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INTER-REGIONAL AGEING WORKSHOP

June 17 - 18, 1997

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Abstract

These proceedings record the discussions from an Inter-Regional Ageing Workshop held at the Bedford Institute of Oceanography from 17 - 18 June 1997. The aim of the workshop was to review the current ageing procedures at each laboratory and develop a common set of minimum standards and protocols for ageing, training and consistency evaluation. Terms of reference for an Inter-Regional Ageing Working Group were also established. These proceedings outline the main points of discussions, proposals, and recommendations.

Résumé

Ce document présente les actes d'un colloque interrégional sur l'âgeage qui s'est tenu les 17 et 18 juin 1997 à l'Institut océanographique de Bedford. Le but du colloque était d'examiner les méthodes d'âgeage actuellement employées dans chaque laboratoire et d'élaborer une série commune de normes minimales et de protocoles pour l'âgeage, la formation et l'évaluation de l'uniformité. Le mandat d'un groupe de travail interrégional sur l'âgeage a également été défini. Les actes présentent les principaux sujets des débats, les propositions et les recommandations.

INTRODUCTION/WELCOME

Chairperson: **Diane Beanlands** Rapporteur: **Maria-Ines Buzeta**

The meeting was opened by the Chair of the first session, Diane Beanlands, who welcomed the participants. In the introductory remarks, the objectives of the meeting were reviewed and the agenda accepted (Appendix 1). Workshop participants are listed in Appendix 2, and all handouts available during the meeting are listed in Appendix 3.

Workshop Objectives:

- review the current ageing procedures at each laboratory
- recommend a common set of minimum standards and protocols for ageing
- record the workshop proceedings and submit recommendations to Section Heads
- establish a Regional Ageing Working group

OVERVIEW

Chairperson: **Diane Beanlands** Rapporteur: **Maria-Ines Buzeta**

INTRODUCTION OF PARTICIPANTS

All participants were asked to introduce themselves and include the laboratory they were representing and the species they are responsible for ageing.

CURRENT PROCESSES

i. Procedures

- A stock by stock summary document of current ageing methodologies at each site was compiled and tabled. The variety and volume of information made for a rather unwieldy document. Participants felt it should be included in these proceedings but it should be reformatted for easier viewing. Possibly grouping information by site, or by species. (Appendix 5.)
- A summary document of recommendations (Appendix 3a) from other workshops was tabled but not discussed directly. It was felt that the recommendations would be better addressed in context with the agenda item to which they referred.

ii. Criteria

a. EDGE TYPE:

SABS records the edge type and number of annuli. A software program uses a conversion table (Kohler, 1958) upon entry of survey samples to calculate a final age. In the case of commercial samples, age is calculated by the age reader using a conversion table prior to data entry. GFC uses a variation of the SABS model. For most species they record edge type and number of annuli and use a conversion table to determine the age and corresponding year-class. For herring, although the edge type is not recorded, it is considered along with the gonado-somatic index table, in the assignment of the age.

- In general, BIO is not currently using the conversion table. The 4VsW cod ager, however, does use a modified version in otolith interpretation.
- It was felt by some participants, that all agers should be urged to record edge type. It was later suggested that data i.e., number of annuli and edge type, should go into the databases raw and that any conversions (to final age) be made by special software.
- A comment was made that all these conventions ignore differences in growth, so edge types in the first and second quarter may not be responding. For example, in 4VN, growth would not be seen until later. It was suggested that perhaps each stock should have its own conversion table which would reflect these differences. Age interpretation should not be based on what is expected of growth in any one time of year.

RECOMMENDATION:

- *Each site should prepare a detailed, step by step summary of ageing methods used for each stock. The summary should include birthdate, edge type, other criteria used, and the interpretation of these criteria to arrive at the final age. In the case of edge types, there should be an explanation of how these are used for age assignment. Agers should also document whether the table by Kohler or some modified version, is used to convert number of annuli to age.*

b. BIRTHDATE:

- Birthdate conventions among the four sites include both January 1st and February 1st. IML uses January 1st, SABS and BIO use February 1, and GFC uses both dates.
- It was suggested that Ralph Halliday be asked to address the workshop to provide insight on the birthdate protocol, but he was not available.
- A common birthdate of January 1 was put forward. This would require that samples in databases and software be modified to accommodate this change.
- Concern was raised that this may cause a change in age composition and interpretation. However, it was pointed out by SABS participants that January ages are incremented by one during the analysis anyway. For example, a fish recorded by the ager as 6 in January, is converted to a 7 by the assessment software. In other words we use a February 1st birthdate when ageing, but this is changed to a January 1st birthdate during the analysis.
- This change would have no effect on an assessment done by year class. This would , however, eliminate problems due to the confusion of 2 birthdates.
- It was suggested that there should be a species by species study to assess the impact of this change. However, it was again pointed out that if the edge conversion table is not changed, then there will be no effect, because during the analysis the January ages are reverted back.

- If management agrees to standardize birthdate to Jan 1, then someone should be assigned to overview each stock and determine what changes need to be made to software and data. It was suggested that Bob Mohn may be able to test these changes in a model that would assess the impact on assessments.
- It was noted that GFC has already undergone this process when the birthdate for cod was changed from February to January. This was done to accommodate data from the January survey. Therefore, an otolith that is 7NH in a January sample remains a 7 year old. Gloria Poirier from GFC, changed the data and the age length analysis. No changes in assessment results occurred because the program was already doing this conversion anyway.
- It was widely felt that there should be a standard birthdate especially now that databases at all sites are currently going, or have gone, to Oracle and common tables.

RECOMMENDATIONS:

- *The January 1st birthdate convention should be adopted as a standard, and that recorded ages (historical data) be adjusted accordingly, and that programs be modified to accommodate this change. The problem of birthdate is well documented and we should proceed. (Buzeta et al. 1992; Hunt ed. 1993)*
- *GFC should summarize steps taken and problems solved during their birthdate conversion for 4T cod.*

c. STORAGE:

- The problem of storage, in terms of appropriate space to house the otolith collections at each site as well as the treatment of individual otoliths i.e. dry in envelopes, in glycerine-thymol solution etc., was discussed.
- It was noted that inadequate space (in terms of temperature and humidity) for storage of otolith collections causes deterioration of the samples. The coating on the otoliths becomes yellow or cracked, or the otoliths themselves crack or become covered in mold.
- GFC and IML expressed concern over their current storage space causing deterioration of samples. Indeed, IML has a number of samples stored out of doors!
- SABS currently stores all their otoliths at the Atlantic Reference Center in a temperature, and humidity controlled environment. The suggestion was made that if a site cannot provide warm dry storage as a minimum, perhaps a university or museum could be a source of appropriate storage.
- Some concerns were expressed not only about the type of storage space but also about the increasing amount of space needed, particularly now with the large numbers of otoliths collected from the sentinel fisheries. Perhaps in the budgets for these fisheries, storage costs could be factored in.
- In discussions of dry versus wet storage of otoliths, it was pointed out that glycerine-thymol storage used for winter flounder and silver hake will eventually destroy the otoliths, so dry storage is preferred if possible. GFC expressed a desire to move to dry storage for their winter flounder otoliths. Isabelle Forest-Gallant is currently testing the possibility of ageing these dry.
- Gerry Young at BIO pointed out that dry reading silver hake otoliths is not an option as they must be stored for a period of time in glycerine-thymol solution so that the otolith will clear and be readable.

- There are a variety of coatings or wetting solutions (soapy water, alcohol, Histoclear etc.) as well as adhesives, applied to otoliths in order to facilitate age determination. Concern was raised over the long term effect of these coatings on the quality of otoliths.

RECOMMENDATIONS:

- *Proper storage must be ensured at each site, so that deterioration of otolith collections does not occur.*
- *Sentinel Fisheries should factor in costs of otolith storage in their expense budgets.*
- *A section should be added to the procedures document on types of coatings and adhesives used in the preparation of otoliths for reading.*

GENERAL DISCUSSION

- This session began with a discussion of the BIO site's suggestion to establish a Regional Ageing Working Group (RAWG) to review ageing issues at the 3 maritime sites. (At the time this proposal was made the inclusion of IML had not been considered.) There is a concern from all sites that a number of recommendations made at previous workshops have not been addressed. The group felt that this type of working group could facilitate the implementation of many of these recommendations as well as deal with ageing issues in general.
- It would be expected that the site managers would keep the RAWG informed of proposed changes to ageing procedures at their site.
- It was agreed by the participants that the RAWG should have representatives from all sites and classifications. One suggestion was to have the ageing coordinator and one other (preferably an assessment biologist) sit on the working group.
- It was noted that currently, only BIO and SABS have ageing co-ordinators. There should be a minimum description of the responsibilities and duties of these co-ordinators.
- There was a suggestion that future workshops should focus on more specific ageing problems such as interpretation, testing for quality control etc.

RECOMMENDATIONS:

-A Regional Ageing Working Group should be established with a terms of reference as follows:

Regional Ageing Working Group Terms of Reference

- Produce a Regional Ageing Manual.
- Maintain a database of annual changes such as birthdates, software, criteria, testing methods etc.
- Promote otolith atlas and reference collections for every stock.
- Oversee all ageing and quality control procedures. Changes in ageing methodologies at all sites must be reviewed by the RAWG. Recommendations from the RAWG will be forwarded to site managers for final approval.
- Provide a mechanism to review recommendations.
- Produce an annual report on ageing at the 3 sites, to be presented at a Regional Assessment Process (RAP) meeting. This could include the number of otoliths collected and read for both survey and commercial fisheries, types of testing done, results of testing, changes to ageing software and databases etc. The RAWG in consultation with assessment teams and agers would decide details.
- Act as liaison between managers, agers and assessment team.

- Annually review these terms of reference for additions and or deletions.

-The recommendations, criteria and documentation from previous workshops should be reviewed by the RAWG.

-Each site should have an ageing co-ordinator and their duties and responsibilities established.

PROCEDURES

Chairperson: **Mike Power** Rapporteur: **Joanne Hamel**

TRAINING

A proposal for a training protocol (Appendix 3b) for new age readers, drafted by S. Campana, D. Beanlands and J. Hamel from BIO, was presented by D. Beanlands. It is intended that this training protocol be formalized and approved by the RAWG and included in the Regional Ageing Manual.

The proposed outline was reviewed and modified as follows:

REVISED TRAINING PROTOCOL FOR NEW AGE READER

1. Conduct a literature review of relevant documentation for ageing in general and species/stock in particular (e.g. stock atlas when available).
2. Age a minimum of 100 otoliths (more if necessary, depending on species) with the primary ager, using an Image Analysis System (IAS) or a discussion microscope. This familiarizes the new ager with terminology and process.
3. Age a random sample of a minimum of 100 otoliths on their own. This allows the new ager to develop a search image and start to apply the standard criteria. The primary ager should prepare this sample from otoliths collected from different gear types, time of year, areas, etc.).
4. Age approximately 50 otoliths with the primary ager. Some of these can come from the otoliths in step 3. When possible, use the IAS to annotate the images.
5. Age an additional 1000 otoliths previously read by the primary ager. As in step 3, select samples that are widely representative of the stock.
6. Prepare bias plots and CV's for the previous 1000 otoliths.

   a/ If no bias is apparent and CV is appropriate, age the reference collection and again prepare bias plots and CV's.

   b/If there is a bias, further work with the primary ager is necessary. Repeat steps 2 to 7 until bias plots and CV's show acceptable results.
7. Re-age a subset of the 1000 otoliths aged in step 5 to test the new ager's consistency. Again prepare bias plots and CV's.
8. Start production ageing if all the criteria have been met using the accepted quality control protocols.
9. Age a subset of the reference collection on a quarterly basis for the first year of production ageing and test using bias plots and CV's.

Note: This training protocol requires that reference collections, both historical and contemporary, be established for all species. However, modifications to this may be required for species with otoliths that deteriorate rapidly i.e. silver hake.

GENERAL DISCUSSION

- It was acknowledged that ideally the new ager should spend an extensive period of time with the primary ager while in training but that realistically this wasn't always possible. Therefore, the role of reference collections and IAS as training tools was recognized. It was also noted that the minimum amount of time for training, as well as the number of otoliths aged, would be stock/species dependent although it was felt that a period of 2 weeks should be the minimum standard.
- The test sample selection method (see Step 3 and 5 of the Training Protocol) was discussed at length without any consensus being reached. Although participants agreed that the selected samples should widely represent the population to be aged (area, gear, month, length, etc.), two different approaches were presented: random selection of individual otoliths throughout the collection or random selection of whole samples or plates. The benefits and inconvenience of both methods were discussed but the selection process issue was eventually left unresolved.

