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ICNAF Herring Otolith Exchange 1971-72

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Introduction

At the 1971 Annual Meeting of the International Commission for the Northwest Atlantic Fisheries, the Fisheries Research Board of Canada's Biological Station at St. John's, Newfoundland agreed to organize and co-ordinate a program of herring otolith exchange between experts from member countries engaged in routine age determination and other otolith studies. At that time Canada, Federal Republic of Germany, France, UK, USA and USSR agreed to participate (Anon., 1971).

Previous scale and otolith exchanges between member countries of ICNAF had revealed no significant differences between age estimates from scales and otoliths within countries but had indicated a lack of uniformity in age estimates between countries (Tibbo, MS 1968, 1969, 1970). Because some of the participants now rely exclusively on otoliths for age determination, the present exchange was limited to otoliths. In order to obtain as broad a selection of otoliths as possible, 6 samples of 50 otoliths each representing herring from Georges Bank, Bay of Fundy, southwest Nova Scotia, Canso Bank, southern Gulf of St. Lawrence and southwest Newfoundland were circulated with appropriate information on locality and date of capture and length, sex and maturity (according to the official ICNAF maturity scale) for each specimen. Photographs of these otoliths were also circulated. It was realized that the photographs would be of little value for actual ageing of older fish but might be of value in clarifying inner zones on the otolith at future discussions between age readers. Participants were also requested to provide a description of the age definitions, conventions and techniques used by herring age readers at their laboratories.

Results

To date these otolith samples have been examined by scientists at laboratories in Canada, the USA, Germany and the USSR. Both age and year-class designations were recorded by all participants. Year-class designations for individual specimens are tabulated in Appendix Tables 1-6. Comparisons of year-class estimates for each pair of laboratories are presented in Tables 1-7. The instances in which year-class estimates were identical are shown by numbers inside the squares.

Examination of the tables suggests the following observations:

(1) The degree of uncertainty for older specimens is such that most participants employ some kind of grouping category but this differs between laboratories. USA scientists group any herring older than age 8 into an 8+ category. German scientists and Canadian scientists at St. Andrews, New Brunswick, group all fish older than age 9 into a > 9 category. At St. John's, Newfoundland, herring older than age 10 are grouped into a > 10 category. USSR scientists apparently do not group older herring but rather assign individual ages to each specimen.

(2) The level of agreement for relatively small herring (12-23 cm in length) in the Bay of Fundy sample was high (greater than 90% between all pairs of laboratories with the exception of Germany). However, the degree of agreement decreases markedly with increase in fish size. Valid comparisons could not be made for the southern Gulf of St. Lawrence and southwest Newfoundland samples because of the nigh proportion of relatively old fish (greater than age 8) in these samples and differences in the grouping categories employed by the various laboratories. If all herring older than age 8 were grouped into a > 8 category, then the overall level of agreement would be considerably higher than is shown in the present comparisons.

(3) There was generally closer agreement between the two Canadian laboratories than for any of the other paired comparisons, undoubtedly because several consultations on ageing techniques have been held between these two laboratories.

(4) Year-class estimates by German workers differed greatly from all others for two samples, those from Georges Bank and Bay of Fundy, both of which contained relatively small fish. For the Bay of Fundy sample, agreement between German readings and those from other laboratories ranged from 2 to 8% whereas agreements between all other pairs of laboratories were greater than 90% (Table 7). For the Georges Bank sample, agreement of German estimates with those from other laboratories ranged from 6 to 38% whereas agreements between other pairs of laboratories were all greater than 60%. German readers had noted that virtually all of the otoliths in both samples exhibited a "missing ring". This may account for the very high discrepancy between their readings and those of other age readers.

(5) Overall results of this exchange reveal considerable discrepancies in year-class estimates between participating laboratories and cast doubt on comparisons of the age- and year-class structure of herring in the ICNAF area.

Age and year-class conventions

In a questionnaire circulated to all participants information was solicited on the following points:

(1) Are hyaline (winter) or opaque (summer) zones counted as annuli?

(2) What is the preferred section of the otolith for age readings (e.g. rostrum, post-rostrum, para-rostrum, etc.)?

(3) Is the nucleus counted as the first annulus?

(4) Which date is selected as the arbitrary birthdate of the herring?

(5) How are year-classes assigned? Is spawning season considered when assigning year-classes?

Responses to these queries have been received from the USA, Germany and Canada (St. Andrews and St. John's) and are summarized below:

(1) USA - Both hyaline and opaque zones are counted as annuli to check against each other when possible.

Germany - Hyaline winter rings are counted as annuli.

Canada (St. Andrews) - Hyaline winter rings are counted as annuli.

(St. John's) - Opaque summer zones are counted as annuli (checked against hyaline zones when possible).

(2) USA - No preferred section of the otolith because of frequent poor condition of the otolith.

Germany - Rostrum is preferred for age reading.

Canada (St. Andrews) - Anti-rostrum quadrant is preferred.

(St. John's) - Anti-rostrum - para-rostrum section of the otolith is preferred.

(3) USA - Nucleus is counted as first annulus when counting hyaline rings.

Germany - Nucleus is not counted as first annulus.

Canada (St. Andrews) - Nucleus is generally counted as first annulus with the exception of Gulf of St. Lawrence fish for which the nucleus is not counted until July 1st of the sample year.

(St. John's) - Hyaline nucleus is not counted as first annulus, in age estimation.

(4) All of the respondents considered January 1st to be the arbitrary birthdate for herring.

(5) USA - Year-classes are assigned by birthday of January 1st. Majority of their otoliths are autumn spawners.

Germany -
Spring spawners: Hyaline rings = age = year-class
Autumn spawners: Hyaline rings + 1 = age = year-class

Canada (St. Andrews) -
Year-class = year sampled - age

(St. John's) -
Spring spawners: Year-class = year sampled - age
Autumn spawners: Year-class = year sampled - (age + 1)

Discussion

The results of this otolith exchange indicate considerable discrepancies in age and year-class estimation by herring investigators in different countries as was suggested by previous exchanges. These differences are due to several factors including difficulties in determining zone counts of older herring, differences in interpreting zone patterns and differences in criteria and conventions for age and year-class determination.

This and previous exchanges have delineated the nature and extent of the problem and it is doubtful that future exchanges of the same type will suffice to resolve these differences. Many of the major discrepancies might best be resolved through a special Herring Ageing Workshop to bring together ageing experts from all countries which have an interest in herring of the ICNAF area. Such a Workshop could aid considerably in standardizing and improving techniques for age and year-class determination among different laboratories. Many of the present differences among otolith readers are due to differing definitions, conceptions or interpretations which should be subjected to thorough discussion.

