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Vertebral Number as Method of Separating Intrapopulational Groups of Haddock in the Newfoundland Subarea

by

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Abstract

Basing on the average amount of vertebrae and variability of vertebral number analysed in 3952 specimens of 55 samples taken in the Newfoundland Subarea in 1964-1972, haddock are divided into: 1) the isolated stock of the Flemish Cap Bank, 2) the stock of the southern and 3) of the western parts of the Grand Bank, 4) the stock of the St. Pierre Bank. Haddock of the stocks from the Grand and St.Pierre banks may partly intermix.

The difference in the analysed features between haddock of separate year classes in any part of the Newfoundland Subarea is more important than between haddock of different parts and different samples on the average. As to yearlings and two-year-old fish of the same year class, the average number of vertebrae is usually higher in larger specimens than in small ones.

Introduction

The availability of local stocks in the Subareas of the Newfoundland, Nova Scotia and New England and the degree of their intermixing were determined by tagging, analysis of vertebral number, length-age composition and growth rate of haddock (Needler, 1930, 1931; Vladykov, 1935; McKenzie, 1940; Schroeder, 1942; Schuck, Arnold, 1951; Graham, 1953; Martin, 1953; McCracken,

1956, 1960, 1963, 1965; Clark, 1958; Hart, Edwards, 1959; Clark, Vladykov, 1960; Grosslein, 1962; Letaconnoux, 1964; Halliday, McCracken, 1970; Tyler, 1974).

Known is the reverse relation between the temperature of the surface waters in the spawning area of haddock during the first 5 - 6 weeks after fecundation and the number of formed at this time myomeres and, later, vertebrae (Clark, Vladykov, 1960). Such dependence was found for many species and was confirmed experimentally.

Thus, the small average number (53.49) and the coefficient of vertebral number variation (1.27) of haddock in the Rockall Bank area are apparently accounted for by the high water temperature just slightly changing with development of larvae (Shestov, Blagodelskaya, 1971). In general, with rise of water temperature, from north to south of the areas, the average number of vertebrae decreases in the North American (Vladykov, 1935; Graham, 1953; Martin, 1953; Clark, Vladykov, 1960; Grosslein, 1962) and European haddock (Tånong, 1935; Saetersdal, 1952; Shestov, Blagodelskaya, 1971).

Thus, the amount of vertebrae in haddock is one of the main indications of their stocks, which permit to determine belonging of the aggregate of specimens to this or another spawning ground, to judge of stocks intermixing, the direction of migration, temperatures in the spawning areas and duration of spawning.

In classical studies on the North American haddock stocks (Clark, Vladykov, 1960), considering the small amount of vertebrae (50-56, 52.9[1/]), in the haddock of the St. Pierre Bank, the author detected the Newfoundland group. The problem of the stock locality was not settled because of the lack of the data on the Grand Bank haddock. But it was shown earlier that there is an area on the Grand Bank where haddock with an average number of vertebrae 52.5 - 52.9[1/]) form a separate stock (Thompson, 1939). By the difference in growth rate and strength of the year classes Templeman (1953) divided the haddock of the Grand Bank, on the one hand, and the St. Pierre Bank, on

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[1/] The last vertebra with an urostyle was not counted.

the other hand, into large stocks not differing greatly in vertebral numbers, pointed out a very small stock of the Flemish Cap Bank with quite different growth rate and otolith structure. On the Grand Bank a few large specimens with the growth rate typical of the haddock on the St. Pierre Bank were caught which led to the conclusion that the stocks intermix in the south of the Green Bank. The average number of vertebrae in haddock caught at the south-western coast of the Newfoundland was less than on the St. Pierre and Grand banks, and the author separated out these haddock into a small independent population. Further study of the otolith structure, growth and maturation rates, year class abundance, distribution of fish by seasons confirmed such separation (Templeman, Squires, 1956; Wize, Jensen, 1960; Beverton, Hodder, 1962; Grosslein, 1962; Templeman, Hodder, 1965, 1965a; Templeman, 1972, Hodder, 1966; Tyler, 1974).