Ed. note: The RAWG should review current methodologies for sample selection with input from individual assessment teams, and provide recommendations.

SUBSAMPLING

Steve Smith presented the results of a paper that uses Bayesian methodology to estimate the age composition of a population of Atlantic Cod. The model described, uses prior knowledge to improve estimations of cohort population numbers. By taking a current age/length key and building in structure from earlier data, it is possible to reduce the variance. (i.e. adding precision to an age/length key adds precision to the population estimates.) Alternately, by using this method and keeping the same level of variance, it is possible to reduce the sample size by half.
Quality of age data was seen as an important factor. Since estimates of age composition impact directly on population estimates, inherent ageing errors in catch-at-age matrices continue to compound through to the final stages of the assessment process.

GENERAL DISCUSSION

- There appeared to be a general concern regarding diminishing resources (people, time, storage space) and the increasing number of samples collected. In some cases, participants were questioning the rationale behind collecting more samples than you need and having to subsample prior to ageing. Others felt that cost of subsampling was minimal compared to the cost of collection but that storage for these samples is not being addressed.
- It was apparent that various methods and tools for subsampling exist at each site but no consensus was established regarding the criteria to be used (e.g., subsampling by length, by sex, etc.). Those criteria vary widely between different assessment biologists. It was proposed that the rationale used for each site/species/stock be defined in the compilation of questionnaire results, in order to document the process at each site.
- Bob Branton (BIO) made a short presentation on how the annual sampling requirements, reviewed at the divisional level, are used to produce a target list, the purpose of which is to achieve a realistic level of sampling.

REFERENCE COLLECTION

- There was some confusion surrounding reference collections for training versus reference collections for standard testing procedures. It was generally agreed however that both collections should be widely representative of the stock to be aged. The number of otoliths selected and the methods of storage should be stock specific but the numbers should be large enough to prevent any ager from becoming too familiar with the collection. Specific descriptions of both should be further defined by the RAWG.
- It was agreed that the reference collection can include otoliths that were read by multiple readers to arrive at the most appropriate age.
- It was proposed that a subset of a reference collection be identified and used to test for long term drift in routine ageing.
- The issue of a regional reference collection (one that contained samples from all stocks aged in the region) was discussed. It was felt that individual site collections could be used for inter-lab exchanges and together, would make up the inter-regional reference collection. Having more than one reference collection per stock at each site was believed unnecessary.
- BIO reported that they had recently purchased a CD writer which they found was a useful method for storing the reference collection as well as sharing digitized annotated images.

RECOMMENDATION:

- *A reference collection for each stock should be established, maintained and regularly updated for training and testing purposes. It should be representative of various categories of otoliths (difficulty, age, length, time, gear, area, specific features, checks, etc.). A random subsample representing the stock should be selected for tests of bias and inter-lab exchanges.*

AGEING DATABASES

- An overview presentation of current databases at BIO and SABS (IOP, NSP, GS) was made by Bob Branton (BIO). It was noted that a pelagic database also exists separately at SABS. The group discussed problems in the past with communicating changes in databases to the people using them. It was strongly felt that there needs to be established procedures to inform users of database modifications in a timely fashion. Perhaps the RAWG could make some recommendations in this area. (Bob Branton offered to set up a list server if participants provided their names and email addresses to him.)
- A proposal for a common data entry system as well as a new age table that would include all individual otolith information was made by Peter Comeau (BIO). (Appendix 3c). Diane Archambault (IML) discussed the process and problems incurred to get their current age table, which is very similar to that proposed by BIO, up and running.

RECOMMENDATION:

- *The BIO proposal for a common data entry system and age table should be circulated amongst each of the sites. Comments will be forwarded via ageing co-ordinators to the RAWG for recommendation. Consultation with IML's system designer is desirable.*

Ed. Note: It was agreed by the participants that the agenda items on Image Anaysis System equipment be left to the end and completed if time permitted. It was later cancelled.

QUALITY CONTROL

Chairperson: **Ghislain Chouinard** Rapporteur: **Rod Morin**

PRESENTATIONS

- Bob Mohn presented results of a study he conducted on "Propagation of Ageing Errors in Fish Stock Assessments". He used computer simulations to investigate the impact of ageing inconsistencies on the assessment process. He found that ageing errors did not cancel out but results were biased with a tendency for biomass to be over estimated. The effect of an error in precision resulted in a particularly strong bias. When bias was introduced, the population trends did not follow the true values well. Bob suggested that more work is required in this important area.

- Steve Campana discussed his results from two papers (Campana et. al.,1995 and Campana, 1997) to demonstrate the importance of quality control and validation in ageing methodologies. He reviewed the methods available to ensure accuracy of ages observed from otoliths, including the recent application of C_{14} isotopes to validate ages and measures of precision for haddock and other species. Emphasis was placed on the difference between accuracy and consistency of age determination. His use of the calculation of coefficients of variation and age bias plots for precision testing, provided the basis for our discussions on testing for quality control.

DISCUSSION

- Discussion surrounding Bob Mohn's talk dealt with ways of fine tuning the model he presented. For example: Was it possible to minimize errors by using filters; could more complex aspects like variance over age be incorporated; and could coding for problematic otoliths be used to reduce error. It was felt that all of these options would be interesting to pursue but the time to do so was very limited. What level of agreement was necessary and how you incorporate these results into the assessment process was also asked. Although Bob's analysis did not incorporate this information, he felt that this was an important area to study.

- Discussion after Steve's presentation had mostly to do with alternative statistical methods for testing. An agreement matrix was not considered to be the most effective measure of bias and when asked if a weighted c.v. could be used instead, Steve's reply was yes, but since there is no trend with age and sample size, it would give the same result as an unweighted c.v. When asked why scatter plots were not appropriate, Steve replied that integer values heavily overlap each other, so that it's difficult to see trends. But the bias plots provide both mean age and measures of dispersion. Marginal increment analysis was cited as being used by many labs to validate ages of older fish and although Steve acknowledged this, he noted that as fish growth slows at older ages, it becomes difficult to detect seasonal growth increments using this method.

TESTING METHODS

In this section, participants discussed the types of testing which should be conducted on age determinations and the requirements for a standard set of ageing protocols.

i. Type of Tests

- Much discussion evolved around what tests should be conducted to evaluate:

a. Precision: the measure of repeatability, or consistency, and thus an estimate of the variability of an age interpretation; and

b. Accuracy: the measure of closeness to the 'true' age.

There are several tests available to evaluate precision. While widely used in the past, percent agreement is no longer used routinely, since it does not reflect bias and will always decline as the age range in the sample increases. The participants agreed that a comparison matrix contains all of the data required to give a view of overall agreement, but by itself does not clearly show trends in bias (over- or under-ageing) or provide a summary statistic of precision. Therefore, additional tests are required for routine monitoring.

- Age bias plots (appendix 5) appear to provide the best graphical measure of bias, since they provide an easily-interpreted, age by age measure of deviation away from an accepted, or reference, value. Therefore, they can clearly show under-ageing or over-ageing, even when the under/over-ageing occurs only in young or old fish. In principle, an analysis of variance with a blocked design would be preferable, since it would allow the comparison of more than two age determinations in a single test. However, development of analytical tools would be required for this test, since it would require control plots for easy interpretation. Other statistical tests, such as multiple t-tests performed on age classes, are not appropriate since they can result in chance significant results.
- Coefficients of variation (c.v.) are an easily calculated measure of the precision of two or more matched age determinations, and are considered to be the best available measure of precision. Unlike percent agreement, c.v. is stable across ages, and therefore is a useful summary statistic when bias is absent. For labs currently using percent agreement as a measure of precision, it was suggested that a transition period be adopted during which both c.v. and percent agreement are included in assessment documents for comparison with past test results.
- Tests for accuracy however are much more difficult and require extensive validation studies for all stocks and ages. Although agreed by all participants to be an important and indeed, integral part of the monitoring of quality control, the costs involved in both money and time requires a divisional mandate to carry out.

Ed. note: Because of confusion in terminology during discussions, I have defined accuracy and precision in accordance with current literature and have endeavoured to distill the conversation into these 2 areas.

RECOMMENDATIONS:

- *The percent agreement method for precision testing should be phased out in preference to the coefficient of variation (c.v.).*

- *Minimum test results should include age bias plots and c.v.'s in all age comparisons until analytical tools can be developed to run "ANOVA" tests in SPSS, SAS or other utilities. However, during the ransition period, percent agreement, along with overall and past c.v.'s should be tabled. A comparison matrix is also a useful table when more detailed information is required.*

ii. Protocols

a. Type of sample to be used for testing:

- The participants described the various approaches to sampling otolith collections for testing precision and bias. Some reported drawing a random sample from otoliths collected in the fishery, while others used a length-stratified random sampling within fishing quarter (for intra- and inter-reader variability) and still others drew 100 fish at random from a reference collection for comparison testing with the secondary ager. At the SABS, periodic exchanges are made with U. S. ageing technicians. These exchanges involve a limited number of samples drawn selectively from the collections.
- In general, participants felt that sampling could be size- or age-stratified and that it may also be drawn randomly from the collection. A random sampling may ensure the presence of "bad" samples in their relative proportion within the comparison.
- The goal of testing is one of quality control by maintaining precision and detecting patterns of bias in age interpretations. There are two issues: comparing primary and secondary readers (secondary reader has no knowledge of the primary reader ages); and testing precision against the reference or historical collections. (In this case, it would be desirable to have the secondary reader unaware that he/she is being tested.)

RECOMMENDATION:

-Because sampling is an important aspect of comparison testing, readers must consider an appropriate methodology that reflects the range of sizes, ages, gear sectors, etc. for their stocks.

b. Sample size:

- Sample size has been 100 at GFC. Some participants felt that 200 is more appropriate for their stocks.

RECOMMENDATION:

-Sample size for testing should be at least 100 otoliths and up to 200 if time permits.
-The problem of sample size should be examined further, on a stock by stock basis, using power tests to determine appropriate minimum sample size.

c. Frequency of tests:

- The participants reported considerable variability in the frequency of consistency and bias testing. At IML, one test has been conducted per year during the ageing of some stocks. Some readers at the SABS have two exchanges per year with U.S. readers as well as additional testing against another reader at the SABS (when available), plus one intra-reader test per year. A reference collection is

used to check on drift and bias. At the GFC, readers of groundfish stocks test themselves against the reference collection at the outset of production reading, then after every 1000 otoliths or two weeks of production ageing. The BIO has a requirement for secondary ageing for all stocks. Secondary agers are currently doing 20 percent reageing with bias plots and c.v.'s run at various times throughout the year.

- It was felt that inter- and intra-reader testing are necessary along with testing against the reference collection. Testing against the reference collection provides an evaluation of bias (detection of drift in interpretation); intra-reader testing evaluates precision. Most participants agreed that it is difficult to assign a strict guideline to the frequency of testing, but that a set of minimum standards should be applied.

RECOMMENDATIONS:

- *The reader should test against the reference collection before commencing, or during, production reading (at minimum this should be conducted yearly).* ***Note****: It is important to have sufficient otoliths in the reference collection to draw a random sample.*
- *Minimum testing is one test each year with inter-, intra-, and reference collection samples. Some level of periodic testing will be required for the ageing of stocks with large numbers of otoliths or ageing that extends over a lengthy period.*

d. Remedial Measures:

- This discussion surrounded steps to take when a bias is discovered or when the reader fails to attain an acceptable level of ageing precision.
- It was felt that reageing a subset of the historical reference collection (preferably including otoliths aged by both the previous reader as well as the current ager) was the first step.
- Annotated images would be a good way to assess where the changes in criteria happened.
- Once the ager felt their age interpretations were back on track, a blind test should be conducted, again using a subset of the historical collection.
- Tests for bias and consistency should then be run and if results meet the test standards, then reageing of all otoliths since the last test would be conducted.
- It was noted, however, that these measures should only be necessary if a bias consistently turns up with each testing.

