

Estimation of the Mortality Rates of the Flounder
in the Gdańsk Bay

by

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Tagging experiments of the flounder (Pleuronectes flesus L.) conducted during 1960 and 1961 in the Gdańsk Bay give the possibility to estimate the fishing mortality coefficient of this fish.

The calculations were made using the following formula given in the book of R.J.H. Beverton and S. Holt (1957):

$$F = \frac{\frac{n_1}{\tau} \log \left(\frac{n_1}{n_2} \right)}{N_0 \left(1 - \frac{n_2}{n_1} \right)}$$

Where n_1 and n_2 means the number of fish recaptured in successive time intervals τ , and N_0 - the initial number of tagged fish.

As the tagging of 962 flounder was conducted in several experiments with rather small number of fish liberated in each experiment, the number of recaptures from these experiments were summed according to the number of months of their liberty (Table 1).

When recaptures are grouped in three-month period we have:

3-month period	Nos recaptures	\log_e Nos
1	144	4,97
2	30	3,40
3	24	3,18
4	13	2,56
5	9	2,20

Hence
$$F = \frac{\frac{144}{0,25} \log \left(\frac{144}{30} \right)}{962 \left(1 - \frac{30}{144} \right)} = 1,19$$

However, when recaptures are grouped in 6-month period the value of F is much lower:

$$F = \frac{\frac{174}{0,5} \log \left(\frac{174}{37} \right)}{962 \left(1 - \frac{37}{144} \right)} = 0,71$$

This difference comes from greater rate of the recaptures made during first three-month period than in later periods. The probable cause of this phenomenon may be the seasonal difference in the intensity of fishing (the majority of tagging experiments were conducted during winter and spring), or it may be that the fish were more easily caught during the first three months than later, when they were more dispersed due to their movements.

In order to find the proper solution thanks to the kind advice of Mr. Beverton, a graph of natural logarithm of the number recaptured fish in each three-month period was made (Figure 1).

Taking intercept on y - axis $\log n_1 = 4,85$ and $\log n_5 = 1,68$; $n_1 = 127$. The slope will be:

$$4,85 - 1,68 = 3,17 \left(= \frac{1}{\tau} \log \frac{n_1}{n_2} \right).$$

Hence
$$\frac{1}{0,25} \log \frac{n_1}{n_2} = 3,17$$

$$\log \frac{n_1}{n_2} = 0,79$$

$$\frac{n_1}{n_2} = 2,20$$

$$\frac{n_2}{n_1} = 0,45$$

and

$$F = \frac{\frac{127}{0,25} - 0,79}{962 (1-0,45)} = \frac{401}{529} = 0,76$$

Above value of F corresponds to the annual mortality due to fishing calculated with the help of Ricker tables (1948) = 52,2%.

In order to compare this result with annual total mortality rate of flounder, the estimation of the last one was made on the basis of average age composition of the flounder catches by means of following formula given in Beverton and Holt's book:

$$(F + M)_x = \log \left(\frac{N_x}{N_x + 1} \right)$$

Hence

$$(F + M)_x = \log N_x - \log N_x + 1$$

Where N_x - average percentage of age group x

$N_x + 1$ - average percentage of age group x + 1.

Taking from the Table 2 age composition of the catches in 1957-1961 (Cieglewicz, 1962) we have:

X	N_x o/oo	$\log N_x$	$\overbrace{(\log N_x - \log N_{x+1})}^a$	$\overbrace{(N_x + N_{x+1})}^b$	a · b
4	289	5.6664	1.0012	389	389.47
5	100	4.6052	1.2040	130	156.52
6	30	3.4012	0.9163	42	38.48
7	12	2.4849	1.0986	16	17.58
8	4	1.3863			
				= 577	= 602.05
$Z = F + M = \frac{602.05}{577} = 1.04$					

The obtained value of the total mortality coefficient corresponds to the annual total mortality rate of the flounder of the age groups IV/V - VII/VIII = 64,6%. Hence the natural mortality rate may be estimated as about 12%.

Taking as the basis for calculation the comparison of the average age composition of the flounder catches made during the spawning season in Gdansk Deep (Table 3) we receive the $F + M = 0.95$, what corresponds to the annual total mortality rate 61.3%.

The above values are somewhat lower than the estimations made by A.J.C. Jensen (1959) for the plaice in Bornholm Bassin. On the basis of observations from 1951-1956 he estimated annual total reduction of plaice as 70%, in which the natural mortality was about 10-15%.

The present estimations of the mortality rates will be proved in further experiments with tagging of flatfish in the Baltic.

References:

- Beverton, R.J.H. 1957 "On the dynamics of exploited fish populations." Fish. Investig. ser. II, XIX.
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- Ricker, W.E. 1948 "Methods of estimating vital statistics of fish populations." Indiana Univ.Publ.Sci.Ser. No. 15.
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Table I

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Comparison of the Number of Tagged and Recaptured Flounder
(Gdańsk Bay)

Date of tagging	No. of tagged fish	Period in months				
		3	6	9	12	15
		Number of recaptured fish				
3. 2.60	16	2	5	6	6	6
19. 2.60	79	17	18	20	20	21
5. 4.60	63	8	10	11	12	14
7. 4.60	30	5	5	7	8	8
29. 4.60	19	2	3	4	5	5
5. 9.60	37	3	4	4	7	7
6. 9.60	41	2	3	5	5	5
9.11.60	5	2	3	3	3	3
10.11.60	110	14	24	29	31	32
10. 1.61	23	8	10	11	11	11
11. 1.61	21	5	5	5	5	5
24. 1.61	48	7	9	10	10	10
26. 1.61	106	17	21	23	23	24
12. 4.61	181	22	22	25	29	30
13. 4.61	150	22	24	27	28	29
14. 4.61	33	8	8	8	8	10
Total	962	144	174	198	211	220

