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Herring Aging Workshop
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by

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ABSTRACT

In March 1982, a herring aging workshop was held to define clearly problems related to spawning stock attribution and age reading, and to discuss possible solutions to these problems. Participants from the three laboratories currently involved in herring studies in the Canadian Atlantic area (St.John's, NFLD, St.Andrews, N.-B., Québec, Qué.) attended the meeting.

Sampling techniques were compared and only minor differences between laboratories were noted. ICES criteria for maturity stage assignment were found inadequate for frozen fish, especially for maturity stages III and VIII. Fish spawning before the first of July are considered spring spawners, while those spawning at a later date are categorized as fall spawners. In times when overlap between spawning groups is expected, differentiation is made with the use of subjective knowledge of gonad characteristics and experience with the fishery. The appearance of the otolith nucleus and size of first annulus is often found to be different for spring and fall spawners. However, individual variations and extended spawning periods result in many intermediate types which limits the use of these characteristics for spawning group identification. Age reading techniques are similar between laboratories. During a comparative otolith reading session no consistent assignment to spawning group could be made. A more rigorous definition of parameters to differentiate spawning components was felt necessary and recommendations for specific studies were made.

RESUME

En mars 1982, les représentants des trois laboratoires impliqués dans la recherche sur le hareng (St-Jean, T.-N., St-Andrews, N.B., Québec, Qué.) se sont réunis à St-Jean, T.-N. pour un atelier de travail sur la détermination de l'âge du hareng. Le but de l'atelier était de définir clairement les problèmes associés à l'identification des stocks reproducteurs et à la lecture d'âge, et d'élaborer des solutions à ces problèmes.

Des différences mineures ont été notées entre les techniques d'échantillonnage des trois laboratoires. La charte du C.I.E.M. pour la détermination des stades de maturité a été jugée inadéquate pour les poissons congelés, spécialement ceux des stades III et VIII. Les harengs frayant avant le premier juillet sont considérés reproducteurs de printemps, tandis que ceux qui fraient à une date ultérieure appartiennent au groupe des reproducteurs d'automne. Pour les périodes de l'année durant lesquelles il peut y avoir un recouvrement entre les deux types reproducteurs, on identifie ces groupes en se basant sur une connaissance subjective des caractéristiques des gonades et de la pêche en général.

L'aspect du noyau et le rayon du premier annulus de l'otolithe diffèrent fréquemment chez les deux groupes reproducteurs. Cependant, l'utilisation de ces critères comme facteur discriminant ces deux groupes est limitée par l'abondance des otolithes de type intermédiaire, due à des variations individuelles et à une période de frai étendue. Les techniques de lecture d'âge sont semblables pour les trois laboratoires. Mais lors d'une session de lecture comparative d'otolithes aucun consensus n'a été obtenu quant à la détermination du groupe reproducteur. On a donc jugé nécessaire de définir des paramètres plus stricts pour l'identification des types reproducteurs, et des projets d'études spécifiques ont été recommandés.

INTRODUCTION

In many CAFSAC meetings, it has been recognized that considerable discrepancies occur in spawning stock attribution and age reading of herring particularly of the Southern Gulf (4T) stock, between various samplers and readers. Several attempts have been made to evaluate the degree of divergence between the people involved in such studies and to try to eliminate it. But, although more uniform results were expected after the 1973 aging workshop (Hunt et al. 1973) the problem still persists.

With the decline in abundance of many herring stocks, it becomes more crucial than ever to assign correctly age, year-class and spawning type of the fish. Consequently, an aging workshop was held in St.John's (NFLD) in April 1982 to look again at the problem and come up with solutions, if possible. Representatives of the three laboratories currently involved in herring studies (St.John's, NFLD, St.Andrews, N.B., Quebec, PQ) attended the meeting.

RESULTS

Sampling techniques

A review of the three laboratories' sample collection techniques was conducted at the beginning of the meeting. Differences were found between the participants techniques mainly in two areas: 1) It is only in Newfoundland that frozen length measurements are converted to fresh length measurements before being recorded. 2) In Quebec, fish sampled for biological data and length frequencies are always distinct. In St.Andrews, the same fish can be used for both sets of data, while in St.John's samples for biological data only are collected. Otherwise, most of the sampling procedures are virtually identical.

