NOT TO BE CITED WITHOUT PRIOR
REFERENCE TO THE AUTHOR(S)

Northwest Atlantic Fisheries Organization

Serial No. N2402 NAFO SCR Doc. 94/34

SCIENTIFIC COUNCIL MEETING - JUNE 1994

Summary of Age Training for Silver Hake

by

J. J. Hunt

Gulf of Maine Section, Biological Station, St. Andrews, New Brunswick

and

M. C. Bourbonnais

Marine Fish Division, Bedford Institute of Oceanography, Dartmouth, Nova Scotia

Introduction

The first author has been responsible for the age determination of silver hake since the early 1970's and has participated in several international ageing workshops and otolith exchanges. A decision to move responsibility for silver hake ageing to Marine Fish Division personnel at the Bedford Institute of Oceanography was made in 1992 and the second author was identified as the new age reader. Training was therefore initiated to ensure consistency with historical ageing results and to minimize bias between the two readers. NAFO protocol for ageing silver hake were followed.

This report summarizes the protocol used for developing expertise and the assessment of inter-reader agreement for the new reader.

Methods

The second author had no experience in age determination of fish and therefore the first element of the training required review of literature dealing with basic techniques and the biological basis of otolith interpretations. This included general methods and their specific application to silver hake. Guidelines described by Hunt (1980, 1987) as well as results of otolith exchanges (NAFO) were the primary sources of information used to establish protocol.

Only whole, unsectioned otoliths stored in a glycerin solution (or transferred after dry storage) were used in the study. Both Canadian research survey and Observer samples were included in the comparisons. Readers were aware of the date of capture, sex and fish length for each sample.

Specific characteristics of silver hake otoliths such as pelagic zone, spring/summer check, ring intensity and differences between males and females (Hunt, 1980) were discussed and demonstrated. Initial agreement was assessed by comparison of the new reader's estimated age with that assigned by the first author for a random set of historical samples. Stereo microscopes and an image analysis system were used in the study. The two readers discussed results and in the majority of cases a consensus age was reached when initial differences occurred. This process was repeated several times and in total over 1000 otoliths were discussed and reviewed by both readers.

The training was considered complete in July 1993 and the second author was given responsibility for ageing of all 1993 research survey and Observer samples. Two subsequent evaluations of reader agreement were completed - one based on 1992 samples and the other based on 1993 samples. A subset of the 1993 comparisons for which the readers disagreed on age was re-examined to identify the probable source of disagreement and to determine if one or the other of the two ages was more appropriate.

Results of comparisons were assessed using algorithms developed by Campana and Annand (1994, in press).

To assess the impact of age length keys derived by the two readers for the 1993 samples, a length frequency representative of the commercial fishery (Observer samples for 1993) was partitioned using the two keys. The resultant 'catch at age' was compared to evaluated potential bias between the two estimates.

Results

In general, the new reader considered interpretation of silver hake otoliths to be relatively straight forward once the specific otolith characteristics had been defined. An early tendency to over age was followed by a tendency to under age and finally by an unbiased difference. This progressive convergence of agreement is typical for age training programs.

Proper classification of the pelagic zone and spring check were considered essential to achieving agreed interpretations. The relative intensity of the second annulus was frequently used as a starting reference point since early growth and identification of the true first annulus was difficult.

Comparisons for 1992 samples consisted of 517 samples and results are summarized in Table 1. Regression analysis indicates a slope of .94 which is significantly different from a slope of 1, thus indicating some slight bias. On the other hand, the Wilcoxon matched-pairs test was non-significant, indicating no consistant under or over ageing. The age bias plot in Figure 1 was not appreciably different from the 1:1 line, indicating no appreciable bias. The coefficient of variation for the ages was at a moderate level of 6.49% . Overall percent agreement was 72%.

The 1993 samples consisted of 470 samples (Table 2) and was basically very similar to the 1992 analysis. Regression analysis resulted in a slope not significantly different from 1, indicating no bias. The Wilcoxon matched-pairs test was significant, indicating some bias. In other words, the second author (agera) was under ageing compared to the first author (agerb). The age bias plot (Figure 2) confirms this but also shows that the amount of bias was very small and not of concern. The coefficient of variation improved slightly over the 1992 results to 5.84%, corresponding to an overall percent agreement of 74%.