RECOMMENDATION:

-When tests of consistency and/or bias fail to meet an acceptable standard, the following steps should be taken:

1. Reread the reference collection (the training portion) to recalibrate.
2. Conduct a blind test with the reference collection (the test portion) and run appropriate tests.
3. Re-age all otoliths from the point where the bias was first detected.

e. Secondary Agers:

- The purpose of secondary agers is to ensure the availability of expertise in the event of the departure of the primary ager as well as a tool for quality control.

- At the SABS, it has not been possible for the secondary agers to maintain their expertise and in most cases the system has been phased out.
- The group felt that although it is highly desirable to have secondary agers for each fish stock, expertise may be limited for certain species. As well, it may be difficult for the secondary readers to maintain their expertise.

RECOMMENDATION:

-In the absence of a secondary reader, or in addition to a secondary reader, an atlas of annotated otolith images should be maintained.

f. Reference collection:

- The reference collection is not necessarily a random collection. It should also reflect a variety of ages and otolith features. Annotation is important. The number of otoliths in the collection will depend on the range of ages, sectors, gears and other factors.

RECOMMENDATION:

- Two reference collections should be established for each stock: one for training (i.e., showing diversity in otolith features) and one for bias testing (for consistency in age determination). The reference collection for bias testing could also be used for exchanges with readers in other labs.

Ed. note: There seems to be some confusion over this recommendation. Some participants felt that the recommendation was that one reference collection would be sufficient if it showed adequate diversity and was large enough to allow random sampling. This should be reviewed by the RAWG and the above recommendation changed, if necessary, to reflect its decision.

g. Standards:

- The acceptable level of agreement can vary between stocks. One participant reported c.v.'s of <5% for some cod and haddock stocks. These measures of c.v.'s could become part of the otolith atlas. The acceptable level of consistency (c.v.) is stock-specific and must be evaluated with appropriate simulations for effect on catch-at-age and Adapt output. For bias testing, the customary level of Ho rejection ($P>0.05$) would be appropriate for an ANOVA test.

RECOMMENDATIONS:

- Each stock must develop its own standard for c.v. The acceptability of this standard can be measured by its impact on the stock assessment.
- Should ANOVA tests become the standard for bias testing, values should be in the 5% range with a power test. Visual plots of these tests are considered necessary as well.

WRAP-UP

Chairperson: **Diane Beanlands**

- Rapporteurs presented the recommendations from each session to participants, as well as the Division Chief and section heads for Marine Fish Div., Maritimes Region. Format of the proceedings and a time frame for their distribution to staff for comments was discussed. It was felt that the proceedings should be published, most probably as part of the Canadian Stock Assessment Proceedings Series.
- The question was raised as to whether the RAWG should be inter-regional with formal participation from the Quebec and Newfoundland Regions. Quebec participants were in agreement that this should be the case. It was decided that a formal request be sent to Jacques Gagne (division chief, IML) to participate in this RAWG. Since Newfoundland was not represented at the workshop, it was suggested that a copy of the proceedings should be sent to them for comment and possible participation in the RAWG.
- In closing the meeting, the chair thanked all the attendees for their active participation.

RECOMMENDATIONS:

- *A draft of these proceedings should be made available to participants by July 1 for comment.*
- *The final version of these proceedings should be published as part of the Canadian Stock Assessment Proceedings Series.*

Appendix 1. Workshop Agenda

DAY 1

09h00-09h15

INTRODUCTION / WELCOME

Chairperson: Beanlands **Rapporteur: Buzeta**

Objectives of the workshop:

- To exchange information and expertise;
- To recommend and present to section heads, protocols for quality control;
- To establish a Regional Ageing Working Group with a work plan target to produce a regional ageing procedures manual;
- To produce a research document on the proceedings of the workshop.

09h15-10h00

OVERVIEW

- **Introduction of participants** from each site;

- **Current processes:** 10 min. presentation of summary document to include the following by site and stock:

1. Ageing responsibilities and quality control procedures;
2. Criteria used (i.e. birth date, edge types, preferred area of otolith for ageing, etc.);
3. Procedures (i.e. otolith preparation, subsampling, equipment (IAS, microscope)).

REMARKS: a questionnaire will be sent to each site for the above information and a summary document prepared prior to the workshop.

10h00-10h30

BREAK

10h30-12h00

OVERVIEW (cont.')

- **Review:** Criteria from previous workshops (see references at end);

- **General Discussion.**
-
- Remarks: Participants should be familiar with the above and prepared to discuss.

. PRODUCT OF THIS SESSION:
Site by site summary of the ageing process. Recommendations to be forwarded to the Regional Ageing Working Group.

DAY 1

13h00-15h00

PROCEDURES

Chairperson: TBA **Rapporteur: Hamel**

- **Training**:

Presentation of a draft outline for Regional Training Procedures to be discussed by participants and submitted to the Regional Ageing Working Group (Including: guidelines for training new agers, ageing new species, need for secondary ager, etc.);

REMARKS: Draft outline to be presented by BIO. Each site should prepare their input prior to workshop and output to be included in the Regional Ageing Manual.

- **Reference Collection**:

- Purpose and Methodology: selection of samples, digitization of images, database, updating the collection, etc.;
- Criteria: number of otoliths per age, length, area required.
- Regional Reference Collection: discussion.

- **Subsampling**:

- Rationale for various subsampling (stratification) regimes (Input from assessment biologists important);
- Current research: Bayesian methodology study by S. Smith.
- General discussion.

15h00-15h30

BREAK

15h30-16h30

PROCEDURES (cont.)

- **Ageing Databases and Otolith Inventory:**

- Overview of current systems: Surveys, CGS (Commercial Groundfish Samples), IOP, etc. ;
- Possible modifications: Comeau (BIO), SABS, GFC (Modifications to be tabled and forwarded to Reg. Age. W.G. Discussion should be kept to a minimum);
- Historical inventory: purpose, setup, common Oracle tables etc.

- **Equipment: Image Analysis System**

- Description: components, adjustments, OPTIMAS software (Campana);
- Storage and exchange of information using image files.
- Demonstrations for those who can't remain on day 2 (These will conducted outside of core hours)

PRODUCT OF THIS SESSION:

Recommended modifications to be forwarded to the Regional Ageing Working Group.

DAY 2

08h30-10h00

QUALITY CONTROL

Chairperson: G. Chouinard **Rapporteur: R. Morin**

Presentations:

- Impact of ageing inconsistencies or biases on stock assessments (Mohn)
- Importance of validation studies and quality control in ageing (Campana)

- **Testing Methods:**

  - Presentation of summary document on testing methods used at each site (10 min.);
  - Review of recommendations from previous workshops;
  - Definition of minimum criteria for quality control: general discussion.
    . consistency, precision, bias;
    . secondary ageing (benefits, costs, proportion of samples to be aged, lack of resources etc.);
    . reference collection as a tool for testing agers;
    . frequency of testing: against self, against reference collection, against secondary ager;
    . definition of adequate coefficient of variation;
    . other statistical methods.

  REMARKS: The questionnaire circulated for the overview, will include space for each site to list testing methods currently utilized. This list should be accompanied by a glossary of statistical terms used, along with a brief description, which will be provided as a handout.

10h00-10h30

BREAK

10h30-12h00

QUALITY CONTROL (cont.)

- **Testing Methods** (cont.)

- **Sharing Tools**:

  - Presentations by each site on tools developed for quality control testing, i.e.; SPSS decks, Excel spreadsheets etc.
  - General discussion.

  REMARKS: Each site should provide copies of programs developed, along with their outputs, for distribution.

PRODUCT OF THIS SESSION:
Recommendations to the Regional Ageing Working Group and section heads, on a set of regional requirements for quality control of ageing.

DAY 2
13h00 -14h30 **WRAP UP** **Chairperson: Beanlands** **Rapporteur: Hurlbut** • **Summary of discussions and recommendations:** presentations by each rapporteurs (10-15 min each); • **List of actions:** general discussion; 14h30 - 16h00 **DEMONSTRATIONS** • **Image Analysis System;** • **Embedding/sectioning;**

Appendix 2. List of Participants.

Participant	Address	Phone	Fax	E-Mail
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Appendix 3a. Recommendations from Previous Workshops

1. 1987. Re-Examination of 4T-Vn (Jan-Apr) cod otoliths collected in the period 1982 -1985 for age. (Including a report of the 4T-Vn (Jan. Apr.) cod ageing workshop held in Moncton, June 22-24, 1987).
   From the workshop report:
   - "...It was suggested that workshops are an excellent forum to discuss age determination interpretations and should be held whenever problems appear".
2. 1991. Report of the Ageing Methodologies Working Group (CAFSAC Res. Doc. 91/63) Hunt
   Conclusions:
   -"In general, accuracy of age determinations is not well documented and known age fish are not available. Various techniques such as modal analysis, tag recapture and yearclass progression are used to validate estimates of age".
   -"Precision is maintained by replicate readings, multiple readers, use of reference collections, interlab exchanges and occasional".
3. 1992. Georges Bank Cod and Haddock Ageing Workshop (CAFSAC Res. Doc. 92/119) Buzeta et al
   Recommendation #
   3.I A change in the Canadian birthdate convention from Feb. 1 to Jan. 1 should be considered.
4. 1993. Unpublished Document: Results of 4X Haddock Workshop (Hunt ed.)
   Recommendation #
   5. The Canadian convention of using Feb. 1 should be changed to January 1 effective for 1993 samples and the database adjusted accordingly.
   6. Attempts should be made to validate the age of haddock estimated from otoliths using direct methods such as radioisotopes, etc.
   7. To ensure consistency, a secondary reader should be assigned for each stock with a requirement to age 20% or more of the total samples.
   10. A reference collection of ~200 otoliths should be established and readers required to re-age the sample on a regular basis.
5. 1994. Georges Bank Cod and Haddock Ageing Exchange and Workshop Nov. 8-10, 1993. (DFO ATL. FISH. DOC. 94/84) L. Van Eeckhaute and M.-I. Buzeta
   Recommendation #
   2. Workshops are seen as necessary only every other year, unless agreement decreases in the interim.
6. 1994. Report of the workshop on Sampling Strategies for Age and Maturity. ICES C. M. 1994/D:1
   Sec. 5: Ageing Reading Workshops and Exchanges of Ageing Structures
   5.2 They (control collections) are instruments for achieving formal quality control in the age reading process, and their use is important for providing means of testing the precision of age determinations either within laboratories or during exchanges or workshops.....
   5.7.1 The minimum requirement for age reading consistency is the absence of bias among readers and through time.
7. 1996. SABS Workshop on Age Determination Methodology for Fish Stock Assessments, DFO Atlantic Fisheries Proceedings 96/2 (Tripple ed.).
   Working Paper #1: Frequency of Conducting Intra- and Inter- Reader Tests, Time

Requirement, Half Year vs. Full Year Exploitation. (Trippel)

1. ...Once trained, however, an established schedule to ensure the age reader does not stray from this original consistency needs to be put in place for each stock.

1. ...The recommended target (for intra-reader testing) is to conduct one intra-reader test for each quarter in which the fishery is occurring .

2.....The recommended target (for inter-reader testing) is to conduct one inter-reader test for each quarter. It has been recommended that the secondary age reader conduct about 20% of production ageing.

8. ____. Age Determination Methods of the Marine Fish Division, Scotia- Fundy Region, Fisheries and Oceans Canada. J. Hunt (Unpublished Document)

Validation:

"There is currently a routine to verify ages assigned by experienced age readers. Random selection of samples for re-ageing by the original age reader or another experienced in that species is carried out and results consistently indicate variance of less than 10-20% from the initial reading. The current volume of samples aged precludes any duplicate ageing and it is unlikely that the degree of potential reduction in variance would justify the additional time required."

Appendix 3b. Proposed Training Outline for New Age Reader

The following is being tabled by the ageing staff at BIO, as a proposal for the training of new agers. We feel that this is a workable option for training that keeps the primary ager's involvement limited, but still provides the new ager with enough experience and testing to provide a quality product.

1. A literature review of relevant documentation for ageing in general and species/stock in particular.

2. Age approximately 50 otoliths with the primary ager, using an IAS or discussion microscope. (This familiarizes the new ager with terminology, and process.)

3. Age a random sample of approximately 200 otoliths on their own. (This allows the new ager to develop a search image and start to apply their own criteria. The primary ager should prepare this sample from otoliths collected from different gear types, time of year, area etc.)

