EXTRAIT

RAPPORTS ET PROCÈS-VERBAUX DES RÉUNIONS DU CONSEIL PERMANENT INTERNATIONAL POUR L'EXPLORATION DE LA MER

VOL. LXV, 1930

XIV. Fluctuations in the Stock of Herrings on the North Coast of Donegal.

By

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There is, off the North coast of Donegal, an important drift net herring fishery followed by Scottish and Irish boats, working mainly from the port of Buncrana, during January—March and May—June. The landing of herrings during the month of April is prohibited by bye-law, as in that month the fish are spent and do not come into condition till the beginning or sometimes the middle of May.

For the past eight years Mr. STORROW of the Dove Marine Laboratory has been good enough to examine samples of these herrings sent to him by the Irish Free State Fishery Department, and we are indebted to him for details of the age-composition, rate of growth and condition of these samples. From the figures which he has supplied, and which can also be found in the Reports of the Dove Marine Laboratory, I have attempted to make an estimate of the relative sizes of the successive year-classes.

It has been pointed out by LEA[1]) that if an approximately correct mortality or loss factor can be deduced for a stock of herrings it will be possible to estimate the size of the stock in successive years in units of the size of the stock in a given year, and it is on these lines that my estimate is based.

The Buncrana herrings seem to be well fitted for treatment in this way as they apparently consist of a single stock fished for in a well defined area, within a radius of about 30 miles from off the mouth of Lough Swilly, for a limited period. The spawning period is early and short, and not likely to contribute to two successive year-classes, though we do not know whether the herrings from the West coast of Donegal, which seem to spawn in October, may not also make an addition to the stock. (In using the term "year-class" I refer all fish showing one Winter ring in any year to the year-class of the previous year.) The samples, which are caught by drift nets of 32 meshes to the yard, are usually very uniform in any one year, unlike those from the Irish Sea and South coast of Ireland which vary very much in composition even when taken at short intervals in the same locality, and for this reason it is permissible to use a small number of samples, though it would have been better if more had been taken.

[1]) Rapports et Procès-Verbaux (September 1926) XLI.

The following table shows the average percentage composition of the samples examined by Mr. STORROW each year and the average for the whole period, omitting in both cases the fish with two winter rings, as their appearance in the samples is very irregular.

Winter rings	3	4	5	6	7	8	9	10	11	12
1921 (3 samples)	16.4	25.1	16.5	11.3	19.5	8.8	2.3	0.8	0.2	..
1922 (2 samples)	6.3	26.0	22.0	20.0	6.7	13.8	3.6	1.3	0.2	0.3
1923 (2 samples)	45.5	16.0	18.6	12.4	2.3	1.3	2.6	0.6	0.6	..
1924 (6 samples)	11.6	41.7	14.9	18.0	4.7	6.1	1.1	1.3	0.4	0.1
1925 (8 samples)	9.5	21.6	40.3	5.5	14.8	3.7	2.8	1.1	0.3	..
1926 (3 samples)	44.2	13.6	14.7	16.4	3.6	4.1	1.0	1.8	0.2	..
1927 (6 samples)	63.0	11.7	4.9	10.0	7.4	1.0	1.4	0.3	0.1	0.1
1928 (6 samples)	25.6	52.4	11.8	4.7	2.9	1.6	0.8	0.2	..	..
Average	27.76	26.01	17.96	12.29	7.74	5.05	1.9	0.92	0.25	0.06
Average smoothed on graph	27.76	26.01	17.96	12.3	8.0	4.8	2.5	0.9	0.24	0.06
Loss per cent. each year	6.0	31.0	31.5	35.0	40.0	48.0	64.0	73.0	75.0	..
Percentage surviving to the following year	94.0	69.0	68.5	65.0	60.0	52.0	36.0	27.0	25.0	..

From this table we see that the stock of any year-class decreases at a rate which increases with each year. In its fifth year the loss is 30 per cent., in its twelfth year it is 75 per cent. and by this time the year-class has practically disappeared. We cannot call this a death rate as probably many causes combine to produce the result, natural enemies such as dogfish and hake, fishing, gradual migration to other grounds, perhaps loss of the shoaling habit and, it may be, growth of the older fish to a size too large for the mesh of the nets. Whatever the causes may be, if only they are uniform, they do not affect the validity of the method, which is only concerned with the fish available for capture.

