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The Arcto-Norwegian Haddock (*Melanogrammus aeglefinus*
(Linne) Fishery and their Stock Status

by

Sonina, M.A.

Abstract

The haddock fishery in the Barents Sea in 1950-1974, their abundance and stock (biomass) are considered in the paper. The relationship between the fishery and stock and growth rate of the species is analysed. The cause of the abundance reduction of immature fish population in 1974 is revealed. The forecast of the stock status and possible optimum yield of haddock in 1975 and 1976 is given due to the assessment of the year classes abundance.

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Immature haddock mainly inhabit in the southern Barents Sea and Bear Island - Spitsbergen area. The species, reached

x/ The Polar Research Institute of Marine Fisheries and Oceanography (PINRO), Murmansk, USSR.

the maturity, migrate to the spawning grounds into the Norwegian Sea. As usually, after spawning mature haddock migrate back to the southern Barents Sea in small numbers (Sonina, 1969, 1973).

Haddock start to mature since the age of 3-4 years at the length of 37-42 cm and on the whole they become matured at the age of 5-6 complete years with mean length of 47 cm. Thus, haddock inhabit in the Barents Sea mainly at the age up to 7 years and constitute the bulk of the catches at the age of 3-5 complete years (Konstantinov and Mukhin, 1965; Sonina, 1967). Mean length of haddock in the southern Barents Sea in 1950-1974 was equal to 40.7 cm and their average weight was 795 g (Table 1).

Haddock at the age of 5-10 years with the length of 50-70 cm dominated in the catches taken in the Norwegian Sea.

In 1950-1966 an annual mean yield of haddock taken by all countries and USSR in the southern Barents Sea constituted 102.2 thou.t. 46.6 thou.t. was taken by USSR. Annual mean yield of haddock in the Norwegian Sea was 35.3 thou.t. and in the Bear Island-Spitsbergen area - 4.3 thou.t. (Nizovtsev, Ponomarenko, Sonina, Shestova, 1970). The Soviet Union chiefly undertakes the haddock fishery in the southern Barents Sea.

The investigations showed that the existing fishery does not mainly effect the stock and abundance of haddock, because the commercial mortality is greatly overlapped by

natural fluctuations of the year classes abundance. The haddock stock in the Barents Sea depends mainly upon the abundance of successive year classes, growth and maturity rates (Sonina, 1969, 1970a).

The abundance fluctuations of the Arcto-Norwegian haddock year classes are fairly great: for fry - 250 times.

The abundance of the haddock year classes depends mainly upon the survival conditions of fry (Sonina, 1969; Ponomarenko, 1973; Hysten and Dragesund, 1973) and at present time it does not depend upon the parents stock value, size-age composition and sex composition of spawners, ratio between recruits and second spawners in population and extruded eggs (Sonina, 1969, 1970a, 1972, 1973).

The efficiency of haddock fishery in the southern Barents Sea depends upon the stock state, distribution and behaviour of fish, chiefly (Sonina, 1969, 1970b). The coefficient of correlation between the yield taken by the Soviet steam trawlers and their catch (stock index) per one hour trawling taken in the southern Barents Sea in 1950-1963 constituted $+0.89 \pm 0.05$. The greatest catches of haddock for the period analysed were taken in those years (1954, 1955, 1956, 1957, 1961, 1962, 1965, 1966, 1967, 1968, 1972, 1973), when the stock was fairly great. In 1952-1968 in most cases the abundance and stock of commercial stock of haddock were on the average and good levels, because in these years the abundant year classes dominated in stock.

In 1950-1964 one strong, six rich, four average and four poor year classes were registered (Table 2). The year classes with the greatest abundance we refer to the "strong" ones. The next symbols for year classes are: "rich", "average" and "poor". In 1969-1971 the abundance and biomass of the commercial haddock stock in the Barents Sea sharply decreased because of scanty of the 1965, 1966 and 1968 year classes. In these years the haddock yield in the Barents Sea considerably reduced. However, in 1972 and 1973 the abundance and biomass considerably increased because the haddock of the abundant 1969 year class reached the commercial size and their yield was record. In 1972 and 1973 the Soviet vessels took 176 and 186 thou.t. of haddock, that exceeded the maximum yield taken in 1956, when the species of the abundant 1950 year class at the age of 6 years constituted the bulk of catches. In 1973 the haddock abundance in the Barents Sea was on considerably high level. 546 specimens were registered in the mean weighted catch per one hour trawling, that exceeded the indexes of relative abundance of population in all the previous years since 1927 (Sonina, 1969). The 1969 year class of haddock was greater than the 1950 one, which up to the present time was considered to be the most abundant for the last 35 years. So, if the species of the 1950 year class at the age of 3 complete years constituted 137*7 specimens in the mean weighted catch per one hour trawling and at the age of 4 years - 193*7 specimens, then the 1969

year class haddock at the adequate age constituted 252·5 and 300·2 specimens, respectively (Table 3). The average catch per one hour trawling taken by the Soviet steam trawlers in 1972 and 1973 was twice higher than in 1953 and 1954 - 2·3 and 3·2 against 1·1 and 1·6 centners.