Depths up to 250-300 m are not an insurmountable barrier for haddock (Raitt, 1939), the more so that the Halibut and Haddock deeps are about 200 m deep. But the constant low temperature at the bottom restricts intermixing of haddock from neighbouring stocks (Templeman et al., 1978). They may intermix more intensely at the stages of eggs, larvae and pelagic juveniles. Thus, in 1949 masses of larvae were transported from the Grand Bank to the St. Pierre Bank (Hodder, 1966). Apparent is the migration of larger haddock from the St. Pierre Bank in deep waters along the slope to the western part of the Grand Bank (Templeman et al., 1978).

To specify the locality of haddock stocks in the Newfoundland Subarea, the amount of vertebrae in fish on the St.Pierre, Green and Grand banks was analysed.

Material and methods

In 1961, 1964-1972 a total of 3 952 specimens from 55 samples was analysed (Appendix I). Till 1970 the author counted the haddock vertebrae on board the ship, in 1970-1972 - in frozen fish in the PINRO laboratory. The vertebra with an urostyle

was counted as well. The material was classified by the areas: 1) the Flemish Cap Bank (3M), 2) the north-eastern (3L), 3) south-eastern (3N) and 4) south-western (3O) slopes of the Grand Bank, 5) the Green Bank; 6) the south-western and 7) north-western slopes of the St.Pierre Bank (Fig.1). The collected data were processed mathematically by the commonly accepted methods of variational statistics (Snedecor, 1957). The results of the analysis are given in Table 1.

Small errors of selection ($S_{\bar{x}}$) show that the sufficient amount of specimens were examined in every area. Small values and fluctuations of the root-mean-square deviations (S) and coefficients of variation of the vertebral number (C) point to low variability. That is why any constant of the variational series is considered statistically reliable with the confidence level (t) of 0.05.

Results

The number of vertebrae in haddock from our samples varied from 50 to 57, the average number ($\bar{x}$) being 53.57 to 54.60. The average values of $\bar{x}$ for haddock of the Green Bank and Divs. 3N and 3O are close to the average values of $\bar{x}$ (53.85) (Grosslein, 1962), almost coincide with those for the Flemish Cap haddock (54.10) and completely coincide (53.90) for the St.Pierre haddock (Clark, Vladykov, 1960). For the Grand Bank haddock $\bar{x}$ in the samples of ours fluctuate mainly within the same limits as by Thompson's data (53.50 - 53.90) (Thompson, 1939).

The analysis shows that in general $\bar{x}$ for the haddock in the Newfoundland Subarea (Table 1 and Fig.1) decreases from the north to the south of the Grand Bank, then grows towards the north of the St. Pierre Bank. Relatively $\bar{x}$ there is some reliable difference ($t_{\bar{x}}$) between haddock from some of the considered areas (Table 2). But statistically meaningful $t_{\bar{x}}$, estimating the reliability of the difference between the compared $\bar{x}$, does not yet testify to the taxonomic distinctions. To determine the reliability of difference between the variability degrees of the compared

distributions of vertebral numbers we apply mainly the Fisher's criterion (F).

For the haddock on the slopes of the St. Pierre Bank, as well as in Divs. 3L and 3O the values of $\bar{x}$, S and C coincide, $t_{\bar{x}}$ are very small, $t_c=0$ and F=1, which points to the unity of the St. Pierre Bank haddock and to that of the haddock from Divs. 3L and 3O.

For the haddock from Div.3N the values of $\bar{x}$, S and C are the lowest. The reliable $t_{\bar{x}}$ are obtained between the haddock of Div.3N, on the one hand, of Divs. 3L, 3O and the St. Pierre Bank, on the other hand, and the reliable t_c and F - between the haddock of Divs. 3N and 3O, the Green Bank. Undoubtedly, haddock of the Div. 3N are mainly of another origin than those of Divs. 3L and 3O, the Green and St.Pierre banks.

The highest S and C are obtained for the haddock of the Green Bank; $t_{\bar{x}}$, t_c, F for these haddock and those of other areas grow towards the north of the St. Pierre Bank and towards Div.3N, which testifies to the intermixing of haddock of different origin in the Green Bank area. Relatively C and F they differ significantly from the haddock of the St. Pierre Bank and Div. 3N, but do not differ from the haddock of Div. 3O. Apparently, haddock migrate mainly from Div. 3O to the Green Bank.

