A test on the accuracy of ageing of chinook salmon (*Oncorhynchus tshawytscha*) of known age from their scales

by

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Submitted to the

INTERNATIONAL NORTH PACIFIC FISHERIES COMMISSION

by the

CANADIAN NATIONAL SECTION

July 1985

THIS PAPER MAY BE CITED IN THE FOLLOWING MANNER:

Bilton, H. T. 1985. MS. A test on the accuracy of ageing of chinook salmon (*Oncorhynchus tshawytscha*) of known age from their scales. 21 p. (Document submitted to the Annual Meeting of the International North Pacific Fisheries Commission, Tokyo, Japan, October, 1985). Department of Fisheries and Oceans, Fisheries Research Branch, Pacific Biological Station, Nanaimo, B.C., Canada V9R 5K6.

Introduction

Salmon scale readers generally agree that chinook salmon scales are the most difficult of the Pacific salmon species to age with confidence. The difficulty arises from the complexity of the chinook salmon's life history which can vary among stocks and races.

Stocks of young wild chinook salmon may migrate from fresh water to the ocean within hours of emergence, or after periods of residence that can vary from days, weeks, or months to as much as several years. Release of hatchery-produced stocks from different sites at different times and sizes throughout each year add further to the complexity. All may remain at sea for several months to as long as 6 or more years. Some young leave the stream just after scale formation, whereas others migrate with scales that already show varying numbers of freshwater circuli.

This variability in the life history of the chinook salmon, particularly the early life history, makes scales difficult to interpret for age because criteria are lacking upon which an interpretation can be based with confidence. Hence, interpretation of freshwater growth and designation of checks as freshwater annuli has been a major area of disagreement among readers. To a lesser but still significant extent there is disagreement among readers regarding the designation of checks in the marine area of the scales as marine annuli. Accurate ageing of chinook salmon from their scales continues to be a problem in North America (Godfrey et al. 1968). Godfrey et al. conducted a test to determine how accurately chinook salmon scales could be read. The test was made involving experienced scale readers from a Canadian and several

United States fisheries agencies. For a part of the test, scales of known-age fish were used (scales from recaptured hatchery fish that had been marked when liberated). In general the test indicated an overall accuracy of approximately 75%. The degree of accuracy differed with the true age-class; and scales with both freshwater and ocean annuli misaged more frequently than those with only ocean annuli. They concluded that the age compositions derived by the readers were very similar and approximated the true age compositions. To some extent this resulted from cancelling out over-ageing by under-ageing, but was mainly due to the accuracy with which readers assigned ages to scales. However, they also concluded the fund of reliable criteria used in making age determinations from scales must be increased, if improvements in both accuracy and consistency are to be achieved.

Since the test by Godfrey et al. (1968) 16 years have elapsed and both the scale readers and the problems associated with ageing of this species have changed in the meantime, the latter being the result of a number of production hatcheries coming on line in British Columbia. Because of these changes and the possibility that the earlier test is likely not applicable to the present time, the need for more recent scale reader tests was apparent. In October 1984, as a result of an International North Pacific Fisheries Commission Workshop on the Ageing of Fishes, members from Japan, United States, and Canada were invited to participate in a scale-reading test using scales from chinooks of known age. This report presents the results of this test.

Methods and Materials

The test was made involving both experienced and less experienced scale readers from one Japanese, one Canadian, and several United States fisheries agencies. In this report the scale readers and the agencies to which they belong are not identified; instead a number serves to designate each individual reader.

The number of readers from each country and agency are as follows:

Japan

1 reader, Far Seas Fisheries Laboratory, Japan Fisheries Agency

United States

2 readers, Alaska Department of Fish and Game

1 reader, State of Washington Department of Fisheries

3 readers, University of Washington

Canada

5 readers, Fisheries Research Branch

Eighty-six scales from chinook salmon of known age were selected by Mrs. Y. Yole of the Canadian Department of Fisheries and Oceans scale laboratory in Vancouver, B.C. for the purpose of this test. The selector was not otherwise involved in the test. The scales originated from marked and binary-coded, nose-tagged hatchery chinooks recovered in the B.C. commercial fishery and landed at Prince Rupert B.C. in 1983. The only information provided the readers was the date of capture and that they were chinook salmon scales.

Scale readers from each country were provided with a copy of acetate plastic impressions of these scales (Clutter and Whitesel 1956) for microscopic examination back at their respective laboratories. Upon completion of age determinations from these scales the data was then sent in to the author for compilation and analyses.

