Georges Bank Cod and Haddock Ageing Exchange and Workshop November 8-10, 1993

by

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ABSTRACT

Age readers from the St. Andrews Biological Station at St. Andrews, N.B. and the Northeast Fisheries Science Center at Woods Hole, Massachusetts participated in an ageing workshop to discuss results of exchanges of Georges Bank cod and haddock ageing material. The objectives were to document interlab comparison readings of cod otoliths and haddock otoliths and scales and to discuss specific characteristics of otoliths which caused discrepancies in age assignments.

For cod, discussions included edge type assignment and double/split annuli. Agreement in age assignment between the two labs was satisfactory (89%) and reflects previous results.

Agreement between Canadian and USA reader's age assignments for haddock otoliths was 90% for the 1992 Canadian research survey and 86% for 1993 Canadian commercial samples. Agreement for scales versus otoliths, as assigned by the USA age reader, for the same samples was 75% and 76% respectively and a bias toward underageing by scales was observed.

Workshop participants agreed that a maximum of 100 otoliths per year should be exchanged, and that seasonality should be incorporated into sample selection. Recommendations included the continuation of workshops on alternate years and that the USA lab assess the magnitude of the scale underageing bias on their haddock survey and commercial catch age structures.

RÉSUMÉ

Les spécialistes de la détermination de l'âge de la Station de biologie de St. Andrews (N.-B.) et ceux du Northeast Fisheries Science Center de Woods Hole, au Massachusets, ont participé à un atelier sur la détermination de l'âge de la morue et de l'aiglefin du banc Georges, au cours duquel ils ont discuté des résultats de leurs échanges de données à ce sujet. L'atelier en question avait pour but de documenter les lectures comparatives des otolithes de morue et d'aiglefin ainsi que des écailles d'aiglefin réalisées par les deux laboratoires et de traiter des caractéristiques particulières des otolithes qui sont à l'origine d'erreurs dans l'attribution des âges.

En ce qui a trait à la morue, il s'agissait de discuter de certaines notions comme les types de bord et le dédoublement des anneaux. La concordance dans l'attribution des âges entre les deux laboratoires était satisfaisante (89 %) et conforme aux résultats antérieurs.

Quant à la concordance entre les chercheurs canadiens et américains dans l'attribution des âges d'après les otolithes de l'aiglefin, elle était de 90 % sur le relevé de recherche canadien de 1992 et de 86 % sur les échantillons commerciaux canadiens de 1993. La concordance entre la lecture des écailles et celle des otolithes par les spécialistes américains s'établissait respectivement à 75 % et 76 % sur les mêmes échantillons et on a observé une tendance systématique à la sous-estimation dans la détermination de l'âge d'après les écailles.

Les participants ont convenu d'échanger un maximum de 100 otolithes par an et de tenir compte de la saisonnalité dans le choix de l'échantillon. Les recommandations formulées portaient notamment sur la poursuite des ateliers tous les deux ans et sur la nécessité pour le laboratoire américain d'évaluer l'importance de la tendance à la sous-estimation dans le relevé de recherche sur l'aiglefin et dans les structures d'âge des prises commerciales de ce poisson.

INTRODUCTION

A conclusion of the 1991 Georges Bank cod (*Gadus morhua*) and haddock (*Melanogrammus aeglefinus*) ageing workshop was to continue a yearly exchange of age material between age readers at the Biological Station in St. Andrews, N.B. and the Northeast Fisheries Science Center at Woods Hole, Mass. and to document results (Buzeta et al. 1992). Age readers from St. Andrews and Woods Hole exchanged ageing material collected during 1992 and 1993 from Georges Bank cod and haddock. This exchange was followed by an age reading workshop at Woods Hole on October 8-10, 1993. The objectives of the exchange and workshop were to document comparison readings by the labs and to provide a venue whereby age readers could discuss specific characteristics of otoliths which caused discrepancies in age assignments.

I. GEORGES BANK COD

Participants:

Nancy Munroe, NEFSC, Woods Hole, Mass.
Vaughn Silva, NEFSC, Woods Hole, Mass.
Maria-Ines Buzeta, Biological Station, St.Andrews, N.B.

The assignment of fish age following the Canadian convention utilizes the otolith's edge type and width to determine whether or not that edge is to be counted as an annulus. The USA convention includes the edge as an annulus during the first two quarters and does not do so in the last two quarters. This difference in convention was first discussed at the 1991 ageing workshop (Buzeta et al 1992). Incompatible interpretations of edge characteristics therefore could cause discrepancies between Canadian and USA age assignments.

A double or split annulus is described by Penttila and Dery (1988) as having a discontinuity or check causing the annulus to appear as two closely spaced hyaline zones. When this occurs at the otolith edge, it is difficult to ascertain whether it represents two years of growth or a single year's interrupted growth pattern. While a split may occur in other annuli, it is most frequently seen in the second year. This feature is of interest as a possible indicator of first spawning or as an aid in identification of the second annulus. Incorrect identification of this feature can potentially change the age assignment by 1 year.

METHODS

One cod otolith from each of 90 pairs collected during the 1993 USA spring survey (93-04) was sent to the Canadian ager in August 1993. These were prepared and read according to Canadian procedures (Strong et al.1985) and the ages were subsequently compared to those assigned earlier by the USA ager. USA procedures are documented in Pentilla and Dery (1988). Disagreements in age assignments, including edge type, were discussed during this workshop.

