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The use of redfish statistical data by depth zones

by J. A. Gulland
Fisheries Laboratory,
Lowestoft

It is a commonplace in fishery research that the size of fish often increases with depth, and that this tendency is particularly marked among redfish. This effect has been clearly shown in several contributions to previous ICNAF meetings. For example Hennemuth and Brown (1964) gave a detailed statistical treatment of United States data, and showed that, using four depth zones at intervals of ca. 50 fathoms, the differences were statistically significant; between the deepest and shallowest zones the difference in median was over 7 cm, which is biologically a very important difference for a fish which (in the areas considered) only grows to around 35 cm. As these and other authors have pointed out, these differences may be very important in the study of the dynamics of redfish populations.

So long as the depth distribution of fishing (either by research vessels or by the commercial fleet) does not change there is no special problem, though the size composition of the catch may not be the same as that of the population. Changes in the size composition of the population will be reflected in proportional changes in the size composition of the catch. Any changes in the depth being fished will, however, produce changes in the size composition of the catches which may be quite different from the changes in the population. For instance, if the fleet fishes deeper the average size of the catch will tend to increase, perhaps enough to hide completely any possible decrease in average size of the population due to heavy fishing.

Correct estimates of any change in the size composition of the population will be obtained by using only data from the same depth zones, e.g. from routine research vessel surveys, or from commercial trawlers when depth of fishing is known. However, this information by itself is not sufficient to determine the size composition of the catches. It follows from the differences in size with depth that, except for a uniform distribution of fishing with depth, the fishing mortality is not the same for all sizes or ages of fish, and a detailed study of the population dynamics is only possible by taking into account this variation of fishing with size, for which the actual size composition of the commercial catches is a vital piece of information. Recent experience of the cod stocks in the north-east Atlantic has shown that fishing mortality varies with size, and that the pattern has probably not remained constant; it appears that in recent years there has been a shift toward concentrating more on the smaller fish. It has been possible to study successfully some of the effects because full data of the size and age composition of the catches were available, but the results are not entirely satisfactory because without data on the detailed fishing positions, e.g. by depth zones, the shift to smaller fish is a presumption rather than a demonstrable fact.

To estimate the possible size of effect on redfish I have looked at one area (3M) where there are both length data by depth zones (from U.S.S.R., Chekhova (1964) and catch data for two years which show changes in the depth distribution (from Poland, Chrzan 1963, 1964). Assuming that the length distribution in each depth zone is the same in both years, the percentage length composition of Polish catches in 1963 and 1964 was estimated as follows:

Length (cm)	26	28	30	32	34	36	38	40	42	44	46	48	Polish catches	
						Russian catches (%)							1962	1963
150-200 fm	1.6	4.4	16.4	12.8	20.4	13.6	18.8	10.4	1.6				60.2	210.6
200-250 fm		0.6	2.9	18.0	35.2	20.6	16.6	4.5	1.0	0.6			182.2	175.8
250-300 fm			2.9	18.9	27.2	27.5	12.2	6.4	3.5	0.8	0.6		19.3	100.4
						Polish catches (%)								
1962	0.4	1.4	6.0	16.9	31.2	19.5	16.8	6.0	1.3	0.5	0.1			
1963	0.7	2.1	8.7	15.9	27.1	19.0	16.6	7.4	1.8	0.4	0.1			

The first three rows give the composition of Russian catches from each depth zone (taking the 300-400 metre zone as equivalent to 150-200 fathoms etc.), and the last two rows the weighted mean percentages, using as weighting factors the Polish catches given in the right-hand columns. There is no very obvious difference in the distributions for the two years, particularly for the central length groups, for which in fact the percentage does not vary very much between the depth zones. However, there are substantial differences at the tails of the distribution; as proportionally more fishing was done in both the shallowest and deepest zones in 1963, there are more of both very small and very big fish in the 1963 catches. Thus the percentage of fish over 40 cm increases from about 7.8% in 1962 to 9.7% in 1963, i.e. by about a quarter.

The implications of this depend on whether the Polish data are used to give estimates of the size composition of the actual population (in which case there would be an apparent increase of 25% in the abundance of large redfish), or whether the Polish data are used to estimate the effort on redfish (in which case there would, for a given catch, be a real but undetected increase of fishing on large redfish of 25%). Either of these changes could be important, and the changes in the pattern of fishing over a longer period than just two years would probably cause even more significan changes.

To avoid these errors both catch and length-composition data should be presented in depth zones. Then the best estimate of the composition of the catch would be obtained by weighting the composition in each depth zone by the catch in that zone, and the composition of the stock by weighting according to the estimated abundance in each zone. This requires more detailed sampling data than are at present given in the Sampling Year Book, where the depth zones samples are usually stated, but there is no separation of data when more than one zone has been sampled. There is also some lack of uniformity in depth zones used, though zones at 50-fathom intervals seem the most frequent.

No detailed examination of seasonal variation of either depth of fishery, or of size composition by depth has been made. If there is no seasonal variation in either of these then it would be possible to use annual figures of catch and length data by depth zones without introducing a risk of bias, but until such constancy has been established it seems advisable to use monthly or quarterly data.

Detailed statistics of catch and effort by depth zones have also been provided; if the catches vary greatly with depth then a change in the average depth fished could alter the catch per unit effort even though the abundance does not change. However, in a commercial fishery it seems unlikely that there will be any substantial amount of fishing in a depth zone in which the catch per unit effort is much less than at another depth

in the same area. Thus Brown and Dreyer (1964) found no consistent differences in catch per unit effort between depth zones in the same area, and where the differences were large (e.g. in 3P in 1963) the data were based on only a small amount of fishing. Probably therefore depth-zone data may not be particularly helpful in interpreting catch and effort data, but if catch statistics are produced to be used with length composition data, then the small extra trouble involved in including effort statistics as well may be worth while.

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