There is no apparent reason why the loss factor of 3 w.r. fish should differ materially from that of 4 and 5 w.r. fish so we may conclude that the remarkably low apparent loss of 6 per cent. is due to a fresh stock of 4 w.r. fish coming on to the fishing grounds and compensating for the real loss. These late arrivals are evidently more slowly growing fish than those which appeared first as 3 w.r. fish, since the size of the 3 w.r. fish, as deduced from the scales of the 4 w.r. fish, is on an average 1.4 cm. less than that of those which first appeared as 3 w.r. fish.

Median size when 3rd Winter ring is formed.

Year-class	From scales of 3 w. r. fish (January to March)	From scales of 4 w. r. fish
1920	25.91	24.91
1921	25.50	23.54
1922	26.48	25.01
1923	25.02	24.40
1924	26.43	24.54

Assuming now that the loss factor for each year given above is approximately correct and taking the stock of the year 1921, reckoned as 100, as our starting point, we may infer that in 1922 the stock will have been reduced to:—

94 per cent of 16.4 = 15.4
69 - - - 25.1 = 17.3
68.5 - - - 16.5 = 11.3
65 - - - 11.3 = 7.3
60 - - - 19.5 = 11.7
52 - - - 8.8 = 4.6
36 - - - 2.3 = 0.8
27 - - - 0.8 = 0.2
25 - - - 0.2 = 0.05

or, summing up, to 68.6 per cent. of the stock of 1921,

and will be increased by the appearance of a new group, the 3 w.r. fish. If we compare these figures with the distribution of the 4 to 12 w.r. fish actually found in the 1922 samples we see that although there is a general correspondence there is not an exact agreement. This may be due to errors in sampling either in 1921 or 1922, to abnormal migration out of the area of one or more of the year-classes present in 1921 or to additions to one or more of the year-classes of 1922 by migration into the area. As with our present knowledge we cannot say what is the true reason, though errors of sampling would seem in most cases to give a sufficient explanation, we must deal with the discrepancy as best we can and the method I have followed is to assume that the estimate of the total quantity surviving is correct but that the distribution of the year-classes is as shown by the samples of the following year. Now the samples for 1922 show the 3 w.r. fish as 6.3 per cent. and the remainder, 4 to 12 w.r., as 93.7 per cent. This 93.7 per cent. taking the 1921 stock as 100, will represent 68.6 and the 6.3 per cent. in the same proportion will represent 4.6, making a total of 75.2 as the stock for 1922. We can now divide up this 75.2 in the proportion shown by the 1922 samples getting the following result:—

winter rings	3	4	5	6	7	8	9	10	11	12	
distribution	4.6	19.0	16.0	14.6	4.9	10.1	2.7	1.0	0.15	0.2	= 75.2

Taking now these figures as representing the 1922 stock, we may in the same way work out the relative sizes of the stock in each year from 1923 to 1928 with the following result:—

Winter rings	3	4	5	6	7	8	9	10	11	12	
1921.....	16.4	25.1	16.5	11.3	19.5	8.8	2.3	0.8	0.2	..	= 100.0
1922.....	4.6	19.0	16.0	14.6	4.9	10.1	2.7	1.0	0.15	0.2	= 75.2
1923.....	39.5	13.9	16.2	10.8	2.0	1.1	2.3	0.5	0.5	..	= 86.8
1924.....	8.9	31.8	11.4	13.8	3.6	4.7	0.9	1.0	0.3	0.08	= 76.5
1925.....	5.5	12.6	23.5	3.2	8.6	2.1	1.6	0.6	1.7	..	= 58.0
1926.....	31.2	9.6	10.4	11.6	2.5	2.9	0.7	1.3	0.14	..	= 70.3
1927.....	92.3	17.1	7.2	14.7	10.8	1.5	2.1	0.4	0.15	0.15	= 146.4
1928.....	41.6	85.7	19.2	7.7	4.7	2.6	1.3	0.3	..	..	= 163.1

This table read diagonally will give the relative size of each year-class in each successive year and from this we can deduce the initial size of the year-class, making proportionate allowances for the cases in which the earlier or later year-groups are not represented in the record.