Compared to the previous year in 1974 the abundance of population considerably decreased. So, if in 1973 in May and June in the coastal areas 666 specimens were registered in the mean catch per one hour trawling, then in 1974 - 193 specimens.

In 1973 the species of the abundant 1969 and rich 1970 year classes of 31-50 cm long dominated in population. The species of the 1969 year class constituted 68·0% in the catches, and those of 1970 - 20·7%.

In 1974 the catches of haddock in the southern Barents Sea mainly consisted of the 1969-1971 year classes species of 31-55 cm long. The species of the abundant 1969 and rich 1970 year classes constituted the same percentage : 39·5 and 39·9%. The haddock of the 1969 year class was registered in greater quantities than those of 1970 and 1971 year classes. Consequently, in 1974 the abundance of species of the strong 1969 year class considerably decreased, that caused the abundance reduction of immature fish population. The investigations showed that this took place mainly in consequence of early sex maturity of the 1969 year class species and transport of mature fish into the spawning stock.

It is known that sex maturity of fish depends upon their growth rate. Faster the haddock grow, at earlier age they become to be matured and earlier migrate from the Barents Sea (Sonina, 1967, 1969).

In the fifties-sixties the slowest growth was observed for the 1950 and 1951 year classes haddock (Table 4). In this connection the species of these year classes as a whole reached the maturity at the age of 6-7 years and inhabited in the Barents Sea up to 8-9 years old. Comparatively low growth rate was typical for the species of the rich 1959-1961 year classes and they also matured later than those of fast growing year classes and occurred in the Barents Sea up to 7-8 years old. On contrary, the haddock of the 1956, 1957, 1963-1969 year classes had the high growth rate. The species of the 1956, 1957, 1963 and 1964 year classes reached their maturity at the age of 5-6 years. Much earlier the haddock of the 1967 year class matured. The males of this year class at the age of 4 years constituted among the recruits on spawning grounds over 50%, and females - about 25% in samples collected (Sonina, 1972).

The 1969 year class species were characterized with approximately the same growth rate as the haddock of the 1967 year class and they reached their maturity also early. They started to spawn at the age of 3 years, a lot of fish matured at the age of 4 years and, on the whole, they became matured at the age of 5 complete years.

The studying of the spawning population of haddock showed that in 1973 the species of the 1969 year class at the age of 4 years constituted among the recruits 85.5%. Besides, the haddock of this year class at the age of 4 years spawned for the second time (4.1%). In 1974 the haddock of the 1969 year class also dominated among the recruits population (94.5%), and among the second spawners the species of this year class constituted 32.7%.

If in 1973 the "remainder" in the spawning population (59.8%) exceeded the recruitment (40.2%), then in 1974 the recruitment (77.9%) was considerably greater than the "remainder" (22.1%); that was the evidence of significant recruitment of the spawning haddock population with the species of the most abundant 1969 year class, which the recruits population was mainly consisted of (94.5%). In spring 1974 during the ichthyoplankton survey an extraordinary great number of extruded eggs of haddock was observed, that was also the evidence of fairly great abundance of the spawning fish, and it was considerably higher than that of 1959-1973. Thus, the main mass of fish of the 1969 year class reached their maturity at the age of 5 years and migrated away from the Barents Sea. In 1975 the species of the rich 1970 and average 1971 and 1972 year classes constituted the bulk of haddock catches in the Barents Sea. In 1976 the population will recruit with the species of the rich 1973 year class. Thus, in 1975 and 1976 the haddock stocks will be on the average level and in interests of rational exploration the annual yield in the Barents Sea

in these years can constitute 100-120 thou.t.

CONCLUSIONS

1. In 1950-1974 the abundance and stock (biomass) of haddock in the Barents Sea were on the comparatively high level. The population was rather regularly recruited with the abundant year classes. From 1950 to 1973 two strong, eight rich, seven average and seven poor year classes were registered.

2. Commercial stock of haddock depends upon the abundance of successive year classes, recruited the commercial stock and upon the growth rate of species. The higher the growth rate, earlier haddock reach the sex maturity and migrate from the Barents Sea.

3. A close relationship exists between the haddock stocks and their annual yield ($r = +0.89 \pm 0.05$).

4. The 1969 year class was more abundant than the 1950 one, that was considered up to present to be the most abundant for the last 35 years. In consequence of this in 1972 and 1973 the abundance of the commercial stock of haddock in the Barents Sea was the highest for the period analysed. However, the 1969 year class haddock had the high rate of growth and on the whole reached their maturity at an age of 5 years and transported into the spawning stock. Considerable abundance reduction of the immature fish in the Barents Sea in 1974 was explained mainly by this fact.