Otolith quality was assessed to be a factor in assigning ages and there was a significant difference in percent agreement for comparisons based on research samples (87%) compared to Observer samples (71%). Two factors are probably relevant. The survey samples are confined to a single time period and the otoliths are stored in glycerin rather than transferred after dry storage as for the Observer samples.

Forty-three samples in which the readers disagreed, and for which the second reader confirmed her initial interpretation, were re-examined to assess the source of difference but there appeared not to be a predominant factor. Size of the first annulus, checks, ring spacing and edge type were all considered the basis of differences. The first reader changed his interpretation to agree with the second reader in 20 cases, confirmed his first reading in 17 cases and assigned a new age in 6 cases. These results indicate that differing estimates of age are probably due to the degree of otolith difficulty and not due to a difference in the conventions used for interpretation.

Results of the two catch at age estimates, by sex and combined, are shown in Table 3 as the percent age composition. At ages 1-4 the percent composition is very similar although the difference at age 5 appears to be more substantial. A two-sample analysis of variance indicates no significant difference between the estimates for males, females or the total. Results are summarized in Figure 3 by sex and for the total.

Conclusions

The approach used to develop ageing expertise appears to have resulted in an acceptable degree of inter-reader agreement with no implied bias between historical and current interpretations. The overall level of agreement is in excess of 70% and, while there is some indication of bias, the differences can generally be considered random and with minimal impact on estimated catch at age. The fact that re-examination of a subset of the comparisons to assess possible sources of differing interpretation did not indicate bias also indicates that ageing has a substantial degree of subjectivity. It is therefore unlikely that percent agreement can be improved much beyond the level of 75-85% reported in this study. We therefore conclude that estimated ages for 1993 are based on criterion consistant with those used in the past and that precision of ages by the new age reader are similar to those for historic samples.

The advantage of using glycerin-stored otoliths was apparent and the need to minimize the time between collection and transfer to glycerin for Observer samples must be emphasized.

The authors also note the advantage of having more than one reader involved in ageing of a stock/species and the opportunity to discuss interpretations. Training of an additional reader will be required to meet this objective.

References

Hunt, J.J. 1980. Guidelines for age determination of silver hake. J. Northw. Atl. Fish. Sci., Vol 1:65-80

Hunt, J.J. 1987. Inconsistencies in the ageing of silver hake. NAFO SCR Doc. 87/51

Campana, S.E, C.M. Annand and J. MacMillan. 1994. Graphical and statistical methods for age comparisons. (Trans. Am. Fish. Soc. in press)

Table 1. Summary of statistical comparisons between the 1992 age readers.

```
STOCK:          27   4VWX Silver Hake

Variable(s) Entered on Step Number  1..     AGERA

Multiple R              .92385
R Square                .85349
Adjusted R Square       .85321
Standard Error          .71061

F =     3000.20889        Signif F =  .0000

------------------------------ Variables in the Equation ------------------------------
Variable               B        SE B      95% Confdnce Intrvl B        Beta          T   Sig T
AGERA            .942869     .017214       .909051      .976686     .923847     54.774   .0000
(Constant)       .220354     .066090       .090514      .350193                  3.334   .0009

- - - - - Wilcoxon Matched-Pairs Signed-Ranks Test  AGERA    with AGERB
      Mean Rank    Cases

          74.08       69  - Ranks  (AGERB LT AGERA)
          74.87       79  + Ranks  (AGERB GT AGERA)
                     369    Ties   (AGERB EQ AGERA)
                     ---
                     517    Total

      Z =     -.7686              2-Tailed P =  .4421
```

STOCK	AGERA	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B96	B97	B98	B99	TOT
27	1	68	8	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	76
27	2	5	97	12	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	115
27	3	.	7	78	11	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	99
27	4	.	.	21	63	19	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	105
27	5	1	.	2	13	34	9	1	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	62
27	6	.	.	.	1	9	12	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	27
27	7	.	.	.	.	4	3	10	2	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	20
27	8	.	.	.	.	.	.	1	3	3	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	7
27	9	.	.	.	.	.	.	.	1	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	3
27	10	.	.	.	.	.	.	.	.	.	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	2
27	11	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1

STOCK	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B96	B97	B98	B99	TOTAGERB	TOTAGERA
27	74	112	113	89	68	27	17	8	6	2	1	.	.	.	.	.	.	.	.	.	.	.	.	.	517	517

