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Aging Accuracy, Precision, and Inter-laboratory Comparisons for the 2007 Assessments of Georges Bank Yellowtail Flounder and Eastern Georges Bank Cod and Haddock

S. J. Sutherland[1], L. Van Eeckhaute[2], B. Hatt[2], N. Munroe[1],
S. E. Pregracke[1], N. L. Shepherd[1], and J. M. Burnett[1]

[1]NOAA Fisheries
Northeast Fisheries Science Center
166 Water Street
Woods Hole, Massachusetts 02543-1097
USA

[2]Fisheries and Oceans Canada
531 Brandy Cove Road
St. Andrews, New Brunswick E5B 2L9
Canada

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ABSTRACT

Exercises were undertaken to estimate the accuracy and precision of production aging for three Georges Bank fish stocks in support of assessments of these stocks at the 2007 meeting of the Transboundary Resources Assessment Committee (TRAC). Both the Northeast Fisheries Science Center (NEFSC) and the St. Andrews Biological Station (SABS) conducted aging of cod, *Gadus morhua*, and haddock, *Melanogrammus aeglefinus*, and the NEFSC conducted aging for yellowtail flounder, *Limanda ferruginea*. In addition, inter-laboratory comparisons were conducted for cod and haddock between the two aging laboratories.

To assess precision, random subsamples taken from sets of previously aged fish were re-aged within each laboratory. Accuracy was assessed at the NEFSC only, by re-aging a subset of samples from species reference collections. Inter-laboratory comparisons were conducted for cod and haddock via an exchange of age samples between the two aging laboratories. Results were presented in terms of percentage agreement, total coefficient of variation (CV), age bias plots, and tests of symmetry.

Results of these exercises were high overall, indicating that age determinations for these species at both the SABS and NEFSC continue to be reliable. For cod, the NEFSC accuracy estimate was 97% agreement (0.6% CV), while overall precision levels were 92% agreement (1.3% CV) for the NEFSC and 92% agreement (1.1% CV) for the SABS. The exchange resulted in an agreement of 90% and a CV of 1.6%. Two accuracy tests by the NEFSC haddock age-reader resulted in values of 77% agreement (6.2% CV) and 96% agreement (0.6% CV). Haddock precision tests yielded overall levels of 95% agreement (0.5% CV) at NEFSC and 92% agreement (1.0% CV) at SABS. The inter-laboratory results were 86% agreement and 1.8% CV. For yellowtail flounder, which is aged only at the NEFSC, the age reader attained an overall accuracy level of 93% agreement (1.2% CV) and an overall precision level of 85% (3.1% CV).

RÉSUMÉ

On a entrepris des exercices pour estimer l'exactitude et la précision de données de détermination de l'âge concernant trois stocks de poisson de fond du banc Georges, à l'appui de l'évaluation de ces stocks, lors de la réunion du Comité d'évaluation des ressources transfrontalières (CERT) de 2007. Le Northeast Fisheries Science Center (NEFSC) et la Station biologique de St. Andrews (SBSA) ont tous deux procédé à des opérations de détermination de l'âge de morues, *Gadus morhua*, et d'aiglefins, *Melanogrammus aeglefinus*, et le NEFSC a mené seul de telles opérations sur des limandes à queue jaune, *Limanda ferruginea*. Des comparaisons entre les deux laboratoires ayant participé à la détermination de l'âge des morues et des aiglefins ont aussi été effectuées.

Pour évaluer la précision des données, des sous-échantillons aléatoires ont été prélevés au sein de chaque laboratoire parmi des poissons dont ont avait déjà établi l'âge et ils ont été soumis de nouveau à une détermination de l'âge. Quant à l'exactitude des données, elle a été évaluée seulement au NEFSC, par répétition de la détermination de l'âge dans un sous-échantillon prélevé dans les collections d'espèces de référence. Des comparaisons entre les deux laboratoires participants ont été effectuées dans le cas de la morue et de l'aiglefin au moyen d'un échange d'échantillons d'âge. Les résultats ont été présentés sous forme de pourcentage de concordance, de coefficient de variation (c.v.) total, de diagrammes des biais d'âge et de tests de symétrie.

Les résultats des exercices étaient bons dans l'ensemble, révélant que les données de détermination de l'âge obtenues tant à la SBSA qu'au NEFSC au sujet des espèces considérées continuent d'être fiables. Pour ce qui est de la morue, l'estimation d'exactitude du NEFSC était de 97 % de concordance (c.v. de 0,6 %), tandis que dans le cas de la précision, le NEFSC obtenait 92 % de concordance (c.v. de 1,3 %) et la SBSA également 92 % de concordance (c.v. de 1,1 %). L'échange d'échantillons a abouti à une concordance de 90 % et un c.v. de 1,6 %. Deux tests d'exactitude réalisés par le lecteur d'âge du NEFSC sur des aiglefins ont abouti à des taux de concordance de 77 % (c.v. de 6,2 %) et de 96 % (c.v. de 0,6 %). Les tests de précision concernant l'aiglefin se sont soldés par des taux de concordance de 95,0 % (c.v. de 0,5 %) au NEFSC et de 92 % (c.v. de 1,0 %) à la SBSA. Les résultats interlaboratoires se traduisaient par 86 % de concordance et 1,8 % de c.v. Pour ce qui est de l'exactitude totale des données concernant la limande à queue jaune, dont l'âge est déterminé uniquement au NEFSC, le lecteur d'âge a obtenu une concordance de 93 % (c.v. de 1,2 %), et une précision globale de 85 % (c.v. de 3,1 %).

Introduction

The annual Transboundary Resources Assessment Committee (TRAC) is a joint United States/Canadian effort to assess populations of the Georges Bank stock of yellowtail flounder, *Limanda ferruginea*, and the eastern Georges Bank stocks of cod, *Gadus morhua*, and haddock, *Melanogrammus aeglefinus*. Production aging, in which large numbers of commercial fishery and survey samples are aged by established methods, is conducted for each species each year to provide data to these assessments. Fish are aged at the Population Ecology Section at the St. Andrews Biological Station (SABS), part of Canada's Department of Fisheries and Oceans (DFO), and at the Fishery Biology Program at the Northeast Fisheries Science Center (NEFSC), part of the National Marine Fisheries Service of the United States' National Oceanic and Atmospheric Administration. The NEFSC and SABS estimate ages separately for the samples of haddock and cod collected by each laboratory, and the NEFSC ages all yellowtail.

With production aging comes a responsibility to ensure consistency in the fish ages generated. When multiple laboratories are involved in aging one stock of fish, there are three components to measuring consistency, namely accuracy, precision, and inter-laboratory comparisons. Accuracy is determined by how closely the ages generated are to the known ages of a set of fish, and is a measure of whether the age reader applies aging criteria correctly. Intrareader precision is determined by how reliably an age reader will assign the same age to a given fish and is a measure of how consistently the aging criteria are applied from day to day. Finally, inter-laboratory comparisons determine whether fish ages are comparable between the laboratories involved. This is established by an exchange of samples, where age readers from each laboratory determine an age for each fish exchanged. In all three cases, age is determined multiple times for each fish, and a comparison of the resulting ages determines the level of consistency. All three of these components may change over time or between age readers, so it is necessary to measure them regularly throughout the production aging process.

These three components affect the production age data in different ways, but all introduce errors into the data. Low precision will introduce random errors and may reduce the apparent abundance of strong year classes while making weak year classes appear more abundant. Reduced accuracy, however, may introduce a bias and make the current year's ages inconsistent with past years' data. If two aging laboratories differ in their age determinations, it becomes more difficult to utilize age data in a joint assessment. Providing measures of the reliability of production age data to assessment scientists allows these sources of variability to be considered within stock assessments.

Acceptable levels of accuracy, precision, and inter-laboratory consistency are related to various factors, including the fish species, the age reader's experience, and the structure used for age determination. The aging laboratory at the NEFSC has long considered agreement levels over 80% to be adequate. The total coefficient of variation (CV, Chang 1982), a newer approach to measuring agreement, is more reliable as it gives more comparable results between species and structures. Campana (2001) indicated that many aging laboratories around the world view total CVs of below 5% to be acceptable among species of moderate longevity and aging complexity, such as the species included in this report.

In order to measure accuracy, it is necessary to first establish a reference collection for each species. Ideally, reference collections consist of fish for which the age is definitively known, such as samples from a tagging study or other age-validation effort. However, it is difficult to obtain such samples. Instead, the NEFSC aging laboratory has amassed samples which have been aged by multiple experienced age readers and for which a consensus age has been agreed upon (Silva et al. 2004). For cod and haddock, samples have been assembled from past inter-laboratory exchanges with the SABS. Therefore, these reference collections only include fish from the Georges Bank stock. In the case of yellowtail flounder, however, samples from various stocks were chosen for the collection and later distributed to four age readers experienced in aging this species. Only fish for which the readers agreed on the age were retained in the collection. This is the first year in which the yellowtail reference collection has been used to measure accuracy.

Measurement and monitoring of aging errors have been an on-going effort by both NEFSC and SABS. Assessment of intrareader precision has been a regular part of the SABS aging program since its inception. Regular inter-laboratory sample exchanges and workshops have been conducted since 1986. The NEFSC began systematically assessing precision and accuracy in 2004.

This report lists the results of all exercises used to monitor aging precision, accuracy, and inter-laboratory exchanges for these production aging efforts by both the NEFSC and SABS between June 2006 and May 2007 in preparation for the 2007 TRAC meeting. These tests establish consistency levels applicable to production ages for the following samples: NEFSC and DFO port samples from 2006, DFO 2006 at-sea observer samples, NEFSC bottom trawl surveys from fall 2006 and spring 2007, and the DFO 2007 spring survey.

Data and Methods

Production aging was conducted by the primary age reader for each species following standard aging criteria and methods. Cod and haddock are aged using otoliths by both laboratories; yellowtail flounder are aged at the NEFSC only, using scale samples. Both locations use similar processing methods for haddock, but cod samples are processed differently by each laboratory. At the NEFSC, one cod otolith of a pair is baked and broken prior to aging, while at SABS, both otoliths are sectioned but not baked. Another important distinction between the aging laboratories is that age readers at the NEFSC assign a January 1st birth-date to fish, while the SABS age readers use a February 1st birth-date. Full descriptions of NEFSC production aging methods for these species can be found in Penttila and Dery (1988); the SABS uses similar methods.

Before the commencement of production aging, the SABS cod age reader completed various exercises. The first phase was a warm-up to production aging and consisted of re-aging historical samples that had been aged by a previous age reader. Afterwards, samples that the current age reader had aged in past years were re-aged before conducting production aging for each month and/or quarter. If the first of these exercises produced acceptable precision levels, production aging was begun; if not, more samples were re-aged until an acceptable precision level was achieved. This latter set of exercises is reported (by quarter) as this year’s precision tests. Pre-production aging exercises are not undertaken by the SABS haddock age reader and are not yet a requirement at the NEFSC.

In accuracy tests at the NEFSC, age readers were asked to re-age a random subset (N = 50 to 100) of the reference collection. During these tests, the age reader had knowledge of the data that are typically available during production aging (i.e., fish length, collection date, and collection area) but not the consensus age given to the fish. For haddock, an accuracy test was conducted both before and after production aging. For cod and yellowtail flounder, only one test was conducted after production aging was complete.

For precision tests, a random sample of fish from the production age set was selected and re-aged by the same age reader. Each sample was selected to cover the range of lengths in the production age sample. Age readers had knowledge of the data normally available during production aging, but no knowledge of the previous age given to that fish. The production age is the original age assigned to a fish, and the second (or 'test') age is the age given during the test exercise. If two ages were not assigned to a fish for any reason, the fish was excluded from further analysis. No effort was made to update production ages where the second age differed, or, at the NEFSC, to improve results by further examination of samples.

Precision tests were undertaken after completion of production aging at the NEFSC. For cod, precision exercises were conducted twice: The first used a combination of NEFSC bottom trawl survey samples (autumn 2006 and spring 2007), and the second used NEFSC port samples evenly distributed throughout the year. The NEFSC haddock age reader tested precision six times, once for each NEFSC survey (autumn 2006 and spring 2007) and once for each quarter (Q1–4) of NEFSC port samples. Yellowtail flounder precision was also measured six times by using a scheme similar to that for haddock.

As mentioned above, the SABS cod age reader completed a series of precision exercises using previous years' samples before production aging began. These tests used samples from the 2005 DFO survey and DFO port samples from 2002, 2004, and 2005. For SABS haddock aging, precision exercises occurred after production aging. Two tests were completed on haddock by re-aging using fish from the 2006 DFO survey and DFO port samples (Q2–4). These haddock samples were also used in the inter-laboratory exchange.

Inter-laboratory exchanges were conducted for both haddock and cod. Fish from Georges Bank were selected over a range of sizes and collection dates. For NEFSC-sampled cod and for haddock from both sources, fish were randomly selected and one whole otolith of the pair was shipped to the other laboratory, enabling each laboratory to use their standard otolith processing methods. At SABS, however, both cod otoliths of a pair are routinely sectioned and mounted prior to production aging, so these paired sections were shipped to the NEFSC for the exchange. Lengths and collection date information were included with all shipped samples, but age data were not exchanged until after both readers had completed age determinations for all fish.

Exchanges consisted of about 50 fish per sample set. Cod samples consisted of fish from DFO 2004 port and at-sea observer samples and fish captured in 2005 from the DFO survey, the NEFSC spring survey, and NEFSC port samples. Haddock samples were selected from 2006 NEFSC and DFO port samples, the 2006 DFO survey, and the NEFSC 2006 autumn survey.

Results for each exercise are presented in terms of percent agreement, total CV, age-bias plots, and age-frequency tables (Campana et al. 1995, Campana 2001). In the figures for the precision tests, age-bias plots show the average age attained during the exercise versus the production age. Age-frequency tables show the numbers of samples at each age for both the test age (across the top) and the production age (on the left). Numbers in boxes along the main diagonal indicate samples where both ages were in agreement. The inset gives the total number of samples for which the ages were agreed upon (difference = 0), and the total numbers for each difference between ages (difference = -1, +1, etc.). In cases where the percent agreement dropped below 90% in the precision exercises, a Bowker's test (Bowker 1948; Hoenig et al. 1995) was used to test for departures from symmetry on the age-frequency table.

In the figures for accuracy tests, reference ages are listed on the x-axis of the age-bias plots and on the left in the age-frequency tables, replacing production age in these figures. For the exchange samples, the SABS age is on the x-axis; no assumption was made as to which set of ages was more likely to be accurate.

Results and Discussion

The total sample sizes associated with the accuracy and precision exercises were $N = 768$, 960, and 515 for cod, haddock, and yellowtail flounder, respectively. Results for cod are presented in Figures 1–12, haddock in Figures 13–26, and yellowtail flounder in Figures 27–33. The results of the NEFSC accuracy tests are shown in the first one or two figures for each species and are summarized in Table 1. The precision results for the NEFSC follow and are summarized in Table 2. Precision exercise results completed by SABS age readers are listed in Table 3 and shown in the next set of figures for cod and haddock. The inter-laboratory exchange results for cod and haddock are shown last within each species and are summarized in Table 4.

Agreement levels fell below 90% only seven times among 20 precision exercises and three times for the nine sets of exchange samples (Tables 2–4). In only one of these cases did the Bowker's test reveal a significant deviation from symmetry.