4. Age approximately 50 otoliths with the primary ager. Some of these can come from the previous 200.

5. Age an additional 1000 otoliths. The majority of these should be previously read.

6. Conduct bias plots and CV's for otoliths that have been previously read.

7. If no bias is apparent and CV is appropriate, age the reference collection and run bias plots and CV's.

8. Start production aging if all the criteria have been met.

9. Age a subset of the reference collection on a quarterly basis for the first year of production ageing and test using bias plots and CV's.

Note: This requires that reference collections, both historical and contemporary, be established for all species. However, modifications to this maybe required for species with otoliths that deteriorate rapidly i.e. silver hake

Appendix 3c. Data Entry System

Proposed
Ageing Data Entry System
and Database

The current method of handling ageing data requires the use of 3 independent data entry systems in order to deal with the Research Vessel (RV) Survey, National Sampling Program (NSP), and International Observer Program (IOP) data. This results in resources being required to maintain the three independent systems and increases the training time for new agers. This system also does not provide for storage of secondary ageing information or reference collection data.

Data Entry System:

The proposed data entry system would provide a series of data entry windows that are identical for the three systems (RV, NSP, IOP).The first data entry window would prompt the user for the data source and sample number. The system would then query the appropriate data source for all available sample details and present the user with a data entry form that would require the entry of the required ageing information (age, edge type, etc.).
Any new data entry system would be set up in consultation with agers in order to incorporate features that would improve the system from a user's perspective.

Ageing Database:

The proposed new Ageing Database would provide for storage of ageing data not currently captured in the production database (without the need to alter the production database). The greatest shortfall of the current system is the ad hoc manner in which secondary ageing and reference collection data is dealt with. A new database would allow for the storage of multiple ages for individual fish.

A common database for all ageing information would facilitate quality control analysis and formalize the storage of ageing data reducing the risk of data loss. The new system would provide for quality control analysis prior to the data being entered into the production database without the need for data to be entered twice.

The new system would likely have 2 ORACLE tables, a header table that would contain sample information and a detail table that would capture the data for individual otoliths. The structure of these tables has not been finalized, however, attached is a very rough draft.

The development of this system would provide for the addition of fields to capture information that agers now collect but are unable to enter into the production database.

Appendix 4. References.

- Buzeta, M.-I., J. J. Hunt, L. VanEeckhaute. 1992. George's Bank Cod and Haddock Ageing Workshop, CAFSAC Res. Doc. 92/119.

- 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.

- Campana, S. E. 1997. Use of Radiocarbon from Nulear Fallout as a Dated Marker in the Otoliths of Haddock Melanogrammus aeglefinus. Marine Ecology Progress Series 150:49-56.

- Chouinard, G. A., L. Currie, J. Murphy. 1987. Re-examination of 4T-Vn (Jan.-Apr.) cod otoliths collected in the period 1982-1985 for age. CAFSAC Res. Doc. 87/99.

- Hunt, J. J. 1991. Report of the Ageing Methodologies Working Group. CAFSAC Res. Doc. 91/63.

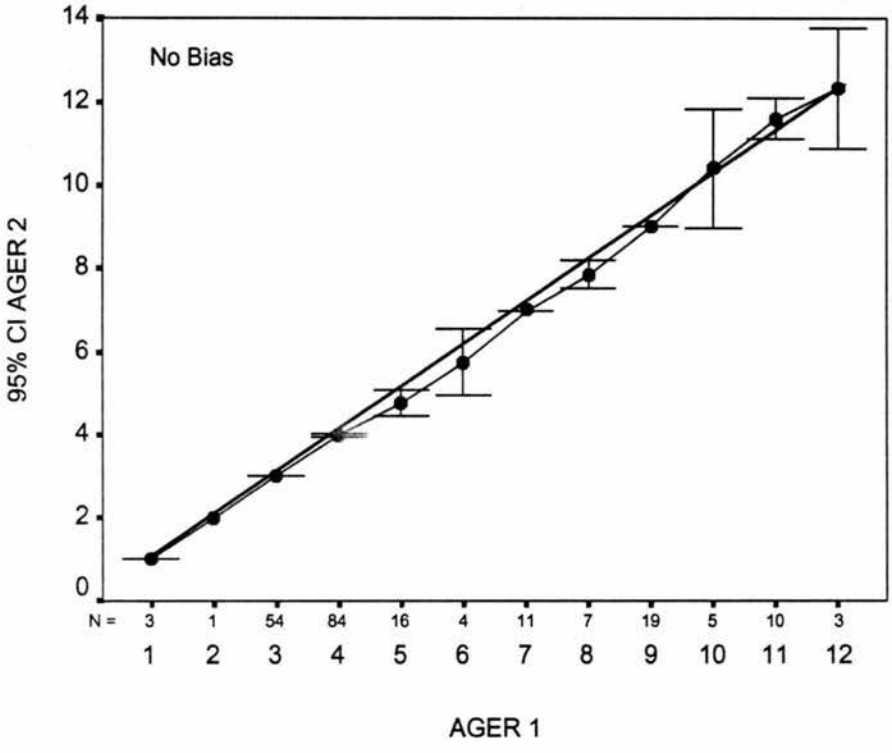
- Nandram, B., J. Sedransk and S. J. Smith. 1997. Order-Restricted Bayesian Estimation of the Age Composition of a Population of Atlantic Cod. J. Amer. Stat. Ass. Vol. 92, No. 437: 33-40.

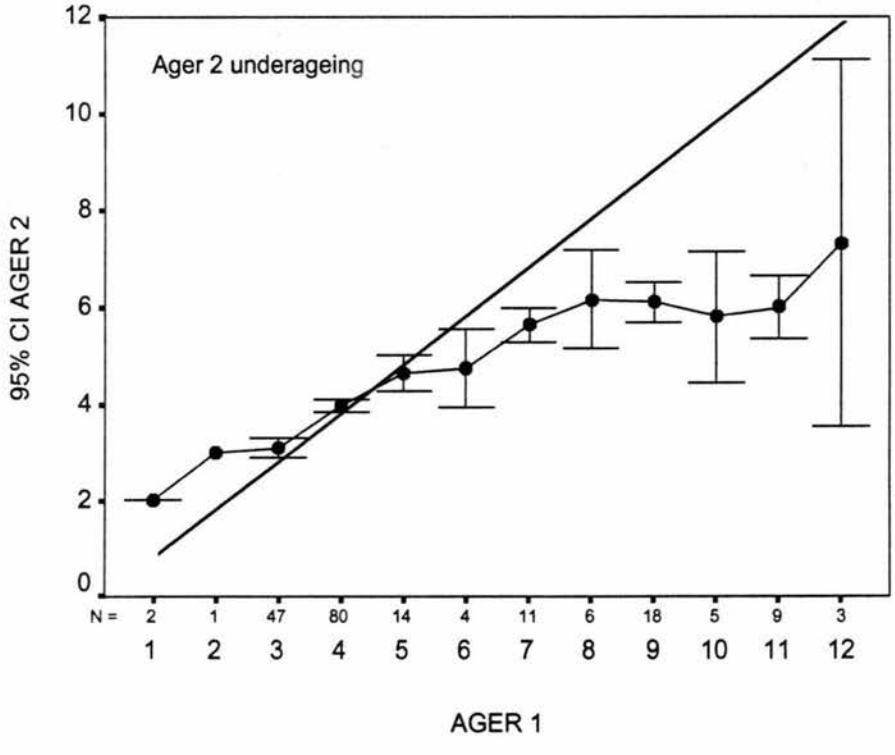
- Pentilla, J., L. M. Dery (eds.). 1988. Age Determination Methods for Northwest Atlantic Species. NOAA Tech Rept. NMFS 72.

- Trippel, E. A.(ed.) 1996. SABS Workshop on Age Determination Methodology for Fish Stock Assessments, DFO Atlantic Fisheries Proceedings 96/2.

- VanEeckhaute, L., M.-I. Buzeta et al. 1994. Georges Bank Cod and Haddock Ageing Exchange and Workshop, Nov. 8-10, 1993. CAFSAC Res. Doc. 94/84.

Appendix 5. Example of Age Bias Plot.





Appendix 6. Results of ageing questionnaires.

OUTLINE OF AGEING PROCEDURES IN DFO LABS AT THE BEDFORD INST. OF OCEANOGRAPHY, GULF FISHERIES CTR., INSTITUT MAURICE-LAMONTAGNE, AND ST. ANDREWS BIOLOGICAL STATION.

TABLE OF CONTENTS

Stock **Page**

4Vn Cod

Lab	BIO
Species - Stock	Cod - 4Vn(M-O)
Assessment Biologist	Mohn
Biologist Phone/Email	P: (902) 426-4592 F: (902) 426-1506 E: r_mohn@bionet.bio.dfo.ca
Primary Ager	Wilson
Ager - Phone/Email	P: (902) 426-3318 F: (902) 426-1506 E: wilsons@mar.dfo-mpo.gc.ca
Secondary Ager	Hamel
Ager - Phone/Email	P: (902) 426-4435 F: (902) 426-9710 E: hamelj@mar.dfo-mpo.gc.ca
Average Number Aged - RV	200/yr from 4VW July Survey; 300/yr from Inshore 4Vn Survey
Average Number Aged - Comm.	100-200/yr since 4Vn closure (~1000/year before closure); ~5000/yr from Sentinel Fishery
Average Aged/Week	500
Sampling Method	Length-stratified for RV and commercial samples; random for Sentinel Fishery.
Percent of Collection Aged	100%
Subsampling Protocol	N/A
Catch-at-Age Stratification	Stratification by quarter, area and gear.
Structure used for Ageing	Otoliths
Storage Method before Ageing	Dry in envelopes
Storage Method after Ageing	Sectioned otoliths mounted on plexiglass plates or dry envelopes. Stored indefinitely.
Surface Aged	Cross-section
Sectioning Method	High-speed diamond-blade saw (approx. 1.0 mm thick)
Preparation Method	Otoliths are embedded in polyester resin, sectioned, and mounted on acrylic plates (~50/plate). Sections are coated with "Krylon" clear coat.
Viewing Technique	Image Analysis System (Microscope magnification=15X) with reflected light.
Information Available to Ager	Fish number & sample date
Birth Date	N/A, (Fish only caught in summer)

4Vn Cod (cont.)

Nucleus Included in Age	No
Prefered Axis for Ageing	Dorsal + proximal axes
Which Otolith Aged	Both
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	No - Checks are excluded
Is a plus group used?	No
'Other' Ageing Conventions	5 "Edge Types" are recognized: Narrow Hyaline, Wide Hyaline, Narrow Opaque, Wide Opaque, Crystalized. Depending on the time of year when the fish was sampled and the edge type, the age may be increased or decreased.
Maximum Assigned Age	20+
Procedures used for Quality Control	Inter-reader comparison (primary and secondary agers). 25% overlap by secondary ager.
Frequency of Testing	3 times a year
Statistics for Testing	CV and bias plots.
Criteria for Passing Quality Test	Max. CV of 5 with no bias.
Remedial Action	Re-ageing of sample(s) and discussion using IAS to reach agreement.
Does a Reference Collection exist?	Y
Size of Reference Collection	500 otolith sections on plates and 500 digitized and anotated images.
Freq. of Updating Ref. Collection	As needed.
Training Procedures	The new ager(s) initially work with the primary ager on the IAS, aging historic and current material before going solo. After training, the new agers are tested for precision and bias (CV and bias plots) against established ages.
Databases that use Age Data for Stock	Scotian Shelf Survey, IOP(?), NSP, 4Vn Inshore, 4Vn Sentinel
Ageing Reports for Stock	(1)Chouinard et al 1987. Re-examination of 4TVn(J-A) cod. (2)Hunt MS. Age determination methods of S-F region. (3)Hunt 1991. Report of aging methodologies working group. (4)Penttila & Dery 1988. Age determination methods for NW Atlantic species.
Comments	4Vn Sentinel Fishery has collected ~5,000 otoliths/yr since 1993. These are aged by 4Vn Sentinel Fishery employees T. Jewett & T. Davignon with training & guidance by MFD/BIO personnel.