Sufficient time should be allocated (possibly a week) for delegates to concentrate on the study of objective criteria for herring age determination and on standardizing methods and conventions, with a view to eliminating as far as possible, existing discrepancies in the age and year-class determination of herring in the ICNAF Convention Area. The Workshop could subsequently be supplemented by further exchange of otolith material among member countries.

References

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Table 1.

Sample No. 1
Location: Georges Bank

Date: July 27, 1970
No. of fish: 50

Germany

U.S.S.R.	1968	1967	1966	1965	Not Read	Total
1968						
1967	2					2
1966		39	3			42
1965		2	4			6
Not Read						
Total	2	41	7			50

Canada - St. John's

U.S.S.R.	1967	1966	1965	Not Read	Total
1967	2				2
1966	6	34	2		42
1965		4	2		6
Not Read					
Total	8	38	4		50

U.S.A.

U.S.S.R.	1968	1967	1966	1965	Not Read	Total
1968						
1967		2				2
1966		14	26	2		42
1965			3	3		6
Not Read						
Total		16	29	5		50

Canada - St. Andrews

U.S.S.R.	1967	1966	1965	Not Read	Total
1967	2				2
1966	6	35	1		42
1965		4	2		6
Not Read					
Total	8	39	3		50

U.S.A.

Germany	1968	1967	1966	1965	Not Read	Total
1968						
1967		2				2
1966		14	24	3		41
1965			5	2		7
Not Read						
Total		16	29	5		50

Canada - St. John's

U.S.A.	1967	1966	1965	Not Read	Total
1967	7	9			16
1966	1	26	2		29
1965		3	2		5
Not Read					
Total	8	38	4		50

Sample No. 1
Location: Georges Bank

Date: July 27, 1970
No. of fish: 50

Canada - St. John's

Germany	1968	1967	1966	1965	Not Read	Total
1968		2				2
1967		6	33	2		41
1966			5	2		7
1965						
Not Read						
Total		8	38	4		50

Canada - St. Andrews

U.S.A.	1967	1966	1965	Not Read	Total
1967	7	9			16
1966	1	27	1		29
1965		3	2		5
Not Read					
Total	8	39	3		50

Canada - St. Andrews

Germany	1968	1967	1966	1965	Not Read	Total
1968		2				2
1967		6	34	1		41
1966			5	2		7
1965						
Not Read						
Total		8	39	3		50

Canada - St. Andrews

Canada - St. John's	1967	1966	1965	Not Read	Total
1967	8				8
1966		38			38
1965		1	3		4
Not Read					
Total	8	39	3		50

Table 2.

Sample No. 2
Location: Bliss Island, N.B.

Date: July 27, 1970
No. of fish: 50

Germany

U.S.S.R.	1969	1968	1967	Not Read	Total
1969					
1968	42	1			43
1967		7			7
Not Read					
Total	42	8			50

U.S.A.

Germany	1969	1968	1967	Not Read	Total
1969		42			42
1968		4	4		8
1967					
Not Read					
Total		46	4		50

U.S.A.

U.S.S.R.	1968	1967	Not Read	Total
1968	43			43
1967	3	4		7
Not Read				
Total	46	4		50

Canada - St. John's

Germany	1969	1968	1967	Not Read	Total
1969		42			42
1968		1	7		8
1967					
Not Read					
Total		43	7		50

Canada - St. John's

U.S.S.R.	1968	1967	Not Read	Total
1968	42	1		43
1967	1	6		7
Not Read				
Total	43	7		50

Canada - St. Andrews

Germany	1969	1968	1967	Not Read	Total
1969		42			42
1968		2	6		8
1967					
Not Read					
Total		44	6		50

Sample No. 2
Location: Bliss Island, N.B.

Date: July 27, 1970
No. of fish: 50

Canada - St. Andrews

U.S.S.R.	1968	1967	Not Read	Total
1968	43			43
1967	1	6		7
Not Read				
Total	44	6		50

Canada - St. Andrews

Canada - St. John's	1968	1967	Not Read	Total
1968	43			43
1967	1	6		7
Not Read				
Total	44	6		50

Canada - St. John's

U.S.A.	1968	1967	Not Read	Total
1968	43	3		46
1967		4		4
Not Read				
Total	43	7		50

Canada - St. Andrews

U.S.A.	1968	1967	Not Read	Total
1968	44	2		46
1967		4		4
Not Read				
Total	44	6		50

Table 3.

Sample No. 3
Location: Dry Ledge, Yarmouth County, N.S.

Date: July 20, 1970
No. of fish: 50

Germany

U.S.S.R. \ Germany	1967	1966	1965	1964	1963	1962	1961	1960	<1961	Not Read	Total
1967											
1966	4	8									12
1965	2	2	4	3							11
1964		1	8	5	1						15
1963			1	2	5						8
1962					1				2		3
1961									1		1
1960											
<1962											
Not Read											
Total	6	10	5	12	7	7			3		50

Canada St. John's, Nfld.

U.S.S.R. \ Canada	1966	1965	1964	1963	1962	1961	1960	Not Read	Total
1966									
1965	10	2							12
1964	2	4	5						11
1963			8	7					15
1962			1	4	3				8
1961					1	2			3
1960						1			1
Not Read									
Total	12	6	14	11	4	3			50

U.S.A.

U.S.S.R. \ U.S.A.	1966	1965	1964	1963	1962	1961	1960	<1962	Not Read	Total
1966	1	7	2						2	12
1965		3	3	4					1	11
1964			2	8	3			1	1	15
1963				1	4			2	1	8
1962					2			1		3
1961								1		1
1960										
<1962										
Not Read										
Total	1	10	7	13	9			5	5*	50

Canada St. Andrews, N.B.

U.S.S.R. \ Canada	1966	1965	1964	1963	1962	1961	1960	Not Read	Total
1966									
1965	11	1							12
1964	2	5	4						11
1963	1	1	12	1					15
1962			2	5	1				8
1961				3					3
1960						1			1
Not Read									
Total	14	7	18	9	1	1			50

Canada St. John's, Nfld.

Germany \ Canada	1967	1966	1965	1964	1963	1962	1961	<1961	Not Read	Total
1967		6								6
1966		6	4							10
1965			5							5
1964			2	7	3					12
1963				2	5					7
1962					3	4				7
1961										
<1961									3	3
Not Read										
Total	12	6	14	11	4	3				50

U.S.A.

Germany \ U.S.A.	1967	1966	1965	1964	1963	1962	<1962	<1961	Not Read	Total
1967		1	5							6
1966			5	2					3	10
1965				2	3					5
1964				3	7	1			1	12
1963					3	2	1		1	7
1962						4	3			7
1961										
<1961							2	1		3
Not Read										
Total	1	10	7	13	9	5			5	50

Sample No. 3 Date: July 20, 1970
Location: Dry Ledge, Yarmouth County, N.S. No. of fish: 50

Canada St. Andrews, N.B.