Cod

The NEFSC accuracy estimate for cod was high (97% agreement) and the total CV (0.6%) was low (Figure 1). This accuracy has increased since last year (87% agreement and 3.9% CV, Sutherland et al. 2007). Only three fish in the exercise were given test ages that did not match the reference ages, and these were only one year apart. Excellent agreement was achieved for up to age-10 fish.

Cod precision levels were high at the NEFSC, with agreements of 91 and 92% and CVs of 1.0 and 1.6% (Table 2, Figures 2 and 3). No bias was apparent. The overall precision for the NEFSC age reader was 1.3% CV with 92% agreement (Table 2). The age reader showed good agreement for samples up to age 8, although test ages for older fish were 1 or 2 years above production ages. This year's precision levels are slightly lower than last year (94–98% agreement and CVs of 0.2–1.2%, Sutherland et al. 2007), but are still considered adequate.

At the SABS, cod precision levels were similarly high, with an overall CV of 1.1% and 92% agreement (Table 3). When the quarters were calculated separately (Table 3, Figures 4–7), the precision ranged from 89 to 100% and from 0.0 to 1.4% CV, and no bias was detected. In only one case did the age reader need to repeat a precision exercise due to a low agreement level (80%, July 2002 samples); these results were combined with the additional Q3 exercises and are shown in Figure 6. This age reader showed good agreement for samples up to ages 8–9. In 2004, this age reader had comparable precision levels of 1.7% CV and 90% agreement (Hunt et al. 2005).

In the aging exchange, a high level of consistency was also observed. The two laboratories achieved an overall agreement of 90% (range 83–97%) and an overall CV of 1.6% (range 0.3–3.0%), as shown in Table 4 and Figures 8–12. All ages agreed within one year for a given fish, and no bias was apparent. The difference in processing methods between the two laboratories did not appear to impact the resulting agreement levels. These results are higher than in last year's exchange, which had an overall agreement of 88% and a 2.3% CV (Gavaris et al. 2006).

These high intra-reader precision levels and inter-laboratory consistency, along with a high level of accuracy by the NEFSC age reader, indicate that the cod age readers at each laboratory have both maintained an acceptable level of aging capability.

Haddock

The accuracy estimates for haddock aged at the NEFSC were acceptable, with agreement levels of 80 and 96% and total CVs of 6.2 and 0.6% (Table 1, Figures 13 and 14). No test age differed from the reference age by more than one year. The first test dropped below standards for accuracy and showed a slight bias toward overaging. The second exercise, after production aging was completed, yielded higher accuracy levels and indicated a consistent application of aging criteria up to age-11 fish. This latter exercise is comparable to last year's exercises (92–96% agreement and CVs of 1.0–1.1%, Sutherland et al. 2007).

The overall haddock precision level achieved by the NEFSC age reader was high, with 95% agreement and a CV of 0.5% (Table 2). For each exercise, the precision level was consistently high, with 89–99% agreement and CVs of 0.1–1.1% (Table 2, Figures 15–20). More fish were given lower test ages than production ages, but there is no clear evidence of bias in any one quarter. Among all six exercises, only one fish was given a test age different from the production age by more than one year. Good precision was observed for fish of up to 14 years old. This year's precision levels are slightly better than those from last year (median of 89% agreement and 1.5% CV, Sutherland et al. 2007).

For the SABS age reader, precision levels were also high, with overall levels of 92% agreement and 1.0% CV (Table 3). Within each of the two exercises, levels were similar (92 and 93% agreement, 0.9 and 1.0% CV; Figures 21 and 22), and no bias was observed. Only twice were the ages given to a fish more than one year apart. This high precision extended to age-11 fish. In the previous intrareader exercise conducted at SABS (in 2003), this same age reader achieved comparable agreement levels of 90–95% (Van Eeckhaute and Brodziak 2004 [CVs not reported]).

In the aging exchange, there was an overall consistency of 86% and 1.8% CV (Table 4). Among each sample set, the consistency ranged from 69 to 94% agreement and from 0.7 to 3.7% CV (Table 4, Figures 23–26). In general, there was good agreement between the two age readers for fish up to age 10 or more. One exercise, using NEFSC port samples[*] (Figure 24), dropped below acceptable levels of agreement, but still had a CV below 5%. For this sample set, there may have been a slight bias in which the SABS age reader recorded higher ages than the NEFSC reader. However, a Bowker's test did not reveal this to be a significant deviation from symmetry ($P > 0.05$). The SABS reader also noted that many (N = 13 of 58) otoliths in this set had poorly defined annuli, which made

[*] This exercise included nine fish which were sampled in January, and therefore would be affected by the different birth-dates used by the two laboratories. This was resolved by adding one year to all the SABS ages for these fish before calculating agreement levels.

interpretation difficult. When these otoliths were excluded (as they would have been in production aging), the levels rose to 78% agreement and 2.5% CV (not shown). The other three sample sets in the exchange had much better consistency, and it is not believed that this one sample is an indication of a systematic difference in aging between the two laboratories. The previous aging exchange, in 2005, showed better results, with an agreement of about 96% on two sets of samples from SABS (Van Eeckhaute and Brodziak 2005 [CVs not reported]).

The continued high precision results, primarily consistent exchange results, and good accuracy estimates indicate that both haddock age readers continue to provide reliable ages.

Yellowtail Flounder

The accuracy level achieved by the NEFSC yellowtail flounder age reader was high, with an agreement of 93% and a CV of 1.2% (Table 1, Figure 27). Only once was the test age different from the reference age by more than one year. Agreement with the reference ages was good up to age 5, but two older fish were underaged by 1–2 years.

Precision levels for NEFSC yellowtail flounder ages were somewhat lower than for the other species but were still adequate, with an overall precision of 85% agreement and 3.1% CV (Table 2). Within each of the six exercises, agreement ranged from 79 to 91% and CVs ranged from 2.0 to 4.9% (Figures 28–33). Two exercises, involving NEFSC port samples from Q1 and Q4, dropped below acceptable levels of agreement but still had CVs below 5%. No consistent bias was observed among all exercises. However, results from Q4 port samples demonstrated a significant bias (Bowker's test, $P = 0.005$) toward underaging in the second readings. In all the precision exercises, only once were the two ages assigned to a fish different by more than one year.

This is the second year this age reader has been responsible for production aging of this species, and similar precision results were attained last year (median of 87% agreement and 2.5% CV, Sutherland et al. 2007), indicating consistency in this reader's application of aging criteria. The combination of a high accuracy level and adequate, but consistent, levels of precision indicate that the NEFSC age reader is continuing to provide reliable age data to the assessment.

Conclusions

Among these three species, the three measures of aging consistency remained at acceptable levels in the past year of production aging. In most cases, these levels were exceeded. Therefore, age determinations for these species at both the SABS and NEFSC aging laboratories are considered to be reliable.

References

Bowker, A.H. 1948. A test for symmetry in contingency tables. J. Am. Statistical Assoc. 43: 572–574.

Campana, S.E. 2001. Accuracy, precision, and quality control in age determination, including a review of the use and abuse of age validation methods. J. Fish. Biol. 59: 197-242.

Campana, S.E., M.C. Annand, and J.I. McMillan. 1995. Graphical and statistical methods for determining the consistency of age determinations. Trans. Am. Fish. Soc. 124: 131-138.

Chang, W.Y.B. 1982. A statistical method for evaluating the reproducibility of age determination. Can. J. Fish. Aquat. Sci. 39: 1208-1210.

Gavaris, S., L. O'Brien, B. Hatt, and K. Clark. 2006. Assessment of eastern Georges Bank cod for 2006. TRAC Ref. Doc. 2006/05; 48 p.

Hoenig, J.M., M.J. Morgan, and C.A. Brown. 1995. Analysing differences between two age determination methods by tests of symmetry. Can. J. Fish. Aquat. Sci. 52: 364-368.

Hunt, J.J., L. O'Brien, and B. Hatt. 2005. Population status of eastern Georges Bank cod (unit areas 5Zj,m) for 1978-2006. TRAC Ref. Doc. 2005/01; 48 p.

Penttila, J., and L.M. Dery. 1988. Age determination methods for northwest Atlantic species. NOAA Tech. Rep. NMFS-72; 135 p. [Available from: http://www.nefsc.noaa.gov/fbi/age-man.html]

Silva, V., N. Munroe, S.E. Pregracke, and J. Burnett. 2004. Age structure reference collections: the importance of being earnest; p. 60. *In:* Johnson, D.L., T.W. Finneran, B.A. Phelan, A.D. Deshpande, C.L. Noonan, S. Fromm, and D.M. Dowds [compilers]. Current fisheries research and future ecosystems science in the Northeast Center: collected abstracts of the Northeast Fisheries Science Center's Eighth Science Symposium, Atlantic City, New Jersey, February 3-5, 2004. NEFSC Ref. Doc. 04-01. [Available from: http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0401/]

Sutherland, S.J., N.L. Shepherd, S.E. Pregracke, and J.M. Burnett. 2007. Accuracy and precision exercises associated with 2006 TRAC production aging. NEFSC Ref. Doc. 07-01; 20 p. [Available from: http://www.nefsc.noaa.gov/nefsc/publications/crd/crd0701/]

Van Eeckhaute, L., and J. Brodziak. 2004. Assessment of eastern Georges Bank haddock. TRAC Ref. Doc. 2004/01; 70 p.

Van Eeckhaute, L., and J. Brodziak. 2005. Assessment of haddock on eastern Georges Bank. TRAC Ref. Doc. 2005/03; 77 p.

Table 1. Results of NEFSC aging accuracy exercises using the NEFSC reference collections. Figure numbers indicate the corresponding figures in this report. The primary NEFSC reader for each species conducted the tests in all cases (NS = N. Shepherd, SS = S. Sutherland, SP = S. Pregracke).

Figure	Age Reader	Species	Test Date	*N*	Total CV (%)	Agreement (%)
1	NS	Cod	May 2007	100	0.61	97.0
13	SS	Haddock	Dec. 2006	54	6.22	79.6
14	SS	Haddock	May 2007	55	0.60	96.4
27	SP	Yellowtail Flounder	May 2007	75	1.16	93.3

Table 2. Results of NEFSC aging precision exercises. Figure numbers indicate the corresponding figures in this report. The primary reader for each species conducted the tests in all cases (NS = N. Shepherd, SS = S. Sutherland, SP = S. Pregracke). All samples were collected by the NEFSC. Bowker's test results either show the *P*-value, 'n/s' (not significant at the α = 0.05 level), or are left blank where the test was not applicable.

Figure	Age Reader	Source	Test Date	*N*	Total CV (%)	Agreement (%)	Bowker's Test
Cod							
2	NS	2006-07 Surveys (combined)	May 2007	100	1.61	92.0	
3	NS	2006 Port Samples Q1–4	May 2007	99	1.01	90.9	
		Overall NEFSC Cod Precision		*199*	*1.31*	*91.5*	
Haddock							
15	SS	Autumn 2006 Survey	Jan. 2007	80	0.35	98.8	
16	SS	Spring 2007 Survey	May 2007	75	0.10	98.7	
17	SS	2006 Port Samples Q1	Jan. 2007	104	0.35	96.2	
18	SS	2006 Port Samples Q2	March 2007	105	0.48	94.3	
19	SS	2006 Port Samples Q3	March 2007	79	1.06	88.6	n/s
20	SS	2006 Port Samples Q4	April 2007	90	0.47	95.6	
		Overall NEFSC Haddock Precision		*533*	*0.46*	*95.3*	
Yellowtail Flounder							
28	SP	Autumn 2006 Survey	Feb. 2007	75	3.57	88.0	n/s
29	SP	Spring 2007 Survey	May 2007	75	2.41	88.0	n/s
30	SP	2006 Port Samples Q1	March 2007	70	3.25	78.6	n/s
31	SP	2006 Port Samples Q2	April 2007	75	2.35	84.0	n/s
32	SP	2006 Port Samples Q3	May 2007	75	1.97	90.7	
33	SP	2006 Port Samples Q4	May 2007	70	4.94	78.6	0.005
		Overall NEFSC YT Precision		*440*	*3.06*	*84.8*	*n/s*

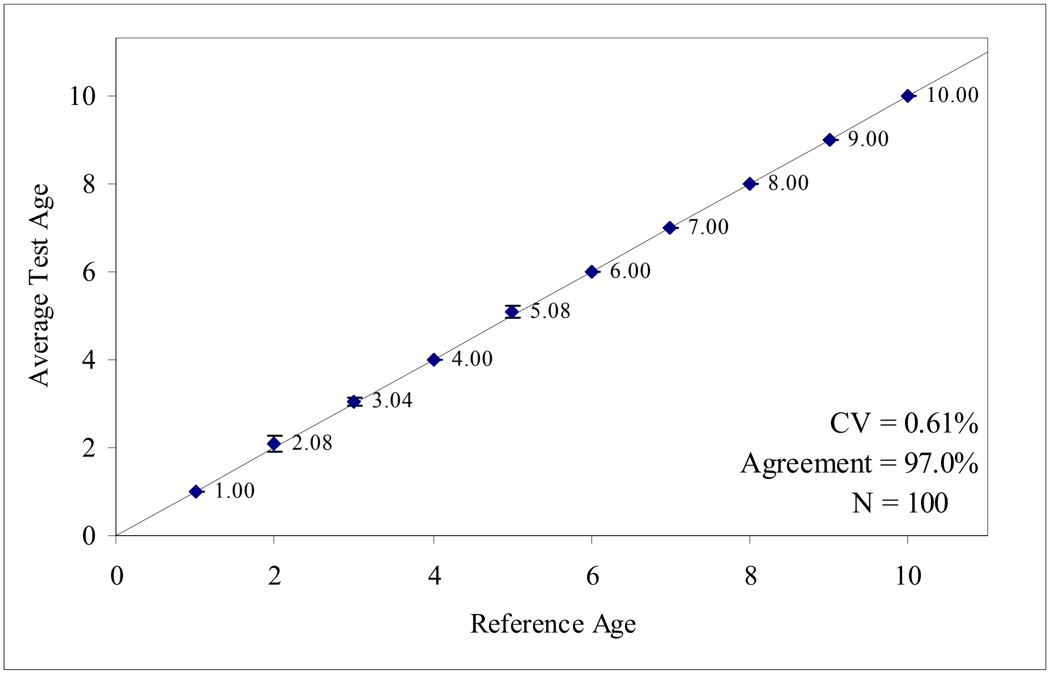
Table 3. Results of SABS aging precision exercises. Figure numbers indicate the corresponding figures in this report. The primary reader for each species conducted the tests in all cases (BH = B. Hatt, LVE = L. Van Eeckhaute). All samples were collected by the DFO. Bowker's test results either show the *P*-value, 'n/s' (not significant at the α = 0.05 level), or are left blank where the test was not applicable.

Figure	Age Reader	Source	Quarter	*N*	Total CV (%)	Agreement (%)	Bowker's Test
Cod							
4	BH	2005 Port Samples & Survey	1	51	0.97	94.1	
5	BH	2005 Port Samples	2	25	0.00	100.0	
6	BH	2002 & 2005 Port Samples	3	103	1.35	89.3	n/s
7	BH	2004 Port Samples	4	75	1.31	92.0	
		Overall SABS Cod Precision	*1–4*	*254*	*1.13*	*92.1*	
Haddock							
21	LVE	2006 Survey	1	50	0.93	92.0	
22	LVE	2006 Port Samples	2–4	55	0.99	92.7	
		Overall SABS Haddock Precision	*1–4*	*105*	*0.96*	*92.4*	

Table 4. Results of NEFSC and SABS aging exchange exercises for Georges Bank cod and haddock, by quarter. Figure numbers indicate the corresponding figures in this report. The SABS reader is listed before the NEFSC reader (BH = B. Hatt, NS = N. Shepherd, LVE = L. Van Eeckhaute, SS = S. Sutherland). Samples were collected by both laboratories, as indicated. Bowker's test results either show the *P*-value, 'n/s' (not significant at the α = 0.05 level), or are left blank where the test was not applicable.