Sixty-three otoliths from the 1993 Georges Bank spring groundfish survey (T134) and 20 otoliths

from the 1992 commercial samples, which were determined by the Canadian age reader as exhibiting a double/split second annulus, were examined by the USA age readers. Notes were made for each otolith regarding the detailed characteristics of a double/split second annulus.

RESULTS

Age assignments by the USA and Canadian age readers for the otolith exchange are presented in Table 1. Agreement between age readers, where ages were assigned by both age readers, was 89% (Table 2). Of the 10 disagreements, 7 were aged as older by the Canadian age reader. Four of the disagreements occurred where otoliths were assigned age 3 by the USA age reader and age 4 by the Canadian age reader. Six of the disagreements were associated with edge type assignment, and the remainder were associated with checks and otoliths of poor reading quality.

After examining 82 of the otoliths which exhibited a double/split annulus only 3 were reassigned an age because of this feature. Although age readers agreed on the presence of a continuous second annulus (96%), agreement as to what defined a double/split annulus versus a wide or a checky second annulus was very low (52%).

CONCLUSIONS

Agreement between the USA/Canadian age readers was considered satisfactory as it reflects the 1992 exchange results. It was agreed that the assignment of edge types should be carefully evaluated.

Recognition of a second annulus as a single annulus, even though it may exhibit a split, a wide band or several checks, was not considered a problem during age assignment.

It was agreed that a "double/split" annulus by definition must show a measurable opaque zone between two closely spaced hyaline zones.

II. GEORGES BANK HADDOCK

Participants:

Nancy Munroe, NEFSC, Woods Hole, Mass.
L. Van Eeckhaute, Biological Station, St.Andrews, N.B.

The Canadian lab has traditionally used otoliths to age haddock. For haddock sampled from surveys, the USA lab routinely used scales but did use otoliths for fish >65 cm from 1963 to 1984 and for fish >50 cm since 1991. Scales exclusively were used from 1985 to 1990. Very few samples from the USA commercial haddock fishery have been aged using otoliths and scales still predominate.

The objectives of this exchange originate from recommendations made at the previous workshop (Buzeta et al. 1991): 1) that the USA lab re-examine the use of otoliths to age larger haddock, 2)

that the effect of geographic origin of the sample on scale ages should be examined and 3) that the USA ager read several otolith samples to compare with the Canadian ages to assess interlab agreement on otoliths. The workshop objective was to discuss criteria for assigning haddock ages to otoliths by the two haddock age readers.

METHODS

To effect these recommendations both scale and otolith ageing materials for this workshop were taken from haddock which came from both the eastern and western portions of Georges Bank and from deeper waters off the bank. Otoliths and scales from 310 fish collected during the Canadian 1992 spring Georges Bank survey, N165, and 3 samples (104 otoliths) from the Canadian commercial fishery were exchanged. Otoliths were prepared by the method routinely used by each lab; the Canadian lab sections otoliths using the methods of Strong et al 1985, the USA lab cuts thin-sections using an Isomet low-speed saw (Penttila and Dery 1988).

Agreement was determined from independent readings of otoliths. Only the USA ager examined the scales.

During the workshop a double microscope was used to discuss otoliths from the N165 survey for which the assigned ages were in disagreement. When a consensus could not be reached for an individual age, other age readers at the lab were asked for their opinion. Canadian commercial fishery samples were not discussed due to time constraints.

RESULTS

The levels of agreement where ages were assigned by both age readers, for the N165 survey otoliths (Table 3) and Canadian commercial samples (Table 4) were 90% and 86%, respectively (Tables 5 and 6). However, of the 20 otoliths assigned age 6 by the USA reader (survey and commercial fishery samples combined), only 2 were assigned age 6 by the Canadian reader. These otoliths were assigned to either age 5 or 7 by the Canadian reader. Consensus on 18 of the 32 otolith ages (from the N165 survey) which were in disagreement was reached during the workshop (Table 3). Reasons for the disagreements were determined as follows:

a. A proximity of the last 2 hyaline zones may have been interpreted as a check within one annulus or alternately as 2 annuli (Fish Nos. 166,184,192,195,440,890).

b. The second hyaline zone was identified as a check by the Canadian ager but as the second annulus by the USA ager. The Canadian ager's interpretation allowed for a great deal of growth between the 1st and 2nd annulus. This difference in interpretation was discussed with several other age readers. The interpretation that a large amount of growth existed between the 1st and 2nd annulus was considered correct (Fish No. 183).

c. A strong hyaline zone was interpreted as a check by the Canadian ager but as the 1st annulus by the USA ager (Fish Nos. 173,183,213,215).

d. There was difficulty in interpreting poorly defined hyaline zones. This occurred if checks in the dorsal zone were abundant, or when spacing of zones was irregular (Fish Nos. 239, 262, 851), or when the first annulus was poorly defined (Fish Nos. 862, 867).

e. Discrimination of zones in the terminal dorsal area of older otoliths was found to be difficult, causing one of the readers to count one more annulus than the other (Fish No. 882).

f. Use by the Canadian ager of the proximal reading axis for ageing when the dorsal area was hard to interpret due to a high number of checks. (Fish Nos. 875, 940)

The level of agreement between scales and otoliths as read by the USA ager was 75% for the N165 survey (Tables 3 and 7) and 76% for the commercial fishery samples (Tables 4 and 8). When differences in the ages determined from scales and otoliths occurred, the scale age was almost always lower. A difference of up to 8 annuli occurred between scales and otoliths. As the otolith age increased, the difference between otolith and scale age generally increased. The smallest fish length for which the scale age was less than the otolith age was 55 cm. Unfortunately, only 16 otoliths were collected during the N165 survey from the western part of Georges Bank (Strata 5Z5, 5Z6, 5Z7) due to the small number of haddock caught. Of the 9 fish that were over 50 cm in length, 3 of the scale ages were lower than the otolith ages (Table 3).