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Table 1

The indexes of abundance and stock of the Arcto-
Norwegian haddock in the Barents Sea

Year	Mean length of one spe- cimen, cm	Mean weight of one speci- men, g	Number of speci- mens in average- weighted catch per 1 hour- trawling	Mean catch per one hour trawl- ing, centners
1950	33,0	625	128	0,8
1951	33,8	480	128	0,6
1952	30,2	380	264	1,0
1953	34,8	500	223	1,1
1954	37,5	630	255	1,6
1955	40,1	700	329	2,3
1956	44,8	950	315	3,0
1957	43,8	860	232	2,0
1958	42,4	880	102	0,9
1959	37,0	700	129	0,9
1960	38,1	700	187	1,3
1961	42,9	950	147	1,4
1962	42,8	930	161	1,5
1963	40,9	760	132	1,0
1964	38,3	590	237	1,4
1965	41,6	765	236	1,7
1966	42,4	850	177	1,5
1967	46,6	1110	162	1,8
1968	46,2	980	149	1,5
1969	49,8	1350	41	0,6
1970	41,5	840	75	0,7
1971	46,3	1135	62	0,7
1972	40,6	700	330	2,3
1973	38,7	590	546	3,2
1974	43,2	925	160	1,5
1950- 1974	40,7	795	196	1,5

Table 2

The abundance of haddock year classes due to the data of young determination and fishery in 1950-1973

Strong	Rich	Average	Poor
I950		I95I	I952
I969	I953	I958	I954
	I956	I963	I955
	I957	I964	I962
	I959	I967	I965
	I960	I97I	I966
	I96I	I972	I968
	I970		
	I973		

Table 3

Number of the 1950-1970 year classes haddock at different age in the average-weighted catch per one hour trawling (in specimens)

Year class	Age, years									
	2	3	4	5	6	7	8	9	Over 9	
1950	157,2	137,7	193,7	245,7	207,3	75,9	13,2	2,4	2,2	
1951	27,8	13,9	29,4	22,6	13,6	4,4	1,3	0,8	0,3	
1952	4,3	13,4	10,3	12,7	4,2	0,7	0,6	0,1	0,1	
1953	17,9	46,7	96,0	39,6	11,9	2,3	1,2	0,9	0,2	
1954	10,1	18,5	9,5	5,1	1,5	0,5	0,5	0,1	-	
1955	3,4	6,7	8,8	7,9	1,9	1,0	0,3	0,1	-	
1956	21,1	70,8	84,2	39,5	17,5	5,0	1,2	0,6	-	
1957	26,5	67,4	55,0	38,0	7,1	1,7	0,6	0,4	0,2	
1958	9,9	27,5	27,6	11,6	3,8	0,8	0,4	0,1	-	
1959	19,2	59,9	64,0	39,9	13,0	3,0	1,2	0,2	0,2	
1960	14,0	39,0	115,7	80,1	27,4	10,0	1,7	0,3	1,1	
1961	4,1	69,0	119,3	64,6	28,5	4,6	1,4	0,7	1,0	
1962	4,4	13,4	23,4	17,9	3,3	1,3	1,0	0,4	0,2	
1963	7,4	48,7	70,0	31,4	6,6	3,7	1,8	0,6	0,2	
1964	9,1	33,9	107,0	23,1	9,4	2,5	0,7	0,2		
1965	0,2	0,8	1,2	1,3	0,5	0,6	-			
1966	-	2,2	2,7	1,7	2,6	0,1				
1967	4,8	54,6	37,6	30,4	2,4					
1968	0,6	2,9	19,5	25,2						
1969	13,7	252,5	300,2							
1970	21,3	170,0								

Table 4

Mean length of the 1950-1972 year classes haddock at different age in the southern Barents Sea (cm)

Year class	Age, years						
	2	3	4	5	6	7	8
I950	29,2	33,0	40,0	43,0	48,0	52,4	58,8
I951	25,4	33,6	36,6	43,4	49,2	56,0	61,5
I952	26,4	30,8	38,3	44,2	49,3	56,0	62,6
I953	25,1	34,5	40,5	45,2	51,1	57,7	65,9
I954	32,0	34,6	40,9	45,9	51,4	63,0	68,7
I955	26,5	34,5	40,5	45,4	55,7	62,4	63,6
I956	29,6	37,1	42,3	51,0	57,5	60,0	69,4
I957	30,0	37,8	45,5	51,0	55,5	64,4	69,6
I958	28,4	38,5	43,9	47,7	54,1	58,8	62,6
I959	29,5	37,0	41,0	45,4	49,6	53,8	60,9
I960	28,4	35,0	38,7	44,0	49,2	56,4	60,9
I961	28,8	34,1	40,7	45,9	53,9	59,1	65,1
I962	28,9	37,5	43,0	51,0	56,4	62,7	66,8
I963	32,1	36,9	46,0	52,0	57,7	64,3	67,9
I964	29,5	39,4	44,9	52,3	59,5	65,4	67,2
I965	33,7	38,4	46,1	54,7	63,2	66,8	-
I966	-	37,5	45,3	52,8	59,2	62,4	78,0
I967	31,3	39,8	48,5	54,1	60,6	64,3	
I968	30,1	39,3	45,5	50,7	58,7		
I969	32,8	39,8	43,2	54,0			
I970	30,8	35,2	43,8				
I971	30,3	35,6					
I972	29,5						

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