Figure	Age Readers	Source	Quarter	*N*	Total CV (%)	Agreement (%)	Bowker's Test
Cod							
8	BH/NS	DFO 2005 Survey	1	50	0.89	94.0	
9	BH/NS	NEFSC 2005 Port Samples	1	53	2.28	84.9	n/s
10	BH/NS	DFO 2004 Port Samples	3	33	0.29	97.0	
11	BH/NS	NEFSC Autumn 2005 Survey	3–4	56	1.79	91.1	
12	BH/NS	DFO 2004 Observer Samples	4	23	2.99	82.6	n/s
		Overall Cod Exchange Results	*1–4*	*215*	*1.60*	*90.2*	
Haddock							
23	LVE/SS	DFO 2006 Survey	1	48	0.69	93.8	
24	LVE/SS	NEFSC 2006 Port Samples	1–2	58	3.73	69.0	n/s
25	LVE/SS	DFO 2006 Port Samples	2–4	55	1.25	90.9	
26	LVE/SS	NEFSC Autumn 2006 Survey	3–4	52	1.27	92.3	
		Overall Haddock Exchange Results	*1–4*	*213*	*1.81*	*85.9*	*n/s*

A.



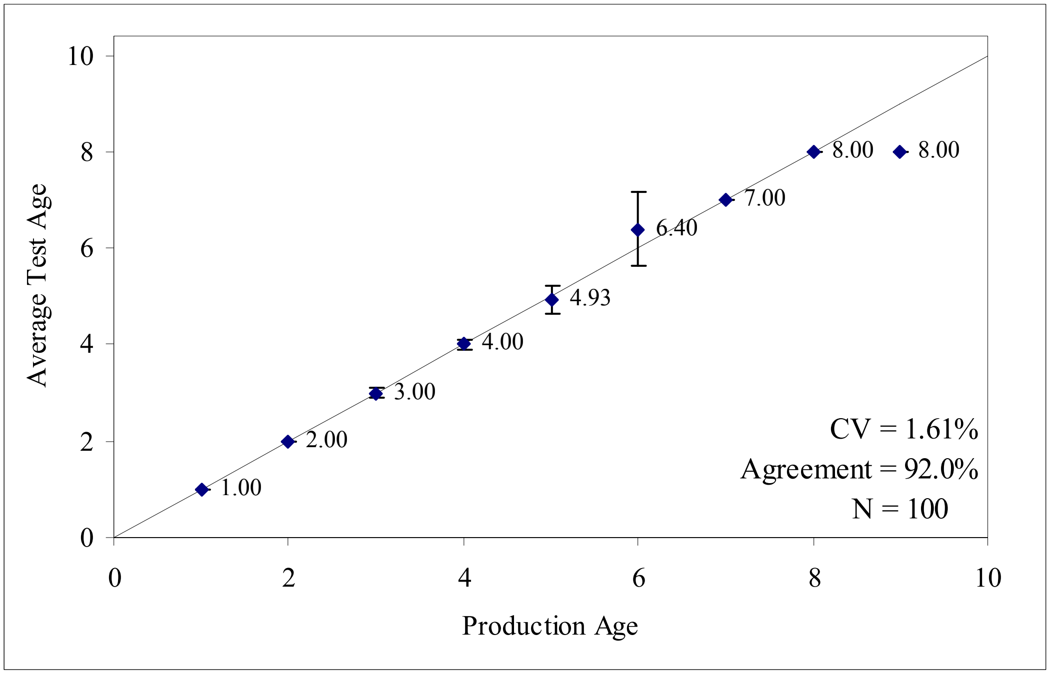
B.

Ref. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	10	Total
0												
1		5										5
2			11	1								12
3				26	1							27
4					22							22
5						12	1					13
6							14					14
7								3				3
8									2			2
9										1		1
10											1	1
Total		5	11	27	23	12	15	3	2	1	1	100

DIFFERENCE		
-1	0	+1
0	97	3

Figure 1. Results of NEFSC cod age-reader accuracy exercise against randomly selected samples from the NEFSC cod reference collection, conducted after production aging. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



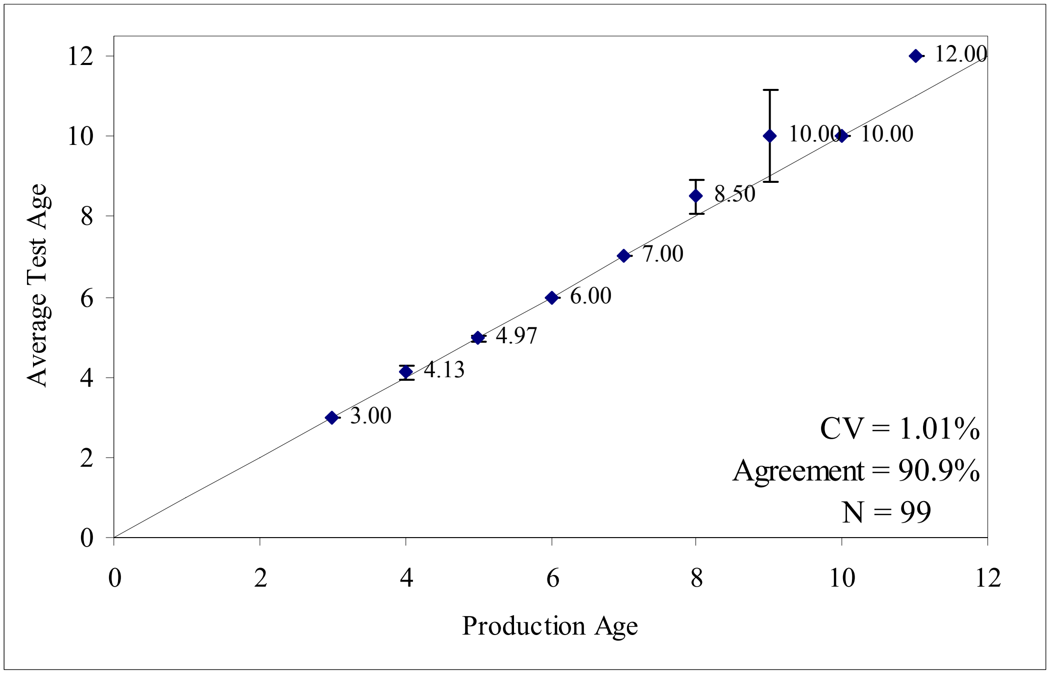
B.

Prod. Age	Test Age 0	1	2	3	4	5	6	7	8	9	Total
0											
1		8									8
2			10								10
3			1	25	1						27
4				1	30	1					32
5				1		13	1				15
6							4		1		5
7								1			1
8									1		1
9									1		1
Total		8	11	27	31	14	5	1	3		100

DIFFERENCE				
-2	-1	0	+1	+2
1	3	92	3	1

Figure 2. Results of NEFSC cod age-reader precision exercise against randomly selected samples from the NEFSC autumn 2006 (AL200610) and spring 2007 (AL200703) bottom trawl surveys. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



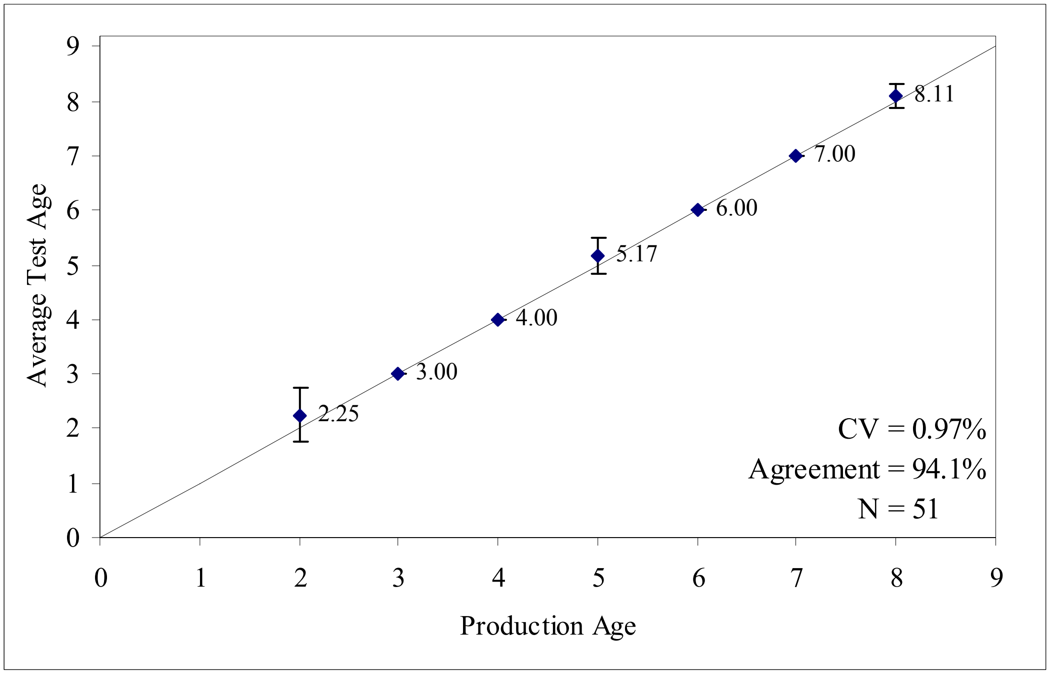
B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1														
2														
3				30										30
4					14	2								16
5					1	29								30
6							6							6
7								5						5
8									3	3				6
9										1	1	1		3
10											2			2
11													1	1
12														
Total				30	15	31	6	5	3	4	3	1	1	99

DIFFERENCE			
-1	0	+1	+2
1	90	7	1

Figure 3. Results of NEFSC cod age-reader precision exercise against randomly selected fish from NEFSC 2006 port samples (Q1–4). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



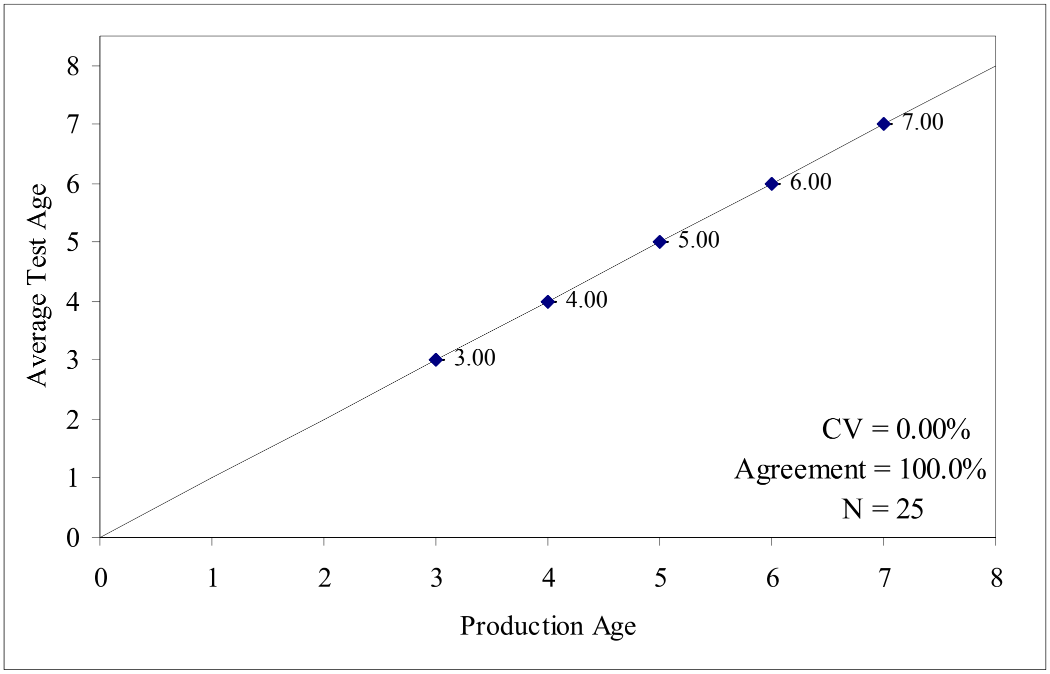
B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	Total
0											
1											
2			3	1							4
3				5							5
4					13						13
5						5	1				6
6							10				10
7								4			4
8									8	1	9
9											
Total			3	6	13	5	11	4	8	1	51

DIFFERENCE		
+1	0	-1
0	48	3

Figure 4. Results of SABS cod age-reader precision exercise against randomly selected fish from Q1, including samples from both SABS 2005 port samples (various sources, Jan. 2005) and the SABS 2005 survey (NED2005001). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



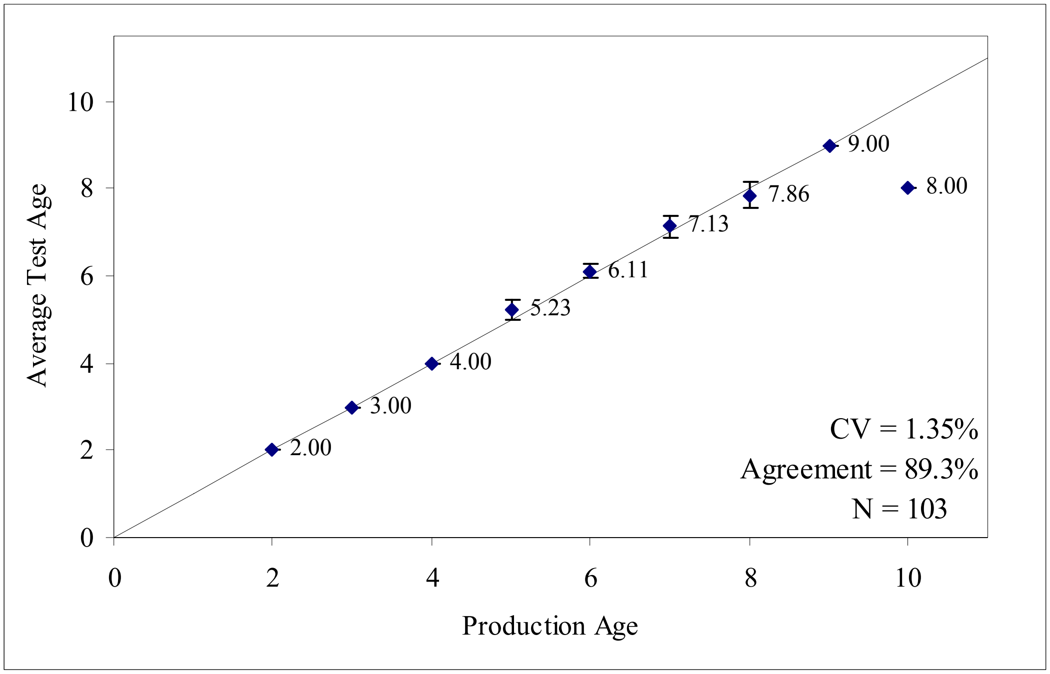
B.