CONCLUSIONS

Agreement between the Canadian and USA ageing of haddock otoliths was satisfactory although there was a bias against age 6 by the Canadian reader that was not resolved. The Canadian reader's ages of 5 or 7 placed those fish in the strong 1985 or 1987 year classes as opposed to the very weak 1986 yearclass (for age 6).

The scale versus otolith results verify conclusions from the 1991 ageing workshop (Buzeta et al. 1992) that there is a bias towards under-ageing 5Z haddock greater than 50 cm with scales. Although sampling from the western portion of Georges Bank was inadequate, there are indications that this bias is a problem in that region also. The USA lab has changed to a policy of collecting otoliths for haddock greater than 50 cm. during surveys but scales were still the predominate structure used to age the 1993 commercial fishery samples. The magnitude of the effect of ageing haddock with scales on the catch at age structure of the USA commercial fishery and surveys should be ascertained. It is recommended that the USA lab address this problem.

III. GENERAL RECOMMENDATIONS

1. It was agreed that a maximum of one hundred otoliths per year be exchanged. The number exchanged should be increased if agreement becomes poor. Seasonality should be incorporated into the sample selection (ie., 50 otoliths from the Canadian spring survey and 50 from the USA fall survey).

2. Workshops are seen as necessary only every other year, unless agreement decreases in the interim.

3. The magnitude of the effect of ageing haddock with scales on the USA catch and survey age structure needs to be determined.

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Table 1. Age assignments to 5Z cod otoliths by Canadian and USA age readers. Samples were collected during the 1993 USA spring groundfish survey on Georges Bank (Albatross 9304). Disagreements are marked with "*".

Fish No.	Len. (cm)	USA age	CDN age	Canadian reader's comments	USA reader's comments
1	78	4	4	NH DBL2	
2	66	3	3	NH DBL2	
3	67	3	3	NH	SH
4*	64	4	5	NO weak3 or 4DBL2,CY2	CY2,3
5	43	3	3	NH DBL2	weak3
6	60	3	3	NH	
7	57	3	3	WH	
8	56	3	3	WH	broken
9	64	3	3	WH DBL2	DBL2,3
10	45	3	3	WH	
11	40	2	-	broken	
12	90	6	6	NH	SH
13	66	3	3	WH DBL2,3	
14	65	3	3	NH	
15	61	3	3	WH	
16	59	3	3	NO	
17	63	3	3	NH	CY2,3 broken
18*	66	3	4	WO DBL2,3	
19*	68	3	4	NH	
20	65	3	3	WH	
21*	83	5	6	NH	SH
22	61	3	3	WH	
23	77	4	4	NH	
24	89	7	7	NH	SH
25	95	6	6	NH	SH
26*	89	8	7	NH wide2	CY1,2,3
27	67	6	6	NH	SH broken
28	56	3	3	NH DBL2	
29	59	3	-	-	
30	98	10	10	NH	SH
31	96	6	6	NH	SH
32	61	3	3	C	CY1
33	55	3	3	NH	
34	56	3	3	NH	broken
35	38	2	2	WH SC	
36	101	8	8	NH SC	
37	88	6	6	NH	SH
38*	106	9	7	NH	SH weak ann.
39*	96	8	9	NH	SH
40*	82	9	8	NH	SH
41	85	5	-	NH SH	
42	86	6	6	NH	
43	108	7	7	NH or 8 bad cut	
44	98	7	7	NH	SH
45	56	4	4	NH DBL2	
46	88	6	6	NH	SH
47	87	6	6	NH C SH	SH
48	70	4	4	NH DBL2	DBL2
49	65	4	4	NH	SH
50	44	2	2	WH DBL2	broken
51	62	3	3	NH	
52	59	3	3	NH DBL2	broken
53	42	2	2	WH DBL1,2	
54	61	3	3	NH	broken
55*	60	3	4	NH DBL2 SC	CY2
56	63	4	4	NH DBL2 SC	broken
57	54	4	4	WH SC	CY1
58	57	3	3	NH DBL2	DBL2
59	46	2	2	WH	
60	59	3	3	NH wide3	
61	51	3	3	NH SC	
62	54	3	3	NH DBL2	

Fish No.	Len. (cm)	USA age	CDN age	Canadian reader's comments	USA reader's comments
63	46	2	2	NO DBL2	
64	44	2	2	WH DBL2	
65	44	2	2	WH	
66	51	3	3	NH wide2	
67	60	3	3	NH	
68	54	3	3	NH	poor
69	87	6	6	NH C	SH
70	79	6	6	NH	broken
71	60	3	3	WH wide2	broken
72	66	3	3	NH	
73	60	3	3	NH	
74	67	3	3	NH	
75	57	3	3	NH	broken
76	53	3	3	NH	
77	59	3	3	NH	
78	52	3	3	NH	
79	56	3	3	NH	CY3
80	57	3	3	NH	
81	52	3	3	NH DBL2	CY2
82	49	3	3	NH	
83	48	3	3	NH	
84	59	3	3	NH	
85*	67	3	4	NH or 3	CY2,3
86	61	3	3	NH	
87	62	3	3	NH	broken
88	53	3	3	WH	
89*	50	2	3	WO	
90	51	3	3	NH	broken

