1	1	1	0,1034	-0,1034	
ANTILAG1	1	1	0,1604	-0,1604	783,39

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