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SCHEME FOR DISPLAYING FISH POSITION DATA IN REAL TIME

by

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ABSTRACT

Fish reaction to the passage of acoustic surveying vessels may be at least partly assessed through use of the angle data derived with the SIMRAD split-beam echo sounder. Several schemes are outlined for displaying and quantifying such data in real time.

RÉSUMÉ: PROJET DE VISUALISATION EN TEMPS RÉEL DES DONNÉES SUR LA POSITION DES POISSONS

Les réactions des poissons au passage des navires de prospection acoustique peuvent être au moins partiellement estimées par l'utilisation des données angulaires provenant du sondeur Simrad à faisceau scindé. Plusieurs projets sont présentés pour visualiser et quantifier en temps réel de telles données.

INTRODUCTION

In determining the target strengths of fish, split-beam echo sounders observe the target's position in the beam. The position data are available in the SIMRAD split-beam echo sounder in the form of alongship and athwartship angles (Brede et al. 1987). The angle data have had rather limited application until recently, consisting mainly in beam-mapping exercises (Reynisson 1986, 1987), schemes for interpreting target strength data (Degnbol and Lewy 1987), and target-tracking in a fish farm (Brede et al. 1987).

Given the steady interest in fish behaviour as it affects measurements of fish density, especially because of the possibility of avoidance reactions to the passage of the survey vessel (Olsen 1979, 1981, 1987, Olsen et al. 1983a and b, Bercy and Bordeau 1987, Diner and Masse 1987, Misund 1987),

there is every reason to extend the present uses of angle data. Several schemes are outlined here for the visual presentation of such data. These will partly quantify the behavioural patterns of observed fish and, in some circumstances, also detect the presence of reactions to the passage of the surveying vessel.

#### THE SCHEMES

Each measurement by the split-beam echo sounder is characterized by five data: ping number, depth, alongship and athwartship angles, and target strength. The angle data are currently used internally in the echo sounder to derive beam pattern values which, in turn, are used with the sum-signal or echo strength value to determine the target strength. The target strength data from a single ping may be presented as a function of depth in an A-scan over a selected depth interval. If the data from each new ping are presented alongside the previous data, a colour echogram results. This gives an impression of the spatial and size distribution of the fish along the ship's track. Collection of the target strength data corresponding to resolved single-fish echoes in a histogram quantifies the size information.

Other data presentations are also possible. In particular, to assess where the observed fish are in the acoustic beam, the angle data can be presented directly on a display, as on a Plan Position Indicator or PPI (Forbes and Nakken 1972). The pair of angles characterizing a fish position can define a spot on an X-Y plot or circle representing the horizontal cross section of the beam. The angle data from successive pings can be continually added to the display until a certain number of fish positions are indicated, when the screen may be cleared and the next presentation begun. As with the colour echogram, the presented data will be those falling within a specified depth interval.

Four variants of the presentation are enumerated. (1) Simple spot. This is the simplest scheme. Each fish position is represented by a spot of constant size and intensity. (2) Coloured spot. The spot may be coloured or shaded to indicate target strength in addition to position. (3) Sized spot. The size of the spot may be coded or scaled to indicate the associated target strength value. (4) Coloured and sized spot. The target strength datum is coded twice, both by colour and by size, in presenting a spot. The first three schemes are illustrated in Fig. 1 for 17 fish echoes with non-coincident angles.

In order to quantify the position data, histograms may be formed by counting the number of echoes lying within sectors, slices or other divisions of the beam and by normalizing each to the respective area. Five types are shown in Fig. 2. These are described according to the geometry of the division. (1) Sector slices. (2) Alongship slices. (3) Athwartship slices. (4) Sector tesserae. The first geometry is further divided by superposition of annuli. (5) Rectangular tesserae. The second and third geometries are superimposed to form a rectangular grid.