DBL=double/split annulus
C=crystallyzed otolith
CY=checky annulus
SC=settling check
SH=shifted
NH=narrow hyaline edge
WH=wide hyaline edge
NO=narrow opaque edge
WO=wide opaque edge

Table 2. Canadian/USA ageing comparison matrix of Georges Bank cod otoliths collected during the 1993 USA spring groundfish survey. (Albatross 9304)

Nancy Munroe (USA ager)

	1	2	3	4	5	6	7	8	9	10	Omit	Tot
1												0
2		7										7
3		1	47									48
4			4	7								11
5					1							1
6					1	10						11
7							3	1	1			5
8								1	1			2
9								1				1
10										1		1
Omit		1	1		1							3
Tot.	0	9	52	7	3	10	3	3	2	1	0	90
% agreement (omits excluded) =								89				
% agreement (omits included) =								86				

M-I.Buzeta (Canadian ager)

Number aged by both age readers = 87/90= 97%
Overaged by Canadian reader vs. USA reader = 7/10 = 70%
Underaged by Canadian reader vs. USA reader = 3/10 = 30%

Table 3. Ages assigned by the Canadian haddock age reader, (L. Van Eeckhaute) and the USA haddock age reader (N. Munroe) to otoliths and scales from haddock collected during the 1992 Canadian spring survey, N165, on Georges Bank. "←" indicates otoliths which were examined during the workshop, "√" indicates consensus reached on age and "( )" indicates that onsensus was reached that there was a good probability this age could be correct. (UO=otolith read by N. Munroe, CO=otolith read by L. Van Eeckhaute, S=scale read by N. Munroe).

Set No.	Stratum	Fish No.	Fish Len. (cm)	Otolith Age		Scale Age (S)	Differences		
				USA(UO)	Can.(CO)		CO-UO	S-CO	S-UO
				Eastern Georges Bank					
10	5Z2	157	57	5	5	5			
10	5Z2	158	67	9	9	8		-1	-1
10	5Z2	159	61	7	7	7			
10	5Z2	160	57	7	7	7			
10	5Z2	161	58	7	7	6		-1	-1
10	5Z2	162	62	7	7	7			
10	5Z2	163	50	5	5	5			
10	5Z2	164	60	7	7	6		-1	-1
10	5Z2	165	65	7	7	7			
10	5Z2	166←	64	9	10√	7	+1	-3	-2
10	5Z2	167	62	9	9	8		-1	-1
10	5Z2	168	66		5	5	-		-
10	5Z2	169	58	5	5	5			
10	5Z2	170	71	5		5	-	-	
10	5Z2	171	70	9	9	7		-2	-2
10	5Z2	172	52	5	5	5			
10	5Z2	173←	54	6	5	5	-1		-1
10	5Z2	174	72	7	7	7			
10	5Z2	175	55	5	5	5			
10	5Z2	176	69	9	9	8		-1	-1
10	5Z2	177	68	5	5	5			
10	5Z2	178	53	5	5	5			
10	5Z2	179	72	7	7	7			
10	5Z2	180	48		3	3	-		-
10	5Z2	181←	86	15	17√	10	+2	-7	-5
10	5Z2	182	51	5	5	5			
10	5Z2	183←	49	6	5	6	-1	+1	
10	5Z2	184←	75	8	9√	8	+1	-1	
11	5Z2	185	60	5	5	5			
11	5Z2	186	54		3	5	-	+2	-
11	5Z2	187	57	5	5	5			
11	5Z2	188	59	7	7	6		-1	-1
11	5Z2	189	52	3	3	3			
11	5Z2	190	75	9	9	8		-1	-1
11	5Z2	191	67	7	7	6		-1	-1
11	5Z2	192←	58	8	9√	6	+1	-3	-2
11	5Z2	193	55	5	5	5			
11	5Z2	194	60	7	7	6		-1	-1
12	5Z2	195←	54	7	8√	7	+1	-1	
12	5Z2	196	69	9	9	6		-3	-3
12	5Z2	197	61	5	5	4		-1	-1
12	5Z2	198	69	9	9	7		-2	-2
12	5Z2	199	61	8		7	-	-	-1
12	5Z2	200	63	5	5	5			
12	5Z2	201	49	3	3	3			
13	5Z2	202	67	5	5	5			
13	5Z2	203	68	9	9	7		-2	-2
13	5Z2	204	59	5	5	5			
13	5Z2	205	68	5		5		-	
13	5Z2	206	62	6	6	6			
13	5Z2	207	53	3	3	3			
13	5Z2	208	60	5	5	5			
13	5Z2	209	52	3	3	3			
13	5Z2	210	51			4		-	-
13	5Z2	211	64	9	9	6		-3	-3