Maturity stage assignment

Maturity stages are currently assigned according to the maturity scale recommended by the Herring Committee of ICES (Parrish and Saville, 1965). A step by step study of the scale by the participants led to a consensus about the fact that the characteristics enumerated apply very well to fresh fish, mainly if these are precisely at the stage described in the chart. The stage descriptions were found inadequate for frozen fish, or for fish in transition periods. The participants agreed that the maturity assignment on frozen fish can differ considerably in relation to what it would have been on fresh fish. Color, in any case, should not be used as a criterion. It was also noted that for maturity stages III and VIII, the ICES classification scheme was not definitive enough to account for all variations encountered. Presently, the discrimination between those stages is done mainly according to the "appearance" of the gonad: the visual presence or absence of blood vessels etc, in Quebec and St.Andrews, while the people from St.John's rely on the gonad weight. Comments on the ICES criteria were added to the original chart in order to increase precision (Table 1).

Spawning group assignment

A) Use of maturity stages

A general discussion related to the spawning group most probably encountered at a given time of the year was carried on. The results (summarized in Table 2) apply to a generalized situation and could be subject to variations due to many factors such as peak of spawning, etc. In general, fish spawning before the first of July are considered spring spawners while those spawning later are categorized as fall spawners. In times when overlap between spawning groups is expected, differentiation is made with the use of subjective knowledge of gonad weights related to certain maturity stages, and experience with the fishery. All the participants agreed that for maturity stages III and VIII, the spawning type should not be determined by the maturity stage, but by gonad weight in relation to time of year. All participants felt that a more rigorous definition of the parameters used to differentiate spawning components is necessary to provide more objective basis in component assignments.

B) Use of otolith characteristics

Experienced otolith readers have noticed that there is a general difference between spring and fall spawners' otoliths, and this includes the appearance of the nucleus, and the size of the first annulus. General statements can be made about these two characteristics. All assume that observations are made with reflected light.

Nucleus type and size refer to the appearance of the nucleus. Type ranges from distinctively hyaline to distinctively opaque with various intermediate stages. The biological rationale for separating groups on the basis of nucleus type is the potential growing season in the year spawned. Spring-spawned fish have longer optimum growing season in their first year than do the fall-spawned fish. Since rapid growth is represented by opaque zones in the otolith, the difference in spawning season and/or growing pattern can thus be reflected in the appearance of the nucleus. It has been suggested that fall-spawned fish develop a "large" hyaline nucleus during their first winter, with no annulus, while spring-spawned fish put on sufficient growth in the first summer to have an opaque nucleus, and then lay down an annulus in their first winter. It has also been noted that the focus area of the spring spawner's otolith may be slightly

concave, while it is flatter or slightly convex for the fall spawners. However, individual variation and extended spawning periods result in many intermediate types, which limits the use of these characteristics for separating spawning groups.

The radius of the first annulus is also presumed to be related to the length of the first summer growth period. For spring spawners, this results in sufficient growth to form an annulus (opaque zone plus hyaline zone) in the first winter; for fall-spawned fish, the growth pattern is reflected in the nucleus with no first year annulus. It thus seems reasonable that the radius of the first annulus of spring-spawners, which is formed after 6 months of growth, will be "smaller" than that of fall-spawners, which delineates a full season growth. No precise measurements of the radius of spring and fall spawners are available. However, it is advised that this characteristic be kept as a relative index of spawning season.

Other morphometric characteristics have been identified as spawning type indices (Messieh, 1972; Côté et al., 1980), but they are not used with the same degree of confidence as the nucleus size and type.

COMPARATIVE OTOLITH READING

A short discussion took place on the different ways the laboratories read otoliths. It was noted that when assessing age the Newfoundland readers counted the opaque zones of the otolith, while all other readers counted the hyaline zones. It was then specified that age determination is done by two independent readers in Quebec city, one reader only in St.Andrews, and two readers using a discussion microscope in St.John's. Also, once the ages are assessed the St.John's and St.Andrews people check the reliability of the data, either by using growth curves or age-length keys, and any outlier fish is re-examined.