Germany	1967	1966	1965	1964	1963	1962	1961	<1961	Not Read	Total
1967		6								6
1966		7	2	1						10
1965			2	3						5
1964		1	3	8						12
1963				6	1					7
1962					6	1				7
<1961										
Not Read					2		1			3
Total		14	7	18	9	1	1			50

Canada St. Andrews, N.B.

U.S.A.	1966	1965	1964	1963	1962	1961	<1962	Not Read	Total
1966	1								1
1965	9	1							10
1964	1	5	1						7
1963	1	1	11						13
1962			2	7					9
1961									
<1962			1	2	1	1			5
Not Read	2		3						5*
Total	14	7	18	9	1	1			50

Canada St. John's, Nfld.

U.S.A.	1966	1965	1964	1963	1962	1961	<1962	Not Read	Total
1966	1								1
1965	8	2							10
1964	1	2	3	1					7
1963		1	9	3					13
1962			1	4	2	2			9
1961									
<1962				2	2	1			5
Not Read	2	1	1	1					5*
Total	12	6	14	11	4	3			50

Canada St. Andrews, N.B.

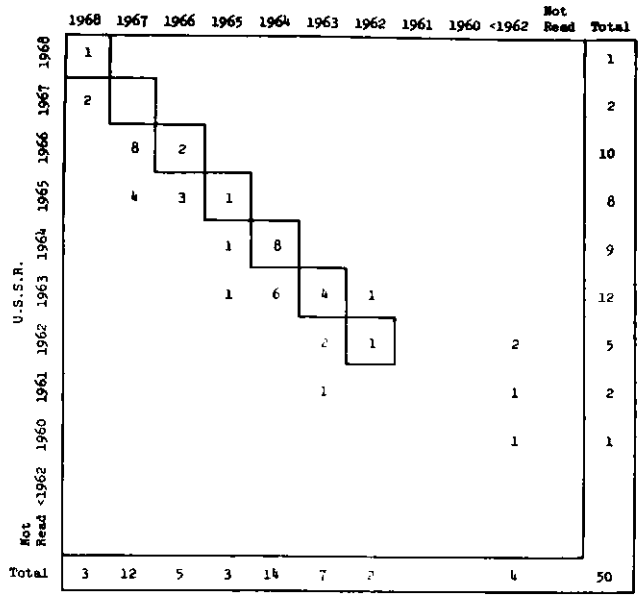
Canada St. John's, Nfld.	1966	1965	1964	1963	1962	1961	Not Read	Total
1966	12							12
1965	1	4	1					6
1964	1	3	10					14
1963			7	3	1			11
1962				4				4
1961				2	1			3
Not Read								
Total	14	7	18	9	1	1		50

*Two year-classes given but no preference expressed.

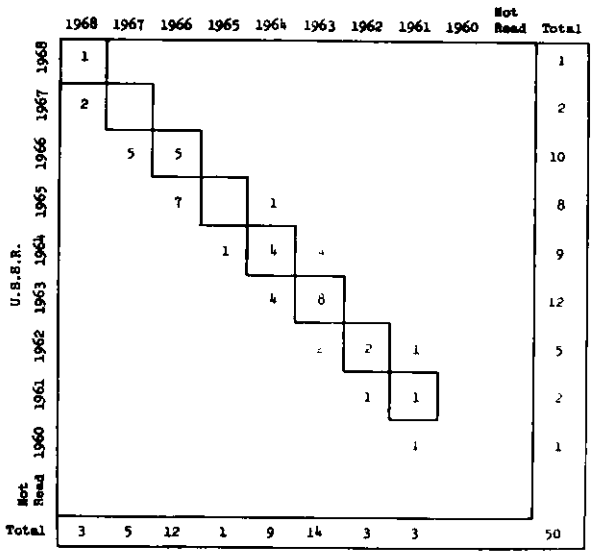
Sample No. 4
Location: Canso Bank, N.S.

Date: March 19, 1971
No. of fish: 50

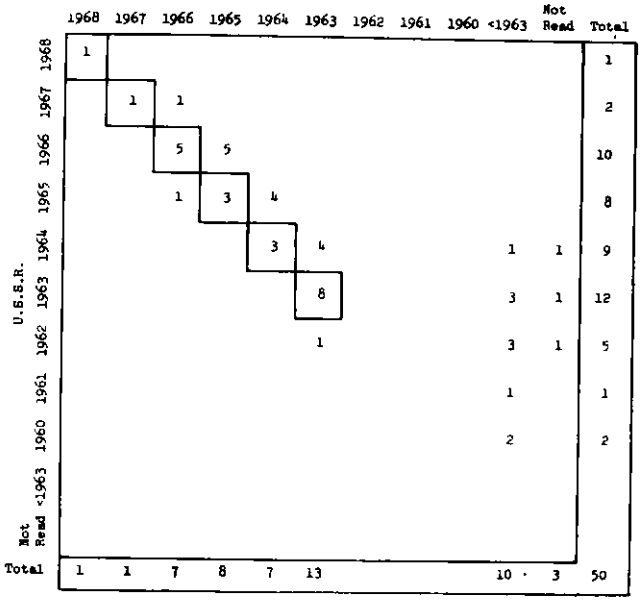
Germany



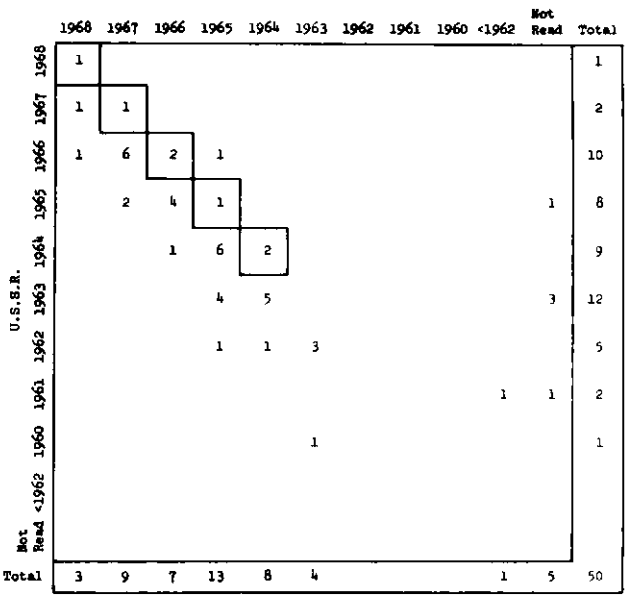
Canada St. John's, Nfld.



