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Re-examination of 4T-Vn (Jan.-Apr.) cod otoliths collected in the period 1982-1985 for age. (Including a report of the 4T-Vn (Jan.-Apr.) cod ageing workshop held in Moncton, June 22-24, 1987)

by

G. A. Chouinard, L. Currie and J. Murphy

Science Branch, Gulf Region
Department of Fisheries and Oceans
P.O. Box 5030
Moncton, New Brunswick
E1C 9B6

ABSTRACT

Re-examination of 4T-Vn (Jan.-Apr.) cod otoliths (1982-1985) for age was necessary due to discrepancies in age determinations which were observed in a recent assessment. Procedures used in sub-sampling, age determination and quality-control are outlined. A report on an age determination workshop to establish criteria for consistent ageing for this stock is presented. Inter-reader comparisons conducted immediately before and during the age determinations indicate levels of agreement of 70 to 80% compared to the 55% previously obtained. Comparisons of catch at age in commercial and research catches, before and after re-ageing, indicate a shift towards the older age groups. This trend is consistent with the bias which was previously observed. Weights at age are now lower than previously reported. The new age interpretations are considered to be more consistent with ageing conducted in the past.

RÉSUMÉ

Des différences dans la détermination de l'âge des poissons qui avaient été observées lors de la dernière évaluation du stock de morue 4T-Vn (jan.-avril) ont créé le besoin de réévaluer l'âge assigné à ces poissons. Les méthodes utilisées pour le sous-échantillonnage des otolites, la détermination de l'âge ainsi que le contrôle de la qualité sont décrites. Un rapport décrivant les activités d'un atelier tenu pour établir des critères uniformes pour la détermination de l'âge de ce stock est présenté. Les comparaisons entre les lecteurs indiquent un niveau d'entente variant entre 70 et 80% pour les otolites lues immédiatement avant et durant le réexamen comparé à un taux de 55% préalablement. Les comparaisons entre les nombres à l'âge de la pêcherie commerciale et des relevés avant et après le réexamen indique une augmentation de l'âge modal. Cette tendance est en accord avec le biais qui avait été observé. Les poids à l'âge sont inférieurs à ceux présentés auparavant. La nouvelle interprétation des âges est maintenant considérée plus uniforme avec celles des années antérieures.

INTRODUCTION

In the most recent assessment of cod in Division 4T and Sub-Division 4Vn (Chouinard and Nielsen, 1986), comparisons of age determination for the period 1982 to 1985 indicated that they were not consistent with ageing conducted before 1982. There was a clear trend for readings from 1982 to 1985 to be underestimated by one year. As the model used in the assessment of this stock is based on age-structured data, it was felt that ageing errors of the magnitude observed could have a large impact on the results of the assessment and, consequently, re-ageing of the otoliths for the 1982-1985 period was necessary.

In order to establish consistency between the otoliths read prior to 1982 and in the subsequent years, two training sessions for Gulf Region cod age readers were held at the Biological Station in St. Andrews, New Brunswick in late 1986 and early 1987. After the two sessions, the results of comparisons of age determinations made by the reference (St. Andrews) and the Gulf Region readers indicated that agreement was still low (60%). To resolve

the discrepancies, a workshop on 4T-Vn (Jan.-Apr.) cod age reading was held at the end of June 1987 (see Report in Addendum I). Following the workshop, age reading of the otoliths was conducted.

This paper outlines the procedures used in the re-examination of the 1982-1985 samples including the sub-sampling of the otoliths, the age reading and quality control. A summary of the ageing workshop is also presented; the aim of this workshop was to identify the techniques and criteria for consistent interpretation of 4T-Vn cod otoliths.

METHODS

a) Otolith Sub-sampling

The otoliths to be re-examined were from the 1983 to 1985 commercial fishery samples and the 1982 to 1985 research collections. Due to the large number of otoliths collected for the period (≅ 25,000) and time constraints, sub-sampling of otoliths was necessary. Sub-sampling was based on the assumption that the age composition at a given length in the commercial fishery does not vary significantly between gears. This assumption was investigated by examining age composition at length for various gears in the 1981 and 1982 fishery. As sampling intensity was considerably lower than it is at present, the three-month periods (quarters) for which the most otoliths were aged and the most gears sampled were used. The modal length group and the two adjoining ones were examined. In Table 1, the proportion of ages at length for the second quarter of 1982 (otter trawls and seines) and the third quarter of 1981 (otter trawls, seines and lines) are presented. They generally indicate that the different gears appear to have similar modal age.

Random-stratified (on length) sub-sampling was then conducted. Otoliths were selected to provide quarterly keys of 425 otoliths for the commercial fishery and annual keys of 620 otoliths for the research surveys.

b) Age reading

The two Gulf Region age readers were provided with the numbers of the otoliths to be aged along with the information on length and time of capture. Following the criteria established during the 4T-Vn cod ageing workshop (Addendum I), the age readers were able to read approximately 175 otoliths per day. Details of otoliths read by each reader are presented in Table 2. Most of the otoliths, with the exception of the 1982 research and some of the 1983 commercial otoliths which were broken in two, had previously been prepared according to the method of Bedford, 1983.

c) Quality-control

Quality control was monitored by submitting a sample of 75 otoliths selected from a reference collection to each reader after each 1,500 otoliths read. Length and time of capture information was provided. Comparisons were made with the readings of the reference reader and were discussed with each reader before starting the next lot. Age reading criteria were reviewed when deemed necessary.

In addition, upon completion of the age determination, graphs of age versus length were produced and otoliths that appeared to be outliers were re-submitted for age reading without the information on the first reading. For these otoliths, the second reading was accepted in all cases.

d) Calculation of catch at age

Catch at age by quarter, gear type and year was calculated by multiplying the length frequency for the given gear type, quarter and year (adjusted for the corresponding landings), by a table of percent at age by length which included all ageing material in the quarter and year. Unsampled landings were estimated by multiplying the catch at age for sampled landings by the ratio of unsampled to sampled landings. Power curves derived from the September research vessel surveys were used in the calculations of weights at age.

$$Y = aX^b$$

where X = length (cm)
Y = weight (g)

The a and b parameters were as follows:

YEAR	1983	1984	1985
a	0.0043648	0.0039119	0.0051116
b	3.166966	3.205474	3.145114

Catch at age from research surveys were calculated using the MALKEY module of the research vessel survey analysis program (RVAN).

RESULTS

The sub-sampling of the otoliths resulted in the most common length groupings being represented by 20 to 30 otoliths, with sample sizes gradually tailing off at both extremes. For the research survey keys, each length grouping with a large number of otoliths taken was represented by approximately 30 otoliths.

In total, 6,714 otoliths were examined by the two readers, of these 653 were either crystallized or unreadable. In addition to the otoliths aged by the Gulf agers, otoliths from the reference collection for 1982 to 1985 were added to the keys (613 otoliths).

The results of the ageing comparisons conducted before and during the age reading indicate that the readers maintained agreement levels of between 70% and 80% (Table 3). In 2 of the 8 tests performed, there is an apparent

bias in the assignment of ages compared to the reference reader. Inter-reader tests between the two Gulf Region readers resulted in agreement of 71%, 83% and 79% (Table 3).

The majority of the otoliths found to be outliers had their age remain unchanged when read a second time.

Summaries of sampling for the years 1983 to 1985, including the number of fish measured and aged, are presented in Tables 4 to 6. Generally, landings were well sampled; however, landings of 8,140 t. by miscellaneous gears were reported for 1983. These landings were treated as unsampled. Catch at age by gear and quarter, for the years 1983 to 1985 are presented in Tables 7 to 9. The corresponding length at age and weights at age are presented in Tables 10 to 12 and 13 to 15 respectively. Numbers at age per tow in the surveys are in Table 16.

Comparisons of the catch at age by gear used in the 1986 assessment (Chouinard and Neilsen, 1986) and the current one (Chouinard and Sinclair, 1987) (Figures 1, 2 and 3, Table 17) indicate a shift in the age composition towards the older age groups. Research vessel surveys numbers at age per tow with the revised ages indicated a similar shift in age composition when compared with numbers at age previously reported in Chouinard and Neilsen, 1986. Revised weights at age and the ones used in the 1986 assessment (Table 18) indicate a general reduction of the average weights at age as would be expected.

DISCUSSION

The result of age determination comparisons conducted during the re-ageing indicate an increase in consistency with the historical series. Past agreement with the reference ager was less than 55%; agreement is 70 to 80% presently. Because of the time constraints, it was impossible to re-examine the otoliths for which the comparisons had indicated some bias. It should be noted however, that, in the two cases where a bias occurred, the comparison done before the ageing of the lot of otoliths had indicated no bias.

The percentage of unreadable otoliths was high (≅ 10%) because in most cases only one of the otoliths was available for sectioning (usually both otoliths are available).

The catch at age for 1983 to 1985 obtained using the revised age-length keys differs from the one calculated previously (Chouinard and Neilsen, 1986). Most notably, for 1983 the 1977 (age 6) year-class catch is now equal to the 1976 (age 7) year-class catch where it was twice as high in the previous estimation. The 1980 (age 5) year-class, which had appeared in large numbers in the 1985 catch at age, was reduced by 50% and was replaced by the 1979 (age 6) year-class as the dominant year-class in the catch. It should be noted as well that the total numbers are also different because of revisions to the landings of 1984 and 1985.