	Test Age								
Prod. Age	0	1	2	3	4	5	6	7	Total
0									
1									
2									
3				1					1
4					15				15
5						6			6
6							1		1
7								2	2
Total				1	15	6	1	2	25

DIFFERENCE		
-1	0	+1
0	25	0

Figure 5. Results of SABS cod age-reader precision exercise against randomly selected fish from Q2 of SABS 2005 port samples (20050191). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



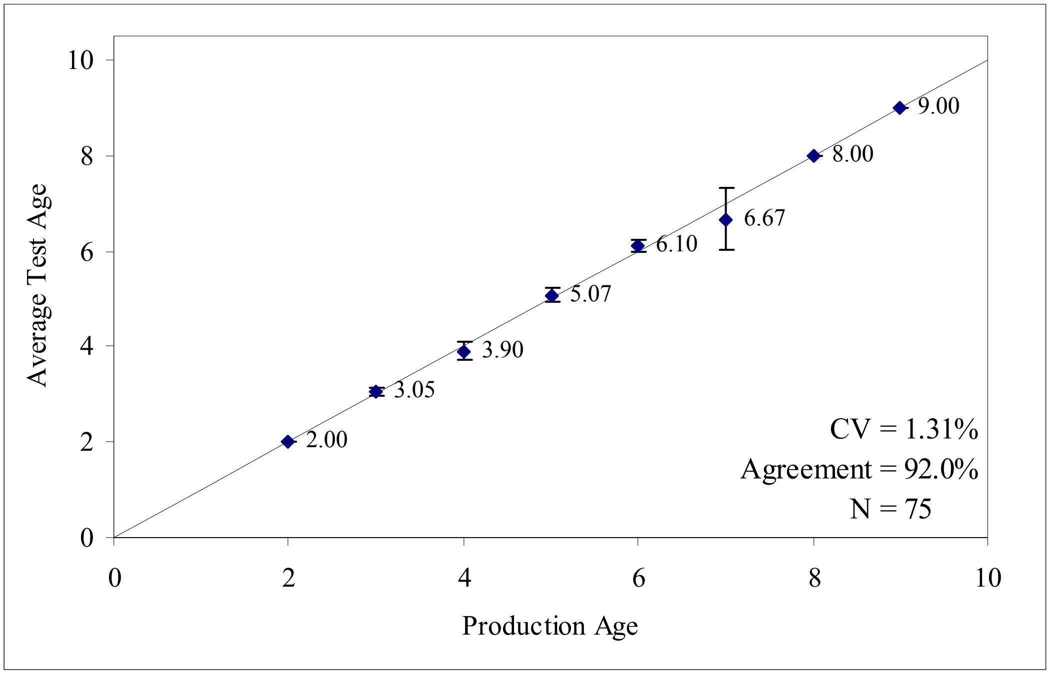
B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	10	Total
0												
1												
2			1									1
3				14								14
4					23							23
5						10	3					13
6						1	30	3	1			35
7								7	1			8
8								1	6			7
9										1		1
10									1			1
Total			1	14	23	11	33	11	9	1		103

DIFFERENCE				
-2	-1	0	+1	+2
1	2	92	7	1

Figure 6. Results of SABS cod age-reader precision exercise against randomly selected fish from Q3 of SABS port samples from 2002 (20020407) and 2004 (20040307, 20040444, and 20040506). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



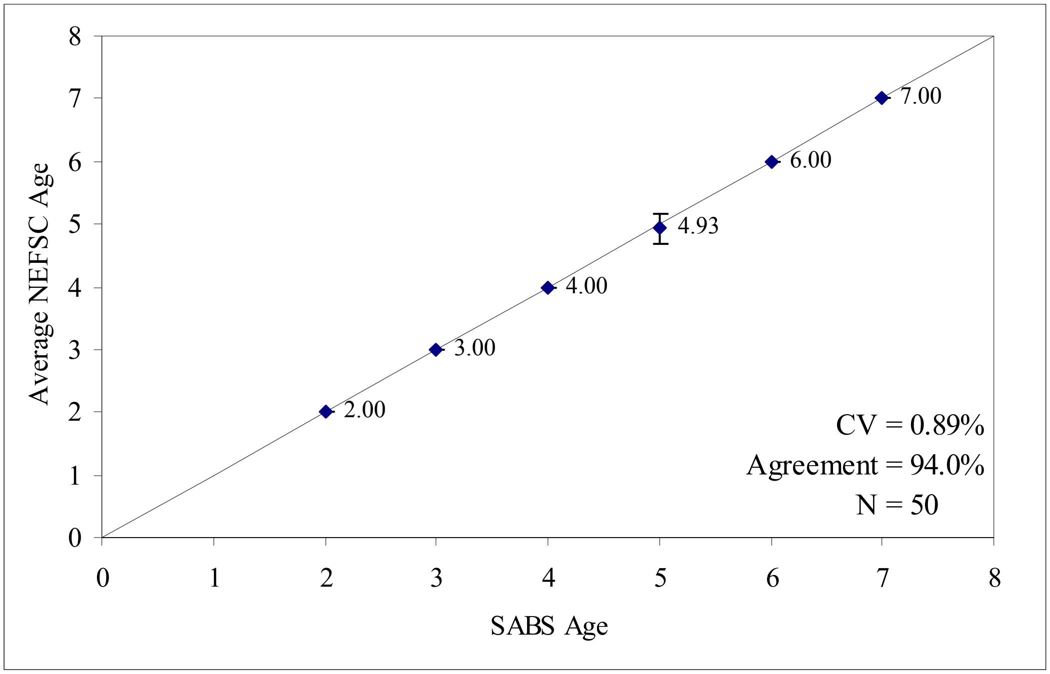
B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	Total
0											
1											
2			1								1
3				20	1						21
4				1	9						10
5						13	1				14
6							19	2			21
7						1		5			6
8									1		1
9										1	1
Total			1	21	10	14	20	7	1	1	75

DIFFERENCE			
-2	-1	0	+1
1	1	69	4

Figure 7. Results of SABS cod age-reader precision exercise against randomly selected samples from Q4 of SABS 2004 port samples (20040571, 20040643, and 20040736). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



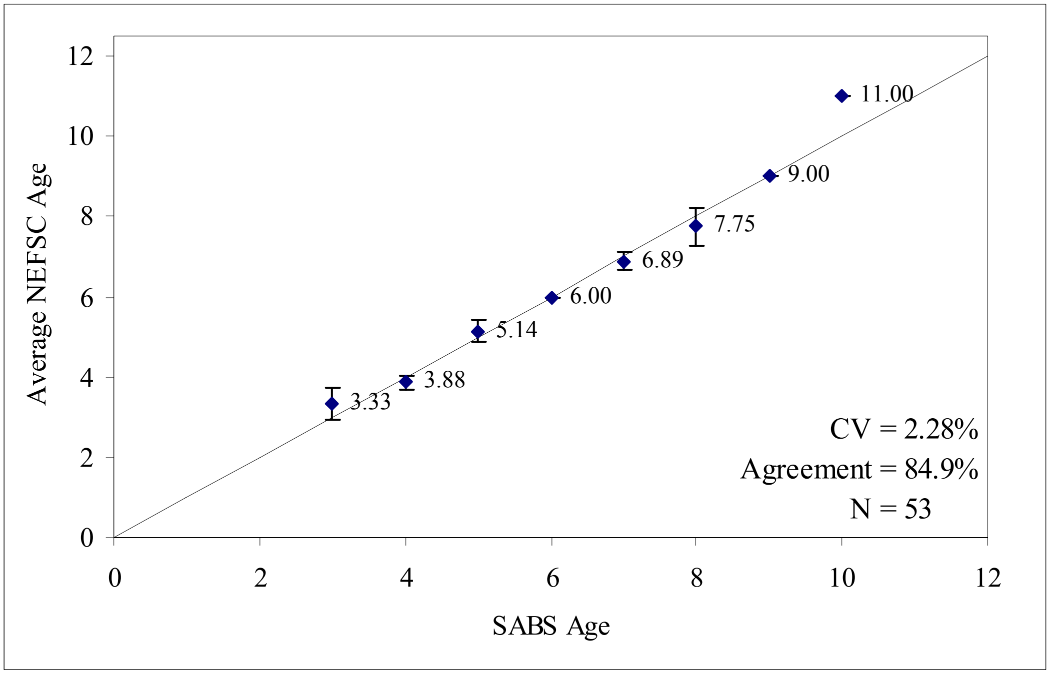
B.

SABS Age \ NEFSC Age	0	1	2	3	4	5	6	7	Total
0									
1									
2			10						10
3				2					2
4					16				16
5					2	11	1		14
6							5		5
7								3	3
Total			10	2	18	11	6	3	50

DIFFERENCE		
-1	0	+1
2	47	1

Figure 8. Results of SABS/NEFSC cod aging exchange using selected samples from the SABS 2005 survey (TEL2005545). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



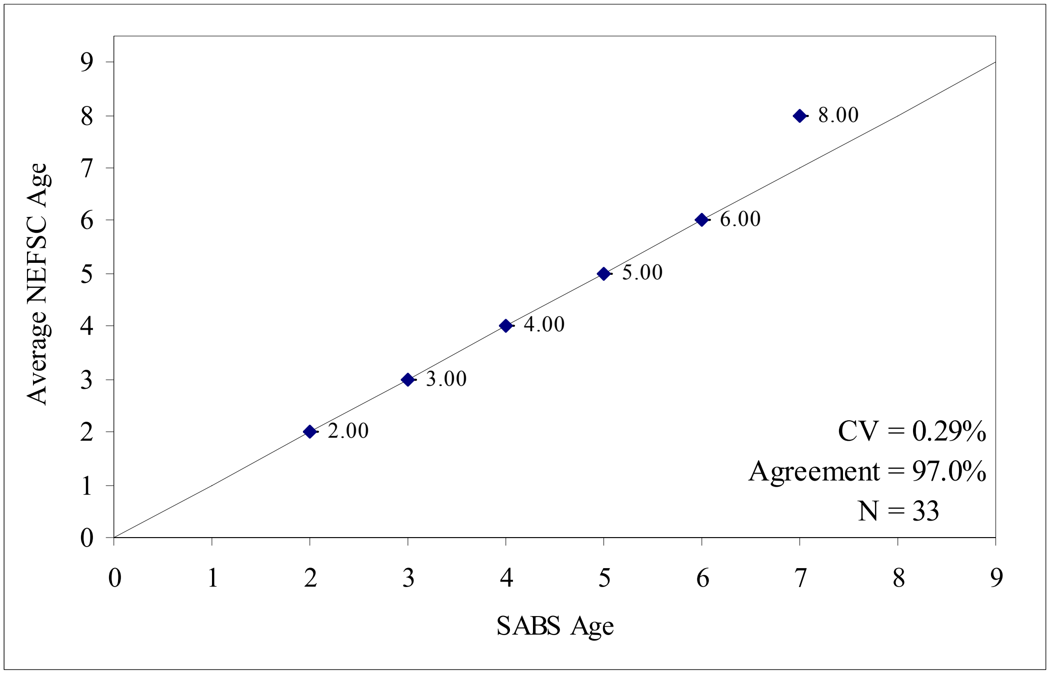
B.

SABS Age \ NEFSC Age	0	1	2	3	4	5	6	7	8	9	10	11	Total
0													
1													
2													
3				4	2								6
4				2	14								16
5						6	1						7
6							7						7
7							1	8					9
8								1	3				4
9										3			3
10												1	1
11													
Total				6	16	6	9	9	3	3		1	53

DIFFERENCE		
-1	0	+1
4	45	4

Figure 9. Results of SABS/NEFSC cod aging exchange using randomly selected fish from Q1 of NEFSC 2005 port samples. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



B.

NEFSC Age

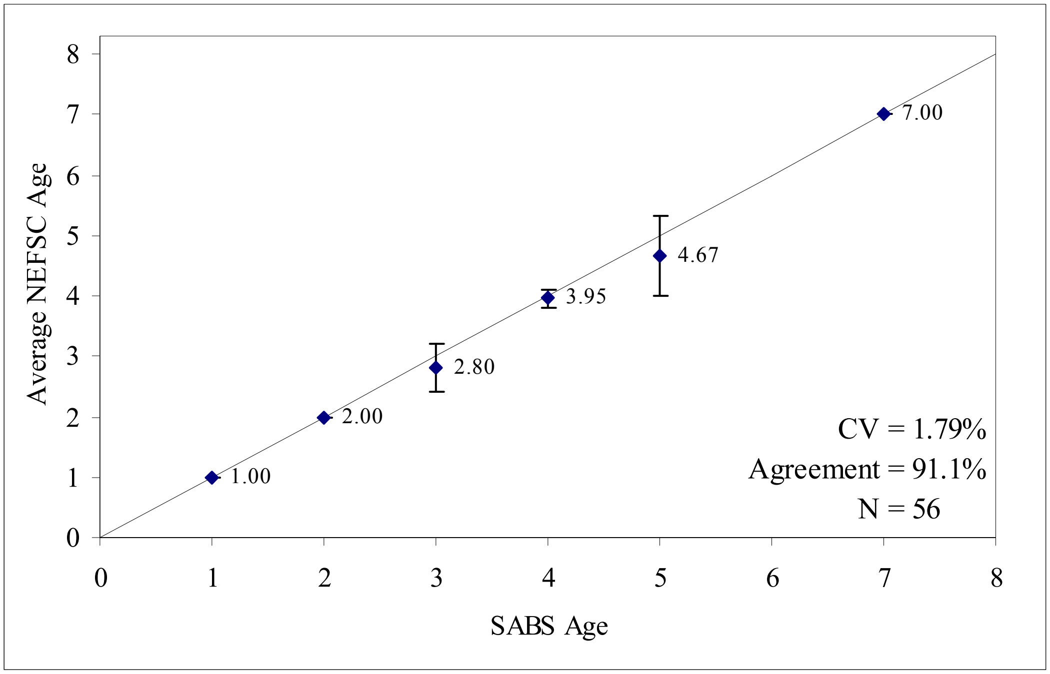
SABS Age	0	1	2	3	4	5	6	7	8	Total
0										
1										
2			1							1
3				18						18
4					4					4
5						7				7
6							2			2
7									1	1
8										
Total			1	18	4	7	2		1	33

DIFFERENCE

-1	0	+1
0	32	1

Figure 10. Results of SABS/NEFSC cod aging exchange using selected fish from Q3 of SABS 2004 port samples (20040368). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



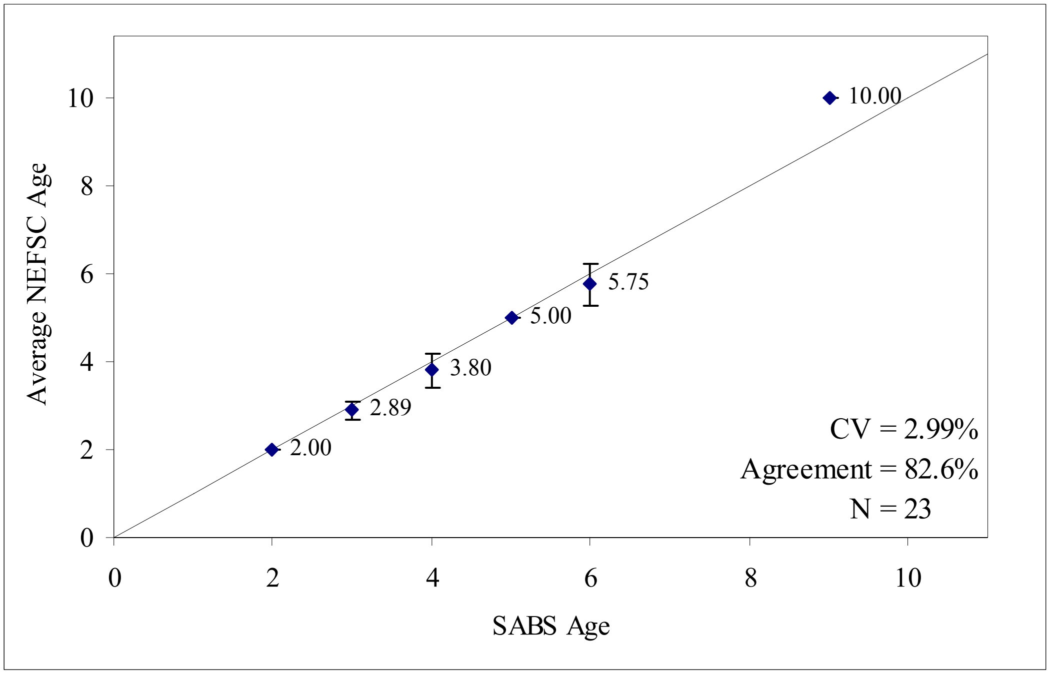
B.