Set No.	Stratum	Fish No.	Fish Len. (cm)	Otolith Age		Scale Age (S)	Differences		
				USA(UO)	Can.(CO)		CO-UO	S-CO	S-UO
13	5Z2	212	55	7	7	6		-1	-1
13	5Z2	213←	60	6	5	5	-1		-1
13	5Z2	214	48	3	3	3			
13	5Z2	215←	41	3	2	2	-1		-1
13	5Z2	216	47	3	3	3			
13	5Z2	217	45	3	3	3			
13	5Z2	218	37	2	2	2			
13	5Z2	219	45	3	3	3			
13	5Z2	220	66	7	7	7			
13	5Z2	221	50	5	5	5			
13	5Z2	222	59	7	7	7			
13	5Z2	223	71		14	7	-	-7	-
13	5Z2	224	56	3	3	3			
13	5Z2	225	62	5	5	5			
13	5Z2	226	64	5	5	5			
13	5Z2	227	57	5	5	5			
13	5Z2	228	47	2	2	2			
13	5Z2	229	54	5	5	5			
14	5Z2	230	65	7	7	7			
14	5Z2	231	53	5	5	5			
14	5Z2	232	64	5	5	5			
14	5Z2	233	60	5	5	5			
14	5Z2	234	49	3	3	3			
14	5Z2	235←	43	3	2	2	-1		-1
14	5Z2	236	56		5	5	-		-
14	5Z2	237	58	5	5	5			
14	5Z2	238	50	3	3	3			
14	5Z2	239←	56	3	5√	3	+2	-2	
14	5Z2	240←	63	5	9√	5	+4	-4	
14	5Z2	241	59	7	7	5		-2	-2
14	5Z2	242	51	5	5	5			
14	5Z2	243	52	3	3	3			
14	5Z2	244	48	4	4	4			
14	5Z2	245	54	5	5	5			
14	5Z2	246	61	5	5	5			
14	5Z2	247	47	3	3			-	-
14	5Z2	248	62	7	7	6		-1	-1
14	5Z2	249	66	7	7	7			
14	5Z2	250	55	5	5	5			
14	5Z2	251	72	8		8	-	-	
14	5Z2	257	66	7	7	6		-1	-1
14	5Z2	258	69	9	9	7		-2	-2
14	5Z2	262←	72	10	11√	7	+1	-4	-3
14	5Z2	264	71	7	7	7			
15	5Z2	265	58	5	5	5			
15	5Z2	266	56	5	5	5			
15	5Z2	267←	60	8	9	7	+1	-2	-1
15	5Z2	268	62	5	5	5			
15	5Z2	269	65	7		6	-	-	-1
15	5Z2	270	51	5	5	5			
15	5Z2	271	71	7	7	7			
15	5Z2	272	60	7		6	-	-	-1
15	5Z2	273	54	5	5	5			
15	5Z2	274	50	5	5	5			
15	5Z2	275	62	5	5	5			
15	5Z2	276	55	5	5	5			
15	5Z2	277	53	3	3	3			
15	5Z2	278	49	5	5	5			
15	5Z2	279	46	4	4	4			
15	5Z2	280	46	3	3	3			
15	5Z2	281	45	3	3	3			
15	5Z2	282	59	5	5	5			
15	5Z2	289	64	7	7	7			
16	5Z2	290	59	5	5	5			
16	5Z2	291	50	5	5	5			
16	5Z2	292	66	9	9	7		-2	-2
16	5Z2	293←	64	4	5√	4	+1	-1	

Set No.	Stratum	Fish No.	Fish Len. (cm)	Otolith Age		Scale Age (S)	Differences		
				USA(UO)	Can.(CO)		—CO-UO	S-CO	S-UO
16	5Z2	294	53	5	5	5			
16	5Z2	295	65	8	8	6		-2	-2
16	5Z2	296	75	9	9	6		-3	-3
16	5Z2	297	55	5	5	5			
16	5Z2	298	67	5	5	5			
16	5Z2	299	54	4		4	-	-	
16	5Z2	301	50	5	5	5			
16	5Z2	302	57	10	10	6		-4	-4
16	5Z2	303←	63	7	5	6	-2	+1	-1
16	5Z2	305	52	5	5	5			
16	5Z2	306	60		5	6	-	+1	-
16	5Z2	308	62	5	5	5			
16	5Z2	309	61	5	5	5			
17	5Z2	310	53	5	5	5			
17	5Z2	311	66	5	5	5			
17	5Z2	312	64	5	5	5			
17	5Z2	313	68	7	7	6		-1	-1
17	5Z2	314	59	7	7	5		-2	-2
17	5Z2	315	59	5	5	5			
17	5Z2	317	66	7		7	-	-	
17	5Z2	318	51	5	5	5			
17	5Z2	319	53	5	5	5			
17	5Z2	320	51			4	-	-	-
17	5Z2	321	55	5	5	5			
18	5Z2	322	59	5	5	5			
18	5Z2	324	56	5	5	5			
18	5Z2	325	63	5	5	5			
18	5Z2	326	55	5		5	-	-	
18	5Z2	327	56	5		5	-	-	
18	5Z2	328	60	5	5	5			
18	5Z2	330	59	5	5	5			
18	5Z2	331	50	5		5	-	-	
19	5Z2	334←	73	13	14√	8	+1	-6	-5
20	5Z2	335	22	1	1			-	-
21	5Z2	336	71	7	7	7			
21	5Z2	337	62	7	7	7			
22	5Z2	338	75	9	9	8		-1	-1
22	5Z2	339	52	5	5	5			
23	5Z2	340	67	9		7	-	-	-2
23	5Z2	342	53	5	5	5			
24	5Z2	344	67	5	5	5			
24	5Z2	345	58	5	5	5			
24	5Z2	346	63	5	5	5			
24	5Z2	347	55	5	5	5			
24	5Z2	348	58	7	7	5		-2	-2
24	5Z2	350	54	5	5	5			
25	5Z2	351	46	3	3	3			
25	5Z2	352	50	4	4	3		-1	-1
25	5Z2	353	47	3	3	3			
25	5Z2	354	43	3	3	3			
25	5Z2	355	52	5	5	5			
25	5Z2	356	35		2	2	-		-
25	5Z2	357	41	2	2	2			
25	5Z2	358	39	2	2	2			
25	5Z2	360	39	2	2	2			
25	5Z2	361	53	3	3	3			
25	5Z2	362	45	3	3	3			
25	5Z2	363	49	3	3	3			
25	5Z2	364	58	5	5	5			
25	5Z2	365	44	3	3	3			
25	5Z2	366	49	3	3	3			
25	5Z2	369←	62	6	5√	5	-1		-1
25	5Z2	370	55	5	5	5			
25	5Z2	371	58	5	5	5			
25	5Z2	372	45	3	3	3			
25	5Z2	373	41	2	2	2			
25	5Z2	374	36	2	2	2			