The average weights at age (Table 18) were reduced markedly for ages 4 - 10 (2 to 31%) when compared with those obtained previously. Overall, average weights at age in the last quarter for mobile gears are less than the ones in

the third quarter. However, it was also found that the average length of fish in the catch was also smaller in the fourth quarter. It has been observed during a series of surveys in the fall and early winter of 1986 that larger fish appear to be moving earlier to the deep waters of the Laurentian Channel which are not as extensively fished in that time of the year. This observation would explain the reduction in size (weight) in the fourth quarter.

Changes in the numbers at age estimated in the research are in the same direction as in the commercial catch. In 1982, the modal age is shifted from the 1977 year-class (5) to the 1976 year-class (6). In 1983, the large 1980 year-class observed previously is reduced by almost 50%. Numbers at age for the 1984 and 1985 surveys are different from the ones previously presented for two reasons: a) the analysis of these years now includes all stations (only random stations were used in the previous design) and b) errors in the 1985 data were discovered and corrected. The same shift in modal age is present and in addition it appears now that the 1979 and 1980 year-class are of similar strength.

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Table 1. Proportion of ages by length group for 4T-Vn cod.

A) July, August, September, 1981.

Age	46 cm. group			49 cm. group			52 cm. group		
	OTB	SNU	LINES	OTB	SNU	LINES	OTB	SNU	LINES
4	13.2	10.7	16.3		3.1				1.7
5	47.4	44.7	43.0	7.7	28.4	15.1	7.7	1.0	15.5
6	31.6	27.7	34.8	66.7	43.2	39.8	56.4	44.7	48.3
7	7.8	17.0	12.3	25.6	21.1	32.2	25.6	35.1	27.6
8					4.2	11.4	10.3	18.1	6.9
9								1.0	

B) April, May, June, 1982

Age	46 cm. group		49 cm. group		52 cm. group	
	OTB	SNU	OTB	SNU	OTB	SNU
4		1.0				
5	48.1	35.8	20.6	21.1	5.8	11.0
6	35.9	34.7	40.2	21.4	29.1	11.0
7	15.1	20.0	31.4	34.8	41.7	35.2
8	0.9	6.3	7.8	12.3	23.3	28.6
9		2.1		9.0		14.3

Table 2. Summary of 4T-Vn cod otoliths examined by each Gulf Region reader.

Reader 1			Reader 2		
Year	Type of Sample	Number of Otoliths	Year	Type of Sample	Number of Otoliths
1983	Research	620	1982	Research	626
	Commercial				
	1st Quarter	471			
	2nd	439	1984	Research	620
	3rd	426		Commercial	
	4th	434		1st Quarter	442
				2nd	456
				3rd	426
1985	Research	620		4th	443
			1985	Commercial	
				1st Quarter	444
				2nd	426
				3rd	426
				4th	441

Table 3. Summary of inter-reader comparisons conducted before and during the re-examination of 4T-Vn cod otoliths (% agreement).

	Test 1 (Before)	Test 2	Test 3 (During)	Test 4
Reader 1 vs Reference	77	92	70	80-
Reader 2 vs Reference	75	69+	73	83
Reader 1 vs Reader 2	N/A	71-	83	79-

(+ or - sign indicate direction of bias of reader x vs reader y)

Table 4 : 4TVn cod commercial sampling in 1983 (numbers measured/ numbers aged)

	MONTH												
Gear	J	F	M	A	M	J	J	A	S	O	N	D	Total
Otter Trawl	6346	2213	619	200	1200	1305	807	661	214	1919	0	0	15484
	318	125	10	15	72	36	24	44	11	84	0	0	739
Seines	0	0	0	400	1848	1523	793	1506	617	481	447	462	8077
	0	0	0	16	105	133	65	95	36	30	6	14	500
Gillnets	0	0	0	0	0	564	70	207	145	799	394	0	2179
	0	0	0	0	0	51	1	15	2	63	7	0	139
Longlines	0	0	0	0	0	0	91	58	133	1051	2107	784	4224
	0	0	0	0	0	0	14	0	19	57	80	24	194
Handlines	0	0	0	0	0	45	672	11	304	971	0	0	2003
	0	0	0	0	0	0	81	0	37	73	0	0	191
Total	6346	2213	619	600	3048	3437	2433	2443	1413	5221	2948	1246	31967
	318	125	10	31	177	220	185	154	105	307	93	38	1763

Table 5 : 4TVn cod commercial sampling in 1984 (numbers measured /numbers aged).

	MONTH												
Gear	J	F	M	A	M	J	J	A	S	O	N	D	Total
Otter Trawl	6477	2636	1897	2490	1951	2554	4024	2149	3601	2894	1034	0	31707
	233	85	47	23	46	38	22	9	4	43	0	0	550
Seines	0	0	0	0	2021	322	2573	1001	1464	1408	1918	0	10707
	0	0	0	0	82	18	21	21	6	72	99	0	319
Gillnets	0	0	0	0	179	2860	3181	2013	747	292	0	0	9272
	0	0	0	0	11	102	130	34	2	40	0	0	319
Longlines	603	0	0	0	275	1251	2700	1541	1235	1024	1228	0	9857
	38	0	0	0	30	56	60	14	6	80	48	0	332
Handlines	0	0	0	0	225	0	1802	925	3294	371	0	0	6617
	0	0	0	0	18	0	35	30	3	49	0	0	135
Total	7080	2636	1897	2490	4651	6987	14280	7629	10341	5989	4180	0	68160
	271	85	47	23	187	214	268	108	21	284	147	0	1655

Table 6 : 4TVn cod commercial sampling in 1985 (numbers measured / numbers aged).

Gear	MONTH J	F	M	A	M	J	J	A	S	O	N	D	Total
Otter Trawl	11626	8192	301	2068	3081	1946	3068	2112	3597	2666	977	0	39634
	276	125	0	21	38	32	47	5	25	96	37	0	702
Seines	0	0	0	0	2548	1256	1201	646	1844	1287	1205	0	9987
	0	0	0	0	71	27	34	5	14	41	50	0	242
Gillnets	0	0	0	575	2538	784	1452	1595	904	193	0	0	8041
	0	0	0	14	93	13	78	33	26	9	0	0	266
Longlines	0	0	0	0	471	1570	1433	2629	2543	963	537	0	10146
	0	0	0	0	29	97	64	30	20	130	41	0	411
Handlines	0	0	0	0	453	497	877	1174	89	228	0	0	3318
	0	0	0	0	8	24	38	18	0	8	0	0	96
Total	11626	8192	301	2643	9091	6053	8031	8156	8977	5337	2719	0	71126
	276	125	0	35	239	193	261	91	85	284	128	0	1717

Table 7 : 4TVn cod catch at age by gear and quarter for 1983 (thousands of fish)
Gear codes: OTB - otter trawls, SNU - seines, GNS - gillnets, LLS - longlines, LHP - handlines.

GEAR	OTB	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	GNS	LLS	LLS	LHP	LHP	LHP	UNSAMPLED	
QUARTER	1	2	3	4	2	3	4	2	3	4	3	4	2	3	4	CATCH	TOTAL
AGE																	
3	0	0	0	14	0	0	11	0	0	0	0	3	0	0	0	5	33
4	20	113	130	161	77	64	186	0	90	0	18	16	3	34	2	159	1073
5	456	929	645	526	895	313	642	3	376	7	90	77	29	134	13	896	6031
6	2108	2203	672	720	2316	298	765	22	284	32	104	169	72	131	33	1733	11662
7	3405	2015	382	362	2035	271	339	40	297	31	126	119	66	133	24	1683	11328
8	2632	1003	224	275	1040	125	237	50	196	35	92	117	29	70	25	1073	7223
9	1586	873	102	173	918	75	152	77	103	26	53	90	26	42	18	753	5067
10	940	409	10	64	389	24	51	28	62	13	33	47	13	19	8	368	2478
11	31	5	0	3	3	2	4	7	7	2	4	17	0	3	1	16	105
12	23	0	0	0	0	0	0	0	2	0	0	9	0	0	0	6	40
13	6	2	0	0	1	0	0	1	1	0	0	2	0	0	0	2	15
14	2	0	0	0	0	0	0	1	1	0	0	2	0	0	0	1	7
15	2	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	4
16	0	0	0	0	0	0	0	0	0	0	0	2	0	0	0	0	2
TOTAL	11211	7552	2165	2298	7674	1172	2387	229	1419	146	520	671	238	566	124	6696	45068

Table 8 : 4TVn cod catch at age by gear and quarter in 1984 (thousands of fish)
Gear codes as in Table 7

GEAR	OTB	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	GNS	LLS	LLS	LLS	LLS	LHP	LHP	LHP	UNSAMPLED	
QUARTER	1	2	3	4	2	3	4	2	3	4	1	2	3	4	2	3	4	CATCH	TOTAL
AGE																			
2	0	0	0	8	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8
3	0	0	2	14	0	0	4	0	0	0	0	0	0	3	0	1	1	0	25
4	210	77	115	413	126	21	101	2	2	2	0	1	6	56	1	34	15	16	1198
5	540	225	486	1365	432	105	369	1	7	15	0	2	32	125	1	100	42	52	3899
6	1340	1190	682	1155	1234	172	539	44	40	39	2	23	99	183	18	135	51	94	7040
7	2467	1710	660	644	1449	188	580	148	111	61	5	50	177	222	42	155	41	118	8828
8	3180	944	315	301	600	92	307	161	204	55	9	41	144	127	33	110	23	90	6736
9	1993	688	264	217	456	80	244	227	261	65	10	54	153	114	37	111	20	68	5062
10	1456	208	98	115	151	29	132	123	210	42	8	27	82	66	16	57	13	38	2871
11	268	159	48	20	99	13	29	89	83	15	2	20	25	18	12	15	4	12	931
12	27	32	1	0	19	0	3	23	30	0	1	6	4	1	3	1	1	2	154
13	10	6	1	0	3	0	0	7	17	0	0	2	3	0	1	1	0	1	52
14	2	0	0	0	0	0	0	1	3	0	0	0	1	0	0	0	0	0	7
15	1	0	0	0	0	0	0	0	3	0	0	0	1	0	0	0	0	0	5
16	0	0	1	0	0	0	0	1	4	0	0	0	1	1	0	0	0	0	8
TOTAL	11494	5239	2673	4252	4569	700	2308	827	975	294	37	226	728	916	164	720	211	491	36824