Relatively F the haddock of Div. 3O and the St. Pierre Bank differ greatly, which testifies to the diverse origin of haddock in these areas. The highest $\bar{x}$ is for the haddock of the local stock of Div. 3M.

Significant values of $t_{\bar{x}}$ are obtained between the haddock samples within one area - Div. 3O - up to 5.53. Still higher is $t_{\bar{x}}$ between fish of separate year classes within the same area - up to 8.71, F - to 3.85. Fluctuations of $\bar{x}$ by year classes are connected with year-to-year difference of water heat content on spawning grounds and are known for the haddock from the New England and Nova Scotia areas (Graham, 1953; Clark, 1958; Clark, Vladykov, 1960).

Consequently, relatively $\bar{x}$ and F differences between haddock of separate year classes within one area are more significant

than between haddock from different areas and samples. The prevalence of that or another year class in the sample provokes great fluctuations of $\bar{x}$ in the samples from one area alongside with the change of fish amount of different origin and may cause smoothing of $\bar{x}$ for haddock in the compared areas.

Among the 1961-1971 year classes the haddock of Divs. 3N and 3O of the 1961, 1962 year classes, as well as of Divs. 3L and 3O of the 1963, 1968 year classes diff-er notably relatively F (Appendix II). The haddock of the Green Bank of the 1965 and 1966 year classes differed from the haddock of the same year classes from the St. Pierre Bank, where fish of the 1962, 1963, 1968 and 1970 year classes differed from those of the same year classes on the slopes of the Grand Bank. The haddock of the 1963 year class on the south-western slope of the St. Pierre Bank differed from the haddock of this year class on the north-western slope of the Bank. Similar differences are obtained relatively $\bar{x}$ as well.

The analysis of fluctuations and differences of $\bar{x}$ and C for haddock of different year classes within one area does not consider possible intermixing of haddock from different stocks with age. Our data do not allow to investigate thouroughly enough the variation of an indication from area to area in haddock of the same year class and age, especially in young age when such intermixing is minimum. But if we unite the haddock of the Grand Bank, on the one hand, and those of the St. Pierre Bank, on the other hand (Appendix III) then relatively $\bar{x}$ the haddock of the 1971 yearclass at an age of 1+, of the 1969 year class at an age of 2+, of the 1966 year class at an age of 3+ and of the 1962 year class at an age of 4+ and 5+ differ notably (Table 3). The haddock of the 1962 and 1966 year classes on the Grand Bank differed from the haddock of the same year classes and age on the Green Bank. The haddock of the 1964 year class of the Green and St. Pierre banks differed at an age of 4+.

The growth of $\bar{x}$ with age of haddock of the 1962 and 1970 year classes on the Grand Bank is caused , apparently, by the migration of the portion of haddock from the St. Pierre and Green

banks to this area, where $\bar{x}$ for specimens of these year classes was higher. The decrease of $\bar{x}$ with age of the 1968 year class haddock on the St. Pierre and Grand banks may be accounted for by migration of haddock with a high vertebral number from the banks to the coastal area of Newfoundland. This supposition coincides with the increase of haddock, especially young, in the by-catch to cod in the coastal area in 1970 and 1971 (Templeman, 1971; Templeman, Fleming, 1972). The decrease of $\bar{x}$ with age of the 1970 year class haddock on the St. Pierre Bank is apparently connected both with migration of haddock to the Grand Bank and to the coast.

Relatively F the differences are diverse and more prominent: between the haddock of the St. Pierre and Grand banks additionally for the 1961 year class at an age of 5+, of the 1962 year class - at an age of 3+, of the 1966 year class - at an age of 2+, but the differences for the 1962 year class at an age of 5+ and for fish of the 1969 and 1971 year classes disappear. Between the haddock of the Green and St. Pierre banks the difference for the 1964 year class at an age of 4+ disappears, but it again appears for the 1966 year class at an age of 2+. The difference between fish of the 1962 year class at an age of 5+ of the Green and Grand banks disappears.

The decrease of difference of $\bar{x}$ and F between haddock of the three banks with age of haddock within the same year class is typical, which is apparently connected with gradual intermixing of haddock from different stocks.