STOCK	CV	APE	D	AGREE	VALIDCNT	PERAGREE
27	6.49	4.59	4.59	369	517	71.37

Table 2. Summary of statistical comparisons between the 1993 age readers.

```
STOCK:          27   4VWX Silver Hake

Variable(s) Entered on Step Number  1..    AGERA

Multiple R           .91141
R Square             .83066
Adjusted R Square    .83030
Standard Error       .67347

F =    2295.67577       Signif F =  .0000

------------------------------ Variables in the Equation ------------------------------
Variable              B        SE B    95% Confdnce Intrvl B       Beta          T  Sig T
AGERA           .994397     .020754     .953614    1.035180     .911406    47.913  .0000
(Constant)      .116797     .069542    -.019857     .253451                 1.680  .0937

- - - - - Wilcoxon Matched-Pairs Signed-Ranks Test AGERA  with AGERB

     Mean Rank    Cases

       55.46        46  - Ranks (AGERB LT AGERA)
       63.64        74  + Ranks (AGERB GT AGERA)
                   350    Ties  (AGERB EQ AGERA)
                   ---
                   470    Total

      Z =    -2.8258              2-Tailed P =  .0047
```

STOCK	AGERA	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B96	B97	B98	B99	TOT
27	1	88	5	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	93
27	2	1	85	9	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	96
27	3	.	8	75	19	3	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	106
27	4	.	.	22	62	15	3	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	104
27	5	.	.	1	7	29	5	2	2	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	46
27	6	.	.	.	1	3	6	4	1	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	16
27	7	.	.	.	.	2	1	4	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	8
27	8	.	.	.	.	.	.	.	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	1

STOCK	B1	B2	B3	B4	B5	B6	B7	B8	B9	B10	B11	B12	B13	B14	B15	B16	B17	B18	B19	B20	B96	B97	B98	B99	TOTAGERB	TOTAGERA
27	89	98	107	90	52	16	11	6	1	.	.	.	.	.	.	.	.	.	.	.	.	.	.	.	470	470

STOCK	CV	APE	D	AGREE	VALIDCNT	PERAGREE
27	5.84	4.13	4.13	350	470	74.47

Table 3 : Calculated catch at age for a 1993 length frequency by authors.

	Age							
	1	2	3	4	5	6	7	8
<u>Males</u>								
author 1	16	33.6	31.6	17.3	1.3	0.1	0	0
author 2	14.3	32	30.8	17.1	4.5	0.9	0.1	0.2
<u>Females</u>								
author 1	15.9	25.9	31.9	19.2	5.9	0.7	0.2	0.1
author 2	15.2	29.7	29.7	15.9	7.8	1	0.4	0.1
<u>Total</u>								
author 1	31.9	59.5	63.4	36.5	7.2	0.8	0.2	0.1
author 2	29.4	61.7	60.5	33	12.3	2	0.5	0.3

Figure 1. Age bias plot for 1992.