The equipment used by the different readers varied among the agencies, but it was that which they preferred, and with which they were most familiar.

The complete data produced by this test are on file with the Canadian Department of Fisheries and Oceans, Fisheries Research Branch, Pacific Biological Station, Nanaimo, B.C.

Results

With each of the 12 readers in reading of the 86 scales the errors in assigned ages included several age-classes and were sometimes high relative to the correct number of scales belonging to a particular age class (Table 1). Among the 1,032 determinations (12 readers x 86 scales = 1,032) the total number of correct age assignments for both freshwater- and ocean-age was 568, or 56.7% (note scales not read for various reasons are included in this total (Table 2)). The correct assignments by the 12 readers ranged from a low of 19.8% to a high of

88.5%. In general ageing of the 0. age fish presented slightly fewer problems to the readers than did the 1. age fish (correct assignments among the age 0. and 1. fish averaged 59.9 and 52.6%, respectively).

Among the 1,032 determinations the total number of correct assignments for only the ocean age was 696, or 67.4% (Table 3). The correct assignments of ocean age by the 12 readers ranged from a low of 55.1% to a high of 88.5%. Ageing of the 0.1, 0.2, and 0.3 age fish were obviously less difficult to determine their ocean age than were the remaining age-classes (correct assignments among the age 0.1 to age 0.3 fish averaged 79.2% and for the remaining age-classes averaged 58.5%).

Table 4 presents the correct assignments of freshwater age for each age class by the 12 readers. Among the 1,032 determinations the total number of correct assignments was 676 or 65.5%, with correct assignments ranging from a low of 24.6% to a high of 91.5% among the 12 readers. In general, determination of the presence or absence of a freshwater annulus on the scales presented slightly greater difficulty among the age 1. fish than among the age 0. fish (correct assignment of freshwater age among the 0. fish and 1. fish averaged 69.6% and 66.0%, respectively).

Percentages of correct assignments to brood-year for each age-class by the 12 readers are given in Table 5. In this case the assignment of the correct ocean age and/or the freshwater age are ignored, only the total number of annuli are considered which provided the correct estimate of the brood-year from which the fish originated. Among the 1,032 determinations the total number of correct assignments was 699 or 67.7%. The correct assignments by the 12 readers ranged from a low of 25.3% to a high of 96.6%. Correct assignment was higher among the 0.1 to 0.3 and 1.2 (average of 74.5%) age-classes than among the remainder (average of 62.6%).

The test provided 12 separate age composition arrays which can be compared with the true age composition of a sample (Table 6). Regardless of the errors all but one of the readers derived an age composition which tended to be similar to the true one. In the case of one reader (reader 12) virtually all of the fish (98.8%) were estimated to have one or more freshwater annuli present on their scales. This was quite unlike the representation of fish of this life-history type in the true age composition where only approximately 25% of the fish in the sample were of this type. Table 7 summarizes the data from Table 6 for each age group the differences in percent representation that occurred.

Table 7.

True age group	Average percent difference for 12 readers	Range of percent difference	No. times differed and direction from true age representation among 12 readers >	<	same
0.1	-0.1	-1.2 to +2.7	6	4	2
0.2	-0.8	-17.4 to +9.9	6	6	0
0.3	+1.6	-43.0 to +13.5	10	2	0
0.4	-6.0	-12.7 to -2.3	0	12	0
1.1	+1.1	-1.1 to +5.7	9	3	0
1.2	-5.2	-18.3 to +48.8	3	9	0
1.3	+6.0	+0.1 to +7.4	12	0	0

As indicated in Table 7 most readers over-estimated the representation of age 0.3, 1.1, and 1.3 fish in the sample of known-age fish. In the case of the 0.1 age fish 6 of the readers over-estimated their representation, even though the average for the 12 readers virtually did not differ from that of the true representation. For the age 1.2 fish 9 of 12 readers under-estimated their representation, and three readers under-estimated their presence.

Discussion

From the test it may be concluded that the degree of accuracy achieved in reading all the scales varied among the readers and that the overall average of 57% cannot be considered adequate. This overall average is much lower than the 75% reported by Godfrey et al. (1968) in earlier tests of ageing known-age chinooks. The reasons for this are not understood and some speculation may be warranted. Perhaps the scale patterns of chinooks in latter years have become increasingly complex as a result of increased representation of B.C. hatchery-produced chinooks in the catches over the past few years. It is well known that juveniles are released at different sizes and times, making it more difficult to interpret correctly the freshwater growth on their scales. Perhaps conditions in the ocean have or are changing to the extent that marine growth of the fish is now more difficult to interpret from their scales.