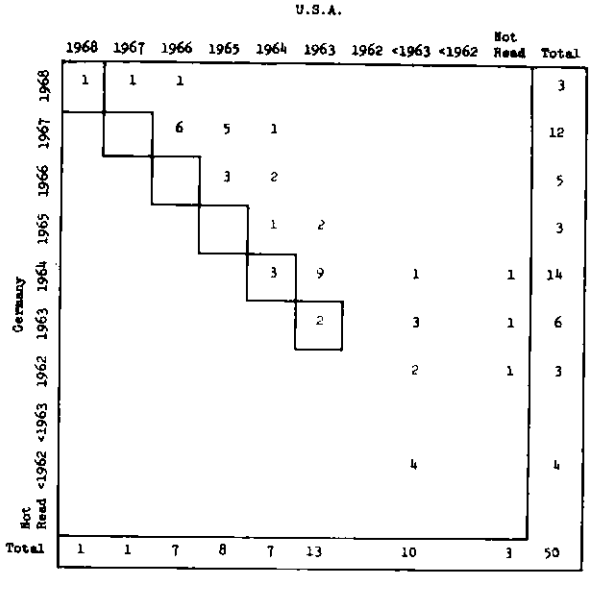
U.S.A.



Canada St. Andrews, N.B.



U.S.A.



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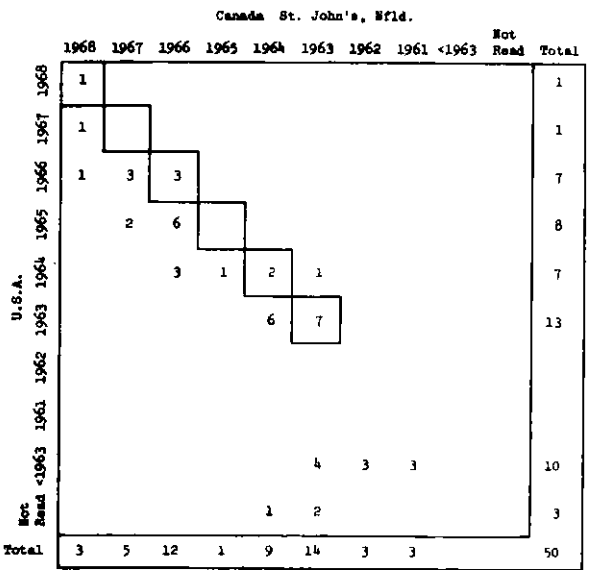
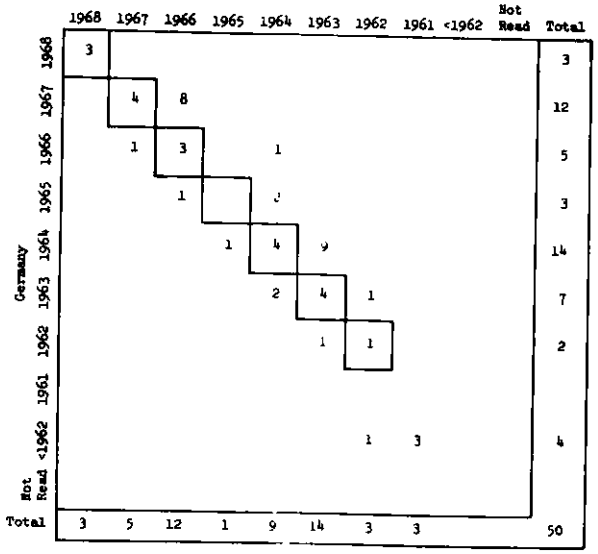


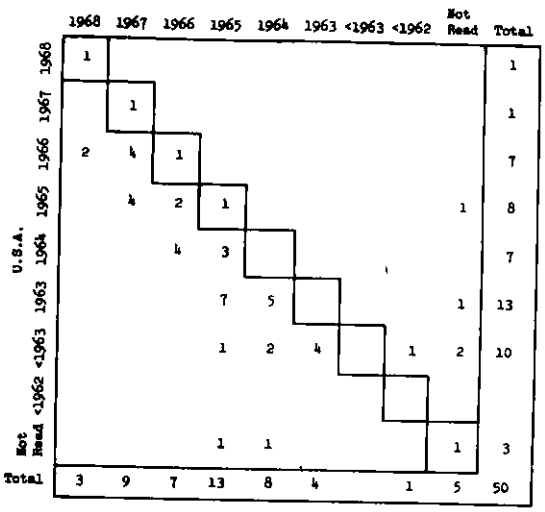
Sample No. 4
Location: Canso Bank, N.S.

Date: March 19, 1971
No. of fish: 50

Canada St. John's, Nfld.



Canada St. Andrews, N.B.



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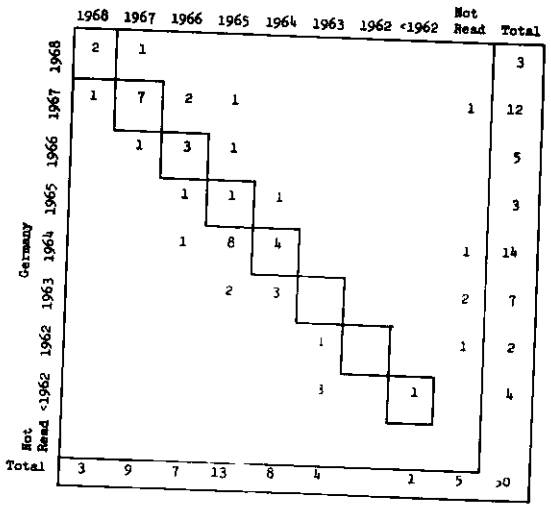


Canada St. Andrews, N.B.

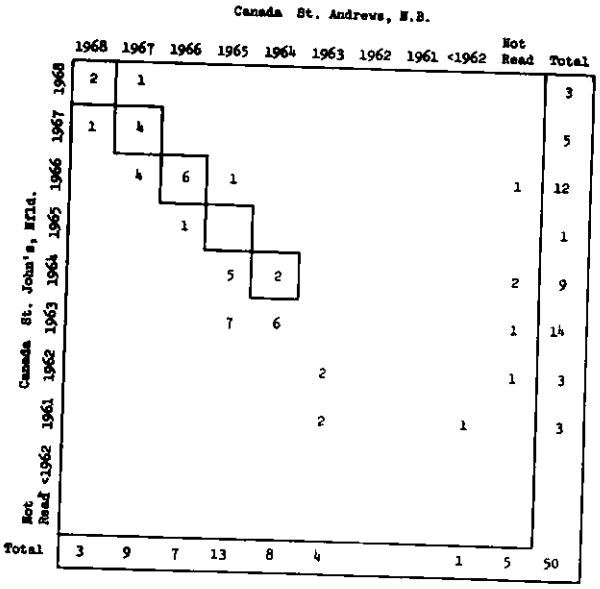


Table 5.