Table 9 : 4TVn cod catch at age by gear and quarter in 1985 (thousands of fish)
Gear codes as in Table 7

GEAR	OTB-F	OTB-C	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	GNS	LLS	LLS	LLS	LHP	LHP	LHP	UNSAMPLED	
QUARTER	1	1	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	CATCH	TOTAL
AGE																			
3	20	8	0	15	45	0	3	61	0	7	0	0	1	0	0	5	5	0	170
4	304	108	97	219	304	62	41	260	0	35	0	0	9	5	11	53	24	3	1535
5	1177	643	975	2898	1623	596	503	1078	9	41	0	4	151	44	92	258	103	22	10217
6	2203	1918	2098	3856	2351	1330	743	1335	89	118	6	16	333	105	146	279	124	37	17087
7	879	980	1308	1458	734	805	376	502	200	332	36	27	276	90	55	181	31	18	8288
8	760	939	1161	628	446	668	179	333	264	203	41	35	145	89	32	95	16	13	6047
9	399	494	894	451	195	510	136	161	230	177	22	33	102	47	23	74	7	9	3964
10	284	357	426	190	108	230	66	103	137	118	26	36	59	46	9	43	2	5	2245
11	72	89	173	96	61	93	35	58	83	72	14	17	34	27	3	25	1	2	955
12	38	46	101	13	7	53	6	5	30	16	3	9	6	7	2	5	0	1	348
13	3	4	1	0	1	1	1	1	0	1	1	2	2	3	0	1	0	0	22
14	0	1	3	0	0	1	0	0	1	0	0	1	0	0	0	0	0	0	7
15	0	0	0	5	0	0	0	0	0	1	0	0	1	0	0	1	0	0	8
16	0	0	0	0	0	0	0	0	0	0	0	1	1	2	0	0	0	0	4
TOTAL	6139	5587	7237	9829	5875	4349	2089	3897	1043	1121	149	181	1120	465	373	1020	313	110	50897

Table 10 : 4TVn cod length (cm) at age by gear and quarter in 1983
Gear codes as in Table 7

GEAR	OTB	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	GNS	LLS	LLS	LHP	LHP	LHP
QUARTER	1	2	3	4	2	3	4	2	3	4	3	4	2	3	4
AGE															
3	0.0	0.0	0.0	33.8	0.0	0.0	35.1	0.0	0.0	0.0	0.0	34.5	0.0	0.0	0.0
4	38.7	40.5	44.1	41.1	40.9	43.7	41.7	0.0	43.2	42.3	43.0	41.4	41.4	43.0	41.8
5	46.5	46.6	47.5	47.2	47.0	47.3	46.9	61.0	46.5	52.2	47.9	48.5	46.1	47.2	49.2
6	49.2	50.9	52.4	51.8	50.8	52.0	51.2	60.0	51.9	56.6	53.6	54.0	50.8	52.3	54.3
7	51.9	52.7	55.3	54.8	52.6	54.0	54.0	61.7	55.8	59.1	56.9	57.4	52.5	55.3	57.5
8	55.6	54.6	59.4	56.7	54.3	56.4	56.3	65.6	61.1	61.1	62.0	59.9	53.4	58.8	60.0
9	58.3	56.2	59.1	57.2	55.7	57.9	56.8	67.4	61.3	62.5	60.8	62.6	54.8	59.5	61.7
10	60.3	56.4	66.4	60.1	56.2	64.4	59.9	71.2	69.8	63.5	69.2	68.4	54.8	66.3	63.2
11	82.3	80.7	69.3	70.9	79.0	67.6	72.5	89.7	76.2	72.9	76.5	82.2	0.0	68.4	73.8
12	88.7	91.0	0.0	85.0	91.0	91.3	83.0	91.0	90.3	85.4	82.0	94.3	0.0	82.4	83.4
13	105.6	70.0	0.0	0.0	70.0	97.0	99.3	70.0	97.0	94.0	0.0	98.4	0.0	0.0	94.0
14	112.0	0.0	0.0	0.0	103.0	97.0	91.0	115.6	97.0	91.0	0.0	96.4	0.0	0.0	0.0
15	113.2	0.0	0.0	0.0	0.0	127.0	103.0	0.0	0.0	0.0	0.0	103.0	0.0	0.0	0.0
16	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	115.1	0.0	0.0	0.0

Table 11 : 4TVn cod length (cm) at age by gear and quarter in 1984
Gear codes as in Table 7

GEAR	OTB	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	GNS	LLS	LLS	LLS	LLS	LHP	LHP	LHP
QUARTER	1	2	3	4	2	3	4	2	3	4	1	2	3	4	2	3	4
AGE																	
2	0.0	0.0	0.0	26.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	31.0
3	0.0	0.0	36.0	37.5	0.0	37.0	38.5	0.0	37.0	0.0	0.0	0.0	35.9	38.3	0.0	36.7	36.1
4	38.2	47.6	43.1	42.8	44.1	42.9	41.8	44.5	41.7	45.2	40.5	47.4	41.8	40.4	52.0	41.9	41.3
5	41.1	44.4	46.0	45.0	44.0	46.6	47.3	46.0	46.9	48.6	42.3	43.7	47.6	47.1	46.0	45.3	46.3
6	46.1	51.2	49.7	48.2	49.4	50.2	51.0	55.7	58.0	55.3	48.4	53.3	53.4	51.7	52.8	50.8	49.7
7	50.6	53.5	53.4	53.9	52.0	53.4	55.2	60.6	62.4	59.2	53.6	57.5	56.6	56.0	57.4	55.6	54.7
8	52.8	56.7	56.3	56.2	56.3	56.5	57.0	64.0	69.1	63.6	57.1	61.3	60.4	58.4	61.5	60.0	58.6
9	56.5	59.6	58.3	60.4	59.2	58.2	60.8	68.3	71.5	65.6	61.2	67.3	62.0	62.2	63.9	61.2	65.4
10	56.8	63.5	61.0	61.1	63.1	61.1	62.0	72.3	73.8	67.1	63.0	72.7	65.2	63.6	65.7	64.2	68.9
11	62.4	64.0	57.7	65.3	65.7	57.3	68.0	72.7	83.2	67.9	67.2	72.6	70.8	68.1	65.6	63.1	75.0
12	74.5	67.1	87.9	85.7	68.1	80.1	92.9	79.1	86.3	89.1	81.1	81.7	94.1	90.1	65.8	83.3	89.6
13	72.1	78.6	86.6	0.0	76.4	88.3	112.0	81.8	84.4	0.0	79.0	93.9	90.9	112.0	71.7	80.4	0.0
14	79.7	103.0	108.5	0.0	103.0	111.8	109.0	103.0	96.6	0.0	82.6	103.0	103.8	0.0	0.0	103.7	0.0
15	109.0	0.0	105.0	0.0	0.0	112.6	112.0	0.0	101.7	0.0	109.0	0.0	104.4	112.0	0.0	101.6	0.0
16	0.0	97.0	108.3	0.0	97.0	113.0	112.0	97.0	104.6	0.0	0.0	97.0	111.2	117.9	0.0	109.4	0.0

Table 12 : 4TVn cod length (cm) at age by gear and quarter in 1985
Gear codes as in Table 7

GEAR	OTB-F	OTB-C	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	GNS	LLS	LLS	LLS	LHP	LHP	LHP
QUARTER	1	1	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4
AGE																	
3	31.8	30.6	0.0	37.0	38.5	0.0	37.0	38.0	0.0	37.0	0.0	0.0	37.0	37.2	0.0	37.0	38.9
4	37.2	37.4	44.0	40.5	41.6	44.5	40.0	40.6	45.0	36.3	0.0	45.2	39.6	42.3	42.4	38.1	41.0
5	41.2	42.6	44.8	44.3	44.2	45.1	44.4	43.6	49.6	43.9	55.0	47.2	45.4	46.0	43.1	43.2	43.5
6	45.7	47.7	48.0	47.3	47.7	48.0	48.0	47.8	54.7	52.9	57.9	51.5	49.5	49.6	45.1	47.8	47.2
7	50.7	51.3	52.3	52.8	51.5	51.5	54.6	52.6	60.0	61.8	62.3	59.9	56.3	57.1	49.3	57.2	50.0
8	54.8	54.6	55.1	54.9	55.0	54.4	56.5	56.0	60.1	64.4	61.6	63.3	57.8	59.1	52.2	60.0	53.6
9	58.5	57.9	55.7	54.6	56.2	55.1	56.7	56.9	60.8	66.3	64.0	64.5	78.5	60.5	52.5	61.5	55.0
10	58.3	57.8	58.7	57.6	58.2	57.5	60.0	58.9	64.2	67.4	64.0	73.9	61.1	65.0	53.7	63.8	54.8
11	60.5	60.9	61.1	60.8	58.3	60.5	61.5	59.1	64.1	66.5	65.4	75.1	62.4	66.7	56.5	64.7	55.4
12	64.3	64.7	59.0	71.4	79.8	57.7	73.5	68.4	63.6	74.7	69.4	77.3	70.5	81.8	53.8	74.7	0.0
13	76.3	83.5	94.0	0.0	74.5	90.7	111.4	71.4	87.1	104.9	73.9	104.9	113.6	93.7	0.0	101.2	0.0
14	88.5	87.4	81.6	0.0	0.0	83.9	100.0	0.0	77.9	100.0	0.0	85.6	100.0	0.0	0.0	100.0	0.0
15	0.0	0.0	106.0	105.8	0.0	106.0	93.0	0.0	0.0	98.5	0.0	106.0	101.6	0.0	0.0	102.8	0.0
16	0.0	104.6	116.7	0.0	0.0	117.3	0.0	0.0	103.0	0.0	0.0	112.7	115.0	106.0	0.0	115.0	0.0