Scales with both freshwater and ocean annuli were misaged only slightly more frequently than those with only ocean annuli (see Table 1). Also, when percentages of correct assignments for ocean-age and for freshwater-age are compared among the 1,032 determinations, the difficulty in correctly assigning age was about the same in both cases (67.4 and 65.5%, respectively). Hence, readers generally had about equal difficulty in interpreting ocean-age as they did freshwater age on the scales. Correct assignment to brood-year regardless of correct interpretation to either freshwater or ocean age was about the same (67.7%).

In this report the different kinds of scales used in the test are not described. Further, no attempt is made to indicate the specific characteristics of scales upon whose interpretation the readers either agreed or disagreed. There will probably always be some disagreement in the interpretation of individual chinook salmon scales. The reasons for this, as was mentioned earlier, arise from the increasing complexity and variability in the freshwater life history of the chinook salmon, due to the increasing number of hatchery releases as more B.C. hatcheries come on line. The problem of interpretation of chinook scales is further compounded by the presence of both hatchery and wild stocks in the catches by the fishery. The results of this test indicate the need for improvement in accuracy in ageing of chinook salmon.

There are several ways this might be achieved. First, more objective criteria for interpretation of both freshwater and marine growth should be developed from detailed study and measurement of scales of known-aged, nose-tagged chinook salmon. Criteria developed from such a study could be used as a guide for ageing of unknown, non-marked chinooks which comprise most of the fish in the catch. Examination of scales from known-age juveniles from both the wild stocks and hatchery releases could also be used in the development of criteria. Some readers believe that wild stocks can be identified from hatchery produced fish on the basis of their scale patterns. If after objective study, this hypothesis proves to be true, such information might also be incorporated in development of criteria. This could be important in ageing of catches where wild stocks represent a significant proportion of the catch. After development of criteria, further tests involving varying proportions of the different age groups in samples of known-age fish would determine the accuracy of ageing. Repeated tests using the same samples would establish the consistency that readers aged the fish. Lastly, it is important to note that achievement of high levels of accuracy and/or consistency depends also upon the use of good, modern equipment, and trained and experienced readers.

Acknowledgments

The writer would like to thank the work of the following who read the scales used in this test: Dr. Mamuro Kato, Far Seas Fisheries Research Laboratory, Japan Fisheries Agency, Orido, Shimizu; Mr. John Sneva, Washington State Department of Fisheries, Olympia, Washington; Mr. Ben Van Alen and Ms. Eileen Sturrock, Alaska Department of Fish and Game, Douglas, Alaska; Mr. Curtis Knudsen and two anonymous readers, University of Washington, Fisheries Research Institute, Seattle, Washington; Mrs. Doris Chilton, Ms. Shayne McLellan, Darlene Dodds, Mrs. Kathy Rutherford, and Mrs. Linda Zado of the Fisheries Research Branch, Biological Station, Nanaimo, B.C. Mrs. Yvonne Yole of the Canada Department of Fisheries and Oceans, Scale Laboratory, Vancouver, B.C., is especially thanked for selecting the scales that were used in the test.

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Table 1. The ages assigned to 86 scales by 12 readers as percentages of the number of scales of each true age class.[a]

Reader No.	True age	No. of scales	Age-class 0.1	0.2	0.3	0.4	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.3	NR[b]
1	0.1	1									100.0					
	0.2	15		66.7	6.7						26.6					
	0.3	38		5.3	86.9	2.6		2.6			2.6					
	0.4	11			27.3	54.5					18.2					
	1.1	2					50.0				50.0					
	1.2	18		16.6	38.9		5.6	38.9								
	1.3	1							100.0							
	0.1	1	100.0													
2	0.2	15	6.7	53.3	20.0		13.3				6.7					
	0.3	38		15.3	57.9	2.6		2.6	10.3		13.3					
	0.4	11			36.3	18.2			18.2	9.1	18.2					
	1.1	2	50.0				50.0									
	1.2	18		44.4	33.3		11.1	5.6			5.6					
	1.3	1			100.0											
	0.1	1	100.0													
3	0.2	15		93.3							6.7					
	0.3	38		2.6	78.9	2.6			5.3		10.6					
	0.4	11			27.3	54.5					18.2					
	1.1	2					100.0									
	1.2	18		5.6	50.0		5.6	38.8								
	1.3	1									100.0					

Table 1 (cont'd)