SABS Age \ NEFSC Age	0	1	2	3	4	5	6	7	Total
0									
1		2							2
2			24						24
3			1	4					5
4				2	18	1			21
5					1	2			3
6									
7								1	1
Total		2	25	6	19	3		1	56

DIFFERENCE		
-1	0	+1
4	51	1

Figure 11. Results of SABS/NEFSC cod aging exchange using randomly selected samples from the NEFSC autumn 2005 survey (AL200508). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



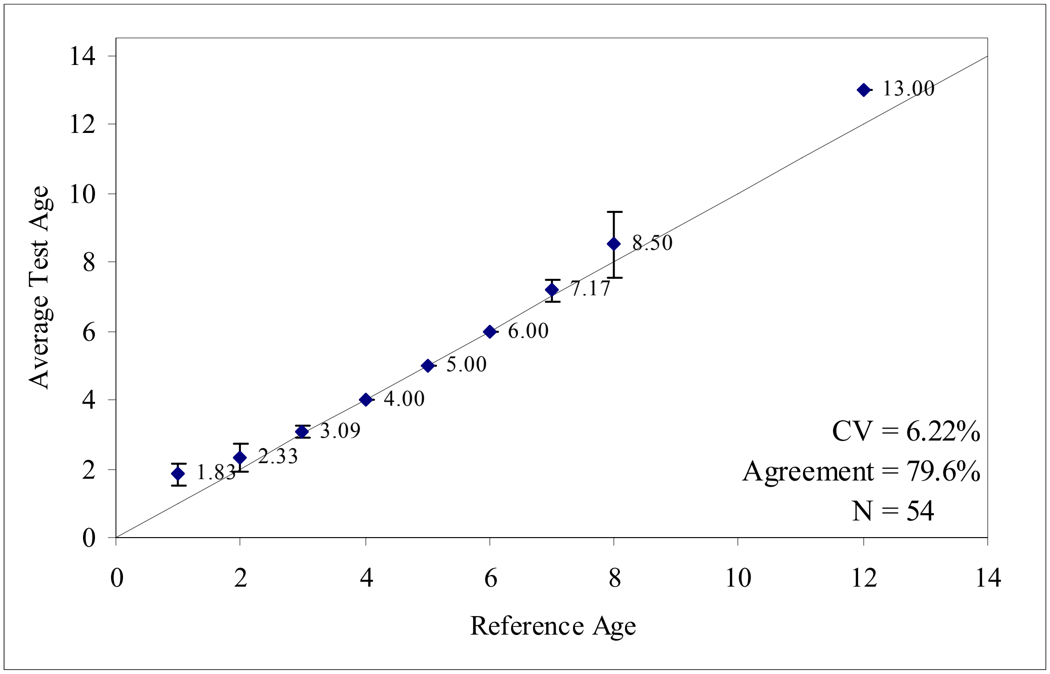
B.

SABS Age \ NEFSC Age	0	1	2	3	4	5	6	7	8	9	10	Total
0												
1												
2			1									1
3			1	8								9
4				1	4							5
5						3						3
6						1	3					4
7												
8												
9											1	1
10												
Total			2	9	4	4	3				1	23

DIFFERENCE		
-1	0	+1
3	19	1

Figure 12. Results of SABS/NEFSC cod aging exchange using selected fish from Q4 of SABS observer samples (J04-0417B). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



B.

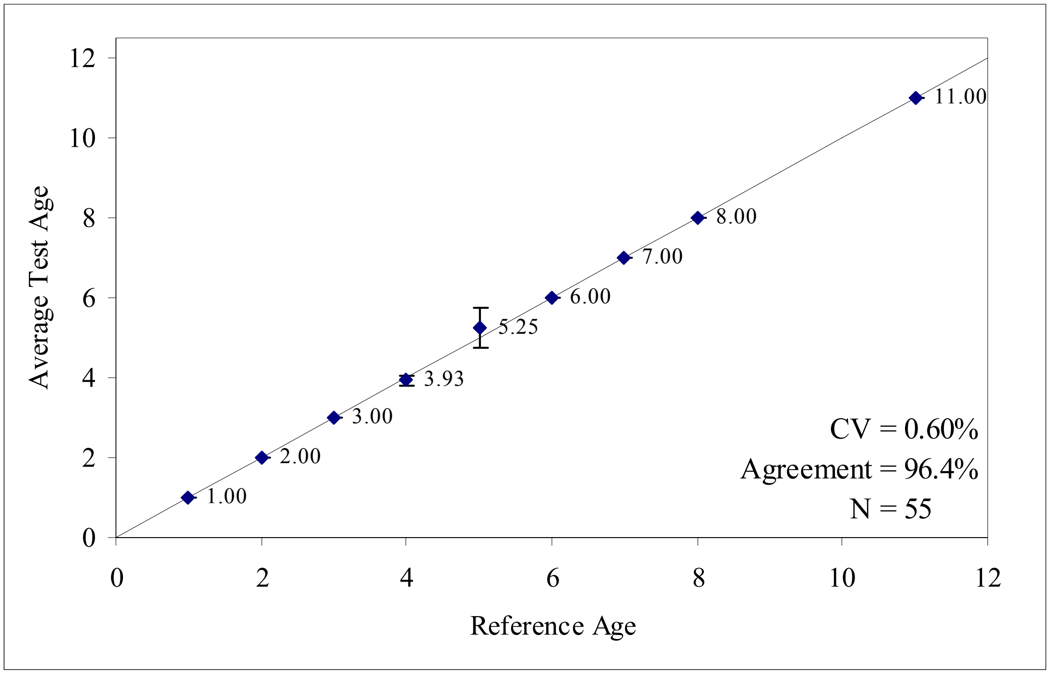
Test Age

Ref. Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
0															
1		1	5												6
2			4	2											6
3				10	1										11
4					14										14
5						5									5
6							3								3
7								5	1						6
8									1	1					2
9															
10															
11															
12														1	1
13															
Total		1	9	12	15	5	3	5	2	1				1	54

DIFFERENCE		
-1	0	+1
0	43	11

Figure 13. Results of NEFSC haddock age-reader accuracy exercise against randomly selected samples from the NEFSC haddock reference collection, conducted before production aging. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



B.

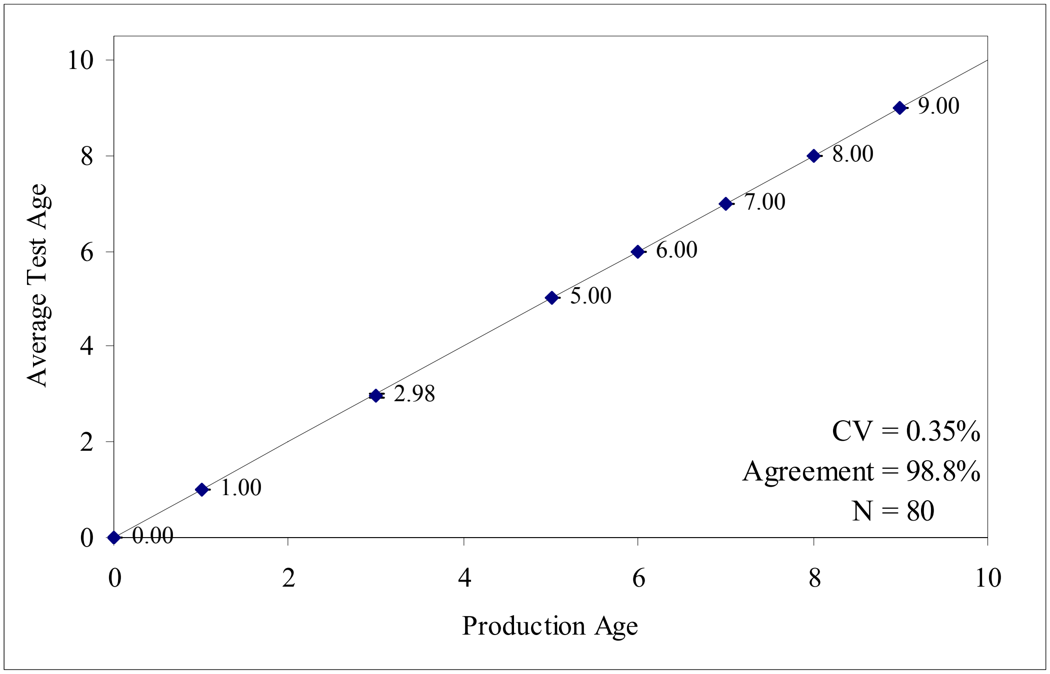
Test Age

Ref. Age	0	1	2	3	4	5	6	7	8	9	10	11	Total
0													
1		7											7
2			10										10
3				9									9
4				1	13								14
5						3	1						4
6							5						5
7								3					3
8									2				2
9													
10													
11												1	1
Total		7	10	10	13	3	6	3	2			1	55

DIFFERENCE		
-1	0	+1
1	53	1

Figure 14. Results of NEFSC haddock age-reader accuracy exercise against randomly selected samples from the NEFSC haddock reference collection, conducted after production aging. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



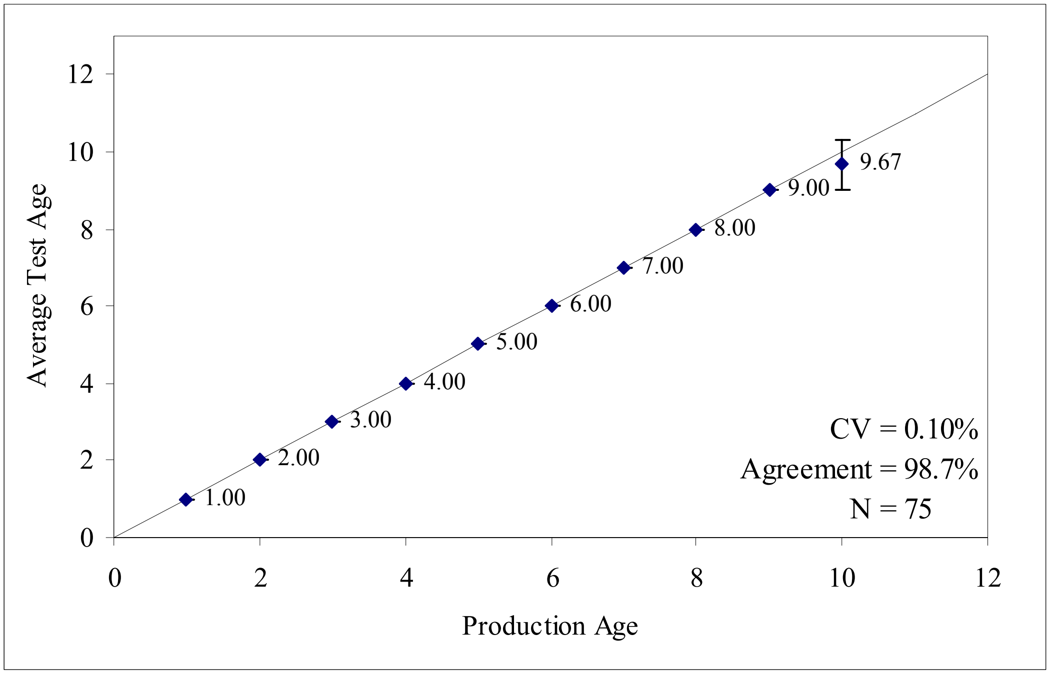
B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	Total
0	3										3
1		7									7
2											
3			1	48							49
4											
5						1					1
6							15				15
7								1			1
8									3		3
9										1	1
Total	3	7	1	48		1	15	1	3	1	80

DIFFERENCE		
-1	0	+1
1	79	0

Figure 15. Results of NEFSC haddock age-reader precision exercise against randomly selected samples from the NEFSC autumn 2006 bottom trawl survey (AL200610). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



B.

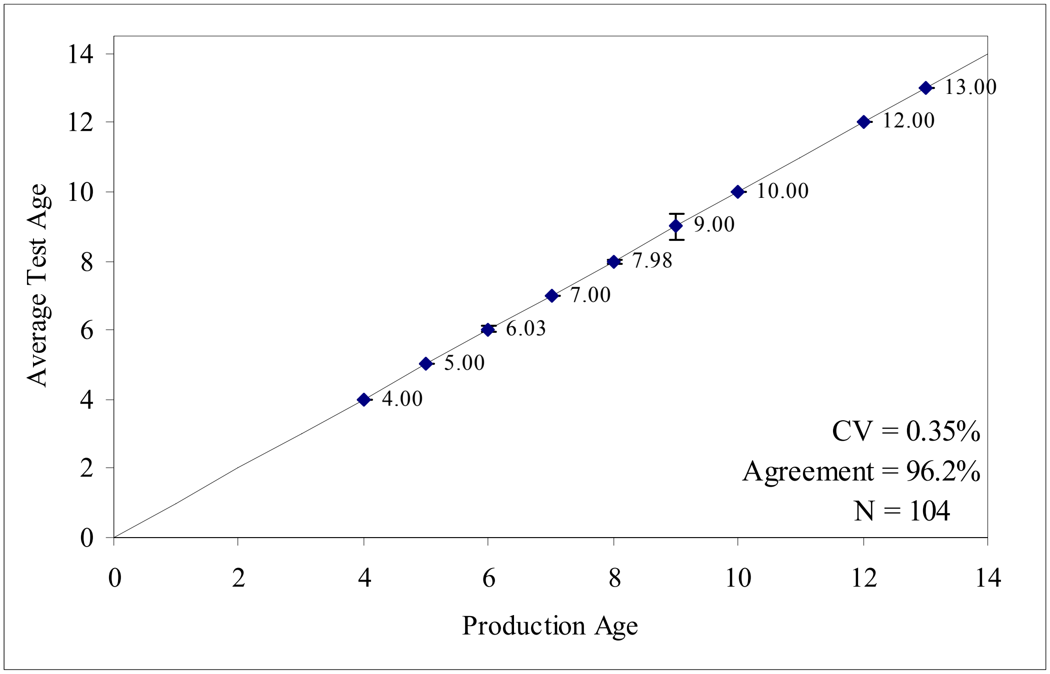
Test Age

Prod. Age	0	1	2	3	4	5	6	7	8	9	10	Total
0												
1		3										3
2			9									9
3				1								1
4					35							35
5						2						2
6							1					1
7								17				17
8									1			1
9										3		3
10										1	2	3
Total		3	9	1	35	2	1	17	1	4	2	75