Sample No. 5
Location: Caraquet Island

Date: September 3, 1970
No. of fish: 50

Germany

U.S.S.R. \ Germany	1965	1964	1963	1962	1961	1960	1959	1958	<1961	Not Read	Total
1965											
1964	2	1									3
1963	5	5	1	1							12
1962		2	1	4					2		9
1961				3					6		9
1960									8		8
1959									7		7
1958									2		2
<1961											
Not Read											
Total	7	8	2	8					25		50

Canada St. John's, Nfld.

U.S.S.R. \ Canada	1965	1964	1963	1962	1961	1960	1959	1958	<1959	Not Read	Total
1965											
1964		2	1								3
1963	1	3	8								12
1962		1	4	2		2					9
1961				1	3	3	2				9
1960						2	5		1		8
1959						1	4		2		7
1958								1	1		2
<1959											
Not Read											
Total	1	6	13	3	3	8	12		4		40

U.S.A.

U.S.S.R. \ U.S.A.	1964	1963	1962	1961	1960	1959	1958	<1962	Not Read	Total
1964	2	1								3
1963	5	7								12
1962		2	4					3		9
1961			1					8		9
1960								8		8
1959								7		7
1958								2		2
<1962										
Not Read										
Total	7	10	5					28		50

Canada St. Andrews, N.B.

U.S.S.R. \ Canada	1965	1964	1963	1962	1961	1960	1959	1958	<1961	Not Read	Total
1965											
1964		2	1								3
1963	1	8	3								12
1962		1	7	1							9
1961			3	5	1						9
1960			1	2	5						8
1959					5				2		7
1958					1				1		2
<1961											
Not Read											
Total	1	11	15	8	12				3		40

Canada St. John's, Nfld.

Germany \ Canada	1965	1964	1963	1962	1961	1960	1959	<1961	<1959	Not Read	Total
1965	1	5	1								7
1964		1	7								8
1963			1	1							2
1962			4	2	2						8
1961											
1960											
1959											
<1961					1	8	12		4		25
<1959											
Not Read											
Total	1	6	13	3	3	8	12		4		50

U.S.A.

Germany \ U.S.A.	1965	1964	1963	1962	<1962	<1961	Not Read	Total
1965		5	2					7
1964	2	6						8
1963		1			1			2
1962		1	3	4				8
1961								
1960								
1959								
<1961					2	23		25
<1959								
Not Read								
Total	7	10	5	28				50

Sample No. 5
Location: Caraquet Island

Date: September 3, 1970
No. of fish: 50

Canada St. Andrews, N.B.

Germany	1965	1964	1963	1962	1961	<1961	Not Read	Total
1965	1	6						7
1964		4	4					8
1963			2					2
1962		1	6	1				8
1961								
<1961			3	7	12	3		25
Not Read								
Total	1	11	15	8	12	3		50

Canada St. Andrews, N.B.

U.S.A.	1965	1964	1963	1962	1961	<1962	<1961	Not Read	Total
1965									
1964	1	4	2						7
1963		7	3						10
1962			4	1					5
1961									
<1962			6	7	12		3		28
<1961									
Not Read									
Total	1	11	15	8	12		3		50

Canada St. John's, Nfld.

U.S.A.	1965	1964	1963	1962	1961	1960	1959	<1962	<1959	Not Read	Total
1965											
1964	1	3	3								7
1963		3	7								10
1962			1	2			2				5
1961											
1960											
1959											
<1962			2	1	3	6	12		4		28
<1959											
Not Read											
Total	1	6	13	3	3	8	12		4		50

Canada St. Andrews, N.B.

Canada St. John's, Nfld.	1965	1964	1963	1962	1961	1960	1959	<1961	<1959	Not Read	Total
1965	1										1
1964		6									6
1963		5	8								13
1962				3							3
1961				2	1						3
1960				2	4	1		1			8
1959					3	8		1			12
<1961											
<1959						3		1			4
Not Read											
Total	1	11	15	8	12			3			50

Sample No. 6
Location: Baie de Vieux, Southwest Nfld.

Date: January 1, 1971
No. of Fish: 50

Germany

U.S.S.R. \ Not Read	1965	1964	1963	1962	1961	1960	1959	1958	1957	<1963	<1962	<1961	<1960	Not Read	Total
1965															
1964			1	1							4				6
1963		1		1							10				12
1962	1				1						6				7
1961											14				14
1960											7				7
1959											2				2
1958											1				1
1957															
<1963															
<1962															
<1961															
<1960															
Not Read						1									1
Total	1	2	2	1							44				50

Canada St. John's, Nfld.

U.S.S.R. \ Not Read	1965	1964	1963	1962	1961	1960	1959	1958	1957	<1961	<1960	Not Read	Total
1965													
1964		1	3		1	1							6
1963			2	3	1	1				4	1		12
1962	1			1		1					4		7
1961						1					13		14
1960											7		7
1959										1	1		2
1958										1			1
1957													
<1961													
<1960													
Not Read						1							1
Total	1	1	5	4	2	5				6	26		50

U.S.A.

U.S.S.R. \ Not Read	1963	1962	1961	1960	1959	1958	1957	<1963	Not Read	Total
1963	3							3		6
1962	2							10		12
1961								7		7
1960								14		14
1959								7		7
1958								2		2
1957								1		1
<1963										
Not Read								1		1
Total	5							45		50

Canada St. Andrews, N.B.

U.S.S.R. \ Not Read	1965	1964	1963	1962	1961	1960	1959	1958	1957	<1962	Not Read	Total
1965												
1964			2	3						1		6
1963	1		6	2						1	2	12
1962			2	3						1	1	7
1961			1	3						8	2	14
1960				1						6		7
1959										2		2
1958										1		1
1957												
<1962												
Not Read				1								1
Total	1	2	13	9						19	6	50

U.S.A.

Germany \ Not Read	1965	1964	1963	1962	1961	1960	<1963	<1962	Not Read	Total
1965		1								1
1964	1						1			2
1963		1								1
1962										
1961										
1960										
<1963										
<1962		2					44			46
Not Read										
Total		5					45			50

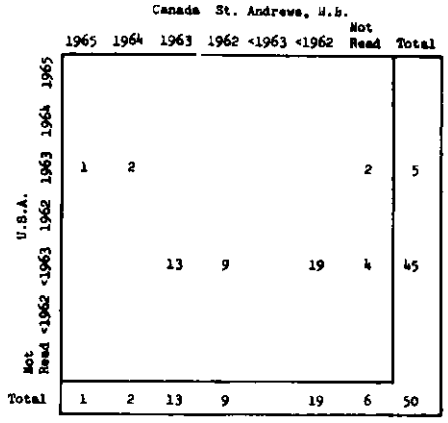
Canada St. John's, Nfld.