Reader No.	True age	No. of scales	Age-class 0.1	0.2	0.3	0.4	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.3	NR[b]
	0.1	1									100.0					
4	0.2	15		53.3	6.7	6.7		6.7			26.6					
	0.3	38		5.3	65.8			2.6	2.6		23.7					
	0.4	11			27.3	54.5					18.2					
	1.1	2					50.0				50.0					
	1.2	18		5.6	27.8			55.6			11.0					
	1.3	1							100.0							
	0.1	1	100.0													
5	0.2	15		93.3			6.7									
	0.3	38		2.6	86.9			7.9			2.6					
	0.4	11			18.2	72.7			9.1							
	1.1	2					100.0									
	1.2	18			33.3			66.7								
	1.3	1							100.0							
6	0.1	1	100.0													
	0.2	15		53.3			26.7	6.7			13.3					
	0.3	38		2.6	63.2			21.1			13.1					
	0.4	11			18.2	27.3			36.3		18.2					
	1.1	2					100.0									
	1.2	18			16.7			72.2			11.1					
	1.3	1							100.0							

Table 1 (cont'd)

Reader No.	True age	No. of scales	Age-class 0.1	0.2	0.3	0.4	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.3	NR[b]
7	0.1	1	100.0													
	0.2	15		80.0	6.7		6.7	6.7								
	0.3	38		2.6	81.5			5.3	5.3		5.3					
	0.4	11			9.1	54.5			18.2		18.2					
	1.1	2					100.0									
	1.2	18			27.8			72.7								
	1.3	1									100.0					
8	0.1	1	100.0													
	0.2	15		86.7			13.3									
	0.3	38		5.3	81.6			2.6	2.6		7.9					
	0.4	11			18.2	54.5			9.1		18.2					
	1.1	2					50.0				50.0					
	1.2	18			44.4			33.3	16.7		5.6					
	1.3	1								100.0						
9	0.1	1					100.0									
	0.2	15		73.0	9.1		9.1	9.1	9.1							
	0.3	38		2.6	78.9			5.3	10.6							2.6
	0.4	11			9.1	54.5			18.2							18.2
	1.1	2					50.0									50.0
	1.2	18			22.2			77.8								
	1.3	1														100.0

Table 1 (cont'd)

Reader No.	True age	No. of scales	Age-class 0.1	0.2	0.3	0.4	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.3	NR[b]
10	0.1	1	100.0													
	0.2	15		80.0				6.7								13.3
	0.3	38		53.3	84.2				2.6							7.9
	0.4	11			18.2	63.6										18.2
	1.1	2		50.0				50.0								
	1.2	18		5.5	61.2			27.8								5.5
	1.3	1							100.0							
11	0.1	1	100.0													
	0.2	15		60.0				6.7								33.3
	0.3	38		2.6	79.0		2.6	5.3	2.6							7.9
	0.4	11			36.3	27.3			9.1	9.1						18.2
	1.1	2					50.0	50.0								
	1.2	18		11.1	22.2			66.7								
	1.3	1			100.0											
12	0.1	1					100.0									
	0.2	15						53.2	20.0		6.7	6.7	6.7			6.7
	0.3	38						5.3	73.7			15.8		2.6		2.6
	0.4	11							27.3	36.3			9.1		9.1	18.2
	1.1	2									100.0					
	1.2	18			5.6			38.9	33.3			22.2				
	1.3	1							100.0							

[a] The European system of age designation (Koo 1962) is used in this report. The first digit indicates the number of annuli formed in fresh water and the second digit the number of annuli formed while the fish were in the ocean.

[b] Not read.

Table 2. Percentages of correct assignments of both freshwater- and ocean-age for each age-class in readings of 86 scales by 12 readers.

True age	No. of scales	Reader 1	2	3	4	5	6	7	8	9	10	11	12	Avg.
0.1	1	0.0	100.0	0.0	0.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	0.0	58.3
0.2	15	66.7	53.3	93.3	53.3	93.3	53.3	80.0	86.7	73.0	80.0	60.0	0.0	66.1
0.3	38	86.9	57.9	78.9	65.8	86.9	63.2	81.5	81.6	78.9	84.2	79.0	0.0	70.4
0.4	11	54.5	18.2	54.5	54.5	72.7	27.3	54.5	54.5	54.5	63.6	27.3	0.0	44.7
1.1	2	50.0	50.0	100.0	50.0	100.0	100.0	100.0	50.0	50.0	0.0	50.0	0.0	58.3
1.2	18	38.9	5.6	38.8	55.6	66.7	72.7	72.7	33.3	77.8	27.8	66.2	38.9	49.5
1.3	1	100.0	0.0	0.0	100.0	100.0	100.0	0.0	0.0	0.0	100.0	0.0	100.0	50.0
Total or Avg.	86	56.7	40.7	52.2	54.2	88.5	73.7	69.7	58.0	47.7	65.1	54.7	19.8	56.7

Table 3. Percentages of correct assignments of ocean-age for each age-class in readings of 86 scales by 12 readers.