4VsW Cod

Lab	BIO
Species - Stock	Cod - 4VsW
Assessment Biologist	Fanning
Biologist Phone/Email	P: (902) 426-3190 F: (902) 426-1506 E: p_fanning@bionet.bio.dfo.ca
Primary Ager	Mac Eachern
Ager - Phone/Email	P: (902) 426-3517 F: (902) 426-1506 E: w_maceachern@bionet.bio.dfo.ca
Secondary Ager	Hamel
Ager - Phone/Email	P: (902) 426-4435 F: (902) 426-9710 E: j_hamel@bionet.bio.dfo.ca
Average Number Aged - RV	200 from 4VW July Survey; 500 from Inshore 4Vn Survey
Average Number Aged - Comm.	300-500 since fishery closure (3000/year before closure)
Average Aged/Week	500
Sampling Method	Length-stratified for RV, NSP, IOP and sentinel samples; opportunistic for others.
Percent of Collection Aged	100 % for 94-96, from 90-94 all except IOP otoliths were done, prior to this ?
Subsampling Protocol	Yes, subsamp program for RV samples, but this has not been necessary for some time.
Catch-at-Age Stratification	Stratification by quarter, area and gear.
Structure used for Ageing	Otoliths
Storage Method before Ageing	Dry in envelopes
Storage Method after Ageing	Mounted plates (indefinitely).
Surface Aged	Cross-section
Sectioning Method	High-speed diamond-blade saw (approx. 1.0 mm thick)
Preparation Method	Sections are embedded in polyester resin on acrylic plates (~50/plate).
Viewing Technique	Image Analysis System (Microscope magnification=15X objective) and reflected light.
Information Available to Ager	Source, sample number, fish number & sample date
Birth Date	Feb. 1

4VsW Cod (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Rostrum
Which Otolith Aged	Both
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	No - Checks are excluded
Is a plus group used?	No
'Other' Ageing Conventions	Depending on the edge type and the time of year when the fish was sampled, the age may be increased or decreased. A narrow hyaline zone near the nucleus is taken to be a settling check.
Maximum Assigned Age	16
Procedures used for Quality Control	Inter & intra-reader comparisons (primary and secondary agers).
Frequency of Testing	Constant. Secondary reader randomly selects 25% of all otoliths asap after primary has completed.
Statistics for Testing	CV and bias plots.
Criteria for Passing Quality Test	CV < 5.0 and no bias.
Remedial Action	Reageing of sample(s) and discussion using IAS to reach agreement.
Does a Reference Collection exist?	Collection of 197 pairs of otoliths was put together and sent out for comparative reading by other labs. Has not been received back again.
Size of Reference Collection	197 pairs of otoliths.
Freq. of Updating Ref. Collection	No updating has ever been done.
Training Procedures	No protocols or procedures have been established for the training of new agers for this stock.
Databases that use Age Data for Stock	RV Survey, IOP, NSP, 4VsW Sentinel
Ageing Reports for Stock	
Comments	none

4TVW Haddock

Lab	BIO
Species - Stock	Haddock - 4TVW
Assessment Biologist	Frank
Biologist Phone/Email	P(902)426-3498 F(902) 426-1506 frankk@mar.dfo-mpo.gc.ca
Primary Ager	Simon
Ager - Phone/Email	P(902) 426-4136 F(902) 426-1506simonj@mar.dfo-mpo.gc.ca
Secondary Ager	Beanlands
Ager - Phone/Email	P(902)426-3515 F(902)426-1506 E beanlandsd@mar.dfo-mpo.gc.ca
Average Number Aged - RV	1000
Average Number Aged - Comm.	1000
Average Aged/Week	unknown
Sampling Method	Length stratified
Percent of Collection Aged	80%
Subsampling Protocol	Subsampling routine on the MFM program on canso
Catch-at-Age Stratification	New assessment
Structure used for Ageing	Otoliths
Storage Method before Ageing	Dry in Envelopes
Storage Method after Ageing	Sectioned otoliths mounted on plexiglass plates or dry envelopes. Stored indefinitely.
Surface Aged	Cross-section
Sectioning Method	'High-speed diamond-blade saw (approx. 1.0 mm thick)
Preparation Method	Otoliths are embedded in polyester resin, sectioned, and mounted on acrylic plates (~50/plate). Sections are coated with "Krylon" clear coat.
Viewing Technique	Image analysis system (Microscope magnification=12X) with reflected light.
Information Available to Ager	Length,Sex & Location
Birth Date	Feb. 1

4TVW Haddock (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Sulcus ridge and then rostrum
Which Otolith Aged	Both
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	No - Checks are excluded
Is a plus group used?	N
'Other' Ageing Conventions	N
Maximum Assigned Age	?
Procedures used for Quality Control	Inter-reader comparison (primary and secondary agers). 20% overlap by secondary ager.
Frequency of Testing	"On the fly".
Statistics for Testing	CV and bias plots.
Criteria for Passing Quality Test	Max. CV of 5 with no bias.
Remedial Action	Re-ageing of sample(s) and discussion using IAS to reach agreement.
Does a Reference Collection exist?	Y
Size of Reference Collection	~200
Freq. of Updating Ref. Collection	As needed
Training Procedures	The new ager must meet the minimum requirements(CV<5 and no bias) on the reference collection and then be tested against the other ager of the stock
Databases that use Age Data for Stock	SS R/V summer survey and Commercial sampling
Ageing Reports for Stock	NA
Comments	The testing procedures etc. will all be up for review when the re-ageing of this stock is complete.

4X Haddock

Lab	BIO
Species - Stock	Haddock - 4X
Assessment Biologist	Hurley
Biologist Phone/Email	P (902)426-3520 F (902) 426-1506 E hurleyp@mar.dfo-mpo.gc.ca
Primary Ager	Comeau
Ager - Phone/Email	P (902) 426-4136 F (902) 426-1506 E comeaup@mar.dfo-mpo.gc.ca
Secondary Ager	Beanlands
Ager - Phone/Email	P(902)426-3515 F(902)426-1506 E beanlandsd@mar.dfo-mpo.gc.ca
Average Number Aged - RV	600
Average Number Aged - Comm.	1800
Average Aged/Week	unknown
Sampling Method	Length stratified
Percent of Collection Aged	80%
Subsampling Protocol	For Survey - Subsamp routine on the MFM program on canso; for Commercial samples subsample for quarters with large number of samples collected
Catch-at-Age Stratification	Stratification by quarter, area, and gear
Structure used for Ageing	Otoliths
Storage Method before Ageing	Dry in Envelopes
Storage Method after Ageing	Sectioned otoliths mounted on plexiglass plates or dry envelopes. Stored indefinitely.
Surface Aged	Cross-section
Sectioning Method	'High-speed diamond-blade saw (approx. 1.0 mm thick)
Preparation Method	Otoliths are embedded in polyester resin, sectioned, and mounted on acrylic plates (~50/plate). Sections are coated with "Krylon" clear coat.
Viewing Technique	Image analysis system (Microscope magnification=12X) with reflected light.
Information Available to Ager	Date and location of capture, length & sex
Birth Date	Feb. 1

4X Haddock (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Sulcus ridge and then rostrum
Which Otolith Aged	Both
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	Yes
Is a plus group used?	N
'Other' Ageing Conventions	None.
Maximum Assigned Age	?
Procedures used for Quality Control	Inter-reader comparison of 20% overlap of otoliths.
Frequency of Testing	Currently about once a month: will likely change after the re-ageing has been completed.
Statistics for Testing	C.V.s and bias plots
Criteria for Passing Quality Test	Max. CV of 5 with no bias.
Remedial Action	Re-ageing of sample(s) and discussion using IAS to reach agreement.
Does a Reference Collection exist?	Y
Size of Reference Collection	~200
Freq. of Updating Ref. Collection	As needed
Training Procedures	New ager must achieve a CV of > 5.0 and minimal bias with the reference collection and the other experienced agers.
Databases that use Age Data for Stock	National Sampling (CGS); Groundfish Survey.
Ageing Reports for Stock	N/A
Comments	Currently re-ageing of 4X haddock from 1985 to present is being completed. Following this exercise, the reference collection and secondary ageing protocols will be reviewed.

4VWX Silver Hake

Lab	BIO
Species - Stock	Silver Hake - 4VWX
Assessment Biologist	Showell
Biologist Phone/Email	P (902) 426-3501 F (902) 426-1506 E SHOWELLM@mar.dfo-mpo.gc
Primary Ager	Young
Ager - Phone/Email	P (902) 426-3294 F (902) 426-1506 E YOUNGG@mar.dfo-mpo.gc.ca
Secondary Ager	Showell
Ager - Phone/Email	P (902) 426-3501 F (902) 426-1506 E SHOWELLM@mar.dfo-mpo.gc.ca
Average Number Aged - RV	400-500
Average Number Aged - Comm.	2500?
Average Aged/Week	400-500
Sampling Method	Length-stratified.
Percent of Collection Aged	?
Subsampling Protocol	Yes, for RV use the one in survey subsampling routine at the rate of 5/cm for all sexes, lengths to 24 cm, and 10 per cm/sex lengths 25 to 60 cm.
Catch-at-Age Stratification	?
Structure used for Ageing	otoliths
Storage Method before Ageing	RV otoliths stored in glycerin/thymol solution, IOP initially stored dry in envelopes, and transferred to glycerin/thymol solution later.
Storage Method after Ageing	otoliths are stored in glycerin/thymol solution. Otoliths structures break down over time, and become impossible to read after a number of years.
Surface Aged	Whole Otolith
Sectioning Method	n/a
Preparation Method	n/a
Viewing Technique	IAS or transmitted light,low magnification used.
Information Available to Ager	Length and sex are available
Birth Date	?

4VWX Silver Hake (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	
Which Otolith Aged	Both
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	Silver Hake otoliths contain many "checks" which are not counted.
Is a plus group used?	No
'Other' Ageing Conventions	5 "Edge Types" are recognized: 1=Narrow Hyaline, 2=Wide Hyaline, 3=Narrow Opaque, 4=Wide Opaque, 5=Crystalized. Depending on the time of year when the fish was sampled and the edge type, the total number of annuli counted may be increased or decreased.
Maximum Assigned Age	N/A
Procedures used for Quality Control	N/A, the plan calls for a secondary ager, but as of yet no inter-reading is done
Frequency of Testing	N/A
Statistics for Testing	N/A
Criteria for Passing Quality Test	N/A
Remedial Action	N/A
Does a Reference Collection exist?	NO
Size of Reference Collection	
Freq. of Updating Ref. Collection	
Training Procedures	200 randomly chosen otoliths are aged by the new ager, followed by side-by-side ageing with an experienced ager to review/discuss the assigned ages. Smaller samples are then aged & checks for % agreement and bias are made.
Databases that use Age Data for Stock	IOP databases and SF R/V surveys database
Ageing Reports for Stock	
Comments	None

4T American Plaice

Lab	GFC
Species - Stock	A. Plaice - 4T
Assessment Biologist	Morin
Biologist Phone/Email	P (506) 851-2073 F (506) 851-2620 E morinr@mar.dfo-mpo.gc.ca
Primary Ager	Forest-Gallant
Ager - Phone/Email	P (506) 851-6242 F (506) 851-2620 E Forest-Gall@mar.dfo-mpo.gc.ca
Secondary Ager	N/A
Ager - Phone/Email	N/A
Average Number Aged - RV	5200
Average Number Aged - Comm.	1500
Average Aged/Week	800
Sampling Method	Length-stratified
Percent of Collection Aged	100%
Subsampling Protocol	No.
Catch-at-Age Stratification	Stratification by halfyear, area and gear.
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Wet, Glycerin-thymol solution in vials
Storage Method after Ageing	Wet, Glycerin-thymol solution in vials (indefinitely)
Surface Aged	Whole otolith
Sectioning Method	Read whole.
Preparation Method	N/A
Viewing Technique	Light microscope (Magnification=10x6.4) and reflected light.
Information Available to Ager	None.
Birth Date	Jan. 1