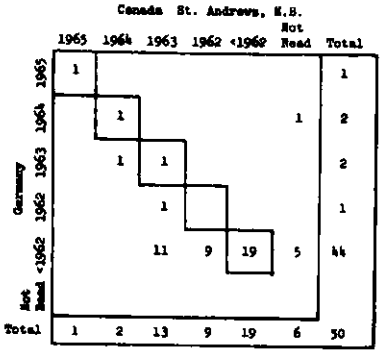
U.S.A. \ Not Read	1965	1964	1963	1962	1961	1960	<1963	<1961	<1960	Not Read	Total
1965											
1964		1	3		1						5
1963											
1962											
1961											
1960											
<1963	1		2	4	1	5		6	26		45
<1961											
<1960											
Not Read											
Total	1	1	5	4	2	5		6	26		50

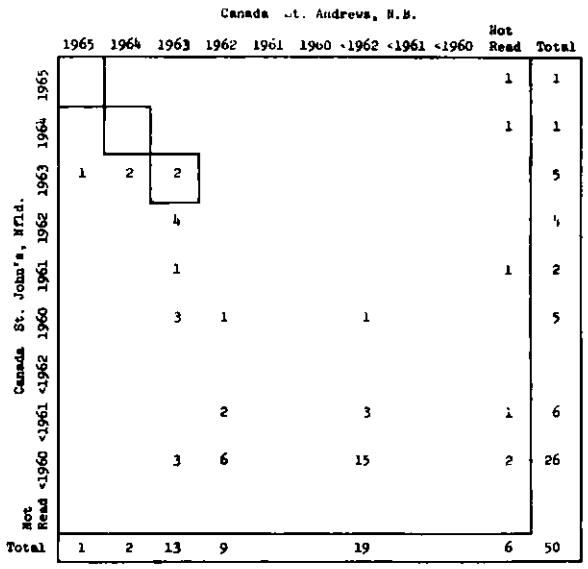
C 2

Sample No. 6
Location: Bay de Vieux, Southwest Nfld.

Date: January 1, 1971
No. of fish: 50







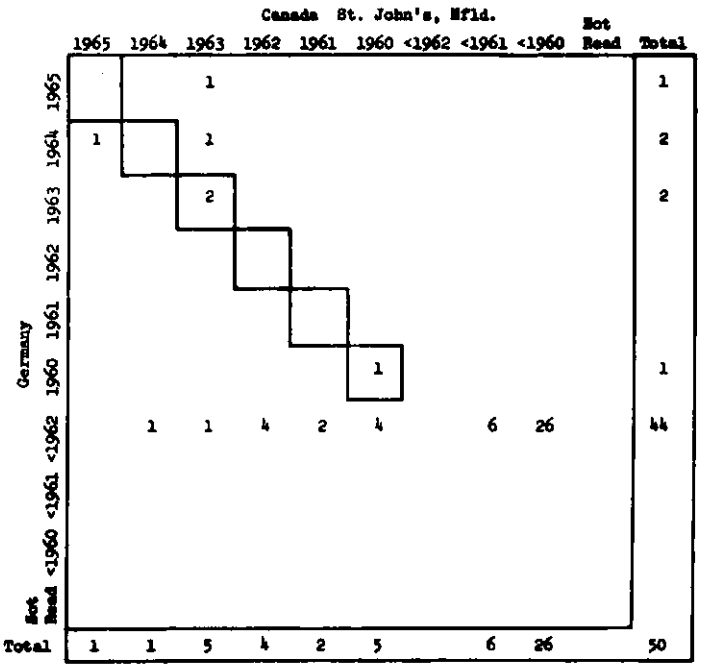


Table 7. Percentages of identical age readings between pairs of laboratories.

	Sample 1 Georges Bank	Sample 2 Bliss Is., N.B.	Sample 3 Dry Ledge Yarmouth County	Sample 4 Canso Bank	Sample 5 Caraquet Is. Gulf St. Lawrence	Sample 6 Bay de Vieux S.W. Nfld.
USSR vs. Germany	6%	2%	26%	34%	12%	2%
USSR vs. USA	62%	94%	44%	42%	26%	6%
USSR vs. Canada (St. John's, Nfld.)	76%	96%	38%	42%	42%	14%
USSR vs. Canada (St. Andrews, N.B.)	78%	98%	14%	14%	14%	10%
Germany vs. USA	38%	8%	20%	12%	12%	2%
Germany vs. Canada (St. John's)	22%	2%	44%	38%	10%	6%
Germany vs. Canada (St. Andrews)	22%	4%	38%	36%	22%	44%
USA vs. Canada (St. John's)	70%	94%	22%	26%	24%	6%
USA vs. Canada (St. Andrews)	72%	96%	6%	8%	16%	0
Canada (St. John's) vs. Canada (St. Andrews)	98%	98%	60%	28%	30%	4%

Appendix Table 1. Year-class estimates for sample of herring from Georges Bank, July 27, 1970.

Spec. No.	Length	Sex	Maturity	USSR	Germany	USA	Canada St. John's Nfld.	Canada St. Andrews N.B.
1	260	F	3	66	67	66	66	66
2	257	M	4	66	67	66	66	66
3	267	F	3	66	67	66	66	66
4	261	F	3	66	67	66	66	66
5	283	F	3	65	66	65	66	66
6	280	M	4	66	67	65	66	66
7	273	F	3	66	67	66	66	66
8	250	F	3	66	67	67	66	66
9	267	M	4	66	67	66	66	66
10	278	M	4	66	66	66	66	66
11	270	F	3	66	66	66	66	66
12	261	M	2	66	66	66	66	66
13	265	M	3	66	67	66	66	66
14	268	F	3	66	67	66	66	66
15	285	F	4	65	67	65	66	66
16	283	M	4	65	66	66	66	66
17	258	M	4	66	67	67	67	67
18	263	F	3	66	67	66	66	66
19	263	F	3	66	67	66	66	66
20	252	F	3	66	67	67	67	67
21	230	M	2	67	68	67	67	67
22	255	F	3	66	67	67	66	66
23	272	F	3	66	67	66	66	66
24	265	F	4	66	67	66	66	66
25	276	M	4	65	66	66	65	65
26	280	M	3	65	66	65	65	65
27	272	M	3	66	67	66	66	66
28	281	M	3	65	67	66	66	66
29	252	F	2	66	67	67	66	66
30	256	F	3	66	67	67	66	66
31	252	F	3	66	67	67	67	67
32	242	F	3	67	68	67	67	67
33	254	M	2	66	67	67	67	67
34	282	M	2	66	67	66	66	66
35	285	M	4	66	67	65	65	65
36	264	F	3	66	67	66	66	66
37	260	F	3	66	67	66	66	66
38	263	M	3	66	67?	66?	67	67
39	256	F	3	66	67	67	66	66
40	272	M	2	66	67	66	65	66
41	256	F	2	66	67	66	66	66
42	265	F	3	66	67	66	66	66
43	257	M	4	66	67	67	66	66
44	259	F	3	66	67	67	66	66
45	266	F	3	66	67	67	66	66
46	270	M	3	66	67	66	66	66
47	273	F	3	66	67	66	66	66
48	267	F	3	66	67	66	66	66
49	250	M	3	66	67	67	67	67
50	250	F	3	66	67	67	66	66

Appendix Table 2. Year-class estimates for sample of herring from Bliss Island, New Brunswick, July 27, 1970.