Considering the distribution of young fish catches (Shestov, 1972), it is apparent that in the samples haddock of the 1964, 1967 and 1969 year classes belonged mainly to the St. Pierre Bank stock, the 1971 year class - to the Grand Bank stock. In 1961 - 1963, 1966, 1968 and 1970 haddock stocks of the Newfoundland Subarea were recruited both at the expense of spawning on the Grand Bank and, mainly, on the St. Pierre Bank, and in 1965 and 1966, apparently, on the Green Bank.

Thus, relatively the average number of vertebrae and the variability of vertebral number of the haddock from the Newfoundland Subarea are

divided into: 1) the isolated stock of the Flemish Cap Bank, 2) the stock of the south, and 3) the stock of the west of the Grand Bank, 4) that of the St. Pierre Bank. The haddock of the St. Pierre and Grand banks may intermix. The highest degree of intermixing is observed in relation to the haddock of the Grand Bank which form a kind of large stock. On the Green Bank where spawning is also observed, intermixing of haddock from the St.Pierre and Grand banks is registered. Apparently, haddock migrate to the Green Bank, mainly, from the south-western slope of the Grand Bank.

Among spring spawners of the same year class and age, especially fingerlings and yearlings, larger specimens usually have a higher $\bar{x}$ of vertebrae (Hart, 1937; Mottley, 1937; Tester, 1937; McHugh, 1942; Dannevig, 1947, 1950, 1951; Wood, 1956). The progeny of early spawning develop in colder and denser water, that is why they have a higher $\bar{x}$ of vertebrae, and reach a great length towards the end of the year. Naturally, autumn spawning larger specimens of the year class, on the contrary, have a smaller $\bar{x}$ of vertebrae (Ford, 1930). We have obtained the direct relationship between $\bar{x}$ and the length of the haddock from the Grand Bank of the 1970 year class at an age of 1+, 2+ and the yearlings of the 1971 year class (Table 4).

Consequently, the average amount and the variability of vertebral number, as indications of haddock belonging to that or another stock, must be considered taking into account their variation both by year classes and within the same year class but of different length.

On the basis of reference data (Tåning, 1935; Saetersdal, 1952; Clark, Vladykov, 1960), we calculated the formula of connection between $\bar{x}$ and water temperature (T) during haddock spawning on spawning grounds of New England, Nova Scotia, St. Pierre Bank, Ireland, Faroes, Iceland, North Sea and Norwegian coast.

The data for 1966-1971 permit to approximately determine the mean temperature of the 0-50 m layer along the section

44-A in the peak of haddock spawning (about 1 July), on the St. Pierre Bank, in the south-west of the Grand Bank (15 June, section 1-A) and its south (1 June, section 2-A). For the St. Pierre Bank the calculated temperature appeared to be 6.55°, for the Grand Bank along two sections - 5.09°. If we use in the formula $\bar{x}$ of vertebra in the 1966-1971 year classes haddock on the St. Pierre Bank (53.97) and Grand Bank (54.04), on the average, then we obtain rather similar temperatures - 6.13 and 5.33°, respectively.

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Table 1 The vertebral number of haddock in the Newfoundland area

Area	Vertebral number	$\bar{x} \pm S\bar{x}$	S	C	n
1. The Flemish Cap Bank	52-56	54.07 ± 0.08	0.83	1.54	118
The Grand Bank					
2. The north-western slope	52-56	53.93 ± 0.08	0.90	1.67	121
3. The south-eastern slope	52-56	53.71 ± 0.05	0.81	1.51	268
4. The south-western slope	51-57	53.94 ± 0.03	0.90	1.67	1173
5. The Green Bank	50-57	53.84 ± 0.05	0.94	1.75	348
The St. Pierre Bank					
6. The South-western slope	50-56	53.90 ± 0.03	0.84	1.56	713
7. The north-western slope	51-57	53.91 ± 0.02	0.84	1.56	1211
Total	50-57	53.90 ± 0.01	0.87	1.62	3952

Table 2 The reliability of the average vertebral number difference $t_{\bar{x}}$, coefficients of variation of the vertebral number t_c and the Fisher's criterion F for haddock from different parts of the Newfoundland. The underlined differences are significant.