Table 13 : 4TVn cod weight (kg) at age by gear and quarter in 1983
Gear codes as in Table 7

GEAR	OTB	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	GNS	LLS	LLS	LHP	LHP	LHP	AVERAGE
QUARTER	1	2	3	4	2	3	4	2	3	4	3	4	2	3	4	WEIGHT
AGE																
3	0.00	0.00	0.00	0.31	0.00	0.00	0.34	0.00	0.00	0.00	0.00	0.33	0.00	0.00	0.00	0.324
4	0.47	0.54	0.71	0.57	0.56	0.70	0.59	0.00	0.67	0.62	0.67	0.58	0.58	0.67	0.60	0.612
5	0.87	0.86	0.91	0.89	0.89	0.90	0.87	2.02	0.85	1.24	0.94	0.98	0.83	0.89	1.02	0.884
6	1.02	1.13	1.25	1.20	1.13	1.21	1.15	1.89	1.21	1.59	1.34	1.38	1.13	1.24	1.40	1.138
7	1.21	1.27	1.49	1.43	1.26	1.38	1.37	2.07	1.56	1.82	1.63	1.68	1.25	1.50	1.68	1.296
8	1.51	1.43	1.92	1.60	1.41	1.62	1.56	2.58	2.12	2.02	2.19	1.92	1.32	1.87	1.92	1.557
9	1.77	1.58	1.84	1.65	1.54	1.72	1.63	2.87	2.08	2.19	2.00	2.27	1.44	1.89	2.13	1.717
10	1.99	1.59	2.69	1.92	1.57	2.49	1.91	3.48	3.25	2.31	3.15	3.14	1.41	2.70	2.28	1.946
11	5.30	5.07	3.06	3.34	4.59	2.97	3.55	6.94	4.42	3.65	4.35	5.28	0.00	2.98	3.77	4.947
12	7.24	6.99	0.00	5.63	6.99	7.37	5.30	6.99	6.88	5.80	5.02	8.16	0.00	5.10	5.35	7.462
13	11.90	3.04	0.00	0.00	3.04	8.55	9.26	3.04	8.55	7.74	0.00	8.97	0.00	0.00	7.74	8.465
14	13.65	0.00	0.00	0.00	10.34	8.55	6.99	15.30	8.55	6.99	0.00	8.50	0.00	0.00	0.00	11.358
15	14.06	0.00	0.00	0.00	0.00	20.07	10.34	0.00	0.00	0.00	0.00	10.34	0.00	0.00	0.00	12.820
16	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	14.76	0.00	0.00	0.00	14.760

Table 14 : 4TVn cod weight (kg) at age by gear and quarter in 1984
Gear codes as in Table 7

GEAR	OTB	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	GNS	LLS	LLS	LLS	LLS	LHP	LHP	LHP	AVERAGE
QUARTER	1	2	3	4	2	3	4	2	3	4	1	2	3	4	2	3	4	WEIGHT
AGE																		
2	0.00	0.00	0.00	0.14	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.24	0.140
3	0.00	0.00	0.38	0.45	0.00	0.42	0.48	0.00	0.42	0.00	0.00	0.00	0.38	0.47	0.00	0.40	0.40	0.448
4	0.47	0.97	0.68	0.67	0.76	0.68	0.63	0.82	0.62	0.79	0.56	0.96	0.63	0.56	1.24	0.63	0.61	0.655
5	0.59	0.75	0.85	0.79	0.73	0.89	0.94	0.84	0.90	1.02	0.65	0.72	0.95	0.94	0.84	0.81	0.87	0.786
6	0.86	1.21	1.09	1.00	1.08	1.13	1.20	1.56	1.83	1.60	1.04	1.37	1.40	1.26	1.33	1.19	1.10	1.082
7	1.17	1.40	1.37	1.43	1.28	1.37	1.54	2.08	2.29	1.94	1.41	1.78	1.67	1.61	1.78	1.59	1.51	1.369
8	1.34	1.68	1.64	1.65	1.65	1.65	1.72	2.53	3.24	2.46	1.75	2.20	2.08	1.88	2.21	2.04	1.96	1.613
9	1.67	2.04	1.83	2.06	2.02	1.82	2.11	3.14	3.67	2.70	2.25	3.06	2.30	2.29	2.48	2.18	2.79	2.058
10	1.72	2.54	2.13	2.13	2.59	2.14	2.27	3.81	4.01	2.93	2.46	3.95	2.75	2.47	2.72	2.54	3.34	2.266
11	2.30	2.55	1.90	2.61	2.84	1.85	3.11	4.03	6.00	3.03	3.06	4.01	4.15	3.06	2.67	2.65	4.28	3.043
12	4.27	3.09	7.24	6.29	3.27	5.25	8.20	5.47	6.72	6.97	5.68	5.98	8.95	7.69	2.69	5.97	7.15	4.880
13	3.73	5.07	7.21	0.00	4.59	7.77	14.49	5.78	6.32	0.00	5.10	9.05	8.19	14.49	3.50	5.52	0.00	5.653
14	4.96	11.08	13.25	0.00	11.08	14.42	13.28	11.08	9.23	0.00	5.55	11.08	11.64	0.00	0.00	11.69	0.00	8.619
15	13.28	0.00	11.80	0.00	0.00	15.13	14.49	0.00	11.16	0.00	13.28	0.00	11.92	14.49	0.00	11.04	0.00	11.736
16	0.00	9.14	13.16	0.00	9.14	15.07	14.49	9.14	12.08	0.00	0.00	9.14	14.77	17.07	0.00	13.64	0.00	12.808

Table 15 : 4TVn cod weight (kg) at age by gear and quarter in 1985
Gear codes as in Table 7

GEAR	OTB-F	OTB-C	OTB	OTB	OTB	SNU	SNU	SNU	GNS	GNS	GNS	LLS	LLS	LLS	LHP	LHP	LHP	AVERAGE
QUARTER	1	1	2	3	4	2	3	4	2	3	4	2	3	4	2	3	4	WEIGHT
AGE																		
3	0.28	0.25	0.00	0.44	0.50	0.00	0.44	0.48	0.00	0.44	0.00	0.00	0.44	0.45	0.00	0.44	0.51	0.445
4	0.45	0.46	0.76	0.59	0.64	0.78	0.57	0.59	0.81	0.42	0.00	0.82	0.55	0.67	0.69	0.49	0.61	0.575
5	0.63	0.71	0.81	0.78	0.78	0.83	0.78	0.75	1.12	0.76	1.52	0.96	0.84	0.89	0.72	0.72	0.74	0.760
6	0.89	1.01	1.02	0.97	0.98	1.02	1.01	0.99	1.51	1.39	1.81	1.26	1.12	1.13	0.84	1.00	0.95	0.988
7	1.25	1.28	1.35	1.38	1.28	1.29	1.54	1.37	2.05	2.26	2.29	2.10	1.70	1.78	1.10	1.81	1.15	1.418
8	1.59	1.57	1.58	1.56	1.56	1.52	1.73	1.65	2.06	2.65	2.21	2.54	1.86	1.96	1.32	2.13	1.42	1.664
9	1.96	1.89	1.64	1.55	1.66	1.58	1.78	1.73	2.14	2.89	2.57	2.67	1.98	2.15	1.34	2.33	1.53	1.820
10	1.95	1.90	2.03	1.83	1.88	1.89	2.13	1.95	2.61	3.09	2.48	4.19	2.28	2.75	1.46	2.62	1.52	2.121
11	2.17	2.26	2.28	2.26	1.88	2.19	2.29	1.97	2.56	2.97	2.80	4.52	2.43	3.08	1.73	2.75	1.58	2.377
12	2.62	2.71	2.17	4.16	5.52	1.96	4.70	3.06	2.55	4.43	3.23	5.07	3.83	5.67	1.45	4.55	0.00	2.808
13	4.38	6.17	8.52	0.00	4.00	7.78	15.80	3.48	6.59	11.82	3.90	12.64	15.09	8.92	0.00	10.38	0.00	8.442
14	6.94	6.64	5.62	0.00	0.00	6.13	9.97	0.00	4.73	9.97	0.00	6.51	9.97	0.00	0.00	9.97	0.00	5.839
15	0.00	0.00	11.98	11.97	0.00	11.98	8.10	0.00	0.00	9.75	0.00	11.98	10.62	0.00	0.00	11.02	0.00	11.405
16	0.00	11.66	16.27	0.00	0.00	16.68	0.00	0.00	10.94	0.00	0.00	14.75	15.48	11.98	0.00	15.48	0.00	13.548

Table 16. Cod 4T-Vn research vessel numbers at age per tow after re-examination of the otoliths.