Spec. No.	Length	Sex	Maturity	USSR	Germany	USA	Canada St. John's Nfld.	Canada St. Andrews N.B.
1	233			67	68	67	67	67
2	237			67	68	67	67	67
3	210			67	68	68	67	67
4	208			67	68	68	68	68
5	239			67	68	68	67	67
6	213			67	68	67	67	67
7	220			67	68	67	67	67
8	202			68	68	68	67	68
9	172			68	69	68	68	68
10	180			68	69	68	68	68
11	172			68	69	68	68	68
12	152			68	69	68	68	68
13	142			68	69	68	68	68
14	154			68	69	68	68	68
15	134			68	69	68	68	68
16	158			68	69	68	68	68
17	148			68	69	68	68	68
18	144			68	69	68	68	68
19	149			68	69	68	68	68
20	158			68	69	68	68	68
21	141			68	69	68	68	68
22	154			68	69	68	68	68
23	143			68	69	68	68	68
24	138			68	69	68	68	68
25	144			68	69	68	68	68
26	129			68	69	68	68	68
27	144			68	69	68	68	68
28	127			68	69	68	68	68
29	133			68	69	68	68	68
30	144			68	69	68	68	68
31	137			68	69	68	68	68
32	142			68	69	68	68	68
33	150			68	69	68	68	68
34	148			68	69	68	68	68
35	149			68	69	68	68	68
36	129			68	69	68	68	68
37	143			68	69	68	68	68
38	135			68	69	68	68	68
39	146			68	69	68	68	68
40	140			68	69	68	68	68
41	144			68	69	68	68	68
42	127			68	69	68	68	68
43	149			68	69	68	68	68
44	137			68	69	68	68	68
45	149			68	69	68	68	68
46	134			68	69	68	68	68
47	155			68	69	68	68	68
48	130			68	69	68	68	68
49	142			68	69	68	68	68
50	145			68	69	68	68	68

Appendix Table 3. Year-class estimates for sample of herring from Dry Ledge, Yarmouth County, July 20, 1970.

Spec. No.	Length	Sex	Maturity	USSR	Germany	USA	Canada St. John's Nfld.	Canada St. Andrews N.B.
1	314	M	5	63	64	63	64	64
2	301	"	4	65	66	64	65	65
3	327	F	4	63	64	62	64	64
4	302	M	5	65	66	64 or 65	66	66
5	324	F	4	63	64	63	64	64
6	327	F	4	63	64	62 or 63	63	64
7	318	F	4	64	65	63	64	64
8	300	F	3	64	66	64 or 65	65	64
9	314	F	4	64	65	63	64	64
10	294	M	5	65	67	65	66	66
11	297	M	5	65	67	65	66	66
12	314	M	5	64	65	63	64	64
13	290	M	4	65	66	65	66	66
14	289	M	5	65	66?	? or 65	66	66
15	289	F	4	65	66	(65)	66	66
16	290	M	4	65	66	65	65	66
17	325	F	4	62	62	62	62	63
18	309	M	5	63	65	64	64	65
19	331	M	5	62	62?	62	62	63
20	318	F	4	63	63	63	64	64
21	337	F	2	61	62	< 62	62	63
22	294	M	4	64	66	65	65	65
23	325	F	4	63	63	63	63	64
24	318	M	5	63	63	63	63	64
25	332	M	5	62	62	62	63	63
26	345	F	4	62	62?	< 62	63	62
27	332	M	5	62	63	62	63	63
28	318	M	5	63	64	63	64	64
29	320	F	3	64	64	63	65	65
30	309	M	6	65	66	64	66	66
31	315	M	5	62	64	63	63	64
32	343	F	5	62	62	< 62	62	63
33	330	F	5	63	62	62	63	63
34	333	M	5	63	63	< 62	63	64
35	309	F	4	64	65	64	64	65
36	316	F	5	63	64	63	64	64
37	329	F	4	61	< 61	62	61	63
38	331	F	4	63	63	62	63	64
39	282	F	3	65	67	66	66	66
40	288	M	5	64	67	65	66	66
41	350	F	5	60	< 61	< 62	61	61
42	296	M	5	65	67	65	66	66
43	301	M	5	63	64	64	63	64
44	329	M	5	61	< 61	62	61	63
45	292	M	5	64	67	65	66	66
46	300	F	2	64	64	64	64	65
47	302	F	3	65	66	64 or 65	66	66
48	303	M	5	64	64	64	65	65
49	331	M	5	62	63	62 or 63	64	64
50	314	M	5	63	64	63	64	66

Appendix Table 4. Year-class estimates for sample of herring from Canso Bank, Nova Scotia, March 19, 1971.

Spec. No.	Length	Sex	Maturity	USSR	Germany	USA	Canada St. John's Nfld.	Canada St. Andrews N.B.
1	327	M	8	63	64	63	64	-
2	363	M	8	61	< 62	< 63	61	< 62
3	352	M	8	60	< 62	< 63	61	63
4	345	F	8	62	< 62	< 63	61	63
5	291	F	3	66	66	65	67	67
6	310	M	8	65	67	64	66	66
7	325	M	3	63	64	63	63	65
8	293	M	2	66	67	65	67	67
9	306	M	2	66	66	65	66	66
10	306	M	8	66	67	65	66	65
11	318	F	8	64	64	63 or 64	63	65
12	321	F	8	63	64	63	63	64
13	319	M	8	64	65	63	64	65
14	282	F	2	66	67?	66	67	67
15	315	F	8	64	64	63	63	64?
16	262	M	4	67	68	67	68	67?
17	233	M	2	68	68	68	68	68
18	325	M	8	64	64?	64	64	65
19	332	F	8	62	63	63 or < 63	63	64
20	328	F	8	63	64	63	63	64
21	326	M	8	64	64?	< 63	63	65
22	317	F	8	65	66	64	64	65?
23	303	M	2	65	65	64	66	66
24	356	F	8	62	< 62	< 63	62	63?
25	307	M	8	64	64	64	63	65
26	320	F	8	63	65	63	64	64
27	338	M	8	63	62?	< 63	63	-
28	295	M	2	66	67	65	66	67
29	323	M	8	63	63	63	64	65
30	334	M	8	63	63	< 63	63	64
31	273	F	3	67	68	66	68	68
32	322	M	8	64	64	64	65	66?
33	314	F	4	65	66	64	66	66
34	296	F	8	65	67	65	66	-
35	322	F	8	63	64	63	63	65
36	327	M	8	64	64	63	64	64
37	311	M	8	65	66	65	66	66
38	297	F	2	65	67	65	66	67
39	347	F	8	62	62	< 63	62	63?
40	326	M	8	63	63	< 63	63	64
41	284	F	2	66	67	66	67	68
42	290	F	2	66	67	66	67	67
43	300	F	8	66	67	66	66	66
44	333	F	8	63	63	63 or < 63	64	-
45	324	F	3	64	64?	63	64	65
46	278	F	2	66	67	66	66	67
47	325	M	8	63	64	63	63	65
48	324	F	3	62	63	63	63	65
49	286	F	2	65	67	66	66	67
50	358	F	3	61	63	< 63	62	-

Appendix Table 5. Year-class estimates for sample of herring from Caraquet Island, N.B., Sept. 3, 1970.