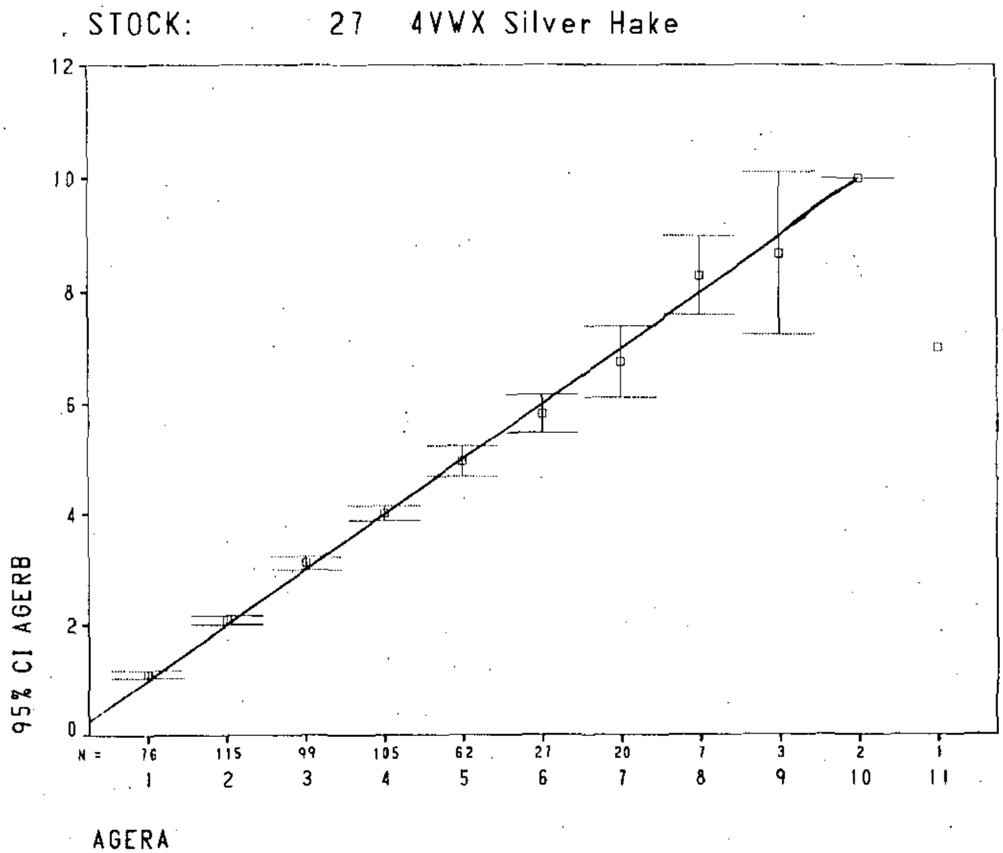

Figure 2. Age bias plot for 1993.

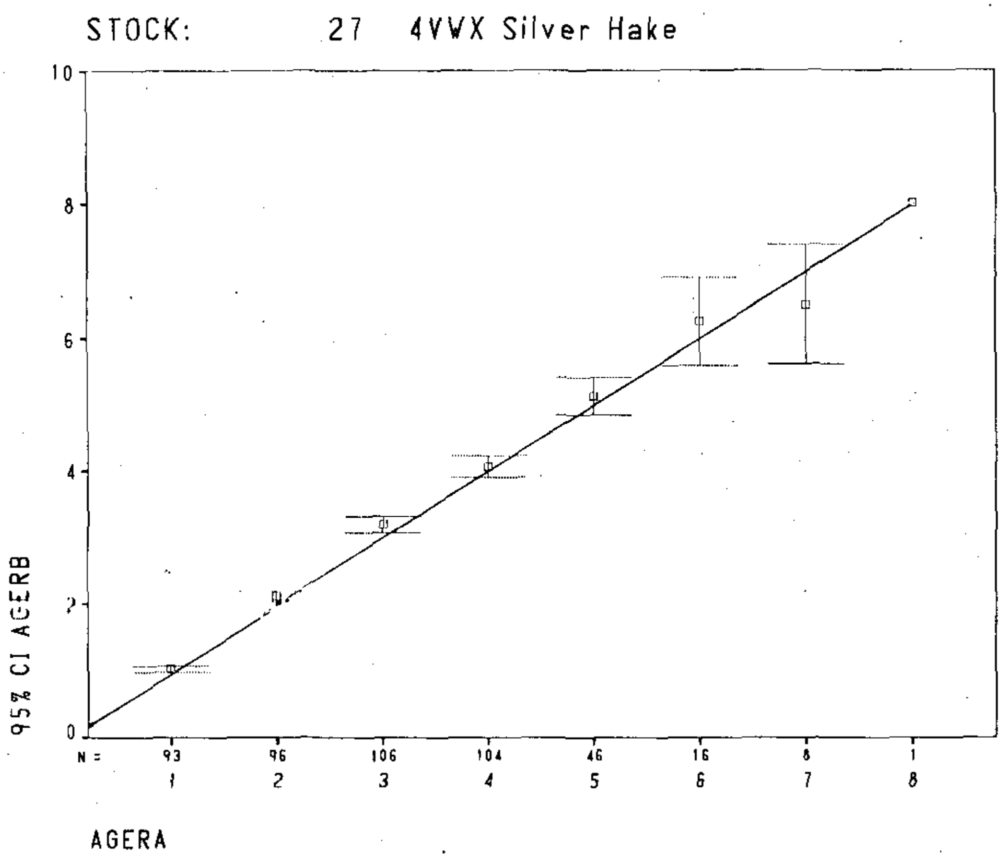

Figure 3. Comparison of percent catch at age for reader 1 and reader 2 ages