4T American Plaice (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Rostrum
Which Otolith Aged	The two otoliths are available and looked at. I use the "best" otolith/axis.
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	Checks are not counted
Is a plus group used?	N
'Other' Ageing Conventions	Edge types: 1=NH, 2=WH, 3=NO, 4=WO, 5= crystalized or unreadable. The no. of annuli can be increased or decreased by one, dependind on the time of year the fish was caught, to get the age.
Maximum Assigned Age	32 (comm.) 28 (RV)
Procedures used for Quality Control	Inter-Reader agreement is assessed by ageing 100 otoliths from the reference collection.
Frequency of Testing	Either weekly or after every 1000 otoliths (whichever occurs first).
Statistics for Testing	% Agreement and Test for Skewness.
Criteria for Passing Quality Test	Min. % Agreement=75% and no skewness.
Remedial Action	Ages since last test are discarded and ager is recalibrated using the reference collection until agreement is 75 % with no skewness.
Does a Reference Collection exist?	Y
Size of Reference Collection	262 otoliths in vials with glycerin/thymol
Freq. of Updating Ref. Collection	Done "As Needed".
Training Procedures	New ager sits with the reference collection and an experienced ager. The new ager "prctices" until he reaches the standards wanted (75 % & no skewness).
Databases that use Age Data for Stock	Southern Gulf R/V Survey and Commercial Sampling Databases.
Ageing Reports for Stock	
Comments	None

4T-Vn(Nov-Apr) Cod

Lab	GFC
Species - Stock	Cod - 4T-Vn(Nov-Apr)
Assessment Biologist	Sinclair
Biologist Phone/Email	P (506) 851-2721 F (506) 851-2620 E sinclaira@mar.dfo-mpo.gc.ca
Primary Ager	Currie Murphy
Ager - Phone/Email	P (506) 851-6145 F (506) 851-2620 E curriel@mar.dfo-mpo.gc.ca P (506) 851-3869 F (506) 851-2620 E murphyj@mar.dfo-mpo.gc.ca
Secondary Ager	N/A
Ager - Phone/Email	N/A
Average Number Aged - RV	3500
Average Number Aged - Comm.	3000-7000
Average Aged/Week	800-1000
Sampling Method	Length-stratified
Percent of Collection Aged	45% - 100%
Subsampling Protocol	Sub-sampling is not routinely done, however, if the volume is too large (eg. sentinel fishery in 1996), otoliths are chosen randomly, stratified by length; to a maximum of 10 fish chosen per one cm length group per gear and quarter.
Catch-at-Age Stratification	Stratification by area (ie 4T vs 4Vn(Nov-Apr)), gear and quarter.
Structure used for Ageing	Otoliths
Storage Method before Ageing	Dry in Envelopes
Storage Method after Ageing	Some are held dry in envelopes. The majority are embedded in resin, sectioned, and the strips containing the otolith sections are mounted on clear plastic plates. (indefinitely).
Surface Aged	Cross-Section.
Sectioning Method	High-speed sectioning machine; sections approx. 0.9mm thick. Otoliths of fish <25cm are broken with a scalpel, mounted in plasticene. Some otoliths are cut in half with a low-speed Isomet and read.
Preparation Method	Sections are mounted on clear plastic plates (15 fish per plate - 2 otoliths each; ie 30 sections). Those broken or cut in half are mounted in plasticene to read.
Viewing Technique	Light microscope (Magnification=20 x 6.4) and reflected light.
Information Available to Ager	Date is known, but we also have access to the length and location of capture.
Birth Date	Jan. 1

4T-Vn(Nov-Apr) Cod (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	3 Axes are read: Rostrum, proximal and the 'back side'.
Which Otolith Aged	Both otoliths are aged if both are embedded, otherwise whichever one is available - no choice is made.
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	Checks and spawning checks are not counted, and split rings are treated as one.
Is a plus group used?	N
'Other' Ageing Conventions	5 "Edge Types" are recognized: 1=Narrow Hyaline, 2=Wide Hyaline, 3=Narrow Opaque, 4=Wide Opaque, 5=Crystalized. Depending on the time of year when the fish was sampled and the edge type, the total number of annuli counted may be increased or decreased.
Maximum Assigned Age	25
Procedures used for Quality Control	Inter-Reader agreement is assessed by ageing 100-120 otoliths randomly chosen from the reference collection. I.A.S. system will be used in future for intra-reader calibrations and discussions.
Frequency of Testing	Before beginning to age, and after every 1000 otoliths.
Statistics for Testing	% Agreement and Test for Skewness; or Chi-Square test if agreement is > 85%.
Criteria for Passing Quality Test	Min. % Agreement=70% and no skewness.
Remedial Action	Re-calibration with the reference collection. There was only one instance where the previous 1000 ages were discarded,and aged again after calibration.Also, after plots of age versus length, outliers are re-aged.
Does a Reference Collection exist?	Y
Size of Reference Collection	One collection comprised of approx. 1650 otoliths from research & commercial. One older/poorer quality collection of 720 fish (research & comm.).
Freq. of Updating Ref. Collection	Done "As Needed".
Training Procedures	No protocols or procedures are established for training new agers. When it does occur, the primary & new ager will examine otoliths using both discussion scope and I.A.S. until the new ager is testing comparably with reference collection and primary ager.
Databases that use Age Data for Stock	Southern Gulf R/V Survey and Commercial and observer Sampling Databases.
Ageing Reports for Stock	Chouinard, G.A., L. Currie and J. Murphy.1987. Re-examination of 4T-Vn(Jan-Apr) cod otoliths collected in the period 1982-1985 for age.(Including a report of the 4T-Vn cod ageing workshop held in Moncton, June 22-24,1987). CAFSAC Res. Doc. 87/99. 34 pp.
Comments	None

4TVn Herring

Lab	GFC
Species - Stock	Herring - 4TVn
Assessment Biologist	Claytor
Biologist Phone/Email	P (506) 851-6249, F (506) 851-2620, E Claytorr@mar.dfo-mpo.gc.ca
Primary Ager	MacDougall
Ager - Phone/Email	P (506) 851-6217 F (506) 851-2620 E MacDougallC@mar.dfo-mpo.gc.ca
Secondary Ager	No Person
Ager - Phone/Email	N/A
Average Number Aged - RV	2500
Average Number Aged - Comm.	5500
Average Aged/Week	500
Sampling Method	Stratified at 2 per 1/2 cm
Percent of Collection Aged	100%
Subsampling Protocol	All aged
Catch-at-Age Stratification	Stratification by time, area, and gear
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Otoliths are set in acrylic otolith trays and covered in solvent based synthetic resin (This is permanent storage).
Storage Method after Ageing	Same as before ageing. Indefinitely.
Surface Aged	Whole
Sectioning Method	Not sectioned
Preparation Method	See storage before Ageing
Viewing Technique	The resin in the tray is covered with water or a weak alcohol water solution. A light microscope at 15 x 16 magnification with polarized, reflected light is used to count the rings.
Information Available to Ager	Gear, Time and location of capture
Birth Date	Jan. 1

4TVn Herring (cont.)

Nucleus Included in Age	When ageing, the number of rings, excluding the nucleus is recorded. For assessment, if gonadosomatic index analysis determines the fish to be autumn spawning the nucleus is added to the number of rings to produce the age. If spring , age = # of rings.
Prefered Axis for Ageing	Rostrum with comparison with post rostrum. If no match no age
Which Otolith Aged	Either otolith or both may be aged, depending on their clarity. The usual procedure is: if clear, just one is aged; if difficult, then both are aged and the ages are compared; if there is no match choose clearest or don't age.
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	Check's or split zones are not counted . (See note on nucleus)
Is a plus group used?	Prior to 1996, age 11 was used to designate a 11+ group of herring. Staring in 1996, fish are aged to maximum number of rings countable and a + sign is recorded if there are more. The > 11 group is still however used for the assessment
'Other' Ageing Conventions	Edge types are not recorded for herring; (they are however taken into account when Ageing). Starting In 1996 (in an Ageing comments field) checks, splits, etc. are being recorded.(i.e. N12c3spl4)
Maximum Assigned Age	One otolith which could be read to 22 but might have been placed in 11+ group and one which could not be accurately read that looked close to 30 years old.
Procedures used for Quality Control	Intra-reader agreement is checked against previously aged samples chosen randomly from historical data base.
Frequency of Testing	When felt necessary
Statistics for Testing	% agreement and bias.
Criteria for Passing Quality Test	
Remedial Action	No set testing procedure has yet been adopted. To this point, these procedures have not been necessary.
Does a Reference Collection exist?	There is no specific collection. Checks have been done on otoliths randomly selected from various years of the total collection
Size of Reference Collection	No specific collection
Freq. of Updating Ref. Collection	No specific collection
Training Procedures	No protocols or procedures have been established for the training of new agers for this stock. This has not occurred since the formation of the G.F.C.
Databases that use Age Data for Stock	Herring detail files
Ageing Reports for Stock	
Comments	Although the most recent video imaging technology has not been tried ;the limited depth of field of previous video analysis systems, coupled with the convexity of herring otoliths, tended to produce unreliable images.

4T White Hake

Lab	GFC
Species - Stock	White Hake - 4T
Assessment Biologist	Hurlbut
Biologist Phone/Email	P (506) 851-6216 F (506) 851-2620 E hurlbutt@mar.dfo-mpo.gc.ca
Primary Ager	Richard
Ager - Phone/Email	P (506) 851-2017 F (506) 851-2620 E richardy@mar.dfo-mpo.gc.ca
Secondary Ager	N/A
Ager - Phone/Email	N/A
Average Number Aged - RV	1000
Average Number Aged - Comm.	2000
Average Aged/Week	500
Sampling Method	Length-stratified.
Percent of Collection Aged	100%
Subsampling Protocol	No.
Catch-at-Age Stratification	Stratification by quarter, area and gear.
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Dry in Envelopes.
Storage Method after Ageing	Dry in Envelopes (indefinitely).
Surface Aged	Cross-Section.
Sectioning Method	Low Speed "Isomet" Saw (sections are approx. 0.5 mm thick).
Preparation Method	Sections are embedded with polyester resin in plastic trays (50/tray).
Viewing Technique	Light microscope (Magnification=10x16) and reflected light.
Information Available to Ager	None.
Birth Date	Jan. 1

4T White Hake (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Rostrum
Which Otolith Aged	Just one - either right or left is sectioned and aged.
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	W. Hake otoliths contain many "checks" which are not counted.
Is a plus group used?	N
'Other' Ageing Conventions	5 "Edge Types" are recognized: 1=Narrow Hyaline, 2=Wide Hyaline, 3=Narrow Opaque, 4=Wide Opaque, 5=Crystalized. Depending on the time of year when the fish was sampled and the edge type, the total number of annuli counted may be increased or decreased.
Maximum Assigned Age	17
Procedures used for Quality Control	Inter-Reader agreement is assessed by ageing two randomly selected trays (50 otoliths each) from the reference collection.
Frequency of Testing	Either weekly or after every 500 otoliths (whichever occurs first).
Statistics for Testing	% Agreement and Test for Skewness.
Criteria for Passing Quality Test	Min. % Agreement=75% and no skewness.
Remedial Action	Recently assigned ages (i.e. in the past week) are discarded and the ager re-calibrates with the reference collection until the % Agreement exceeds 75% and there is no skewness.
Does a Reference Collection exist?	Y
Size of Reference Collection	550 Otolith Sections in Trays.
Freq. of Updating Ref. Collection	Done "As Needed".
Training Procedures	No protocols or procedures have been established for the training of new agers for this stock. When it has occurred, the new ager has conducted side-by-side ageing with the reference or primary ager for variable amounts of time (minimum of 3 weeks).
Databases that use Age Data for Stock	Southern Gulf R/V Survey and Commercial Sampling Databases.
Ageing Reports for Stock	Clay, D. and H. Clay. 1991. Determination of age and growth of white hake (Urophycis tenuis) from the southern Gulf of St. Lawrence, Canada (including techniques for commercial sampling). Can. Tech. Rep. Fish. Aquat. Sci. 1828: 29 + vip.
Comments	None

4T Winter Flounder

Lab	GFC
Species - Stock	Winter flounder - 4T
Assessment Biologist	Morin
Biologist Phone/Email	P (506) 851-2073 F (506) 851-2620 E morinr@mar.dfo-mpo.gc.ca
Primary Ager	Forest-Gallant
Ager - Phone/Email	P (506) 851-6242 F (506) 851-2620 E Forest-Gall@mar.dfo-mpo.gc.ca
Secondary Ager	N/A
Ager - Phone/Email	N/A
Average Number Aged - RV	Collect approx. 800 per year but ageing irregular
Average Number Aged - Comm.	200
Average Aged/Week	N/A
Sampling Method	Length-stratified
Percent of Collection Aged	variable
Subsampling Protocol	No.
Catch-at-Age Stratification	Stratification by halfyear, area and gear. When Possible.
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Dry, in envelloppes, (since 1994 ?)
Storage Method after Ageing	before 94: wet in glycerin/thymol since 1994, dry, in envelopes
Surface Aged	Whole otolith
Sectioning Method	Read whole.
Preparation Method	N/A
Viewing Technique	Light microscope (Magnification=10x6.4) and reflected light.
Information Available to Ager	None.
Birth Date	Jan. 1