Age	1982	1983	1984	1985
0	.21	.01	.00	1.30
1	3.04	5.94	2.18	3.93
2	25.17	19.66	11.06	12.65
3	16.10	42.39	15.06	33.09
4	20.63	36.50	33.86	43.45
5	23.94	19.46	42.10	78.66
6	38.14	14.04	15.67	88.85
7	19.67	12.16	8.09	21.13
8	9.35	8.36	8.54	8.32
9	2.89	3.98	3.41	5.93
10	.32	2.62	1.56	3.06
11	.12	.56	.54	2.00
12	.10	.11	.13	.68
13	.05	.32	.04	.03
14	.02	.04	.13	.00
15	.00	.06	.02	.00
16	.05	.00	.02	.07

Table 17. 4T-Vn cod catch at age from the 1986 assessment, current (after re-examination) assessment and percent change.

Catch at age (1986 assessment)				Catch at age (current assessment)			
	Year				Year		
Age	83	84	85	Age	83	84	85
3	874	82	819	3	33	25	170
4	3857	3761	4714	4	1073	1198	1535
5	5665	6205	20320	5	6031	3899	10217
6	14804	5765	8956	6	11662	7040	17087
7	7320	9883	5218	7	11328	8828	8288
8	8724	4603	5029	8	7223	6736	6047
9	3327	4898	1829	9	5067	5062	3964
10	744	1624	1432	10	2478	2871	2245
11	50	250	324	11	105	931	955
12	26	56	33	12	40	154	348
13	6	19	18	13	15	52	22
14	1	6	2	14	7	7	7
15	1	6	1	15	4	5	8
16	3	7	1	16	2	8	4

Percent change in catch at age relative to 1986

	Year		
Age	1983	1984	1985
3	-96.2	-69.5	-79.2
4	-72.2	-68.1	-67.4
5	6.5	-37.2	-49.7
6	-21.2	22.1	90.8
7	54.8	-10.7	58.8
8	-17.2	46.3	20.2
9	52.3	3.3	116.7
10	233.1	76.8	56.8
11	110.0	272.4	194.8
12	53.8	175.0	954.5
13	150.0	173.7	22.2
14	600.0	16.7	250.0
15	300.0	-16.7	700.0
16	-33.3	14.3	300.0

Table 18. Weights at age from the 1986 assessment, current (after otolith re-examination) and percent change.

Weights at age (1986 assessment)				Weights at age (current assessment)			
	Year				Year		
Age	83	84	85	Age	83	84	85
3	.679	.772	.709	3	.324	.448	.445
4	.863	.872	.824	4	.612	.655	.575
5	1.126	1.073	.958	5	.884	.786	.760
6	1.245	1.508	1.281	6	1.138	1.082	.988
7	1.425	1.592	1.653	7	1.296	1.369	1.418
8	1.596	1.845	1.771	8	1.557	1.613	1.664
9	1.821	2.126	2.028	9	1.717	2.058	1.820
10	2.063	2.576	2.266	10	1.946	2.266	2.121
11	5.245	4.418	2.540	11	4.947	3.043	2.377
12	6.523	6.198	6.486	12	7.462	4.880	2.808
13	6.766	8.761	5.313	13	8.465	5.653	8.442
14	11.380	7.302	6.560	14	11.358	8.619	5.839
15	14.610	11.295	12.090	15	12.820	11.736	11.405
16	11.383	13.279	10.290	16	14.760	12.808	13.548

Percent change in average weight relative to 1986

	Year		
Age	1983	1984	1985
3	-52.3	-42.0	-37.2
4	-29.1	-24.9	-30.2
5	-21.5	-26.7	-20.7
6	-8.6	-28.2	-22.9
7	-9.1	-14.0	-14.2
8	-2.4	-12.6	-6.0
9	-5.7	-3.2	-10.3
10	-5.7	-12.0	-6.4
11	-5.7	-31.1	-6.4
12	14.4	-21.3	-56.7
13	25.1	-35.5	58.9
14	-.2	18.0	-11.0
15	-12.3	3.9	-5.7
16	29.7	-3.5	31.7

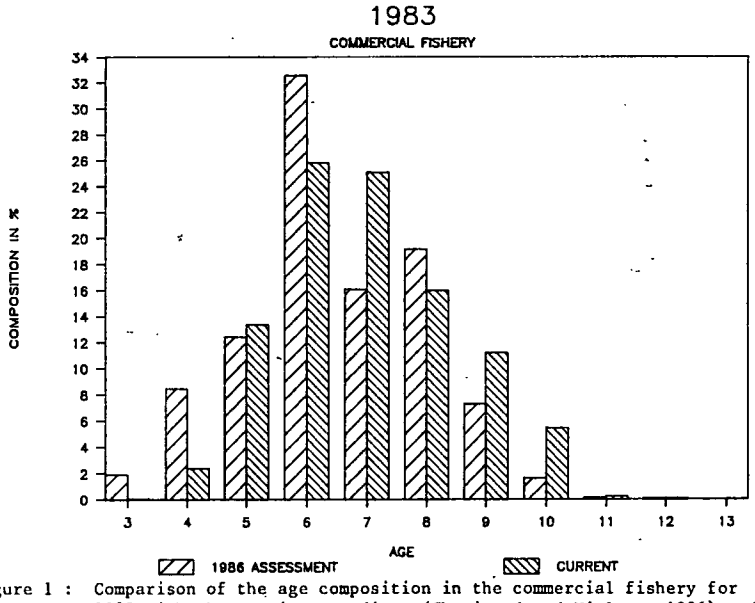

Figure 1 : Comparison of the age composition in the commercial fishery for 1983 with the previous readings (Chouinard and Nielsen, 1986) and the current ones for 4T-Vn cod.

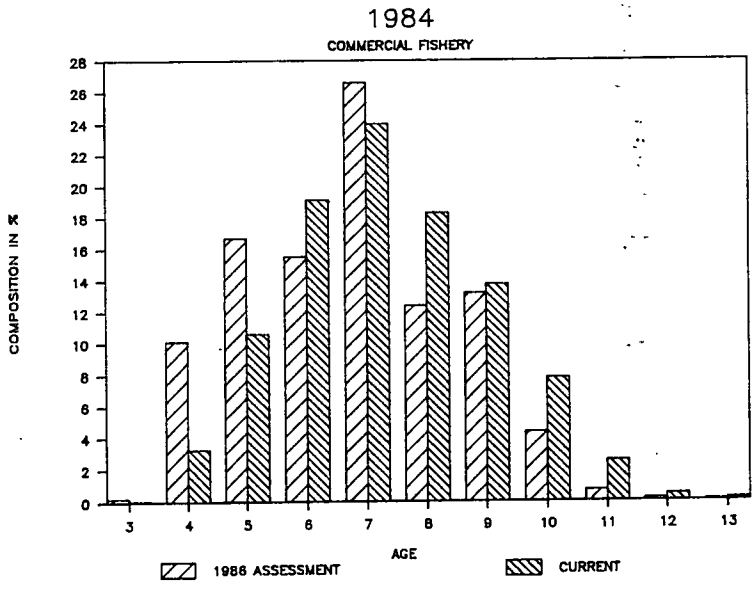

Figure 2 : Comparison of the age composition in the commercial fishery for 1984 with the previous readings (Chouinard and Nielsen, 1986) and the current ones for 4T-Vn cod

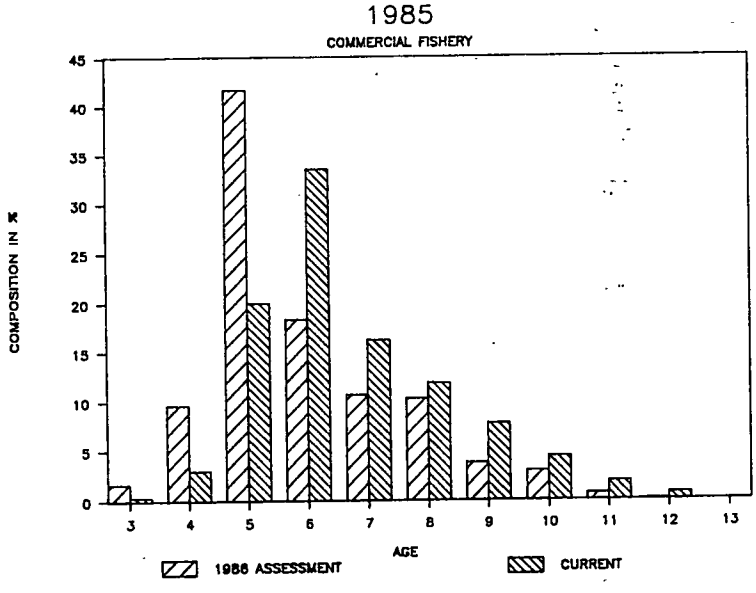

Figure 3 : Comparison of the age composition in the commercial fishery for 1985 with the previous readings (Chouinard and Nielsen, 1986) and the current ones for 4T-Vn cod

Addendum 1

Report of the 4T-Vn (Jan.-Apr.) cod ageing workshop held June 22-24, 1987, in Moncton, N.B.

A workshop on the age determination of 4T-Vn (Jan.-Apr.) cod otoliths was held at the Gulf Fisheries Centre in Moncton, New Brunswick from June 22 to 24, 1987. Participants to the workshop are listed in Table A1. The objective of the workshop was solely to ensure that age determinations of 1982 to 1986 4T-Vn cod otoliths are conducted in a manner consistent with age determinations for previous years. The participants were welcomed and the agenda for the workshop was reviewed. In addition to calibration of the cod age readers by comparison of age readings, preparation and reading techniques were reviewed and some criteria for consistent age determination of 4T-Vn cod otoliths were established.