Part	2	3	4	5	6	7
		$t_{\bar{x}}$				
I	I,28	<u>3,83</u>	I,52	<u>2,45</u>	<u>2,00</u>	I,97
2		<u>2,29</u>	0,I8	0,90	0,29	0,I8
3			<u>3,96</u>	I,83	<u>3,28</u>	<u>3,70</u>
4				I,72	0,95	0,83
5					I,03	I,30
6						0,20
I	0,88	0,25	I,24	I,72	0,I9	0,I9
2		I,23	0,00	0,6I	0,94	0,96
3			<u>2,I0</u>	<u>2,42</u>	0,62	0,66
4				I,05	I,60	I,89
5					<u>2,36</u>	<u>2,49</u>
6						0,00
I	I,I8	I,05	I,I8	I,28	I,02	I,02
2		I,23	I,00	I,09	I,I5	I,I5
3			<u>I,23</u>	<u>I,34</u>	I,07	I,07
4				I,09	<u>I,I5</u>	<u>I,I5</u>
5					<u>I,25</u>	<u>I,25</u>
6						I,00

Table 3 The differences in the average vertebral number ($t\bar{x}$) and variability of vertebral number by Fisher's criterion (F) in haddock year classes at different age. Subarea I - The Grand Bank. The underlined differences are significant.

Year class	Part	Green Bank (2)								St.Pierre Bank									
		2+		3+		4+		5+		I+		2+		3+		4+		5+	
		$t\bar{x}$	F	$t\bar{x}$	F	$t\bar{x}$	F	$t\bar{x}$	F	$t\bar{x}$	F	$t\bar{x}$	F	$t\bar{x}$	F	$t\bar{x}$	F	$t\bar{x}$	F
I96I	I																	0,77	2,07
I962	I							3,32	I,I3					I,0I	2,67	2,05	I,56	2,57	I,26
	2																	0,60	I,42
I963	I					I,I7	I,82							0,04	I,23	0,27	I,34		
	2															0,66	I,35		
I964	I			0,07	I,3I									0,77	I,I3				
	2													0,74	I,I6	2,I4	I,I2		
I965	2													0,I5	I,28				
I966	I	0,35	I,50	2,27	3,46	0,06	I,30					0,62	I,63	2,39	2,58	0,I4	I,I9		
	2											0,85	2,44	0,89	I,34	0,I7	I,54		
I968	I											I,39	I,08	0,92	I,34	0,I2	I,32		
I969	I											2,3I	I,I8	I,28	I,I4				
I970	I									0,72	I,I4	I,3I	I,3I						
I97I	I									2,07	I,58								

Table 4 Variation of the average vertebral number ($\bar{x}$) with increasing length of the 1970 and 1971 year classes of haddock from the Grand Bank

Length, cm	1970 (I+)		1971 (I+)		Length, cm	1970 (2+)	
	$\bar{x}$	n	$\bar{x}$	n		$\bar{x}$	n
I4			52,00	2	24	53,00	I
I5			58,22	9	25	53,67	3
I6			53,33	24	26	54,00	3
I7			53,62	34	27	54,00	7
I8			53,78	23	28	54,I5	I3
I9			53,84	3I	29	54,II	9
20	53,50	2	54,06	I6	30	53,83	6
2I	53,80	4	53,9I	II	3I	53,50	4
22	53,30	3	53,50	4	32	55,00	3
23	54,00	2	54,00	I	33	54,00	2
24	54,00	I			34	54,67	3
25	54,70	3					
Total	53,87	I5	53,68	I55		54,08	54
$\pm s_{\bar{x}}$	0,25		0,07			0,I0	
s	0,96		0,85			0,78	
c	I,77		I,58			I,44	
r	0,404		0,735			0,663	
$\pm s_r$	0,025		0,037			0,077	