True age	No. of scales	Reader 1	2	3	4	5	6	7	8	9	10	11	12	Average
0.1	1	0.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	100.0	83.3
0.2	15	66.7	53.3	93.3	60.0	93.3	60.0	86.7	86.7	82.1	86.7	66.7	53.2	74.1
0.3	38	86.9	68.2	84.2	68.4	86.9	63.2	86.8	84.2	89.5	86.8	81.6	73.7	80.3
0.4	11	54.5	27.3	54.5	54.5	72.9	27.3	54.5	54.5	54.5	63.6	36.4	36.3	49.2
1.1	2	50.0	100.0	100.0	50.0	100.0	100.0	100.0	50.0	50.0	0.0	50.0	0.0	62.5
1.2	18	55.5	50.0	44.4	61.2	66.7	72.7	72.7	33.3	77.8	33.3	77.8	22.2	55.6
1.3	1	100.0	100.0	0.0	100.0	100.0	100.0	0.0	0.0	0.0	100.0	100.0	100.0	66.7
Total or Avg.	86	59.1	71.2	68.1	56.3	88.5	74.7	71.4	58.4	64.8	67.2	73.2	55.1	67.4

Table 4. Percentages of correct assignments of freshwater-age for each age-class in readings of 86 scales by 12 readers.

True age	No. of scales	Reader 1	2	3	4	5	6	7	8	9	10	11	12	Average
0.1	1	0.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	0.0	66.7
0.2	15	73.4	80.0	93.3	66.7	93.3	53.3	86.7	86.7	82.1	80.0	60.0	0.0	71.3
0.3	38	94.8	73.8	84.1	71.1	89.5	65.8	84.1	86.9	81.5	89.7	81.6	0.0	75.2
0.4	11	81.8	54.5	81.5	81.8	90.9	45.5	63.6	72.7	63.6	81.8	63.6	0.0	65.1
1.1	2	50.0	50.0	100.0	50.0	100.0	100.0	100.0	50.0	50.0	50.0	100.0	0.0	66.7
1.2	18	44.5	16.7	44.4	55.6	66.7	72.2	72.2	50.0	77.8	27.8	66.7	72.2	55.6
1.3	1	100.0	0.0	0.0	100.0	100.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	58.3
Total or Avg.	86	63.5	53.4	71.9	60.7	91.5	76.7	72.4	78.0	50.7	75.6	67.4	24.6	65.5

Table 5. Percentages of correct assignments to brood-year for each age-class in readings of 86 scales by 12 readers.

True age	Brood year	No. of scales	Reader												
			1	2	3	4	5	6	7	8	9	10	11	12	Average
0.1	81	1	0.0	100.0	100.0	0.0	100.0	100.0	100.0	100.0	0.0	100.0	100.0	0.0	66.7
0.2	80	15	66.7	66.6	93.3	60.0	100.0	80.0	86.7	100.0	82.1	80.0	60.0	0.0	72.9
0.3	79	38	89.5	60.5	78.9	68.4	94.8	84.3	86.8	84.2	84.2	84.2	84.3	5.3	75.4
0.4	78	11	54.5	36.4	54.5	54.5	81.8	63.6	72.7	63.6	72.7	63.6	36.4	27.3	56.8
1.1	80	2	50.0	50.0	100.0	50.0	100.0	100.0	100.0	50.0	50.0	50.0	50.0	0.0	62.5
1.2	79	18	77.8	38.9	88.8	83.4	100.0	88.9	100.0	77.7	100.0	89.0	88.9	44.5	81.5
1.3	78	1	100.0	0.0	0.0	100.0	100.0	100.0	0.0	100.0	0.0	100.0	0.0	100.0	58.3
Total or average		86	62.6	50.3	73.6	59.5	96.6	88.1	78.0	82.2	55.6	81.0	59.9	25.3	71.6

Table 6. The age composition (percent) derived by each reader compared with the true age composition.[a]