Cod Otolith Ageing Techniques

a) Québec Region

Personnel in Québec Region have been conducting age determination of cod since 1983. After otoliths are catalogued, one otolith is sectionned through the sulcus (nucleus) with a low speed saw (Isomet) fitted with a diamond blade. The longest section is mounted in modelling clay and is examined with a stereomicroscope. The section is illuminated from the side (e.g. transmitted light) with a fibre optic light source. The sectionned surface is flooded with alcohol to increase clarity. Magnification is constant at 12X. Otoliths with unusual patterns, a large number of checks, or evidence of crystallization are not read (≅ 5%). Determination of the nucleus and the first few annuli is usually the most complicated. Checks are often found near the second annulus. Quality control is achieved by conducting comparisons between two readers. In this manner, 6 to 8 thousand otoliths from the 3Pn-4RS cod stock are aged annually.

b) Newfoundland

Otoliths are cut through the sulcus with a scalpel and mounted in trays (50 per tray) containing modelling clay. Otoliths are illuminated from the side. The surface of the section is shielded from the light with a scalpel blade and is also flooded with alcohol to increase clarity. Magnification is constant for each reader but can vary between readers (10 to 15X). Quality control is achieved by circulating one sample of 50 otoliths between the 5 cod age readers usually on a monthly basis and examining the percentage of agreement and pattern of discrepancies obtained. A micrometer disc in the eyepiece is sometimes used as a guideline to verify uncertain annuli. In all, approximately 30,000 otoliths from 4 stocks are aged annually.

Addendum 1 (Cont'd)

c) Scotia-Fundy

Both otoliths from each fish sampled are embedded in polyester resin following a modification of a technique described by Bedford, 1977. Molds which can hold 75 otoliths are used. A first layer of resin is poured. When the surface of the resin becomes tacky, otoliths are embedded and the second layer is poured. When the resin has hardened, the blocks are removed and sectionned using a modified surface grinder equipped with a diamond wafering blade. Strips containing the otolith sections (≅ 0.8 mm thick) are glued on plexiglass slides using a protective coating (Krylon). Two to three coats of this coating are also applied to the surface. Sections are then viewed using reflected light and a magnification of 12X. Quality control is performed by having another reader age a sample of otoliths. This is done every three months. On an annual basis, 10 thousand otoliths from three cod stocks are read.

d) Gulf Region

Cod age determinations have been conducted in the Gulf Region since 1982. From 1982 to 1985, age determinations were performed by personnel under contract. DFO personnel were assigned to cod ageing in November 1986. Otoliths are prepared in a manner similar to Scotia-Fundy. The sulcus is marked using a lead pencil. Otoliths are then placed on the first layer of resin aligning the sulcus with a section line etched in the resin. Molds can hold 30 otoliths. Otoliths are sectionned using a modified surface grinder. Strips are glued to plexiglass slides and the remainder of the blocks are saved for further reference. A protective coating (Krylon) is used as glue and surface protectant. Otoliths are viewed at 12.8X using a reflected light source. When age reading starts, quality control will be maintained by conducting inter-reader tests (50 otoliths) after every lot of 1,000 otoliths as well as ageing of 50 otoliths from a reference collection. Approximately 7,000 cod otoliths from the 4T-Vn (Jan.-Apr.) cod stock are to be aged annually.

e) Discussions

Two different techniques of preparing the otoliths are used. Concerns were expressed about the reliability of the sectionning techniques used by Gulf and Scotia-Fundy to obtain sections passing through the sulcus (nucleus). If alignment in the moulds or the sectionning operation are not accurate, it was noted that use of this technique could lead to errors in interpretation due to missing annuli. This problem may be more acute with otoliths having a small nucleus as in 4T-Vn cod. It was also believed that this technique is more time consuming than sections obtained with a scalpel or low-speed saw, however, manipulation and future referencing of samples are easier.

Addendum 1 (Cont'd)

Otoliths are viewed using transmitted light in Québec and Newfoundland, and reflected light in Gulf and Scotia-Fundy regions. Readers felt that reading otoliths using a source of light or preparation different from what they are accustomed could introduce errors. It was noted that it is very important for magnification to remain constant for a particular reader. Magnification can be increased but only to determine the edge type. Overall a magnification of 12X was commonly used.

Another difference in the age reading was the different birth dates used by the regions. Québec and Newfoundland are using January 1, while Gulf and Scotia-Fundy are using February 1. For ageing comparison purposes, it is required that the various readers use the same system. It was noted that age determinations in Gulf and Scotia-Fundy regions for cod caught in January are transformed to a January 1 birth date when age-length keys are constructed.

Pre-Workshop Otolith Exchange

Between February and April 1987, a sample of 119 4T cod otoliths was exchanged between the regions. In total, 9 readers participated in the exchange (1 from Scotia-Fundy, 2 from Québec, 2 from Gulf and 4 from Newfoundland). The readings were done without any knowledge of the readings of the other agers. In addition, the Gulf agers read the sample twice: before and after they were circulated, and ages previously assigned by the Gulf contract ager in 1985 were available.

The results of this exchange were reviewed at the workshop (Table A2). Because the different birth dates used were not taken into consideration, the agreement between Québec or Newfoundland and the other two regions was in error. By adjusting the month of January ages for Québec and Newfoundland, the percentage of agreement with Scotia-Fundy increased marginally for 3 of the agers and decreased in one case. The agreement between Newfoundland and Québec agers varied between 55% and 60% while the agreement between Scotia-Fundy and Gulf varied between 70% and 80%. It was noted that the Gulf readers had just been calibrated in St. Andrews prior to the exchange and that the percent of agreement obtained was the highest obtained in comparisons conducted between the two regions. A bias in the errors towards under-ageing was evident in most of the comparisons. Causes for this bias were identified as 1) missing the first annulus, 2) second or third annulus counted as a check or 3) error in identification of edge type.

Otolith Photographs

Two series of photographs (one using transmitted light and the other using reflected light) were reviewed at the workshop. Each reader examined the photographs with the corresponding otoliths and the information on date caught and length of fish and indicated the interpretation on the

Addendum 1 (Cont'd)

photograph. Since the objective of the workshop was to calibrate each reader with the Scotia-Fundy reader (considered as the reference for ageing 4T-Vn (Jan.-Apr.) cod otoliths), each photograph was compared with the interpretation of the Scotia-Fundy reader to determine the sources of the discrepancies. Ages for the reference were indicated on each photograph for further reference.

Criteria for consistent age determinations were discussed. Areas where most of the discrepancies occurred were in the interpretation of the nucleus, and the determination of checks in the second and third year of growth. Criteria that were considered useful were as follows:

- first annulus (nucleus) should be well defined and is generally small compared to other stocks;
- in some instances, a check can be observed in the first year of growth;
- a check is often found in the second year of growth, generally close to the annulus.

It was felt that some of the photographs were from sections not passing through the nucleus; the importance of having adequate sections was reiterated.

Workshop Ageing Comparisons

Following the review and discussion of the photographs, the sample of 119 otoliths exchanged prior to the workshop was read using the discussions of the photographs as the basis for the interpretations. Results of the readings are presented in Table A3. Comparison tables are in Table A4. In all but one case, the agreement obtained from this comparison was lower than the pre-workshop comparisons (corrected for birth date). Bias in the errors were large except for one of the readers. One reader tended to overestimate the age compared to the reference while the other five were underestimating the age.

Otoliths for which the readings were in disagreement with the reference were examined and the source of disagreement identified by each reader with assistance of the reference reader. The sources of disagreement were calculated for each. They are:

Sources of Disagreement	Percentage
Edge type	13
Check in second year	30
Check in third year	20
Nucleus	27
Others (i.e. split ring, etc.)	10

Addendum 1 (Cont'd)

The criteria derived from the photographs were refined and new criteria added. For the edge type, the date caught should be used in conjunction with the examination. Generally, opaque edges are present in late spring-summer-early fall, while a hyaline edge is present in the fall-winter and early spring. The second year of growth should be examined closely for a check which is often present. For determination of a check in the third year of growth, the following rule should apply: the space between the second and third annulus is wider than between the first and second; if it is narrower then ensure that the third annulus is well defined (bright) and complete. The determination of the nucleus is based on the qualitative statement that the nucleus is characterized by a small round shape compared to other stocks. The size could not be quantified. For split rings, the criteria to resolve the problem is to examine the ring for a junction with an annulus.

Following this second review of the criteria, another comparison was conducted using a new sample of 57 otoliths. Results are summarized in Table A5 and individual comparisons with the Scotia-Fundy reader are presented in Table A6. One reader obtained a 75% agreement with no bias in the errors, while 4 of the readers obtained between 58 and 64% agreement and the other reader, 36%. Although bias in the errors had been reduced for some of the agers, it was still large for three readers. The sample had been aged by the Scotia-Fundy reader in January 1987. His determinations at the workshop were done without any knowledge of his previous readings. An intra-reader comparison of his readings in January 1987 and at the workshop indicated an 84% agreement thus indicating consistent interpretations.

An agreement of between 70 and 80% with the reference reader and with no bias in the age determinations was considered acceptable for 4T-Vn (Jan.-Apr.) cod otolith at the spring 1987 meeting of CAFSAC. It is noted that, although there appears to be some progress in obtaining consistency for these determinations, only one of the several readers involved in the comparisons and workshop has attained this level. The fact that comparisons between readers other than the reference reader also resulted in low agreement is an indication of the subjectivity involved in age determination of these otoliths. It was suggested that workshops are an excellent forum to discuss age determination interpretations and should be held whenever problems appear.