DIFFERENCE		
-1	0	+1
1	74	0

Figure 16. Results of NEFSC haddock age-reader precision exercise against randomly selected samples from the NEFSC spring 2007 bottom trawl survey (AL200703). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



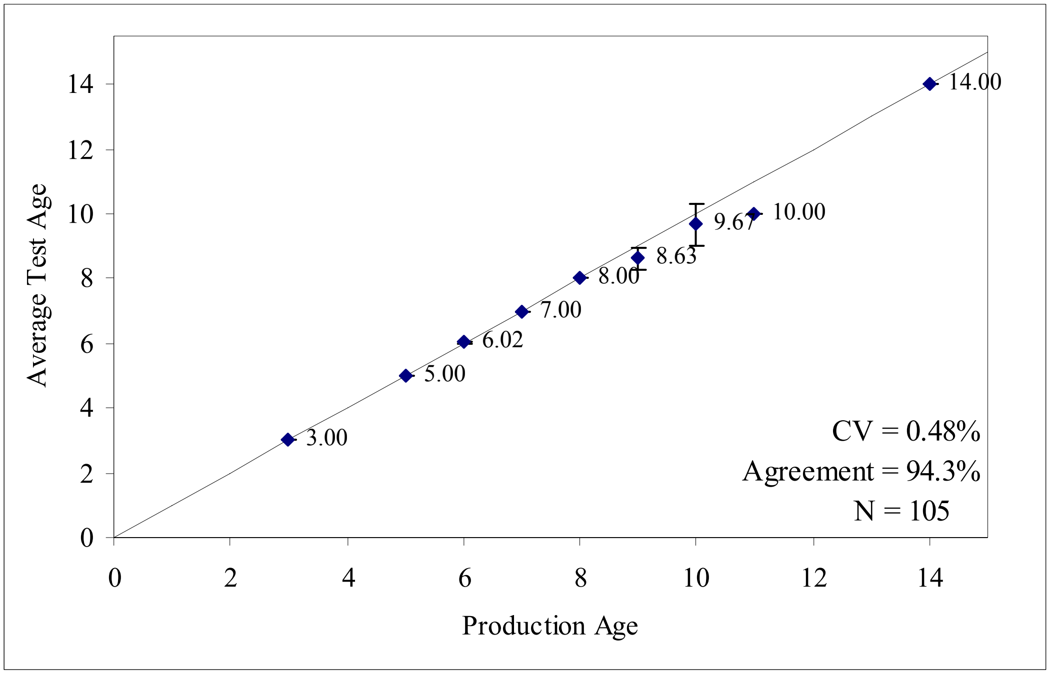
B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	Total
0															
1															
2															
3															
4					1										1
5						6									6
6							29	1							30
7								11							11
8								1	43						44
9									1	6	1				8
10											2				2
11															
12													1		1
13														1	1
Total					1	6	29	13	44	6	3		1	1	104

DIFFERENCE		
-1	0	+1
2	100	2

Figure 17. Results of NEFSC haddock age-reader precision exercise against randomly selected fish from Q1 of NEFSC 2006 port samples. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



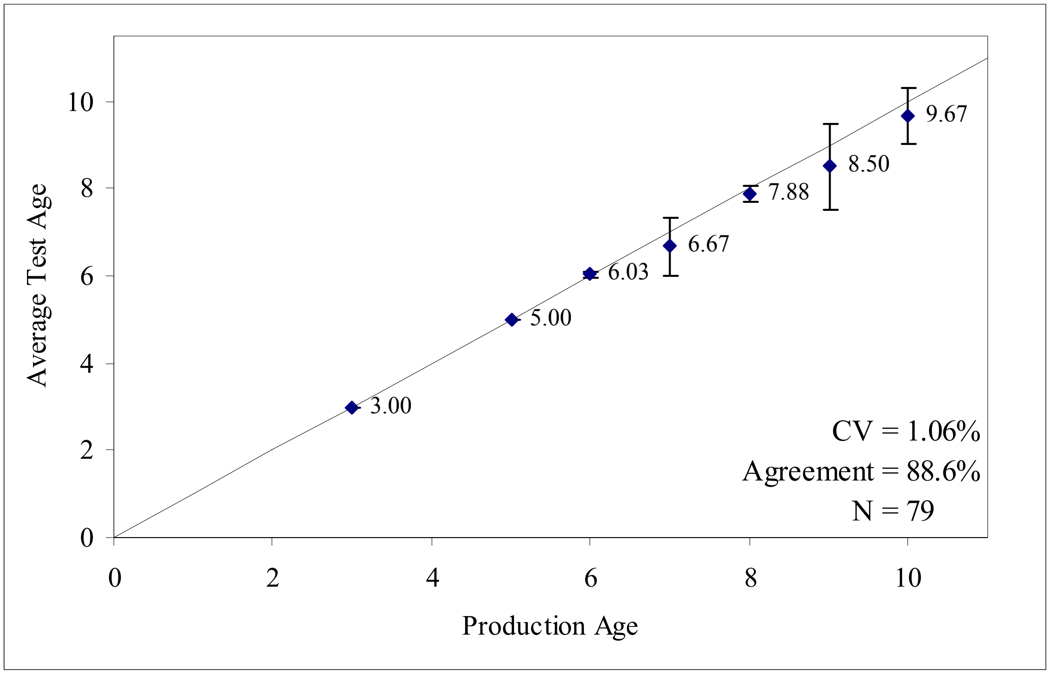
B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	Total
0																
1																
2																
3				4												4
4																
5						9										9
6							44	1								45
7								5								5
8									29							29
9									3	5						8
10										1	2					3
11											1					1
12																
13																
14															1	1
Total				4		9	44	6	32	6	3				1	105

DIFFERENCE		
-1	0	+1
5	99	1

Figure 18. Results of NEFSC haddock age-reader precision exercise against randomly selected fish from Q2 of NEFSC 2006 port samples. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



B.

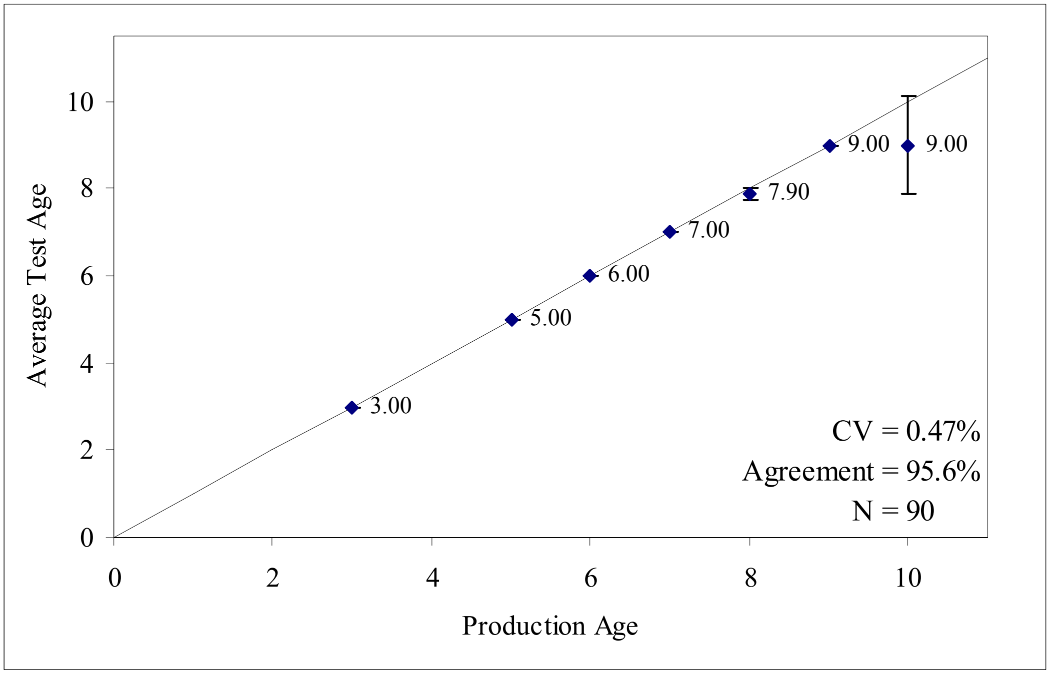
Test Age

Prod. Age	0	1	2	3	4	5	6	7	8	9	10	Total
0												
1												
2												
3				13								13
4												
5						2						2
6							31	1				32
7							1	2				3
8								4	19	1		24
9									1	1		2
10										1	2	3
Total				13		2	32	7	20	3	2	79

DIFFERENCE		
-1	0	+1
7	70	2

Figure 19. Results of NEFSC haddock age-reader precision exercise against randomly selected fish from Q3 of NEFSC 2006 port samples. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



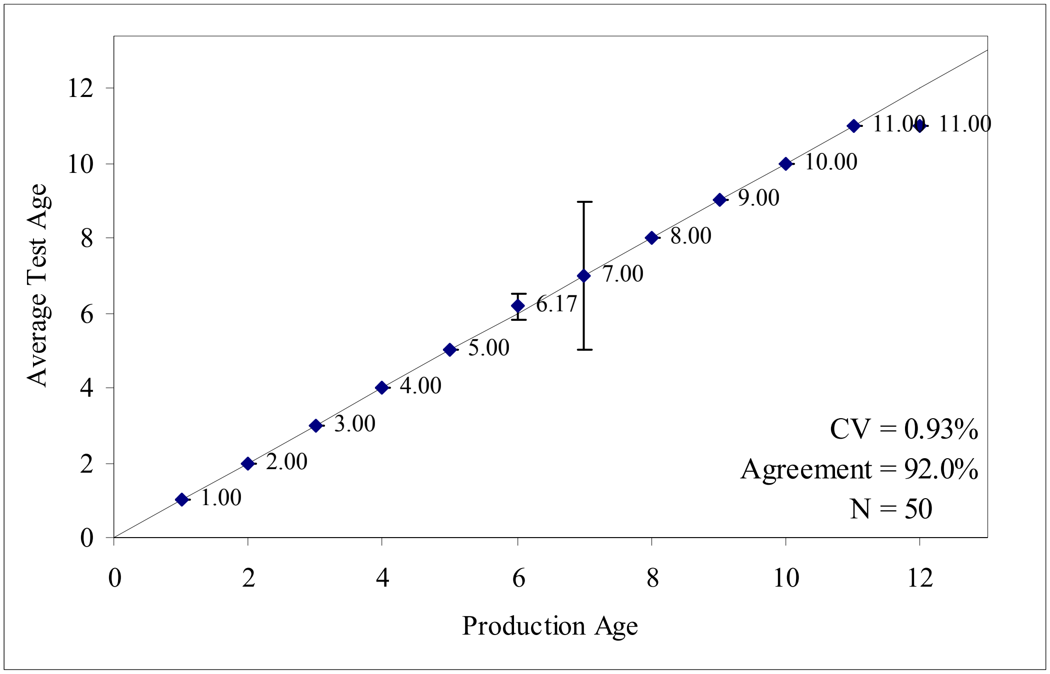
B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	10	Total
0												
1												
2												
3				16								16
4												
5						5						5
6							41					41
7								3				5
8								2	18			20
9										2		2
10									1	1	1	3
Total				16		5	41	5	19	3	1	90

DIFFERENCE			
-2	-1	0	+1
1	3	86	0

Figure 20. Results of NEFSC haddock age-reader precision exercise against randomly selected fish from Q4 of NEFSC 2006 port samples. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



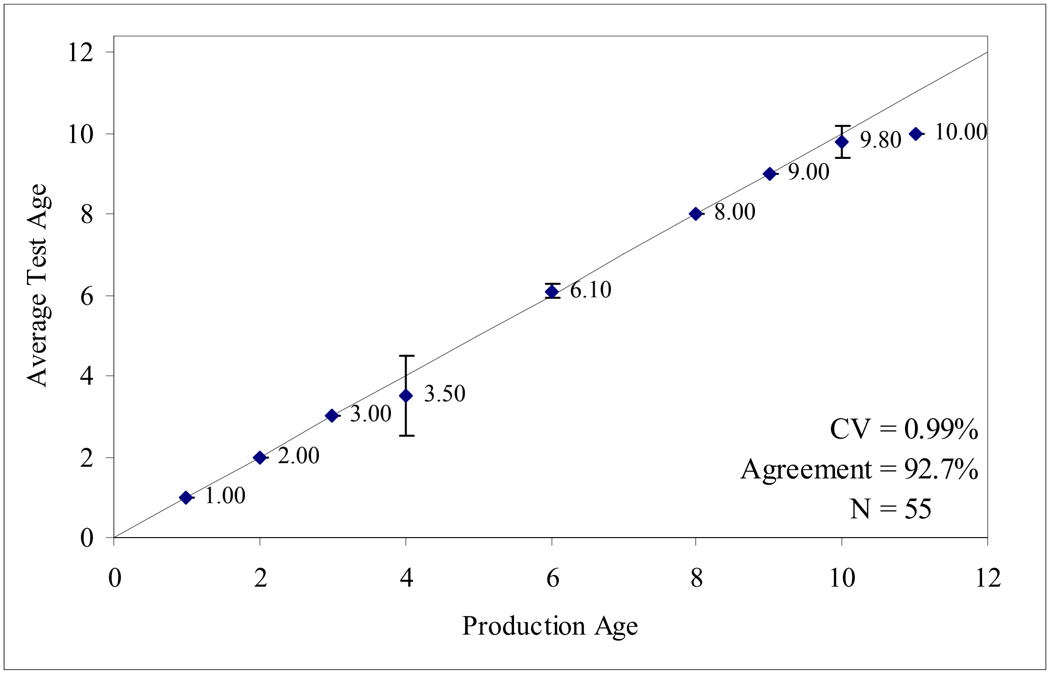
B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1		7												7
2			4											4
3				11										11
4					1									1
5						1								1
6							11		1					12
7							1		1					2
8									5					5
9										1				1
10											3			3
11												2		2
12												1		1
Total		7	4	11	1	1	12		7	1	3	3		50

DIFFERENCE			
-1	0	+1	+2
2	46	1	1

Figure 21. Results of SABS haddock age-reader precision exercise against randomly selected samples from the SABS 2006 survey (NED200601). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