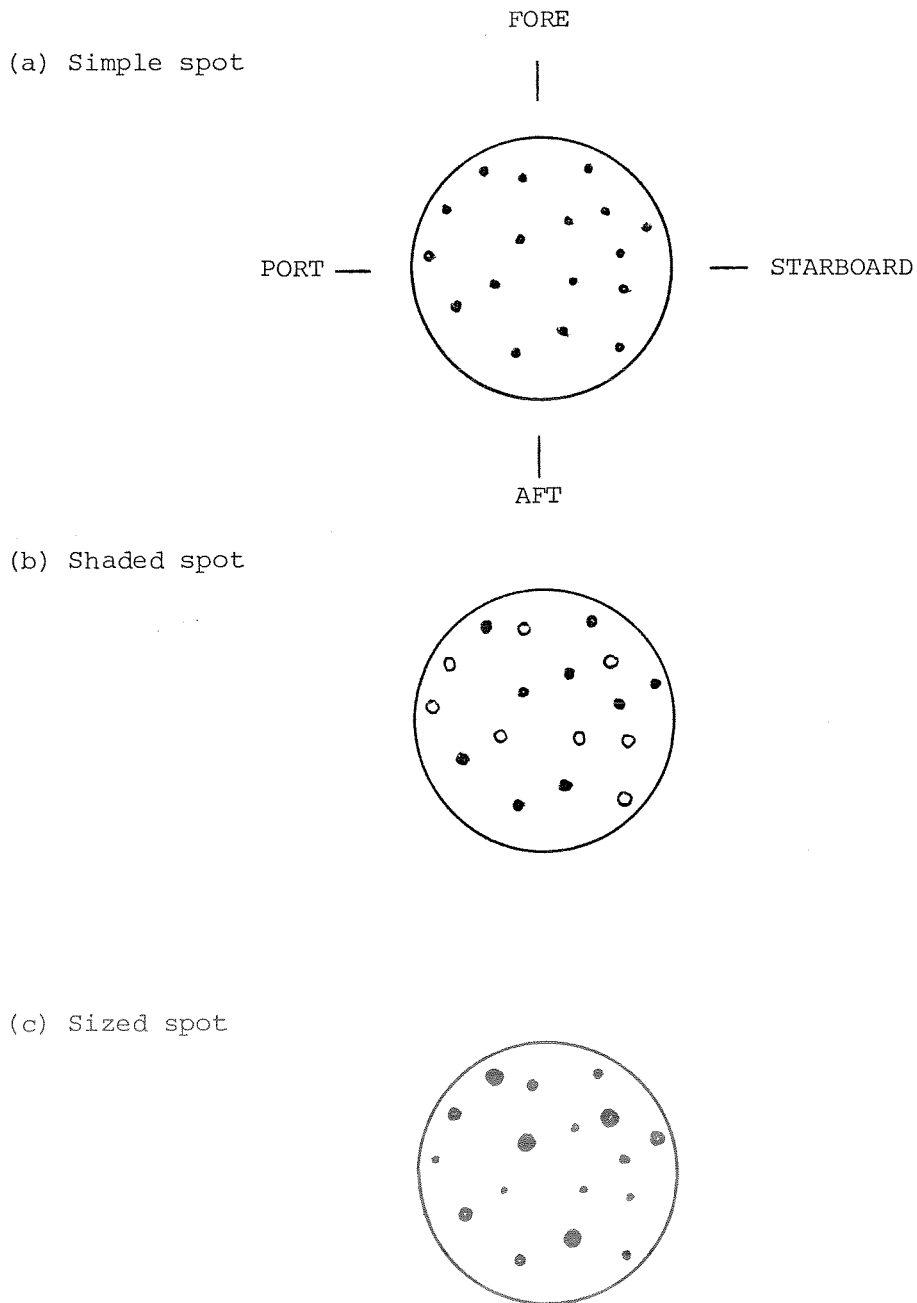
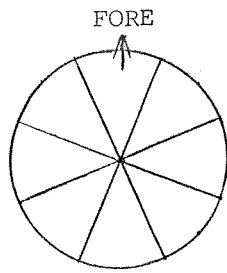


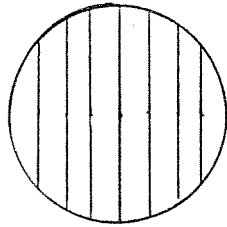
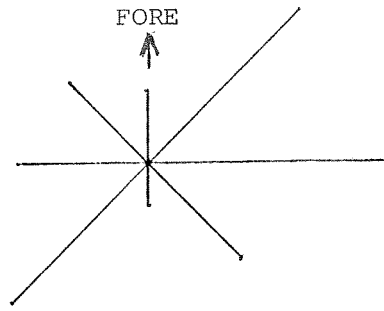
Fig. 1. Presentation of positions of resolved fish echoes in three variants. (a) Simple spot of constant size. (b) Coloured or shaded spot of constant size, where the colour or shading indicates target strength, illustrated here by open and closed circles. (c) Sized spot of fixed colour or shading, but with diameter indicating target strength.