Set No.	Stratum	Fish No.	Fish Len. (cm)	Otolith Age		Scale Age (S)	Differences		
				USA(UO)	Can.(CO)		CO-UO	S-CO	S-UO
28	5Z1	438	59	5	5	5			
28	5Z1	439	53	5	5	5			
28	5Z1	440←	49	3	4	3	+1	-1	
28	5Z1	441←	52	6	5	6	-1	+1	
28	5Z1	442	48	3	3	3			
28	5Z1	444	56	5	5	4		-1	-1
28	5Z1	445	74	12	12	6		-6	-6
28	5Z1	447	50	5	5	5			
28	5Z1	449	50	5	5	5			
31	5Z1	456	47	3	3	3			
31	5Z1	457	55	5	5	5			
31	5Z1	458	52	5	5	5			
31	5Z1	459	47	3	3	3			
31	5Z1	464←	53	4√	3	4	-1	+1	
31	5Z1	465	55	5	5	5			
31	5Z1	466←	58	4	3	4	-1	+1	
31	5Z1	469	50	5	5			-	-
31	5Z1	470	49	4	4	4			
31	5Z1	471	58	5	5	5			
37	5Z1	630	61	5	5	5			
42	5Z1	726	44	4	4	4			
42	5Z1	727	51	4	4	4			
43	5Z1	744	57	5	5	5			
43	5Z1	745	61	5	5	5			
43	5Z1	755	34	2	2	2			
43	5Z1	756	25	1	1	1			
50	5Z4	802	61	5	5	5			
50	5Z4	803	51	3	3	3			
50	5Z4	804	59	5	5	5			
50	5Z4	811	60	5	5	5			
50	5Z4	812	54	5	5	5			
50	5Z4	813	70	5	5	5			
50	5Z4	814	54	5	5	5			
50	5Z4	815	66	7	7	6		-1	-1
50	5Z4	828	57	7	7	6			-1
50	5Z4	829	51	5	5	5			
50	5Z4	830←	52	6	5	6	-1	+1	
50	5Z4	831	61	5	5	5			
50	5Z4	833	53	5		5	-	-	
51	5Z3	837	57	7	7	7			
51	5Z3	838	62	7	7	6		-1	-1
51	5Z3	839	62	7	7	7			
51	5Z3	840	56	3	3	3			
51	5Z3	841	58	5	5	5			
51	5Z3	842	60	5	5	5			
51	5Z3	843	69	7	7	6		-1	-1
51	5Z3	844	60	7	7	5			-2
51	5Z3	845	52	5	5	5			
51	5Z3	851←	72	8	9√	5	+1	-4	-3
51	5Z3	852	52	5	5	5			
51	5Z3	854	55	5	5	5			
53	5Z3	857	71	5		5	-	-	
53	5Z3	858	67	7	7	6		-1	-1
53	5Z3	859	53	5	5	4		-1	-1
53	5Z3	860	62	7	7	7			
53	5Z3	861	69	5	5	5			
53	5Z3	862←	61	6	5	5	-1		-1
53	5Z3	863	61	7	7	7			
53	5Z3	864	56	5	5	5			
53	5Z3	865	62	9	9	8		-1	-1
53	5Z3	866	53	5	5	5			
53	5Z3	867←	58	8√	(7)		-1	-	-
53	5Z3	868	69	9	9	8		-1	-1
53	5Z3	869←	55	4	5√	4	+1	-1	
53	5Z3	870	72	7	7	7			
53	5Z3	871	55	5	5	5			
53	5Z3	872	59	5	5	5			

