INTERNATIONAL COMMISSION FOR   THE NORTHWEST ATLANTIC FISHERIES

ANNUAL MEETING - JUNE 1973

Estimates of fishing mortality and stock size of herring - Georges Bank[1]

by

Bohdan Draganik
Sea Fisheries Institute
Gdynia, Poland

Age composition of the herring population in 1971 taken for further calculations was estimated on the basis of the Polish materials collected during the period from March to October 1971. The changes of year-class frequency in the catches were observed within the whole of the year.

In order to obtain an average annual age composition for herring, the whole period of catches in the Polish fishery was divided into three periods: the first from January to May, the second from June to August and the third from September to December. These data were used for determining the abundance of herring year-classes in the Polish catches in the respective periods of 1971. The average age composition of the exploited fish population was calculated on the basis of total abundance of year-class (by number of fish) in the catches (Table 1).

Table 1. Age composition of Polish herring catches in 1971.

Months	Year-Classes									
	1969	1968	1967	1966	1965	1964	1963	1962	1961	1960
Jan - May	–	46	136	258	178	109	129	32	66	46
Jun - Aug	3	318	210	270	125	35	21	8	6	4
Sep - Oct	–	157	180	266	188	93	64	24	16	12
Average	1	178	179	265	165	80	66	21	25	18

Age composition estimated in this way was taken for further calculations on fishing mortality and stock size. The data of herring age composition for the years 1961-1964 were obtained from the USSR materials (A.S. Noskov - personal communications), for the next years from Polish collections (2,3,4,5,6,7) (Table 2). On this basis the abundance of year-classes in the catches in 1961-1971 was estimated (Table 3).

The observations on changes in the abundance of year-classes in the daily catches of trawlers type B-10 and B-14 during the successive years enabled the assessment of the coefficient of total mortality (Z). The coefficient of natural mortality was estimated on the basis of the relationship between the coefficient of total mortality (Z) and the fishing effort concentrated on the exploitation of stock in the respective periods.

The coefficient of natural mortality (M) obtained by this method is 0.4.

Some kind of evidence justifying the obtained value of natural mortality coefficient is the value of total mortality coefficient determined for Georges Bank herring stock for the year 1959, while during that period the stock was almost unexploited (F = 0). Based on age composition, the coefficient of total mortality of fish was estimated for 1959 as Z = 0.69.

For further calculations of fishing mortality coefficient by virtual population technique it was necessary to assume the coefficient value of "initial" fishing mortality for the various age groups. Estimating

---

[1] Revision of Sp.Mtg.Res.Doc. 73/17 presented to Special Commission Meeting, FAO, Rome, January 1973.

the "initial" values arbitrally, the author took into consideration the data presented at previous meetings by Schumacher (11).

Table 2. Frequency (%₀) of year-classes in Polish catches of herring from Georges Bank.

Year of capture	2	3	4	5	6	7	8	9	10	>10
1961	20	78	279	508	101	14	-	-	-	-
1962	-	5	81	163	520	153	62	16	-	-
1963	-	338	135	297	138	30	12	-	-	-
1964	25	229	350	195	148	53	-	-	-	-
1965	-	47	159	529	131	64	48	15	7	-
1966	5	75	64	202	517	60	44	25	8	-
1967	-	3	100	108	183	433	90	49	34	-
1968	-	14	57	196	113	195	368	48	9	-
1969	-	31	275	156	127	81	126	172	32	-
1970	3	116	460	229	50	44	19	32	40	7
1971	1	178	179	265	167	80	66	21	25	18

Table 3. Abundance of age groups in herring catches 1966-1971 (in millions of fish).

Year	2	3	4	5	6	7	8	9	10	>10	Total
1966	3	47	40	125	321	37	27	16	5	-	621
1967	-	3	86	92	157	370	77	42	29	-	856
1968	-	20	82	283	163	282	531	69	13	-	1,442
1969	-	39	348	198	161	103	160	218	41	-	1,268
1970	4	141	558	278	61	53	23	39	49	8	1,214
1971	1	211	212	314	198	95	78	25	30	21	1,185

The estimated values for coefficients of fishing mortality for the stock in the years 1967-1971 are given in Table 4. It should be mentioned that the fishing mortality of younger fish are not completely reliable. Based on the coefficients of Table 4, the size of herring stock of the period 1966-1972 was estimated. The fishing mortality coefficient for 1971 was estimated from the difference between the amount of fishing effort in the years 1970 and 1971.

There is still no evidence for estimating the stock recruitment value for 1972-1973. This value may vary significantly from that estimated for 1971. It was assumed in this paper that the recruitment level maintains unchanged since 1971.

Based on the coefficients estimated previously as well as the assumptions taken for consideration, the stock size by number of fish was assessed (Table 5).

The principles of herring fishing regulations adopted by the Working Group (10) are based on the assumptions that the fishing intensity in 1972 should be maintained at such a level that would prevent any further stock decline, thus permiting the stock to be in 1973 at least at the same level as in 1972. If the fishing intensity remained at the same level in 1971, the stock would be reduced to a size of 664,000 tons at the beginning of 1973. Thus, in order to maintain the stock size at the level of 1972 (706,000 tons), the fishing intensity should be reduced by 44% in comparison with 1971, and this corresponds to a catch decline to 140,000 tons in 1972. The relationship between the catch value in 1972 and the size of stock in 1973 is shown in Fig. 1.

Table 4. Fishing mortality of Georges Bank herring.