4T Winter Flounder (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Rostrum
Which Otolith Aged	The two otoliths are available and looked at. I use the "best" otolith/axis.
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	Checks are not counted
Is a plus group used?	N
'Other' Ageing Conventions	Edge types: 1=NH, 2=WH, 3=NO, 4=WO, 5= crystalized or unreadable. The no. of annuli can be increased or decreased by one, dependind on the time of year the fish was caught, to get the age.
Maximum Assigned Age	15 (comm.) 12 (RV)
Procedures used for Quality Control	Inter-Reader agreement is assessed by ageing 100 otoliths from the reference collection.
Frequency of Testing	Either weekly or after every 1000 otoliths (whichever occurs first).
Statistics for Testing	% Agreement and Test for Skewness.
Criteria for Passing Quality Test	Min. % Agreement=75% and no skewness.
Remedial Action	Ages since last test are discarded and ager is recalibrated using the reference collection until agreement is 75 % with no skewness.
Does a Reference Collection exist?	Y
Size of Reference Collection	165 otoliths in envelopes
Freq. of Updating Ref. Collection	Done "As Needed".
Training Procedures	New ager sits with the reference collection and an experienced ager. The new ager "prctices" until he reaches the standards wanted (75 % & no skewness).
Databases that use Age Data for Stock	Southern Gulf R/V Survey and Commercial Sampling Databases.
Ageing Reports for Stock	
Comments	None

4RST Atlantic Halibut

Lab	IML
Species - Stock	Atlantic halibut - 4RST
Assessment Biologist	Archambault
Biologist Phone/Email	P (418) 775-0705 F (418) 775-0740 E archambaultd@dfo-mpo.gc.ca
Primary Ager	Archambault
Ager - Phone/Email	P (418) 775-0705 F (418) 775-0740 E archambaultd@dfo-mpo.gc.ca
Secondary Ager	N/A
Ager - Phone/Email	N/A
Average Number Aged - RV	50
Average Number Aged - Comm.	1000
Average Aged/Week	300
Sampling Method	Length-sex-stratified.
Percent of Collection Aged	100%
Subsampling Protocol	No.
Catch-at-Age Stratification	Stratification by year.
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Dry in Envelopes.
Storage Method after Ageing	Dry in Envelopes (indefinitely).
Surface Aged	Whole otolith.
Sectioning Method	N/A
Preparation Method	Alcohol immersion.
Viewing Technique	Light microscope (Magnification=10x21) and reflected light.
Information Available to Ager	Time of capture.
Birth Date	Jan. 1

4RST Atlantic Halibut (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Rostrum and sulcus region.
Which Otolith Aged	Just one - Left sagittae.
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	A. halibut otoliths contain some "checks" which are not counted.
Is a plus group used?	N
'Other' Ageing Conventions	None
Maximum Assigned Age	18
Procedures used for Quality Control	None
Frequency of Testing	None
Statistics for Testing	N/A
Criteria for Passing Quality Test	N/A
Remedial Action	N/A
Does a Reference Collection exist?	Y
Size of Reference Collection	60 otoliths
Freq. of Updating Ref. Collection	Not updated since 1987
Training Procedures	No protocols or procedures have been established for training new agers. When it did occur, the new ager who had some Greenland halibut ageing experience, used the Atlantic halibut reference collection with occasional help from the former ager.
Databases that use Age Data for Stock	Northern Gulf R/V Survey, Sentinel Fisheries and Commercial (including Observer) Sampling Databases.
Ageing Reports for Stock	Chilton, D.E. & R.J. Beamish. 1983. Age determination methods for fishes studied by the Groundfish Program at the Pacific Biological Station. Can. Spec. Publ. Fish. quat. Sci. 60. 102p
Comments	None

3Pn, 4RS Cod

Lab	IML
Species - Stock	Cod - 3Pn, 4RS
Assessment Biologist	Fréchet
Biologist Phone/Email	P (418) 775-0628 F (418) 775-0679 E frecheta@dfo-mpo.gc.ca
Primary Ager	Schwab
Ager - Phone/Email	P (418) 775-0626 F (418) 775-0679 E schwabp@dfo-mpo.gc.ca
Secondary Ager	Rondeau
Ager - Phone/Email	P (418) 775-0737 F (418) 775-0679 E rondeauj@dfo-mpo.gc.ca
Average Number Aged - RV	2000
Average Number Aged - Comm.	8000
Average Aged/Week	1000
Sampling Method	Length-stratified.
Percent of Collection Aged	75%
Subsampling Protocol	Stratification by quarter, area and gear.
Catch-at-Age Stratification	Stratification by quarter, area and gear.
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Dry in Envelopes.
Storage Method after Ageing	Dry in Envelopes (indefinitely).
Surface Aged	Cut in halves.
Sectioning Method	Low Speed "Isomet" Saw.
Preparation Method	N/A
Viewing Technique	Light microscope (Magnification=10x16) and reflected light.
Information Available to Ager	Time of Capture.
Birth Date	Jan. 1

3Pn, 4RS Cod (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Rostrum
Which Otolith Aged	Just one - either right or left is sectioned and aged.
Zones Counted (Hyaline or Opaque)	Opaque
Are All Zones Counted?	Cod otoliths contain some "checks" which are not counted.
Is a plus group used?	N
'Other' Ageing Conventions	None
Maximum Assigned Age	?
Procedures used for Quality Control	Inter-reader and inter-lab testing. Last done in 1990.
Frequency of Testing	Yearly
Statistics for Testing	% Agreement
Criteria for Passing Quality Test	Min. % Agreement=75% and no skewness.
Remedial Action	Never happened.
Does a Reference Collection exist?	Y
Size of Reference Collection	300
Freq. of Updating Ref. Collection	Not updated since 1990
Training Procedures	No protocols or procedures have been established for the training of new agers for this stock. When it has occurred, the new ager has conducted side-by-side ageing with the reference or primary ager for variable amounts of time (minimum of 3 weeks).
Databases that use Age Data for Stock	Northern Gulf R/V Survey, Sentinel fishery and Commercial Sampling Databases.
Ageing Reports for Stock	None
Comments	None

4RST Greenland Halibut

Lab	IML
Species - Stock	Greenland Halibut - 4RST
Assessment Biologist	Morin
Biologist Phone/Email	P (418) 775-0695 F (418) 775-0740 E morinb@dfo-mpo.gc.ca
Primary Ager	Bernier
Ager - Phone/Email	P (418) 775-0633 F (418) 775-0740 E bernierb@dfo-mpo.gc.ca
Secondary Ager	Morin
Ager - Phone/Email	See individual responsible for assessment.
Average Number Aged - RV	1000
Average Number Aged - Comm.	1000
Average Aged/Week	300
Sampling Method	Length-stratified.
Percent of Collection Aged	100%
Subsampling Protocol	No.
Catch-at-Age Stratification	Stratification by quarter, area and gear.
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Dry in Envelopes.
Storage Method after Ageing	Dry in Envelopes (indefinitely).
Surface Aged	Whole Otolith
Sectioning Method	N/A
Preparation Method	Alcohol immersion.
Viewing Technique	Light microscope (Magnification=10x16) and reflected light.
Information Available to Ager	Length
Birth Date	Jan. 1

4RST Greenland Halibut (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Left sacculus
Which Otolith Aged	Just one - left.
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	G. Halibut otoliths contain many "checks" which are not counted.
Is a plus group used?	N
'Other' Ageing Conventions	No other conventions.
Maximum Assigned Age	11
Procedures used for Quality Control	_ _ _
Frequency of Testing	_ _ _
Statistics for Testing	_ _ _
Criteria for Passing Quality Test	_ _ _
Remedial Action	_ _ _
Does a Reference Collection exist?	_ _ _
Size of Reference Collection	_ _ _
Freq. of Updating Ref. Collection	_ _ _
Training Procedures	No protocols or procedures have been established for the training of new agers for this stock. When it has occurred, the new ager has conducted side-by-side ageing with the reference or primary ager for variable amounts of time (minimum of 3 weeks).
Databases that use Age Data for Stock	Northern Gulf R/V Survey and Commercial Sampling Databases.
Ageing Reports for Stock	Bowering W.R. 1982. Population dynamics of Greenland halibut in the Gulf of St. Lawrence. J. Northw. Atl. Fish. Sci. 3: 141-147. Lear, W.H. and T.K. Pitt. 1975. Otolith age validation of G. halibut. J. Fish. Res. Bd. Can. 32(2): 289-292.
Comments	

4RS Herring

Lab	IML
Species - Stock	Herring - 4RS
Assessment Biologist	McQuinn
Biologist Phone/Email	P (418) 775-0627 F (418) 775-0740 E mcquinni@dfo-mpo.gc.ca
Primary Ager	Lefebvre
Ager - Phone/Email	P (418) 775-0615 F (418) 775-0740 E lefebvrel@dfo-mpo.gc.ca
Secondary Ager	No secondary ager at present; from May 92 to Nov. 94, four secondary agers were successively named and trained but were transfered to other duties for several reasons (i.e. budgetary restrictions & reorganization).
Ager - Phone/Email	N/A
Average Number Aged - RV	800
Average Number Aged - Comm.	4000
Average Aged/Week	1500
Sampling Method	Random.
Percent of Collection Aged	80%
Subsampling Protocol	Yes, one sample (50 herring) by gear, week and area.
Catch-at-Age Stratification	Stratification by area, gear, time, spawning group weighted by corresponding catches.
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Soak in water prior to placing them in circular concave depressions in black molded plastic. A drop of 1,2 dichloroéthane is used to make them stick.
Storage Method after Ageing	Stuck in otoliths trays of 50 concave depressions. Storage is indefinite.
Surface Aged	Whole otolith.
Sectioning Method	N/A
Preparation Method	Immersion in alcohol during reading.
Viewing Technique	Stereo microscope 18X (approx.) and direct light.
Information Available to Ager	Length, weight, sex, time of capture, location, maturity stages.
Birth Date	Jan. 1

4RS Herring (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Postrostrum if it is possible, then the subrostrum or the rostrum.
Which Otolith Aged	Both are collected and the best one is aged.
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	Herring otoliths contains many "checks" which are not counted.
Is a plus group used?	11+
'Other' Ageing Conventions	Depending on the time of year when the fish was sampled, the total number of annuli counted may be increased or decreased. Also the radius of the annulus of spring-spawners is smaller than that of fall-spawners. The fall-spawners develop a large nucleus.
Maximum Assigned Age	11
Procedures used for Quality Control	No inter-reading since there is no secondary ager named. If there is a problem in the reading in general, the primary reader has to read the otoliths again.
Frequency of Testing	None
Statistics for Testing	none
Criteria for Passing Quality Test	N/A
Remedial Action	N/A
Does a Reference Collection exist?	N/A
Size of Reference Collection	N/A
Freq. of Updating Ref. Collection	N/A
Training Procedures	No protocols or procedures have been established for the training of new agers for this stock. When it has occurred, the new ager has conducted side-by-side ageing with the reference or primary ager for variable amounts of time.
Databases that use Age Data for Stock	Commercial and research sampling databases.
Ageing Reports for Stock	
Comments	

Sub Area 3-4 Mackerel

Lab	IML
Species - Stock	Mackerel - SubAreas 3-4
Assessment Biologist	Grégoire
Biologist Phone/Email	P (418) 775-0589 F (418) 775-0740 E gregoiref@dfo-mpo.gc.ca
Primary Ager	Gregoire
Ager - Phone/Email	P (418) 775-0589 F (418) 775-0740 E gregoiref@dfo-mpo.gc.ca
Secondary Ager	Levesque
Ager - Phone/Email	P (418) 775-0516 F (418) 775-0740 E levesquec@dfo-mpo.gc.ca
Average Number Aged - RV	?
Average Number Aged - Comm.	2000 to 4000
Average Aged/Week	1000
Sampling Method	Length-Stratified
Percent of Collection Aged	100%
Subsampling Protocol	?
Catch-at-Age Stratification	Stratification by quarter, area and gear.
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Soak in water prior to placing them in circular black molded plastic trays. A drop of 1,2 dichloroéthane is used to make them stick.
Storage Method after Ageing	Stuck in otoliths trays of 50 depressions. Storage is indefinite.
Surface Aged	Whole otolith.
Sectioning Method	N/A
Preparation Method	Immersion in alcohol during reading.
Viewing Technique	Stereo microscope 18X (approx.) and direct light.
Information Available to Ager	Time of the catch only.
Birth Date	Jan. 1