Scale reader number	Diff. from true age	Age-class 0.1	0.2	0.3	0.4	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.3	Total
1		0.0	19.5	57.1	9.1	2.6	10.4	1.3	0.0	0.0	0.0	0.0	0.0	0.0	100.0
	Diff.	-1.2	+2.1	+12.9	-3.6	+0.3	-10.5	+0.1	0.0	0.0	0.0	0.0	0.0	0.0	
2		3.9	27.3	46.7	3.9	6.5	2.6	7.8	1.3	0.0	0.0	0.0	0.0	0.0	100.0
	Diff.	+2.7	+9.9	+2.5	-8.8	+4.2	-18.3	+6.6	+1.3	0.0	0.0	0.0	0.0	0.0	
3		1.3	20.5	53.8	9.0	3.8	9.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	100.0
	Diff.	+0.1	+3.1	+9.6	-12.7	+1.5	-11.9	+1.4	0.0	0.0	0.0	0.0	0.0	0.0	
4		0.0	16.4	50.8	10.4	1.5	17.9	3.0	0.0	0.0	0.0	0.0	0.0	0.0	100.0
	Diff.	-1.2	-1.0	+6.6	-2.3	-0.8	-0.3	+1.8	0.0	0.0	0.0	0.0	0.0	0.0	
5		1.2	17.6	48.2	9.4	3.6	17.6	2.4	0.0	0.0	0.0	0.0	0.0	0.0	100.0
	Diff.	0.0	+0.2	+4.0	-6.3	+1.3	-3.3	+1.2	0.0	0.0	0.0	0.0	0.0	0.0	
6		1.3	12.0	38.7	4.0	8.0	29.3	6.7	0.0	0.0	0.0	0.0	0.0	0.0	100.0
	Diff.	+0.1	-5.4	-5.5	-8.7	+5.7	+8.4	+1.5	0.0	0.0	0.0	0.0	0.0	0.0	
7		1.2	16.1	46.9	7.4	3.7	19.8	4.9	0.0	0.0	0.0	0.0	0.0	0.0	100.0
	Diff.	0.0	-1.3	+2.7	-5.0	+1.4	-0.9	+3.7	0.0	0.0	0.0	0.0	0.0	0.0	

Table 6 (cont'd)

Scale reader number	Diff. from true age	Age-class 0.1	0.2	0.3	0.4	1.1	1.2	1.3	1.4	2.1	2.2	2.3	2.4	3.3	Total
8		1.3	19.0	51.8	7.6	3.8	8.9	6.3	1.3	0.0	0.0	0.0	0.0	0.0	100.0
	Diff.	+0.1	+1.6	+7.6	-5.1	+1.5	-12.0	+5.1	+1.3	0.0	0.0	0.0	0.0	0.0	
9		0.0	14.8	44.5	7.4	3.7	21.0	8.6	0.0	0.0	0.0	0.0	0.0	0.0	100.0
	Diff.	-1.2	-2.6	+0.3	-5.3	+1.4	+0.1	+7.4	0.0	0.0	0.0	0.0	0.0	0.0	
10		1.3	20.4	57.7	9.0	0.0	9.0	2.6	0.0	0.0	0.0	0.0	0.0	0.0	100.0
	Diff.	+0.1	+3.0	+13.5	-12.7	-2.3	-11.9	+1.4	0.0	0.0	0.0	0.0	0.0	0.0	
11		1.3	15.9	51.4	3.9	2.6	21.0	2.6	1.3	0.0	0.0	0.0	0.0	0.0	100.0
	Diff.	+0.1	-1.5	+7.2	-8.8	+0.3	+0.1	+1.4	+1.3	0.0	0.0	0.0	0.0	0.0	
12		0.0	0.0	1.2	0.0	1.2	20.8	50.0	4.9	3.6	13.5	2.4	1.2	1.2	100.0
	Diff.	-1.2	-17.4	-43.0	-12.7	-1.1	-0.1	+48.8	+4.9	+3.6	+13.5	+2.4	+1.2	+1.2	
Average		1.1	16.6	45.8	6.7	3.4	15.7	8.2	0.7	0.3	1.1	0.2	0.1	0.1	100.0
	Diff.	-0.1	-0.8	+1.6	-6.0	+1.1	-5.2	+6.0	+0.7	+0.3	+1.1	+0.2	+0.1	+0.1	
True age		1.2	17.4	44.2	12.7	2.3	20.9	1.2	0.0	0.0	0.0	0.0	0.0	0.0	100.0

[a] In computing a reader's age composition any scales which he did not read were not included.