Year	Age 3	4	5	6	7	8	9	9+	Average
1966	0.02	0.03	0.07	0.12	0.08	0.25	0.28	1.00	0.07
1967	0.01	0.06	0.12	0.14	0.26	0.30	1.03	1.00	0.17
1968	0.01	0.06	0.34	0.43	0.50	0.52	0.61	1.00	0.27
1969	0.02	0.28	0.44	0.37	0.70	0.77	0.99	1.35	0.31
1970	0.10	0.48	0.48	0.29	0.32	0.42	0.56	0.84	0.35
1971[1]	0.14	0.64	0.64	0.39	0.43	0.56	0.75	1.13	0.39

[1] Fishing mortality for 1971 was estimated from the difference between the amount of fishing effort in the years 1970 and 1971 (Report of STACRES on herring 1972).

Table 5. Stock size of Georges Bank herring.

Year	3	4	5	6	7	8	9	9+	Number (millions of fish)	Total weight ('000 tons)
1966[1]	2821	1638	2234	3928	582	147	79	9	10,938	2,220
1967[1]	361	1970	982	1452	1944	357	77	53	6,986	1,603
1968[1]	2412	1169	1179	556	852	1561	179	24	7,932	1,681
1969[1]	2374	1712	665	624	243	352	407	64	6,441	1,251
1970[1]	1789	1823	908	291	232	80	108	101	5,331	975
1971[3]	1951[1]	1085	756	376	146	113	35	41	4,503	817
1972[3]	1951[2]	1137	383	267	171	64	43	12	4,028	706

[1] Calculated from $\dfrac{CZ}{F(1-e^{-Z})}$

[2] Assumed same as in 1971.
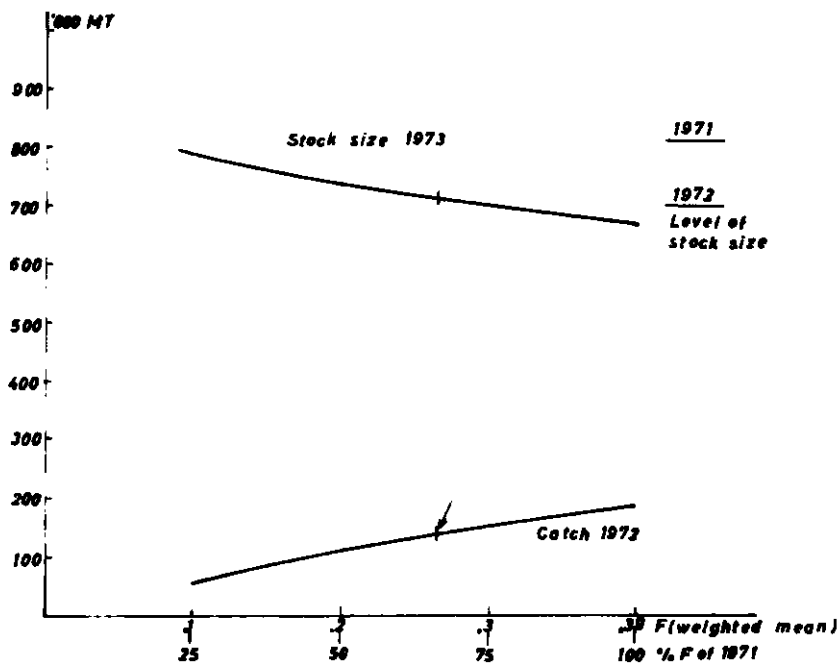
[3] Calculated from $N_{i+1} = N_i e^{-Z}$

Fig. 1. Georges Bank herring stock sizes in 1973 by levels
of catch and fishing mortality in 1972.

References

1. Anthony, V.A. 1971. United States herring assessment material. Materials were presented at ICNAF Session, Copenhagen, January 1971.

2. Chrzan, F. and B. Draganik. 1968. Observations on herring caught in Georges Bank. ICNAF Ann.Meet. 1968, Res.Doc. 68/33.

3. Chrzan, F. and B. Draganik. 1969. Results of studies on herring from the region of Nova Scotia, Georges Bank and Statistical Area 6. ICNAF Ann.Meet. 1969, Res.Doc. 69/57.

4. Chrzan, F. and B. Draganik. 1970. Length and age composition of herring in Polish catches from ICNAF Subareas 4, 5 and 6 in 1969. ICNAF Ann.Meet. 1970, Res.Doc. 70/62.

5. Draganik, B. 1971. Polish research studies on Georges Bank herring. ICNAF Ann.Meet. 1971, Res.Doc. 70/105.

6. Draganik, B. and Cz. Sukowski. 1967. Further studies on herring caught on Georges Bank in November and December 1966. ICNAF Ann.Meet. 1967, Res.Doc. 67/53.

7. Draganik, B. 1966. Age, rate of growth and sexual maturity of herring captured on Georges Bank, 29 August - 1 October 1965. ICNAF Ann.Meet. 1966, Res.Doc. 66/48.

8. Gulland, J.A. 1965. Estimation of mortality rates. Appendix to the Report of the Arctic Working Group of ICES 1965.

9. Judanow, J.G. 1966. Płodowitost i efektywnost nierests zapadnoatlanticzeskich sieldiej zaliwa Men.Trudy PINRO, wyp. XVIII. Moskwa 1966.

10. Report of STACRES on Herring. ICNAF Special Meeting January - February 1972.

11. Schumacher, A. and H. Dornheim. 1971. Estimation of fishing mortality in the Georges Bank herring stock. ICNAF Ann.Meet. 1971, Res.Doc. 71/126.