$$\bar{x} = 55,299 - 0,3364\ T + 0,0I95\ T^2$$

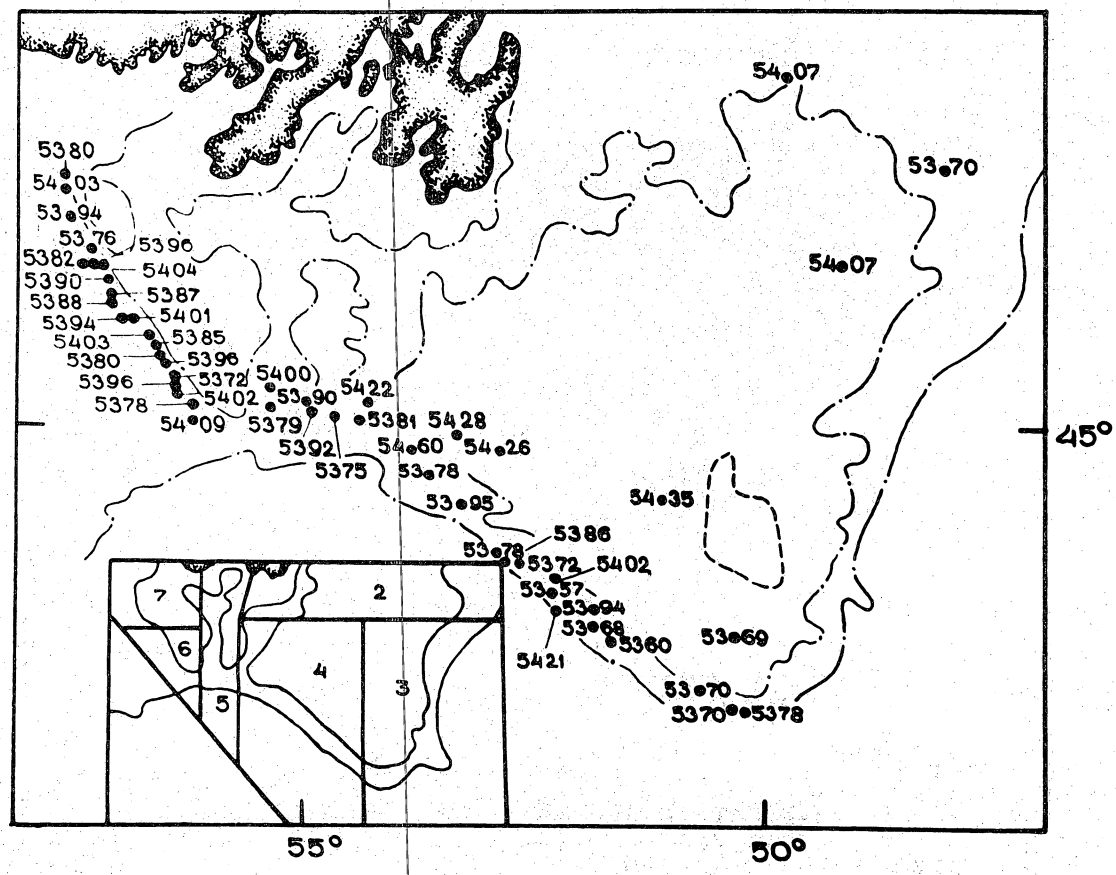

Fig. 1. The average vertebral number of haddock in the Newfoundland Subarea. 1)- The Flemish Cap Bank (3M); 2) the north-eastern (3L); 3)- south-eastern (3N); 4) south-western (3O) slopes of the Grand Bank; 5)- the Green Bank; 6)- the south-western and 7) north-western slopes of the St. Pierre Bank.