GEOMETRY

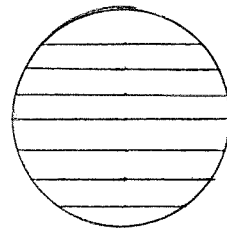
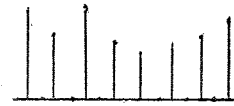
GRAPH



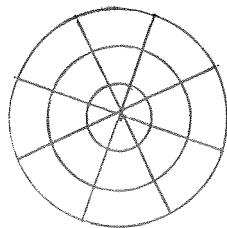
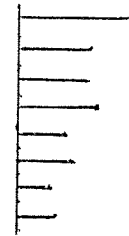
(a) Sector slices



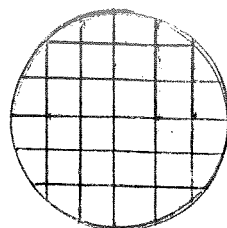
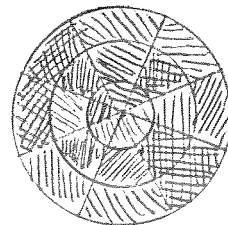
(b) Alongship slices



(c) Athwartship slices



(d) Sector tesserae



(e) Rectangular tesserae

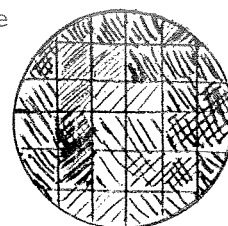


Fig. 2. Geometry of circle subdivisions, with corresponding graphs of area density.

Graphs of fish density accompany each of the circle subdivisions in Fig. 2. In the first three cases these are designed to elicit differences in fish distribution with respect to the acoustic axis (Fig. 2a), detect lateral movements of fish away from the ship's track (Fig. 2b), and assess the precise timing of fish reactions during the passage of the transducer platform (Fig. 2c).

The fourth and fifth graphs aim to give a finer specification of fish distribution. However, since the grid is now two dimensional, the density of fish in each tessera can be intensity- or colour-coded, or a third physical dimension can be added by projective geometry. In Figs. 2d and 2e, intensity-coding is illustrated.

Other graph types can be used. Three variants for the sector-slice subdivision are shown in Fig. 3.

In all cases of quantification of angle data, the area density of fish scatterers is the sought quantity. Thus the number of echoes from resolved targets within each circle subdivision must be counted and normalized by the defined area.

#### DISCUSSION

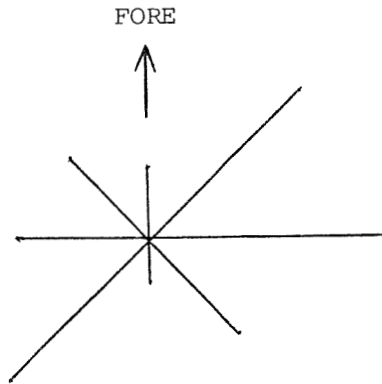
Uses of the particular presentations of angle data proposed here are many. Since the spatial distribution of resolved single fish in the beam is presented, inhomogeneities in the distribution will be immediately evident. The form of these will suggest the manner of fish reaction, for example, avoidance by fleeing away from the ship's track or swimming ahead before turning aside. Examples of fish distributions on the display with the simple-spot format are shown in Fig. 4.

In addition to giving impressions of fish behaviour under surveying conditions, the new schemes can also quantify fish behaviour and reactions through graphs showing the density of fish echoes across the beam. These may be presented collaterally on the position display, much as target strength histograms accompany the echogram on the SIMRAD split-beam colour display.

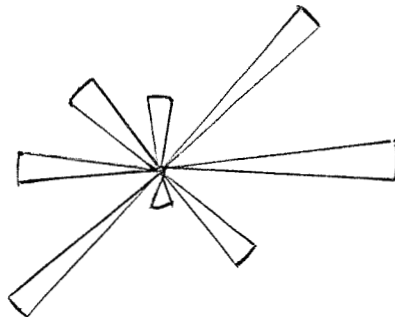
Storage of the histogram data may allow statistical testing for deviations from homogeneity. By comparing successive or more widely separated data sets, changes in fish behaviour in the course of the survey may be detected. Because the nature of fish reactions undoubtedly varies with species, a change in distribution pattern, whether observed visually by an operator or detected by automatic processing of the data by machine, may indicate a change in species in the survey region. Comparison of histograms computed over the same time period but separated in depth may demonstrate depth-dependent reactions, concomitants of the basic noise- and light-stimuli theories of fish reaction.