Spec. No.	Length	Sex	Maturity	USSR	Germany	USA	Canada St. John's Nfld.	Canada St. Andrews N.B.
1	308	M	6	64	65	64	64	64
2	355	M	6	61	< 61	< 62	59	61
3	356	M	6	60	< 61	< 62	< 59	61
4	315	M	5	64	65	63	64	64
5	351	F	6	59	< 61	< 62	< 59	61
6	357	F	6	59	< 61	< 62	< 59	61
7	332	M	7	62	63	62	62	63
8	322	M	6	63	64	63	63	63
9	323	M	6	63	65	63	64	64
10	337	M	6	60	< 61	< 62	59	62
11	334	M	6	62	62	62	63	63
12	339	M	7	62	62	< 62	63	63
13	357	M	6	60	< 61	< 62	59	61
14	316	F	6	63	64	63	63	64
15	324	M	6	63	62	63	63	64
16	345	M	6	61	62?	< 62	61	63
17	343	F	6	61	< 61	< 62	60	62
18	354	F	6	59	< 61	< 62	59	61
19	346	M	5	60	< 61	< 62	59	61
20	340	M	5	60	< 61	< 62	59	62
21	303	F	6	64	64	64	63	63
22	321	M	5	63	63	63	63	63
23	360	F	6	(60) 59	< 61	< 62	60	< 61
24	332	F	6	62	< 61	62	60	62
25	362	M	5	59	< 61	< 62	59	61
26	342	F	6	61	< 61	< 62	61	62
27	332	M	5	62	< 61	62	60	63
28	330	M	6	62	62	62	62	63
29	321	M	5	63	64	63	63	64
30	349	M	6	61	< 61	< 62	59	62
31	351	M	6	(60) 59	< 61	< 62	59	61
32	340	M	6	60	< 61	< 62	60	61
33	343	M	5	62	62?	< 62	63	63
34	312	M	5	63	65	64	63	64
35	315	M	6	63	65	64	64	64
36	367	F	5	58	< 61	< 62	< 59	< 61
37	355	F	6	58	< 61	< 62	59	61
38	350	M	6	59	< 61	< 62	59	< 61
39	342	F	5	61	< 61	< 62	60	62
40	320	M	5	63	64	63	63	64
41	330	M	6	61	62	62	62	63
42	315	F	8	63	65	64	64	64
43	350	M	6	60	< 61	< 62	60	63
44	350	F	6	60	< 61	< 62	59	61
45	344	F	6	61	< 61	< 62	61	63
46	317	M	5	62	64	63	64	64
47	310	M	5	63	65	64	65	65
48	311	F	5	63	64	64	63	63
49	320	M	6	62	64	63	63	63
50	345	F	6	61	62	< 62	61	62

Appendix Table 6. Year-class estimates for sample of herring from Bay de Vieux, Southwest Nfld., Jan. 1, 1971.

Spec. No.	Length	Sex	Maturity	USSR	Germany	USA	Canada St. John's Nfld.	Canada St. Andrews N.B.
1	364	F	8	60(59)	< 62	< 63	< 60	62
2	354	F	8	60	< 62	< 63	< 60	62
3	327	M	8	62	65	63	63	65
4	355	M	8	60	< 62	< 63	< 60	63
5	353	M	4	62	63	< 63	63	63
6	328	M	8	63	63	63	63	64
7	350	M	8	60	< 62	< 63	60	< 62
8	365	M	8	59	< 62	< 63	< 60	< 62
9	347	F	8	62	< 62	< 63	< 60	63
10	360	F	8	59	< 62	< 63	< 60	62
11	346	M	8	62	< 62	< 63	60	63
12	332	M	8	63	64	63	63	64
13	351	M	8	60	< 62	< 63	< 60	< 62
14	348	M	8	61	< 62	< 63	< 60	63
15	360	M	8	59	< 62	< 63	< 60	< 62
16	355	F	8	60	< 62	< 63	< 60	< 62
17	337	F	4	63	< 62	< 63	61	63
18	330	M	4	62	< 62	63	61	-
19	350	F	8	60	< 62	< 63	< 60	< 62
20	361	F	8	60	< 62	< 63	< 60	< 62
21	383	F	8	58	< 62	< 63	< 60	< 62?
22	370	F	8	(60)59	< 62	< 63	< 60	< 62?
23	345	F	4	62	< 62	< 63	< 61	-
24	365	M	8	60	< 62	< 63	< 60	< 62
25	344	F	4	62	< 62	< 63	< 61	62
26	340	F	8	62	< 62	< 63	62	63
27	333	M	4	62	< 62	< 63	< 61	< 62
28	359	M	8	60	< 62	< 63	< 60	62
29	360	F	8	60	< 62	< 63	< 60	< 62
30	354	M	8	61	< 62	< 63	< 60	62
31	317	F	8	63	< 62	63	64	-
32	364	F	8	60	< 62	< 63	< 60	-
33	350	M	8	60	< 62	< 63	< 60	-
34	345	M	8	63	< 62	< 63	63	63
35	351	M	8	61	< 62	< 63	< 60	62
36	361	M	8	60	< 62	< 63	< 60	< 62
37	351	M	8	61	< 62	< 63	62	63
38	349	M	8	61	< 62	< 63	60	62
39	352	M	4	62	< 62	< 63	< 61	62
40	390	F	4	57(56)	< 62	< 63	< 61	< 62?
41	361	M	8	59	< 62	< 63	< 60	< 62
42	339	M	4	62	< 62	< 63	62	63
43	348	M	8	61	< 62	< 63	< 60	< 62
44	338	M	8	-	62?	< 63	60	63
45	370	F	8	59	< 62	< 63	< 60	< 62?
46	366	F	4	61	64?	< 63	65	-
47	335	M	8	62	< 62	< 63	62	63
48	338	M	8	63	< 62	< 63	60	63
49	376	M	4	58	< 62	< 63	< 61	< 62
50	381	F	8	59(58)	< 62	< 63	< 60	< 62