TABLE 2

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Age Composition of the Flounder Catches in Gdańsk Bay
in 1957 - 1961 (in %)

Years	Age groups						
	II	III	IV	V	VI	VII	VIII+
1957	14,0	39,7	33,8	9,7	2,1	0,6	0,1
1958	21,9	39,6	29,0	7,8	1,3	0,3	0,1
1959	17,3	49,5	23,7	6,5	2,1	0,7	0,2
1960	10,4	42,4	24,5	13,5	5,3	2,7	1,2
1961	15,0	33,0	33,2	12,6	4,2	1,6	0,4
Average	15,7	40,8	28,9	10,0	3,0	1,2	0,4

TABLE 3

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Age Composition of the Flounder Catches During Spawning
Seasons of 1957 - 1961 in Gdańsk Deep (in%)

Month and year	Age groups					
	III	IV	V	VI	VII	VIII
March -May 1957	24,9	51,5	17,3	4,0	1,8	0,5
" " 1958	14,3	48,5	28,7	7,2	0,8	0,5
" " 1959	27,0	42,0	23,7	4,0	2,3	1,0
February-April 1960	17,3	54,7	11,7	9,7	4,6	2,0
March -May 1961	18,0	50,2	20,4	6,4	3,8	1,2
Average	20,3	49,3	20,4	6,3	2,7	1,0

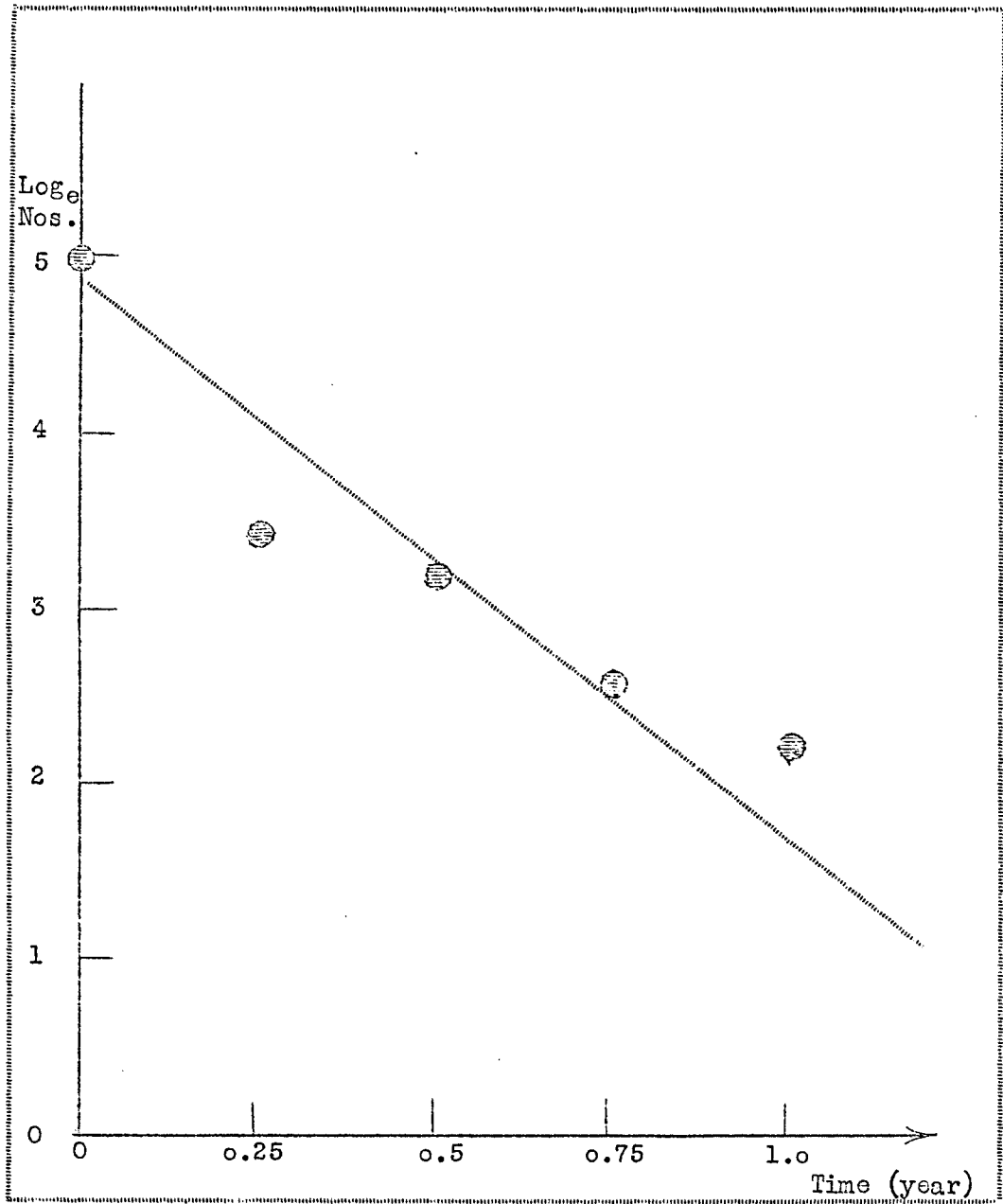


Figure 1. Logarithm of the number of recaptures in each three months period.