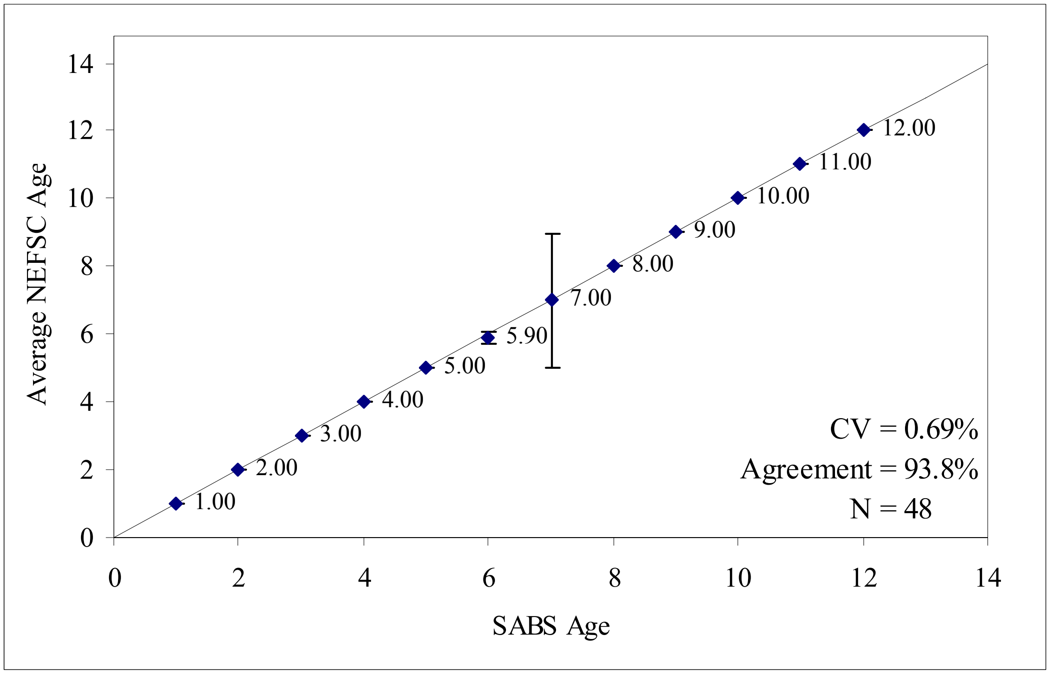
B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	10	11	Total
0													
1		1											1
2			2										2
3				16									16
4				1	1								2
5													
6							20		1				21
7													
8									6				6
9										1			1
10										1	4		5
11											1		1
Total		1	2	17	1		20		7	2	5		55

DIFFERENCE			
-1	0	+1	+2
3	51	0	1

Figure 22. Results of SABS haddock age-reader precision exercise against randomly selected fish from Q2–4 of SABS 2006 port samples. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



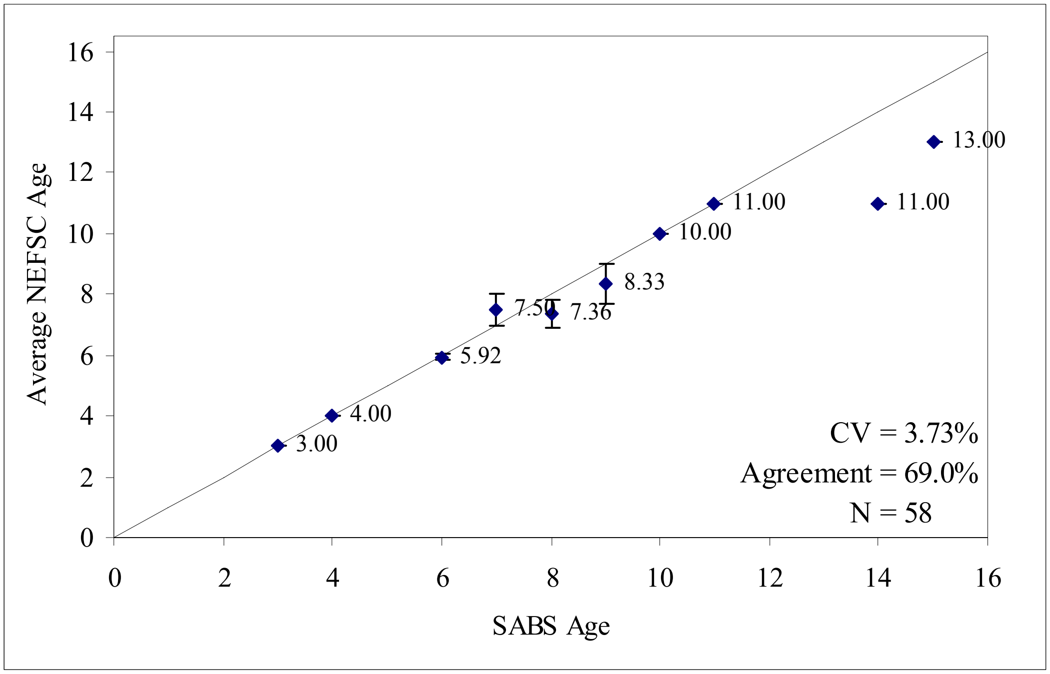
B.

SABS Age \ NEFSC Age	0	1	2	3	4	5	6	7	8	9	10	11	12	Total
0														
1		7												7
2			4											4
3				11										11
4					1									1
5						1								1
6						1	9							10
7							1		1					2
8									5					5
9										1				1
10											3			3
11												2		2
12													1	1
Total		7	4	11	1	2	10		6	1	3	2	1	48

DIFFERENCE		
-1	0	+1
2	45	1

Figure 23. Results of SABS/NEFSC haddock aging exchange using randomly selected samples from the SABS 2006 survey (NED200601). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



B.

NEFSC Age

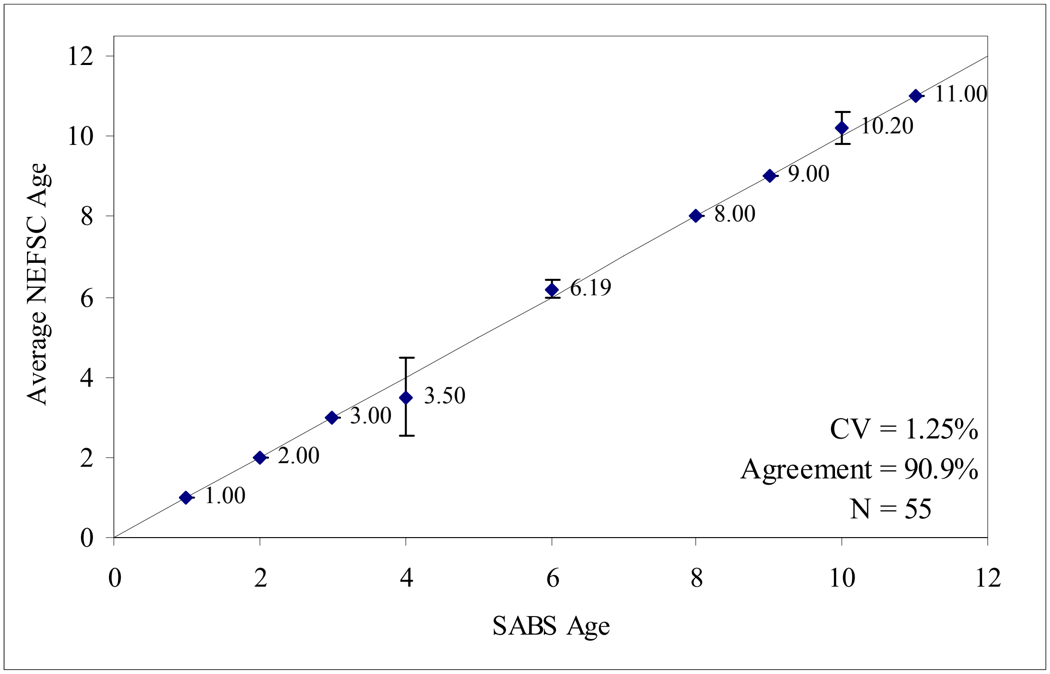
SABS Age	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	Total
0																	
1																	
2																	
3				1													1
4					1												1
5																	
6						2	24										26
7							1	2	5								8
8							3	3	8								14
9									2	1							3
10											2						2
11												1					1
12																	
13																	
14												1					1
15														1			1
Total				1	1	2	28	5	15	1	2	2		1			58

DIFFERENCE

-3	-2	-1	0	+1	+2
1	4	8	40	5	0

Figure 24. Results of SABS/NEFSC haddock aging exchange using randomly selected fish from NEFSC 2006 port samples (Q1–2). Note that for 9 fish sampled in January, one year was added to the SABS ages to account for the difference in birth-dates used by the two laboratories. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



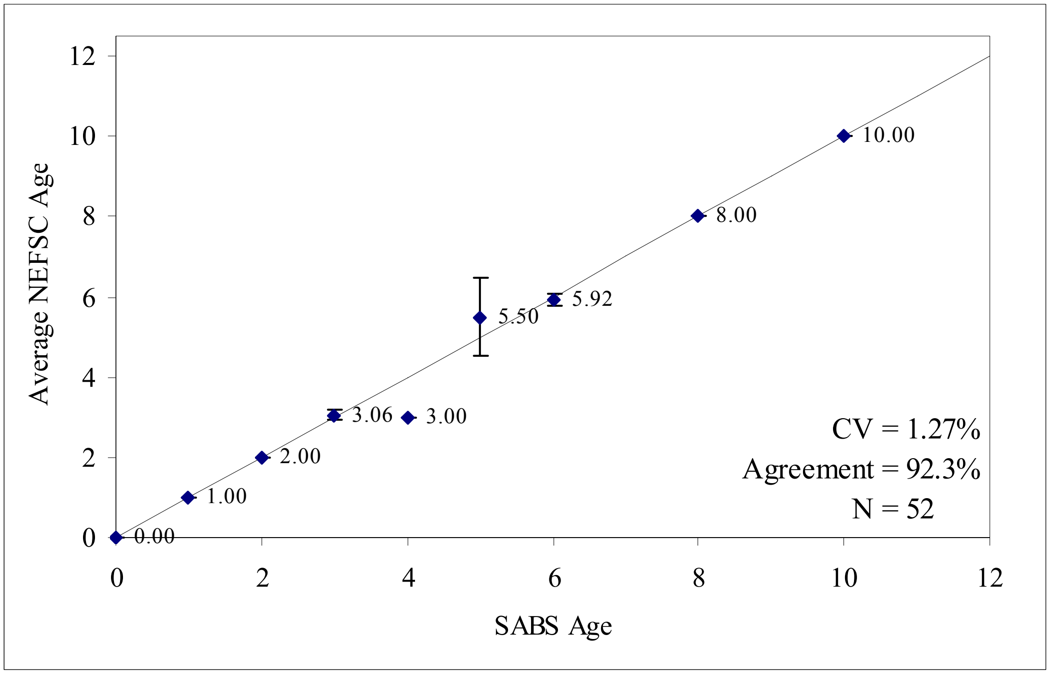
B.

SABS Age \ NEFSC Age	0	1	2	3	4	5	6	7	8	9	10	11	Total
0													
1		1											1
2			2										2
3				16									16
4				1	1								2
5													
6							18	2	1				21
7													
8									6				6
9										1			1
10											4	1	5
11												1	1
Total		1	2	17	1		18	2	7	1	4	2	55

DIFFERENCE			
-1	0	+1	+2
1	50	3	1

Figure 25. Results of SABS/NEFSC haddock aging exchange using randomly selected fish from SABS 2006 port samples (Q2–4). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



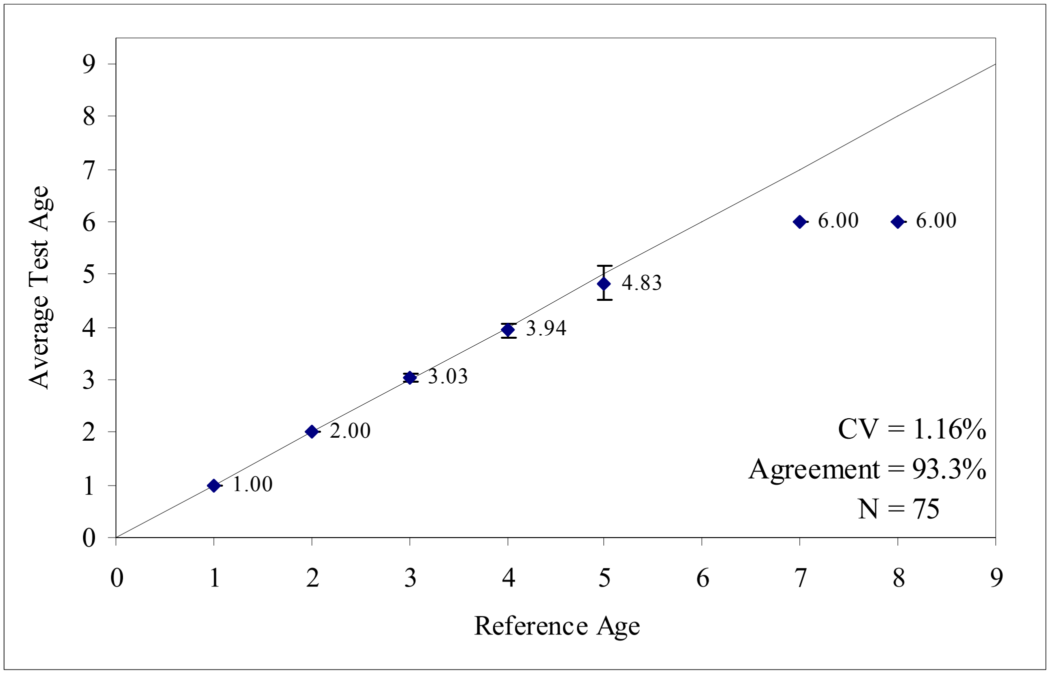
B.

	NEFSC Age											
SABS Age	0	1	2	3	4	5	6	7	8	9	10	Total
0	6											6
1		9										9
2			2									2
3				17	1							18
4				1								1
5						1	1					2
6						1	11					12
7												
8									1			1
9												
10											1	1
Total	6	9	2	18	1	2	12		1		1	52

DIFFERENCE		
-1	0	+1
2	48	2

Figure 26. Results of SABS/NEFSC haddock aging exchange using randomly selected samples from the NEFSC autumn 2005 survey (AL200610). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



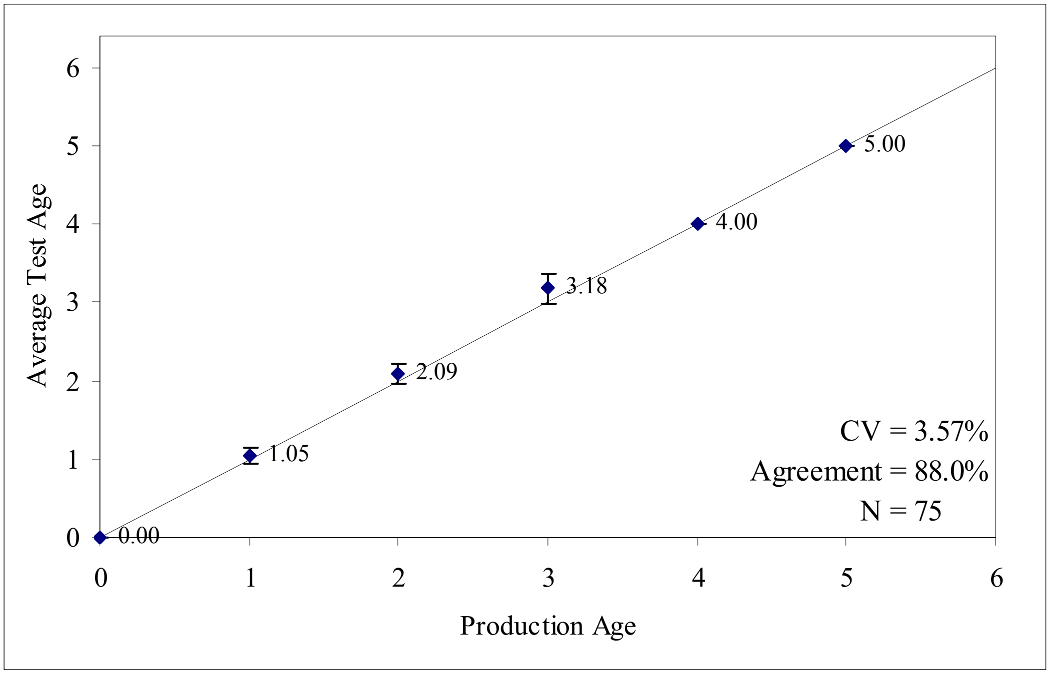
B.