Estimated Size of each Year-class.

Year-class	3	4	5	6	7	8	9	10	11	12	Winter rings	Total
1914.....		($x = 168$)			19.5	10.1	2.3	1.0	0.17	..	$x + 33.1 =$	201.0
1915.....		($x = 47.2$)		11.3	4.9	1.1	0.9	0.6	0.14	0.15	$x + 19.0 =$	66.2
1916.....		($x = 47$)	16.5	14.6	2.0	4.7	1.6	1.3	0.15	..	$x + 40.8 =$	87.8
1917.....	($x = 22.3$)	25.1	16.0	10.8	3.6	2.1	0.7	0.4	..	..	$x + 58.7 =$	81.0
1918.....	16.4	19.0	16.2	13.8	8.6	2.9	2.1	0.3	($x = 0.3$)		$79.3 + x =$	79.6
1919.....	4.6	13.9	11.4	3.2	2.5	1.5	1.3	($x = 0.5$)			$38.4 + x =$	38.9
1920.....	39.5	31.8	23.5	11.6	10.3	2.6	($x = 4.6$)				$119.8 + x =$	124.4
1921.....	8.9	12.6	10.4	14.7	4.7	($x = 4.8$)					$51.3 + x =$	56.1
1922.....	5.5	9.6	7.2	7.7	($x = 5.7$)						$30.0 + x =$	35.7
1923.....	31.2	17.1	19.2	($x = 27.2$)							$67.5 + x =$	94.7
1924.....	92.3	85.7	($x = 154.5$)								$178.0 + x =$	332.5
1925.....	41.6	($x = 109.0$)									$41.6 + x =$	150.6

The sum of all these successive appearances of a year-class may be taken as representative of its original numbers.

The validity of this method of estimation depends on several assumptions which, at best, are only approximately true. We assume for instance:—

1) that the samples fairly represent the stock on the fishing grounds.
2) that the rate of loss is uniform for each year-class.
3) that the proportion of fish which first appear as 3 winter ringed and 4 winter ringed fish respectively is the same for each year-class.
4) that we are dealing with a single community of herrings of fixed habits.

Apart from the sampling, which is clearly insufficient in some years, the largest source of error probably lies in the difference in the proportion of fish which appear first as 3 winter ringed fish and, as this seems to depend on the size of the fish, we might expect that the more plentiful the food supply was in the preceding two years the larger would be the proportion of fish appearing as three ringed fish.

We can now if necessary revise our loss factors by averaging the estimated figures of loss in each of the year-classes which have been worked out. The averages so obtained give after smoothing a percentage of survival each year of:—

Winter rings.....	3	4	5	6	7	8	9	10	11
per cent. surviving to following year.....	92	83	72	59	47	39	34	29	24

which may perhaps be nearer to the facts than the original figures. In any case by using the new factors we get a result which differs very little from that originally obtained but which is given below for what it is worth.

Year	Estimated Stock	Year	Estimated Stock
1921	100	1925	61
1922	73	1926	75
1923	86	1927	158
1924	76	1928	173

Year-class	Estimated Size	Year-class	Estimated Size
1914	$x + 32.0 = 232.0$	1920	$123.0 + x = 125.7$
1915	$x + 19.0 = 65.5$	1921	$53.9 + x = 57.2$
1916	$x + 41.1 = 83.9$	1922	$32.0 + x = 37.1$
1917	$x + 58.8 = 79.5$	1923	$72.4 + x = 102.1$
1918	$80.0 = 80.0$	1924	$191.0 + x = 375.0$
1919	$39.0 + x = 39.3$	1925	$44.2 + x = 170.2$

No great weight can of course be attached to these figures of the relative sizes of the year-classes, but at any rate they give us data for a series of years which can be compared with those from other areas.

An attempt to treat the catches from the Irish Sea in the same manner has not so far given a satisfactory result, mainly on account of the want of uniformity in the samples. It would seem that on the East and South coasts of Ireland there is either a greater segregation of the year-classes or else the stock is of composite origin, as samples taken in the same locality may show wide differences in composition in a short space of time.

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