Other possible uses of the presentation schemes will occur to the interested researcher, as will variations or developments of the schemes

(a) Sector lines



(b) Narrow sector bars



(c) Wide sector bars

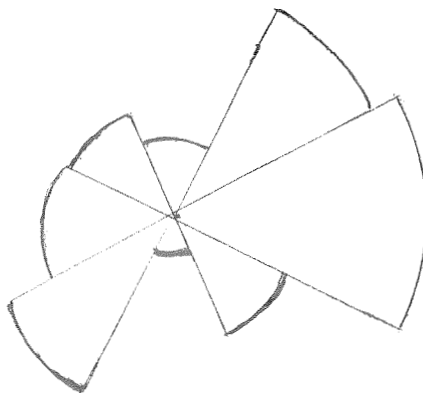


Fig. 3. Quantification of distributions by sector slice by three histogram types.

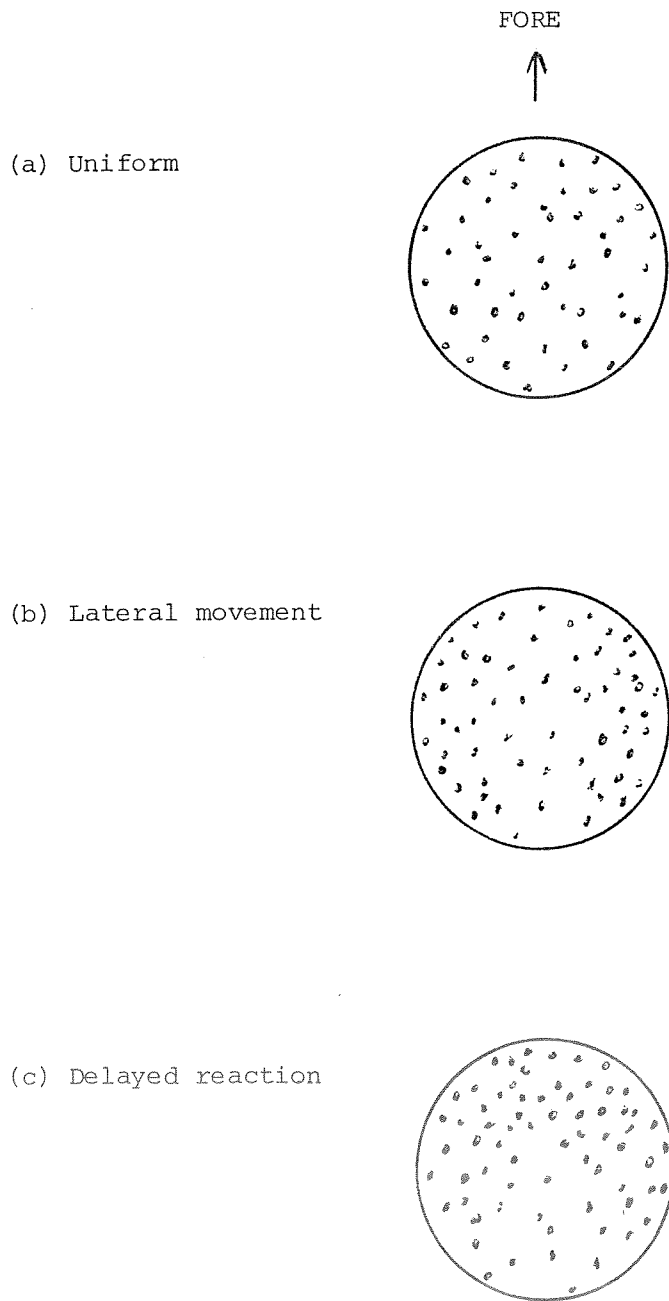


Fig. 4. Examples of three, postulated spatial distributions: (a) Uniform, (b) Lateral or athwartship movement, as in fleeing, (c) Delayed reaction occurring exactly during passage of the transducer over the fish.

themselves. What should be noted particularly is that the introduced schemes can be effected with the technology that is available and is, in fact, already in use, as in the SIMRAD split-beam echo sounder. The presentation of angle data will significantly expand our knowledge of fish behaviour under surveying conditions. Quantification of these data is important both for improving the accuracy of our estimates and for attaching confidence limits to these.

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