Ref. Age	Test Age 0	1	2	3	4	5	6	7	8	Total
0										
1		7								7
2			14							14
3				29	1					30
4				1	15					16
5					1	5				6
6										
7							1			1
8							1			1
Total		7	14	30	17	5	2			75

DIFFERENCE			
-2	-1	0	+1
1	3	70	1

Figure 27. Results of NEFSC yellowtail age-reader accuracy exercise against randomly selected samples from the NEFSC yellowtail flounder reference collection, conducted after production aging. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



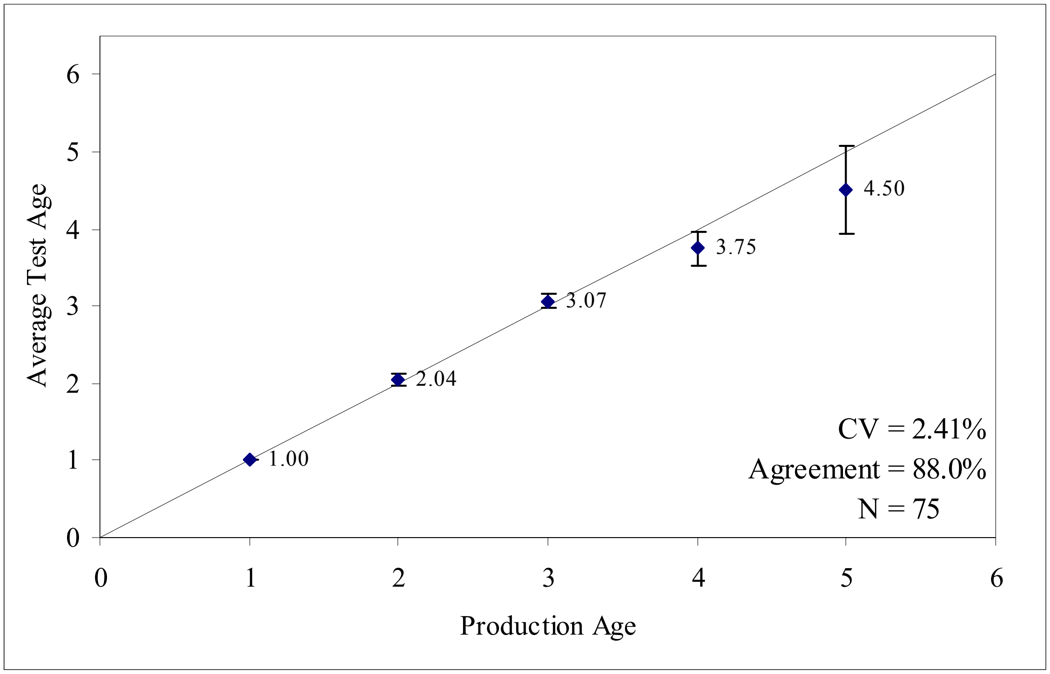
B.

	Test Age							
Prod. Age	0	1	2	3	4	5	6	Total
0	2							2
1		19	1					20
2		1	29	4				34
3				14	3			17
4					1			1
5						1		1
6								
Total	2	20	30	18	4	1		75

DIFFERENCE		
-1	0	+1
1	66	8

Figure 28. Results of NEFSC yellowtail age-reader precision exercise against randomly selected samples from the NEFSC autumn 2006 bottom trawl survey (AL200610). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



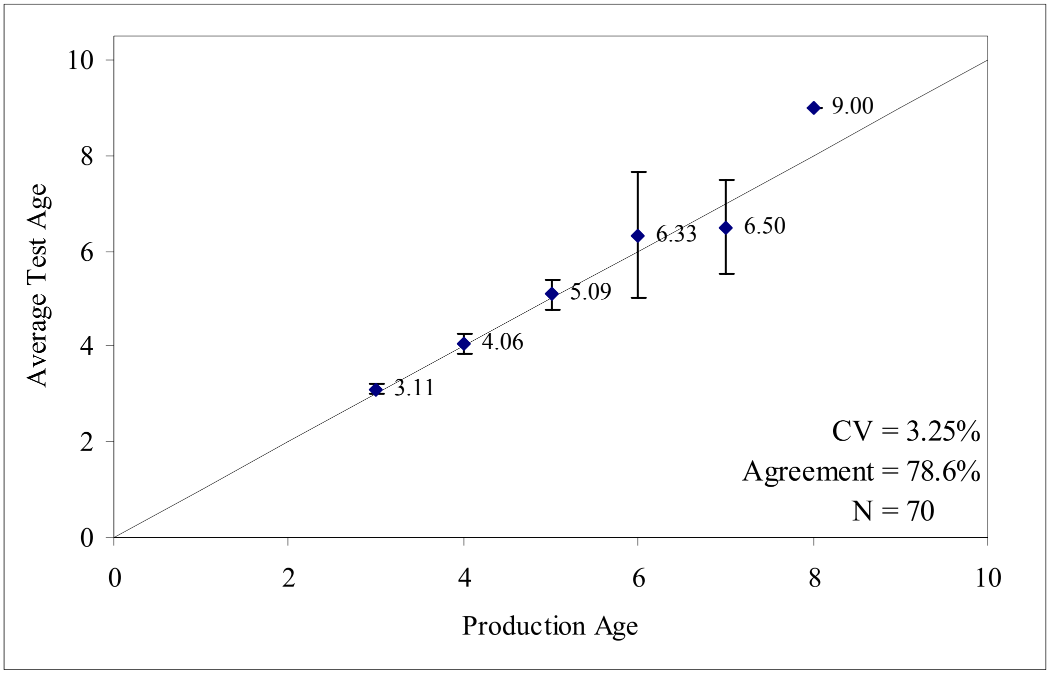
B.

Prod. Age	Test Age 0	1	2	3	4	5	6	Total
0								
1		2						2
2			22	1				23
3				28	2			30
4				4	12			16
5					2	2		4
6								
Total		2	22	33	16	2		75

DIFFERENCE		
-1	0	+1
6	66	3

Figure 29. Results of NEFSC yellowtail age-reader precision exercise against randomly selected samples from the NEFSC spring 2007 bottom trawl survey (AL200703). (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



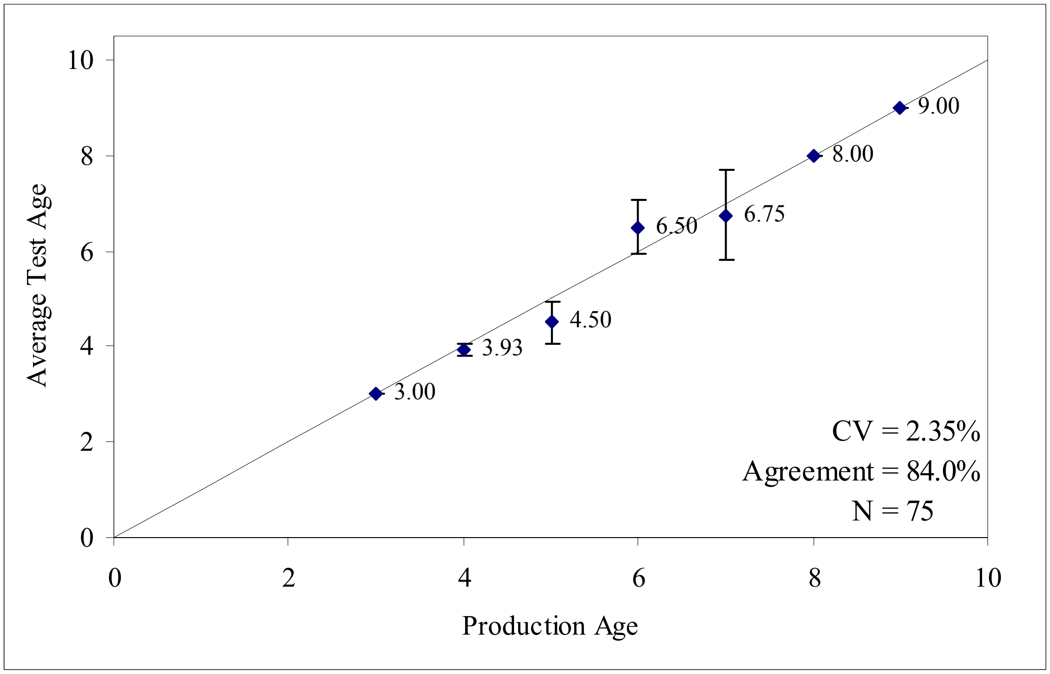
B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	8	9	Total
0											
1											
2											
3				31	4						35
4				1	15	2					18
5					1	8	2				11
6						1		2			3
7							1	1			2
8										1	1
9											
Total				32	20	11	3	3		1	70

DIFFERENCE		
-1	0	+1
4	55	11

Figure 30. Results of NEFSC yellowtail age-reader precision exercise against randomly selected fish from Q1 of NEFSC 2006 port samples. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



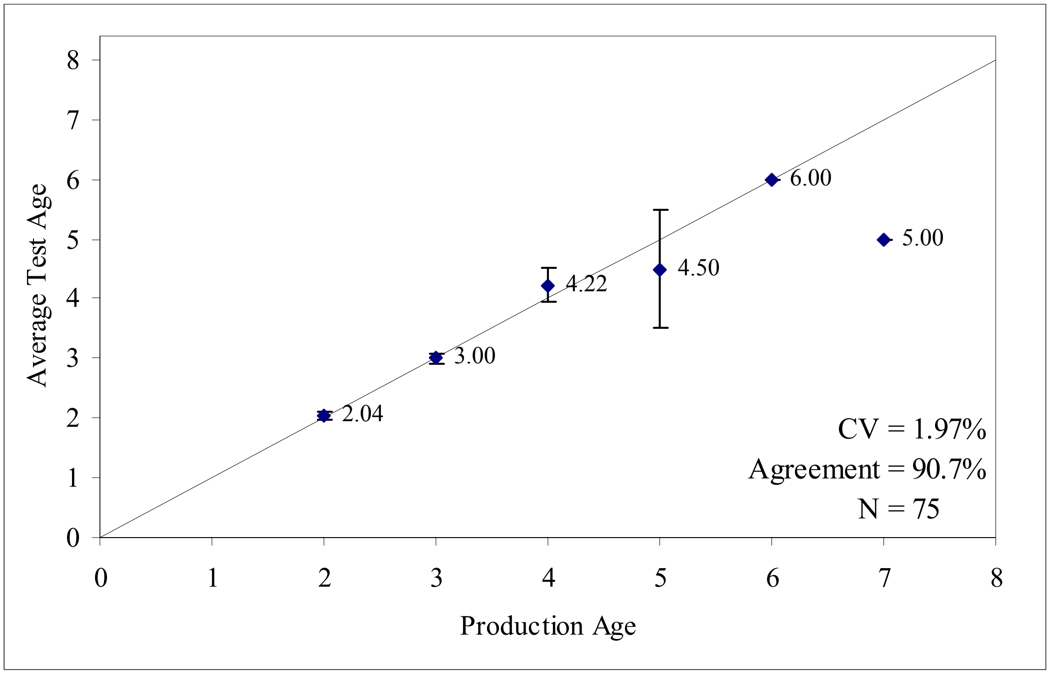
B.

Prod. Age	Test Age 0	1	2	3	4	5	6	7	8	9	Total
0											
1											
2											
3				30							30
4				3	24	1					28
5					3	3					6
6							2	2			4
7							2	1	1		4
8									2		2
9										1	1
Total				33	27	4	4	3	3	1	75

DIFFERENCE		
-1	0	+1
8	63	4

Figure 31. Results of NEFSC yellowtail age-reader precision exercise against randomly selected fish from Q2 of NEFSC 2006 port samples. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



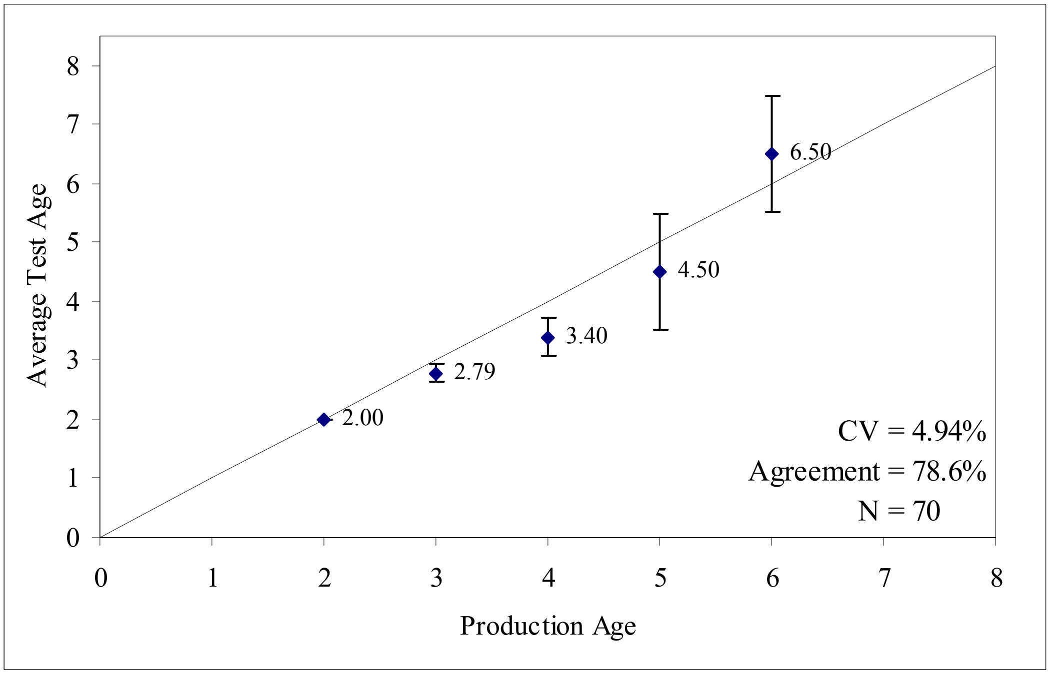
B.

Prod. Age	Test Age 0	1	2	3	4	5	6	7	Total
0									
1									
2			24	1					25
3			1	35	1				37
4					7	2			9
5					1	1			2
6							1		1
7						1			1
Total			25	36	9	4	1		75

DIFFERENCE			
-2	-1	0	+1
1	2	68	4

Figure 32. Results of NEFSC yellowtail age-reader precision exercise against randomly selected fish from Q3 of NEFSC 2006 port samples. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.

A.



B.

Prod. Age \ Test Age	0	1	2	3	4	5	6	7	Total
0									
1									
2			23						23
3			7	26					33
4				6	4				10
5					1	1			2
6							1	1	2
7									
Total			30	32	5	1	1	1	70

DIFFERENCE		
-1	0	+1
14	55	1

Figure 33. Results of NEFSC yellowtail age-reader precision exercise against randomly selected fish from Q4 of NEFSC 2006 port samples. (A) Age-bias plot. Error bars indicate 95% confidence intervals. (B) Age-frequency table. Inset shows the number of age assignments differing by the value indicated.