Subarea 3-4 Mackerel (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Everywhere around the otolith
Which Otolith Aged	Both
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	Yes if they are everywhere on both otoliths
Is a plus group used?	N
'Other' Ageing Conventions	None.
Maximum Assigned Age	18
Procedures used for Quality Control	No inter-reading. If there is a problem in the reading in general, the primary reader has to read the otoliths again.
Frequency of Testing	None.
Statistics for Testing	
Criteria for Passing Quality Test	
Remedial Action	
Does a Reference Collection exist?	
Size of Reference Collection	
Freq. of Updating Ref. Collection	
Training Procedures	
Databases that use Age Data for Stock	Commercial and research sampling databases.
Ageing Reports for Stock	
Comments	

5Zj,m Atlantic Cod

Lab	SABS
Species - Stock	Atlantic Cod - 5Zj,m
Assessment Biologist	Hunt / Buzeta
Biologist Phone/Email	P (506)529-8854 F(506)529-5862 E hunt@sta.dfo.ca mib@sta.dfo.ca
Primary Ager	Buzeta
Ager - Phone/Email	P (506)529-8854 F(506)529-5862 E mib@sta.dfo.ca
Secondary Ager	N/A
Ager - Phone/Email	N/A
Average Number Aged - RV	500
Average Number Aged - Comm.	1000
Average Aged/Week	120 for commercial samples, 500 for Spring survey
Sampling Method	Length-stratified.
Percent of Collection Aged	100%
Subsampling Protocol	SUBSAMP- Length stratified query based routine assoc. with survey database.
Catch-at-Age Stratification	Stratification by quarter
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Dry in Envelopes.
Storage Method after Ageing	One otolith of pair set in resin, the other is not read and is stored dry in envelopes (indefinitely)
Surface Aged	Cross-Section.
Sectioning Method	Low Speed "Isomet" Saw. Standard procedure, Strong et al,1989
Preparation Method	Sections are embedded with polyester resin in plastic trays (100/tray).
Viewing Technique	Light microscope (Magnification=10x6.4 then 10x16) and reflected light. IAS used to measure difficult 1st annulus.
Information Available to Ager	Length, location & time.
Birth Date	Feb. 1

5Zj,m Atlantic Cod (cont.)	
Nucleus Included in Age	N
Prefered Axis for Ageing	Distal side first, then proximal edge near the sulcus groove.
Which Otolith Aged	One otolith is set, usually the right one.
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	Settling check not counted, split/double 2nd annulus counted as one.
Is a plus group used?	N
'Other' Ageing Conventions	Edge types, settling check, split/double 2nd annulus.
Maximum Assigned Age	17
Procedures used for Quality Control	Inter-reader tests (with 4X ager) and precision tests of 100 otoliths randomly selected from all the commercial samples, stratified by length and quarter. Can/USA exchanges of 50 otoliths each time.
Frequency of Testing	Tests within lab are once yearly, at end of fishery. Can/USA exchanges twice yearly (spring and fall).
Statistics for Testing	Comparison matrix, % agreement, CV, bias plots
Criteria for Passing Quality Test	70% agreement and no trend in bias.
Remedial Action	Re-evaluation of test to determine cause. Ages in database may be changed if before completion of assessment. If changes are substantial, re-analysis of CAA and population estimates may be required. Changes are reported in the next assessment document.
Does a Reference Collection exist?	Y
Size of Reference Collection	165 otolith images on tape: includes 70 otoliths used for training and the Can./USA 1991-92 exchanges. About 231 otoliths in trays used for standard comparisons with previous ager.
Freq. of Updating Ref. Collection	Done as time permits.
Training Procedures	No protocols or procedures established. The new ager conducted side-by-side ageing with primary ager when available. Production ageing was started when tests showed 80% agreement. USA ager contributed to training with exchanges and workshops.
Databases that use Age Data for Stock	Commercial (CGS), Observer program (IOP) and groundfish surveys (GS) are all Oracle tables.
Ageing Reports for Stock	A new method of preparing...Strong et al 85. Ageing methods...Hunt (unpub) Age methods...Pentilla and Dery 88 5Z Ageing workshops...Buzeta et al 91 and VanEeckhaute et al 94 Use of backcalc...for assignment of settling checks and first annuli.. Buzeta 92
Comments	Procedures prior to 1991 required subsampling, and both otoliths were used.

4X Atlantic Cod

Lab	SABS
Species - Stock	Atlantic Cod - 4X
Assessment Biologist	Clark / Brown
Biologist Phone/Email	506 529-8854 clark@sta.dfo.ca brown@sta.dfo.ca
Primary Ager	Brown
Ager - Phone/Email	fax 505 529 5862
Secondary Ager	N/A
Ager - Phone/Email	N/A
Average Number Aged - RV	500
Average Number Aged - Comm.	1000-1500
Average Aged/Week	250
Sampling Method	Length-stratified
Percent of Collection Aged	100%
Subsampling Protocol	100%
Catch-at-Age Stratification	Stratification by quarter, gear and tonnage class
Structure used for Ageing	Otoliths
Storage Method before Ageing	Dry in envelopes
Storage Method after Ageing	Both otolith of pair set in resin
Surface Aged	Cross section
Sectioning Method	Low speed "Isomet" saw. Standard procedure
Preparation Method	Sections are embedded with polyester resin in metal trays.
Viewing Technique	Light microscope reflected light.
Information Available to Ager	Length, loaction of capture, date & gear.
Birth Date	Feb. 2

4X Atlantic Cod (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Either side of sulcus groove.
Which Otolith Aged	Both otoliths set.
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	Checks and edges recorded on hard copy only. Settling checks and split second annulus counted as one.
Is a plus group used?	No, but I feel that this should be done as a matter of course.
'Other' Ageing Conventions	Edge types, checks, double second annulus, settling checks, sometime absence of identifyable first annulus.
Maximum Assigned Age	22
Procedures used for Quality Control	Random samples done from current year and past years, and samples from initial learning process - entire samples done.
Frequency of Testing	Three to four times a year.
Statistics for Testing	Percent agreement - if under 85%.
Criteria for Passing Quality Test	85% agreement & no consistent perceptible bias.
Remedial Action	Re-train on historic samples, and random sampling in each area since initial training, with a full check of current year's samples.
Does a Reference Collection exist?	Y
Size of Reference Collection	Approximately 500.
Freq. of Updating Ref. Collection	Marked for reference as needed.
Training Procedures	Side-by-side ageing, beginnng with clearly readable otoliths, progressing to more difficult samples from other areas.
Databases that use Age Data for Stock	Maritime database, CGS.
Ageing Reports for Stock	
Comments	4X cod, as they are presently presented, are a combination of several stocks, most of the time, clearly identifiable.

5Zj,m Haddock

Lab	SABS
Species - Stock	Haddock - 5Zj,m
Assessment Biologist	Gavaris / Van Eeckhaute
Biologist Phone/Email	P (506)529-8854 F(506)529-5862 E sgavaris@sta.dfo.ca lou@sta.dfo.ca
Primary Ager	Van Eeckhaute
Ager - Phone/Email	P (506)529-8854 F(506)529-5862 E lou@sta.dfo.ca
Secondary Ager	N/A
Ager - Phone/Email	N/A
Average Number Aged - RV	500 ages for spring assessment, rest done later for a total of 1000.
Average Number Aged - Comm.	800
Average Aged/Week	120 for commercial samples, 500 for Spring survey.
Sampling Method	Length-stratified.
Percent of Collection Aged	100%
Subsampling Protocol	SUBSAMP- Length stratified query based routine assoc. with survey database.
Catch-at-Age Stratification	Stratification by quarter.
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Dry in Envelopes.
Storage Method after Ageing	One otolith set in resin, 2 sections of each otolith are mounted on slide.
Surface Aged	Cross-Section.
Sectioning Method	Low Speed "Isomet" Saw. Standard procedure, Strong et al,1989
Preparation Method	Sections are embedded with polyester resin in plastic trays (60/tray).
Viewing Technique	Light microscope (Magnification=10x6.4) and reflected light.
Information Available to Ager	Length, location of capture & time.
Birth Date	Feb. 1

5Zj,m Haddock (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Dorsal side.
Which Otolith Aged	One otolith is set
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	
Is a plus group used?	N
'Other' Ageing Conventions	Edge types.
Maximum Assigned Age	17
Procedures used for Quality Control	Precision tests of 100 otoliths, randomly selected from all samples, stratified by length and quarter. Can/USA exchanges of 50 otoliths each time.
Frequency of Testing	Tests within lab are once yearly. Can/USA exchanges twice yearly (spring and fall).
Statistics for Testing	Comparison matrix, % agreement.
Criteria for Passing Quality Test	70% agreement and no trend in bias.
Remedial Action	Re-evaluation of test to determine cause. Use of overlays with IAS to evaluate disagreements. Age values in database are changed if before completion of assment. If changes are substantial, re-analysis of CAA and population estimates may be required.
Does a Reference Collection exist?	Y
Size of Reference Collection	"Have to look at tapes to get a count"
Freq. of Updating Ref. Collection	Done as time permits
Training Procedures	No protocols or procedures established. The new ager conducted side-by-side ageing with previous ager. Production ageing was started when tests showed 80% agreement.
Databases that use Age Data for Stock	Commercial (CGS), Observer program (IOP) and groundfish surveys (GS) are all Oracle tables.
Ageing Reports for Stock	A new method of preparing...Strong et al 85. Ageing methods...Hunt (unpub) Age methods...Pentilla and Dery 88 5Z Ageing workshops...Buzeta et al 91 and VanEeckhaute et al 94
Comments	Procedures prior to 1991 required subsampling.

4VWX5Z Pollock

Lab	SABS
Species - Stock	Pollock - 4VWX5Z
Assessment Biologist	Nelson / Perley
Biologist Phone/Email	P (506)529-8854 F(506)529-5862 E nelson@sta.dfo.ca perley@sta.dfo.ca
Primary Ager	Nelson
Ager - Phone/Email	nelson@sta.dfo.ca
Secondary Ager	N/A
Ager - Phone/Email	N/A
Average Number Aged - RV	700
Average Number Aged - Comm.	1500
Average Aged/Week	300
Sampling Method	Length-stratified.
Percent of Collection Aged	100%
Subsampling Protocol	Subsamp Program.
Catch-at-Age Stratification	All ages used.
Structure used for Ageing	Otoliths.
Storage Method before Ageing	Dry in Envelopes.
Storage Method after Ageing	Both of pair.
Surface Aged	Cross-Section.
Sectioning Method	Low Speed "Isomet" Saw. Standard procedure, Strong et al,1990
Preparation Method	Embedded and mounted on trays.
Viewing Technique	Microscope with reflected light mag=12x.
Information Available to Ager	Length, location of capture & time.
Birth Date	Feb. 1

4VWX5Z Pollock (cont.)

Nucleus Included in Age	N
Prefered Axis for Ageing	Mainly rostrum.
Which Otolith Aged	Both.
Zones Counted (Hyaline or Opaque)	Hyaline
Are All Zones Counted?	Don't count checks.
Is a plus group used?	N
'Other' Ageing Conventions	Edge types used as per Kohler et all (Year?).
Maximum Assigned Age	Whatever is found.
Procedures used for Quality Control	Self test,test against previous ager as per Res Doc Neilson, Nelson and Perley 96/85.
Frequency of Testing	Every 500 otoliths or sooner if needed.
Statistics for Testing	% agreement with no bias
Criteria for Passing Quality Test	same
Remedial Action	Review reference collection and re-test against previous ager as standard.
Does a Reference Collection exist?	y
Size of Reference Collection	About 300.
Freq. of Updating Ref. Collection	As time permits.
Training Procedures	Use Res. Doc. procedures from Neilson, Nelson and Perley 95/86.
Databases that use Age Data for Stock	CGS & GS.
Ageing Reports for Stock	None
Comments	None