Set No.	Stratum	Fish No.	Fish Len. (cm)	Otolith Age		Scale Age (S)	Differences		
				USA(UO)	Can.(CO)		CO-UO	S-CO	S-UO
53	5Z3	873←	26	2	1	2	-1	+1	
53	5Z3	874	50	5	5	5			
53	5Z3	875←	56	(6)	5√	5	-1		-1
53	5Z3	876	65	7	7	7			
53	5Z3	877	67	7	7	7			
53	5Z3	878	65	7	7	7			
53	5Z3	879	71	5	5	5			
53	5Z3	880	51	5	5	5			
53	5Z3	881	38	2	2	2			
53	5Z3	882←	74	13	14√	5	+1	-9	-8
53	5Z3	883	74	5	5			-	-
53	5Z3	884	72	7	7	7			
54	5Z3	885	63	5	5	5			
54	5Z3	886	61	5	5	5			
54	5Z3	887	61	5	5	5			
54	5Z3	888	52	5	5	5			
54	5Z3	889	62	5	5	5			
54	5Z3	890←	66	6	7√	6	+1	-1	
54	5Z3	891	68	7	7	7			
54	5Z3	892	53	5	5	5			
54	5Z3	893	74	9	9	7		-2	-2
54	5Z3	894	65	5	5	5			
54	5Z3	895	64	5	5	5			
54	5Z3	896	67	9	9	8		-1	-1
54	5Z3	897	58	5	5	5			
54	5Z3	898	78	9	9	8		-1	-1
54	5Z3	899	68	7	7	7			
54	5Z3	900	72	7	7	7			
54	5Z3	901	56	5	5	5			
54	5Z3	902	59	7	7	6		-1	-1
54	5Z3	903	56	5	5	5			
54	5Z3	904	71	7	7	7			
54	5Z3	905	54	3	3	3			
55	5Z3	906	66	7	7	6		-1	-1
61	5Z3	907	67	5	5	5			
61	5Z3	908	63	7	7	6		-1	-1
67	5Z4	909	63	6	6	5		-1	
70	5Z4	921	67	4		5	-	-	+1
				Western Georges Bank					
76	5Z5	926	64	5	5	4		-1	-1
76	5Z5	927	51	3		3	-	-	
77	5Z6	934	66	7	7	6		-1	-1
80	5Z7	939	78			5	-	-	-
82	5Z7	940←	70	8	7	6	-1	-1	-2
83	5Z6	941	71	5		5	-	-	
83	5Z6	942	25	1	1	1			
83	5Z6	943	27	1	1	2		+1	+1
86	5Z6	951	55	3	3	3			
86	5Z6	956	47	2		2	-	-	
86	5Z6	957	41	2	2	2			
86	5Z6	958	58	3	3	3			
86	5Z6	960	42	2	2	2			
86	5Z6	961	40	2	2	2			
86	5Z6	962	61	4		4	-	-	
86	5Z6	963	39	2	2	2			
No. of Differences							32	75	71
Sum of -ve and +ve Differences							-17,+21	-129,+11	-117,+2

Table 4a. Age assignments by Canadian (L. Van Eeckhaute) and USA (N. Munroe) readers to Georges Bank haddock otoliths and scales (USA reader only) from the 1992 Canadian commercial fishery. (Sample No. 920336, collected July 20 , 1992 by G. Donaldson from longline gear fished at a depth of 180 - 190 fathoms in the Fundian Channel near the Can/USA boundary line.) (UO=otolith read by N. Munroe, CO=otolith read by L. Van Eeckhaute, S=scale read by N. Munroe).

Otolith Number	Fish Length (cm)	Otolith Age		Scale Age (S)	Differences		
		USA(UO)	Can.(CO)		CO-UO	S-CO	S-UO
1	70	7	7	7			
2	60	5	5	4(5)		-1(0)	-1(0)
3	65	5	5	5			
4	68	5	5	5			
5	66	5	5	5			
6	64	5	5	5			
7	60	5	5	5			
8	60	5	5	5			
9	64	7	7	6		-1	-1
10	59	5	5	5			
11	65	5	5	5			
12	69	7	7	7			
13	71	5	5	5			
14	55	7	7	5		-2	-2
15	64	5	5	5			
16	65	5	5	5			
17	58	5	5	5			
18	62	5	5	5			
19	72	14	14	7		-7	-7
20	63	5	5	4		-1	-1
21	59	7	7	5		-2	-2
22	68	7	7	7			
23	62	6	7	6	+1	-1	
24	70	7	7	6		-1	-1
25	67	7	7	5		-2	-2
26	71	5	5	4		-1	-1
27	58	5	5	5			
28	59	5	5	5			
29	58	5	5	5			
30	63	6	7	6	+1	-1	
31	72	5	5	-		-	-
32	75	5	5	5			
33	58	5	5	5			
34	76	7	7	6		-1	-1
35	63	5	5	5			
36	68	-	7	6	-	-1	-
37	54	5	5	5			
38	60	6	5	5	-1		-1
39	73	9	10	8	+1	-2	-1
40	56	5	5	5			
41	78	9	9	7		-2	-2
42	70	6	7	6	+1	-1	
43	73	14	14 15?	8		-6	-6
44	56	5	5	5			
45	69	7	7	6		-1	-1
46	62	5	5	4		-1	-1
47	78	12	13	7	+1	-6	-5
48	65	5	5	5			
49	73	5	5	5			
50	56	5	5	5			
No. of Differences					6	20	17
Sum of Differences					+5,-1	-41	-36

Table 4b. (Sample No. 920434, collected Sept. 9 , 1992 by D. Lyon from longline gear fished at a depth of 115-135 fathoms in 5Zj, north of Georges Bank in the "Gully").