REFERENCES

Bedford, B.C. 1977. Further development of the technique of preparing thin sections of otoliths set in black polyester resin. ICES C.M. 1977/F:24, 9 pp.

Addendum 1 (Cont'd)

Table A1. List of participants to the 4T-Vn (Jan.-Apr.) cod ageing workshop.

NAME	REGION	LOCATION
C. Bishop	Newfoundland	St. John's, Nfld.
G. Chouinard	Gulf	Moncton, N. B.
L. Currie	Gulf	Moncton, N. B.
A. Fréchet	Québec	Mont Joli, Qué.
H. Hicks	Newfoundland	St. John's, Nfld.
J. Murphy	Gulf	Moncton, N. B.
L. Pagé	Québec	Mont Joli, Qué.
R. Robicheau	Scotia-Fundy	St. Andrews, N. B.
P. Schwab	Québec	Mont Joli, Qué.

Addendum 1 (Cont'd)

Table A2. Agreement (%) between readers on a sample on 119 otoliths exchanged prior to the workshop.

	QUÉBEC-1	QUÉBEC-2	CONTRACT	SCOTIA-FUNDY	GULF-2 APR.	GULF-2 FEB.	GULF-1 APR.	GULF-1 FEB.	NFLD-1	NFLD-2	NFLD-3
NFLD-1	50	56	64	38	37	39	30	40	78	57	67
NFLD-2	45	55	54	33	33	30	23	37	64	45	
NFLD-3	57	57	42	58	57	59	50	58	61		
NFLD-4	57	61	53	43	42	43	36	46			
GULF-1 FEB.	50	49	33	82	70	81	71				
GULF-1 APR.	46	39	18	71	66	71					
GULF-2 FEB.	50	45	26	80	77						
GULF-2 APR.	51	44	30	82							
SCOTIA-FUNDY	48	43	30								
CONTRACT	37	46									
QUÉBEC-1	54										

Addendum 1 (Cont'd)

Table A3. First workshop comparison based on the same 119 otoliths exchanged prior to the workshop.

	Nfld. 2	Nfld. 3	Québec 1	Québec 2	Gulf 1	Gulf 2	S.-Fundy*
Nfld. 2		48	27	27	28	29	56** (29)
Nfld. 3			40	37	53	61	49 (60)
Québec 1				82	39	45	31 (50)
Québec 2					44	46	31 (46)
Gulf 1						67	49 (82)
Gulf 2							48 (80)

* Scotia-Fundy ages were from the pre-workshop comparison

** Numbers in parentheses are the percentage agreement obtained in the pre-workshop comparison (corrected for birth date).

Table A4- Comparisons between each reader and the reference reader (first comparison)

M1: NFLD-2 VS SCOTIA-FUNDY
DATA FILE: B:AGEJUN.DAT
07-07-1987

		NFLD-2																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	3	.	.	.	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	4	.	.	.	5	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	5	.	.	.	.	4	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	6	.	.	.	.	.	10	4	1	.	.	.	.	.	.	.	.	.	.	.	.	15
	7	.	.	.	.	.	.	16	7	.	.	.	.	.	.	.	.	.	.	.	.	23
	8	.	.	.	.	.	.	1	6	8	.	.	.	.	.	.	.	.	.	.	.	15
	9	.	.	.	.	.	.	.	3	11	5	1	.	.	.	.	.	.	.	.	.	20
S-FUNDY	10	.	.	.	.	.	.	.	.	1	5	4	2	.	.	.	.	.	.	.	.	12
	11	.	.	.	.	.	.	.	.	.	.	4	.	1	.	.	.	.	.	.	.	5
	12	.	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	4
	13	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	14	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	CRYST.	.	.	.	.	.	1	1	.	.	2	1	.	.	.	.	.	.	.	.	1	6
	TOTAL	0	0	0	6	6	16	22	17	20	12	10	4	4	1	0	0	0	0	0	1	119

NFLD-2		RELATIVE TO S-FUNDY				
-3	-2	-1	0	1	2	3
0	0	6	63	38	6	0

PERCENTAGE AGREEMENT: 55.75

M1: NFLD-3 VS SCOTIA-FUNDY
DATA FILE: B:AGEJUN.DAT
07-07-1987

		NFLD-3																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	3	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	4	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	5	.	.	.	.	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	6	.	.	.	.	4	9	1	1	.	.	.	.	.	.	.	.	.	.	.	.	15
	7	.	.	.	.	.	9	10	4	.	.	.	.	.	.	.	.	.	.	.	.	23
	8	.	.	.	.	.	.	7	2	6	.	.	.	.	.	.	.	.	.	.	.	15
	9	.	.	.	.	.	.	.	9	9	2	.	.	.	.	.	.	.	.	.	.	20
S-FUNDY	10	.	.	.	.	.	.	.	.	2	7	2	1	.	.	.	.	.	.	.	.	12
	11	.	.	.	.	.	.	.	.	.	3	2	.	.	.	.	.	.	.	.	.	5
	12	.	.	.	.	.	.	.	.	.	.	2	1	1	.	.	.	.	.	.	.	4
	13	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	14	.	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	1
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	CRYST.	.	.	.	.	.	1	1	1	.	1	.	1	.	.	.	.	.	.	.	1	6
	TOTAL	0	0	0	8	11	21	19	17	17	13	6	3	2	1	0	0	0	0	0	1	119

NFLD-3		RELATIVE TO S-FUNDY				
-3	-2	-1	0	1	2	3
0	0	36	55	20	2	0

PERCENTAGE AGREEMENT: 48.67

W1: QUEBEC-1 VS SCOTIA-FUNDY
DATA FILE: B:AGEJUN.DAT
07-07-1987

		QUE-1																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	3	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	4	.	.	1	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	5	.	.	.	1	3	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	6	.	.	.	.	9	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
	7	.	.	.	.	1	13	6	1	2	.	.	.	.	.	.	.	.	.	.	.	23
	8	.	.	.	.	.	.	7	2	2	.	.	.	.	.	.	.	.	.	.	4	15
	9	.	.	.	.	.	.	5	8	3	3	.	.	.	.	.	.	.	.	.	1	20
S-FUNDY	10	.	.	.	.	.	.	.	1	7	3	1	.	.	.	.	.	.	.	.	.	12
	11	.	.	.	.	.	.	.	.	2	1	1	.	.	.	.	.	.	.	.	1	5
	12	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	4
	13	.	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	1
	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	CRYST.	.	.	.	.	1	.	2	.	.	.	1	.	.	.	.	.	.	.	.	2	6
	TOTAL	0	0	2	6	15	24	20	12	16	7	5	2	1	0	0	0	0	0	0	9	119

QUE-1	RELATIVE TO S-FUNDY					
-3	-2	-1	0	1	2	3
0	9	49	33	12	3	0

PERCENTAGE AGREEMENT: 31.13

W1: QUEBEC-2 VS SCOTIA-FUNDY
DATA FILE: B:AGEJUN.DAT
07-07-1987

		QUE-2																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	3	.	.	1	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	4	.	.	1	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	5	.	.	.	.	4	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	6	.	.	.	1	9	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
	7	.	.	.	.	1	14	5	2	.	1	.	.	.	.	.	.	.	.	.	.	23
	8	.	.	.	.	.	2	5	4	2	.	.	.	.	.	.	.	.	.	.	2	15
	9	.	.	.	.	.	.	2	10	4	3	.	.	.	.	.	.	.	.	.	1	20
S-FUNDY	10	.	.	.	.	.	.	.	3	5	3	1	.	.	.	.	.	.	.	.	.	12
	11	.	.	.	.	.	.	.	.	2	2	1	.	.	.	.	.	.	.	.	.	5
	12	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	4
	13	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1	1
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	CRYST.	.	.	.	.	1	1	1	.	.	1	1	.	.	.	.	.	.	.	.	1	6
	TOTAL	0	0	2	6	16	27	13	19	13	10	5	3	0	0	0	0	0	0	0	5	119

QUE-2	RELATIVE TO S-FUNDY					
-3	-2	-1	0	1	2	3
0	11	49	34	13	1	1

PERCENTAGE AGREEMENT: 31.19

Table A4 (Cont'd)

WI: GULF-1 VS SCOTIA-FUNDY
DATA FILE: B:AGEJUN.DAT
07-07-1987

		GULF-1																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	3	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	4	.	.	2	4	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	5	.	.	.	1	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	6	.	.	.	.	6	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
	7	.	.	.	.	.	11	11	1	.	.	.	.	.	.	.	.	.	.	.	.	23
	8	.	.	.	.	.	2	7	6	.	.	.	.	.	.	.	.	.	.	.	.	15
	9	.	.	.	.	.	.	1	13	6	.	.	.	.	.	.	.	.	.	.	.	20
S-FUNDY	10	.	.	.	.	.	.	.	1	6	4	1	.	.	.	.	.	.	.	.	.	12
	11	.	.	.	.	.	.	.	.	1	1	3	.	.	.	.	.	.	.	.	.	5
	12	.	.	.	.	.	.	.	.	1	.	1	2	.	.	.	.	.	.	.	.	4
	13	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
	14	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	CRYST.	.	.	.	.	1	1	.	1	.	.	.	.	.	.	.	.	.	.	.	3	6
	TOTAL	0	0	4	5	15	23	19	22	15	5	5	3	0	0	0	0	0	0	0	3	119