Appendix I

Results of haddock vertebral number analysis in the Newfoundland area

Area and data	Fish amount with vertebral number								Total of fish	Aver. No.
	50	51	52	53	54	55	56	57		
3M, the Flemish Cap Bank										
April, 1967			I	5	8	2	I		I7	53,82
April, 1968			I	4	I0	5	I		2I	54,05
April, 1969				9	23	I2	I		45	54,II
August, 1970				4		6			I0	54,20
April, 1972				6	I0	9			25	54,I2
Total			2	28	5I	34	3		II8	54,07
The Grand Bank										
3L, north-eastern slope										
March, 1967			2	22	I2	I0	I		47	53,70
July, 1971			I	I4	26	I6	2		59	54,07
June, 1972			I	3	5	6			I5	54,07
Total			4	39	43	32	3		I2I	53,93
3N, south-eastern slope										
February, 1966			I	I4	30	5			50	53,78
April, 1967			4	9	I8	6			37	53,70
April, 1967			5	32	53	I0	I		I0I	53,70
April, 1972			6	32	25	I5	2		80	53,69
Total			I6	87	I26	36	3		268	53,7I
30, south-western slope										
May, 1961			4	39	36	I7	4		I00	53,78
December, 1964			6	38	40	I5		I	I00	53,68
October, 1965		I	2	2I	I9	7			50	53,58
February, 1966			2	2I	I5	I0	2		50	53,78
February, 1966		I	2	20	20	7			50	53,60
May, 1966		I	I	30	53	I4	I		I00	53,8I
April, 1967				9	I6	7			32	53,94
May, 1967		I	3	26	29	I3	I		73	53,72
May, 1968			2	3I	43	I9	4	I	I00	53,95
May, 1969				4	I7	I3			34	54,26
May, 1969				I	I0	I2	2		25	54,60
June, 1970			2	3	8	9		I	23	54,22
June, 1970			6	22	63	59	I4	I	I65	54,28
July, 1970				II	20	I0	I		42	54,02
June, 1971				I0	22	I2	5		49	54,35
April, 1972			4	4I	65	26	2		I38	53,86
April, 1972				I0	I7	I4	I		42	54,2I

Appendix I (contd.)

Area and data	Fish amount with vertebral number							Total of fish	Average No.
	50	51	52	53	54	55	56	57		
Total in the area		4	34	337	493	264	37	4	1173	53,94
Total on the Bank		4	54	463	662	332	43	4	1562	53,90
3P, the Green Bank										
April, 1967	I		11	24	45	14	4	I	100	53,75
April, 1967			4	30	51	13	2		100	53,79
May, 1968		2	2	26	44	22	3		99	53,92
June, 1969		I	I	4	19	6			31	53,90
June, 1970			2	2	8	6			18	54,00
Total on the Bank	I	3	20	86	167	61	9	I	348	53,84
3P, the St. Pierre Bank										
a) the south-western slope										
October 1965	I	I	3	14	20	9	2		50	53,72
May, 1966			2	32	51	14	I		100	53,80
April, 1967		I	I	32	51	11	2		98	53,78
April, 1967			4	30	45	15	4		98	53,85
June, 1968			5	19	53	21	2		100	54,02
June, 1969			4	15	54	22	5		100	54,09
May, 1971			2	29	50	27	I		109	53,96
May, 1972			I	6	11	5	I		24	53,96
May, 1972				6	21	7			34	54,03
Total in the area	I	2	22	183	356	131	18		713	53,90
b) the north-western slope										
May, 1966			2	24	44	28	2		100	54,04
April, 1967			5	30	50	14	I		100	53,76
June, 1968			5	31	51	13			100	53,72
June, 1968			6	24	52	18			100	53,80
June, 1969		I	I	9	32	14	I		58	54,03
June, 1969			4	24	57	16			101	53,87
June, 1970			2	9	30	8		I	50	53,96
May, 1971		I	2	36	53	27	5		124	53,94
May, 1971			6	27	41	24	3	I	102	53,94
May, 1972		I	9	35	90	44	7		186	54,01
May, 1972		I	2	24	45	17	I	I	91	53,90
May, 1972		I	5	19	55	17	2		99	53,89
Total in the area		5	49	292	600	240	22	3	1211	53,91
Total on the Bank	I	7	71	475	956	371	40	3	1924	53,91
Total in the Newfoundland area	2	14	147	1052	1836	798	95	8	3952	53,90

Appendix II

The difference in the vertebral number variability in haddock year classes in the Newfoundland area by Fisher's criterion. Underlined differences are sufficient.