Otolith Number	Fish Length (cm)	Otolith Age		Scale Age	Differences		
		USA(UO)	Can(CO)		CO-UO	S-CO	S-UO
123741	55	5	5	5			
123742	58	5	5	5			
123743	62	5	5	5			
123744	67	7	7	Omit		-	-
123745	55	5	5	5			
123746	71	7	7	7			
123747	62	5	5	5			
123748	64	5	5	5			
123749	52	5	5	5			
123750	70	7	7	7			
123751	65	5	Omit	5	-	-	
123752	51	5	5	5			
123753	61	5	5	5			
123754	60	5	5	5			
123755	56	5	5	5			
123756	68	9	9	9			
123757	52	5	5	5			
123758	66	7	7	6		-1	-1
123759	58	5	5	5			
123760	56	5	5	5			
123761	72	6	9	6	+3	-3	
123762	69	5	5	6		+1	+1
123763	73	Omit	9	7	-	-2	-
123764	47	3	4	3	+1	-1	
123765	51	5	5	5			
123766	47	5	5	5(4)		0(-1)	
123767	78	Omit	9	7	-	-2	-
123768	49	3	3	3			
123769	81	Omit	Omit	5	-	-	-
No. of Differences					2	6	2
Sum of Differences					+4	-9,+1	-1,+1

Table 4c.(Sample No. 920351, collected July 16, 1992 by D. Lyon from otter trawl gear fished at a depth of 120 - 160 fathoms).

Otolith Number	Fish Length (cm)	Otolith Age		Scale Age	Differences		
		USA(UO)	Can.(CO)		CO-UO	S-CO	S-UO
122801	66	7	7	7			
122802	59	5	5	5			
122803	55	5	7 6?	5	+2	-2	
122804	68	6	7	6	+1	-1	
122805	58	5	5	5			
122806	67	9	9	8		-1	-1
122807	62	6	5	6	-1	+1	
122808	52	6	7	6	+1	-1	
122809	57	5	5	5			
122810	56	5	5	5			
122811	60	5	5	5			
122812	53	5	5	5			
122813	60	5	5	5			
122814	62	6	7	6	+1	-1	
122815	64	5	5	5			
122816	65	5	5?	5			
122817	49	5	5	Omit		-	-
122818	50	Omit	3	3	-		-
122819	49	2	2	2			
122820	51	5	5	5			
122821	55	5	5	5			
122822	68	7	7	6		-1	-1
122823	71	7	7	6		-1	-1
122824	74	5	5	5			
122825	76	9	9	7		-2	-2
122826	73	12	11	9	-1	-2	-3
No. of Differences					6	10	5
Sum of Differences					+5,-2	+1,-12	-8

Table 5. Comparison of ages derived by the USA reader and Canadian reader from haddock otoliths sampled during the 1992 Canadian spring survey, N165.

USA reader (N. Munroe)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Omit	Tot
1	4	1															5
2		13	2													1	16
3			33	2												2	37
4			1	7												3	11
5				2	120	8	1										131
6						2											2
7						1	50	2									53
8							1	1									2
9					1			4	18								23
10									1	1							2
11										1							1
12												1					1
13													2				2
14																1	1
15																	0
16																	0
17															1		1
Omit		1	1	3	8		3	2	1							3	22
Tot.	4	15	37	14	129	11	55	9	20	2	0	1	2	0	1	10	310
% agreement (omits excluded / omits included) =								90 / 82									

Canadian reader (L. Van Eeckhaute)

Table 6. Comparison of ages derived ty the USA and Canadian readers from otoliths sampled from the 5Z haddock Canadian commercial fishery. (Sample Nos. 920336, 920434 and 920351).

USA reader (N. Munroe)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Omit	Tot
1																0
2		1														1
3			1												1	2
4			1													1
5					60	2										62
6																0
7					1	6	17								1	25
8																0
9						1			4						2	7
10									1							1
11												1				1
12																0
13												1				1
14														2		2
Omit					1										1	2
Tot.	0	1	2	0	62	9	17	0	5	0	0	2	0	2	5	105
% agreement (omits excluded / omits included) =								86 / 82								

Canadian reader (L. Van Eeckhaute)

Table 7. Comparison of ages derived by the USA reader, N. Munroe, from haddock scales and otoliths sampled during the 1992 Canadian spring survey, N165.

Scales

	1	2	3	4	5	6	7	8	9	10	Omit	Tot
1	2	1									1	4
2		15										15
3		2	35								1	38
4			1	11	1							13
5				4	123						2	129
6					6	5						11
7					4	21	30					55
8					1	3	2	2			1	9
9						3	8	9				20
10						1	1					2
11												0
12						1						1
13					1			1				2
14												0
15										1		1
Omit		1	1	2	4	1	1					10
Tot.	2	19	37	17	140	35	42	12	0	1	5	310
% agreement (omits excluded / omits included) =								76 / 72				

Otoliths

Table 8. Comparison of ages derived by the USA reader, N. Munroe, from 1992 Canadian 5Zj,m commercial haddock fishery otoliths and scales. (Sample Nos. 920336, 920434 and 920351).

Scales

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Omit	Tot
1																0
2		1														1
3			2													2
4																0
5				4	55	1									2	62
6					1	8										9
7					3	7	6								1	17
8																0
9							2	2	1							5
10																0
11																0
12							1		1							2
13																0
14							1	1								2
Omit			1		1	1	2									5
Tot.	0	1	3	4	60	17	12	3	2	0	0	0	0	0	3	105
% agreement (omits excluded / omitsincluded) =								75 / 70								

Otoliths