GULF-1	RELATIVE TO	S-FUNDY				
-3	-2	-1	0	1	2	3
1	6	48	55	2	0	0

PERCENTAGE AGREEMENT: 48.67

WI: GULF-2 VS SCOTIA-FUNDY
DATA FILE: B:AGEJUN.DAT
07-07-1987

		GULF-2																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	3	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
	4	.	.	.	6	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	6
	5	.	.	.	1	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	9
	6	.	.	.	.	6	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	15
	7	.	.	.	.	.	14	8	1	.	.	.	.	.	.	.	.	.	.	.	.	23
	8	.	.	.	.	.	2	5	8	.	.	.	.	.	.	.	.	.	.	.	.	15
	9	.	.	.	.	.	.	.	11	7	2	.	.	.	.	.	.	.	.	.	.	20
S-FUNDY	10	.	.	.	.	.	.	.	.	5	4	2	.	.	.	.	.	.	.	.	1	12
	11	.	.	.	.	.	.	.	.	.	5	.	.	.	.	.	.	.	.	.	.	5
	12	.	.	.	.	.	.	.	.	.	.	2	2	.	.	.	.	.	.	.	.	4
	13	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	14	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	CRYST.	.	.	.	.	.	1	.	1	.	1	1	.	.	.	.	.	.	.	.	2	6
	TOTAL	0	0	2	7	14	26	13	21	12	12	5	4	0	0	0	0	0	0	0	3	119

GULF-2	RELATIVE TO	S-FUNDY				
-3	-2	-1	0	1	2	3
0	3	50	54	5	0	0

PERCENTAGE AGREEMENT: 48.21

Addendum 1 (Cont'd)

Table A5. Percentage agreement from the second workshop comparison based on 57 otoliths.

	Nfld. 2	Nfld. 3	Québec 1	Québec 2	Gulf 1	Gulf 2	S.-Fundy Jan.	S.-Fundy June
Nfld. 2		52	38	60	65	66	61	58
Nfld. 3			29	54	64	65	63	61
Québec 1				52	39	29	39	36
Québec 2					60	53	62	64
Gulf 1						61	75	75
Gulf 2							65	61
S.-Fundy (January)								84

Table A6- Final comparison between each reader and the reference reader

W2: NFLD-2 VS SCOTIA-FUNDY
DATA FILE: B:AGEFINAL.DAT
07-07-1987

		NFLD-2																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	4	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	5	.	.	.	1	7	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	6	.	.	.	.	2	7	1	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	7	.	.	.	.	.	3	8	1	1	.	.	.	.	.	.	.	.	.	.	.	13
	8	.	.	.	.	1	2	1	3	3	.	.	.	.	.	.	.	.	.	.	.	10
	9	.	.	.	.	.	.	.	.	5	2	1	.	.	.	.	.	.	.	.	.	8
S-FUNDY(6)	10	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	11	.	.	.	.	.	.	.	.	1	.	1	.	.	.	.	.	.	.	.	.	2
	12	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	CRYST.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	TOTAL	0	0	0	2	10	15	10	4	10	3	3	0	0	0	0	0	0	0	0	0	57

NFLD-2	RELATIVE TO S-FUNDY(6)					
-3	-2	-1	0	1	2	3
1	3	8	33	10	2	0

PERCENTAGE AGREEMENT: 57.89

W2: NFLD-3 VS SCOTIA-FUNDY
DATA FILE: B:AGEFINAL.DAT
07-07-1987

		NFLD-3																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	4	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	5	.	.	.	.	9	1	.	.	.	.	.	.	.	.	.	.	.	.	.	1	11
	6	.	.	.	.	1	7	2	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	7	.	.	.	.	.	3	6	2	1	1	.	.	.	.	.	.	.	.	.	.	13
	8	.	.	.	.	.	1	1	6	2	.	.	.	.	.	.	.	.	.	.	.	10
	9	.	.	.	.	.	.	.	2	2	3	1	.	.	.	.	.	.	.	.	.	8
S-FUNDY(6)	10	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	11	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	2
	12	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	CRYST.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	TOTAL	0	0	0	0	11	12	9	10	5	5	3	1	0	0	0	0	0	0	0	1	57

NFLD-3	RELATIVE TO S-FUNDY(6)					
-3	-2	-1	0	1	2	3
0	1	7	34	11	2	1

PERCENTAGE AGREEMENT: 60.71

Table A8 (Cont'd)

M2: QUEBEC-1 VS SCOTIA-FUNDY
DATA FILE: B:AGEFINAL.DAT
07-07-1987

	QUE-1																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
5	.	.	.	3	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
6	.	.	.	.	6	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	10
7	.	.	.	1	2	3	6	.	.	.	1	.	.	.	.	.	.	.	.	.	13
8	.	.	.	.	.	2	7	1	.	.	.	.	.	.	.	.	.	.	.	.	10
9	.	.	.	.	.	.	1	3	2	1	.	.	.	.	.	.	.	.	.	1	8
S-FUNDY(6) 10	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	1
11	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	2
12	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
CRYST.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	0	0	0	5	16	7	16	4	3	3	2	0	0	0	0	0	0	0	0	1	57

QUE-1	RELATIVE TO S-FUNDY(6)					
-3	-2	-1	0	1	2	3
1	5	26	20	3	0	0

PERCENTAGE AGREEMENT: 35.71

M2: QUEBEC-2 VS SCOTIA-FUNDY
DATA FILE: B:AGEFINAL.DAT
07-07-1987

	QUE-2																				
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
4	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
5	.	.	.	2	9	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
6	.	.	.	.	4	4	2	.	.	.	.	.	.	.	.	.	.	.	.	.	10
7	.	.	.	.	2	2	8	.	.	.	.	.	.	.	.	.	.	.	.	1	13
8	.	.	.	.	.	.	3	7	.	.	.	.	.	.	.	.	.	.	.	.	19
9	.	.	.	.	.	.	2	1	4	1	.	.	.	.	.	.	.	.	.	.	8
S-FUNDY(6) 10	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
11	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1	2
12	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
CRYST.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
TOTAL	0	0	0	3	15	6	15	8	4	2	2	0	0	0	0	0	0	0	0	2	57

QUE-2	RELATIVE TO S-FUNDY(6)					
-3	-2	-1	0	1	2	3
0	4	13	35	3	0	0

PERCENTAGE AGREEMENT: 63.64

Table A6 - (Cont'd)

M2: GULF-1 VS SCOTIA-FUNDY
DATA FILE: B:AGEFINAL.DAT
07-07-1987

		GULF-1																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	4	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	5	.	.	.	.	9	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	6	.	.	.	.	.	9	1	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	7	.	.	.	.	.	3	8	1	1	.	.	.	.	.	.	.	.	.	.	.	13
	8	.	.	.	.	.	1	1	8	.	.	.	.	.	.	.	.	.	.	.	.	10
	9	.	.	.	.	.	.	.	.	6	2	.	.	.	.	.	.	.	.	.	.	8
S-FUNDY(6)	10	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	11	.	.	.	.	.	.	.	.	.	1	1	.	.	.	.	.	.	.	.	.	2
	12	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	1
	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	CRYST.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	TOTAL	0	0	0	1	9	15	10	9	7	4	2	0	0	0	0	0	0	0	0	0	57

GULF-1	RELATIVE TO	S-FUNDY(6)				
-3	-2	-1	0	1	2	3
0	1	6	43	6	1	0

PERCENTAGE AGREEMENT: 75.44

M2: GULF-2 VS SCOTIA-FUNDY
DATA FILE: B:AGEFINAL.DAT
07-07-1987

		GULF-2																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	4	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	5	.	.	.	.	8	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	6	.	.	.	.	.	9	.	1	.	.	.	.	.	.	.	.	.	.	.	.	10
	7	.	.	.	.	.	3	6	3	.	.	1	.	.	.	.	.	.	.	.	.	13
	8	.	.	.	.	.	1	2	5	2	.	.	.	.	.	.	.	.	.	.	.	10
	9	.	.	.	.	.	.	.	1	3	2	2	.	.	.	.	.	.	.	.	.	8
S-FUNDY(6)	10	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	11	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	2
	12	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	CRYST.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	TOTAL	0	0	0	0	9	16	8	10	5	3	5	1	0	0	0	0	0	0	0	0	57

GULF-2	RELATIVE TO	S-FUNDY(6)				
-3	-2	-1	0	1	2	3
0	1	6	35	11	3	0

PERCENTAGE AGREEMENT: 61.40

Table A6 (Cont'd)

M2: SCOTIA FUNDY - JANUARY (1) VS SCOTIA-FUNDY - JUNE (6)
DATA FILE: B:AGEFINAL.DAT
07-07-1987

		S-FUNDY(1)																				
		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	CRYST.	TOTAL
	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	4	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1
	5	.	.	.	.	11	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	11
	6	.	.	.	.	.	10	.	.	.	.	.	.	.	.	.	.	.	.	.	.	10
	7	.	.	.	.	.	3	9	.	.	1	.	.	.	.	.	.	.	.	.	.	13
	8	.	.	.	.	.	1	2	5	2	.	.	.	.	.	.	.	.	.	.	.	10
	9	.	.	.	.	.	.	.	.	8	.	.	.	.	.	.	.	.	.	.	.	8
S-FUNDY(6)	10	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	1
	11	.	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	2
	12	.	.	.	.	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	1
	13	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	14	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	15	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	16	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	17	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	18	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	19	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	CRYST.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	0
	TOTAL	0	0	0	1	11	14	11	5	10	2	2	1	0	0	0	0	0	0	0	0	57

S-FUNDY(1) RELATIVE TO S-FUNDY(6)						
-3	-2	-1	0	1	2	3
0	1	5	48	2	0	1

PERCENTAGE AGREEMENT: 84.21