Year class		AREA						
	Area	2	3	4	5	6	7	
1961	S^2_n		0,43	0,78	0,51	0,67	0,74	
			33	80	11	32	27	
	3			1,81	1,19	1,56	1,73	
	4				1,52	1,16	1,05	
	5					1,31	1,45	
	6						1,11	
1962	S^2	0,64	0,56	0,74	0,69	0,85	0,47	
	n	18	105	293	44	71	32	
	2		1,14	1,16	1,07	1,33	1,38	
	3			1,32	1,22	1,52	1,19	
	4				1,08	1,15	1,57	
	5					1,24	1,46	
	6						1,80	
1963	S^2	1,20	0,69	0,45	0,61	0,70	0,28	
	n	10	10	27	20	77	16	
	2		1,74	2,68	1,97	1,73	4,35	
	3			1,54	1,13	1,01	2,50	
	4				1,36	1,56	1,62	
	5					1,14	2,21	
	6						2,52	
1964	S^2	0,82	0,50	0,62	0,79	0,72	0,73	
	n	14	26	45	153	133	116	
	2		1,62	1,32	1,03	1,13	1,12	
	3			1,22	1,57	1,43	1,45	
	4				1,28	1,17	1,18	
	5					1,10	1,08	
	6						1,01	
1965	S^2			0,59	0,91	0,47	0,49	
	n			13	34	53	21	
	4				1,53	1,26	1,22	
	5					1,93	1,86	
	6						1,03	

Appendix II (contd.)

Year class	Area	2	3	4	5	6	7
1966	s^2			0,75	0,95	0,63	0,62
	n			125	75	178	318
	4				1,26	1,20	1,21
	5					1,51	1,53
	6						1,01
1967	s^2			0,76		0,76	0,68
	n			30		35	104
	4					1,00	1,12
	6						1,13
1968	s^2	0,38		0,86		0,90	1,13
	n	18		221		21	61
	2			2,23		2,35	2,93
	4					1,06	1,32
	6						1,25
1969	s^2	0,84		0,77		0,58	0,73
	n	46		54		109	217
	2			1,09		1,44	1,14
	4					1,32	1,05
	6						1,26
1970	s^2	0,89		0,62		0,46	0,89
	n	10		69		13	221
	2			1,43		1,93	1,00
	4					1,32	1,43
	6						1,93
1971	s^2		0,85	0,60			0,48
	n		74	81			21
	3			1,42			1,79
	4						1,26

For notation of areas see Table 1

Appendix III.

Average vertebral number of haddock of different year classes and age

Year class, age		Grand Bank			Green Bank			St. Pierre Bank		
		$\bar{x} \pm S_{\bar{x}}$	s^2	n	$\bar{x} \pm S_{\bar{x}}$	s^2	n	$\bar{x} \pm S_{\bar{x}}$	s^2	n
I96I	5+	53,7I±0,09	0,38	45				53,87±0,I3	0,79	47
I962	3+	53,6I±0,I4	0,74	36				53,I7±0,4I	I,97	I2
	4+	53,75±0,07	0,73	I58				54,00±0,I0	0,47	5I
	5+	53,77±0,07	0,62	I4I	54,26±0,I3	0,70	43	54,I5±0,I3	0,49	33
I963	3+	53,92±0,22	0,53	I3				53,82±0,I2	0,43	28
	4+	53,96±0,I8	0,84	25	53,75±0,I8	0,46	20	53,90±0,I4	0,62	30
I964	3+	53,62±0,I0	0,6I	60	53,63±0,09	0,80	I20	53,7I±0,06	0,68	205
	4+				54,06±0,I3	0,56	32	53,62±0,I6	0,62	26
I965	3+				53,63±0,I8	0,90	30	53,67±0,20	0,62	I5
I966	2+	53,96±0,II	0,69	80	54,03±0,I7	I,03	36	53,88±0,05	0,42	209
	3+	54,33±0,I2	0,22	I5	53,84±0,I8	0,77	25	54,0I±0,06	0,58	I68
	4+	53,95±0,I8	0,7I	2I	53,93±0,26	0,92	I4	53,98±0,I2	0,60	45
I968	2+	54,36±0,07	0,92	I64				54,I3±0,I5	0,86	40
	3+	54,25±0,I3	0,63	36				54,08±0,I3	0,84	47
	4+	53,90±0,4I	I,00	I0				53,96±0,25	I,32	28
I969	2+	54,I7±0,I2	0,79	55				53,87±0,05	0,67	I93
	3+	54,I5±0,I9	0,79	2I				53,89±0,07	0,70	I33
I970	I+	53,87±0,23	0,86	I6				54,05±0,I0	0,98	9I
	2+	54,08±0,I0	0,60	64				53,92±0,07	0,79	I43
I97I	I+	53,68±0,07	0,72	I55				54,00±0,I4	0,46	22