In the course of the workshop, a relatively small number of otoliths were examined by the participants with the main objective being to determine the agreement in spawning group assignment and also in age determination. No consistent assignment to spawning group was made by the different readers, thus this technique at present appears too subjective to recommend its routine use for

spawning group assignment. Consensus was never reached for otoliths with intermediate characteristics; fish could then be rationally assigned to either spawning group. Cases were noted when one or more otolith characteristics were in conflict with the spawning type designated with the maturity stage: it was commonly observed that an otolith would display both spring and fall spawner characteristics. For samples with definite maturity stages, agreement between "readers" was relatively high if maturity stages were used as spawning type criteria,but was less consistent when otolith characteristics only were used as spawning index.

GENERAL COMMENTS

For fish obviously in maturity stages IV, V and VI, spawning type designation is based on maturity stage (related to season), which takes precedence over all other considerations. For immature fish, otolith characteristics are used to assign the spawning type. In cases where maturity stage is questionable, all available information is employed to determine the spawning group; if the combination of criteria is ambiguous, the designation of the spawning group is done on a subjective basis. Ambiguous cases are very common for the Southern Gulf of St.Lawrence herring. During the workshop the samplers agreed on the fact that in doubtful cases, they will assign a fish to the spawning type that occurs most frequently in their sample. Rejection of all the "uncertain" otoliths would introduce unknown biases in the analysis of the commercial fisheries. The participants thus felt that until some better methods of priorising the characteristics used and "evaluating" the otoliths are found, the current approach will have to be used.

RECOMMENDATIONS

With the formation of the Gulf Region the participants to the workshop expressed great concern in regards to the fate of the 1982 samples.

1- It is not clear whose responsibility it is going to be to read the ages, and in any case, there should be consultation between the different laboratories involved during the transition years.

2- Detailed documentation on how each laboratory processes the samples, assesses maturity stages and reads otoliths should be available as soon as possible.

3- A number of desirable studies have been identified by the participants, in order to solve some of the problems mentioned in this document. These are:

a) Histological investigation of the maturity stages, particularly in relation to transitional stages III and VIII.

b) Analysis of relative gonad size and weight in relation to the season and fish size.

c) Studies on the consistency of otolith characteristics as criteria to define the spawning groups.

d) Development of a more comprehensive index of maturity stages, which would adequately reflects the various sampling conditions, thereby reducing subjectivity.

e) In order to promote consistency in age determination, it would be useful to create a reference collection of otolith, which would be indicative of the otolith type occuring in the various fisheries. This collection should be accompanied with explicative notes on agreed ages and spawning types by the different laboratories.

4- Regular consulting sessions between readers and laboratories should be carried on, and overall sampling techniques should be as uniform as possible.

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Table 1. Maturity scale recommended by Herring Committee of ICES and comments* * given by the participants of the St.John's aging workshop.

Stage	Males	Females
I	Virgin herring. Testes very small, thread-like, whitish or grey-brown. *Assignment of sex generally require microscope examination.*	Virgin herring. Gonads very small 2-3 mm broad, ovaries wine red.
II	Virgin herring with small sexual organs. Width of testes about 3-8 mm and reddish grey in colour. *At stage 2 gonads are clearly visible and can be sexed according to the morphology of the gonad.*	Virgin herring with small sexual organs. Width of ovaries about 3-8 mm, eggs not visible to naked eye but can be seen with a magnifying glass.
III	Testes occupying about half of ventral cavity. Width of testes between 1 and 2 cm. Reddish grey or greyish.	Ovaries occupying about half of ventral cavity, width of ovaries between 1 and 2 cm. Eggs small but can be distinguished with naked eye, orange in colour.
IV	Testes almost as long as body cavity. Testes whitish.	Ovaries almost as long as body cavity. Eggs larger, varying in size, opaque, orange or pale yellow.
V	Testes fill body cavity, testes milk white. Sperm do not flow but can be extruded by pressure. *For stages III, IV and V with frozen fish, size of the gonads in relation to body cavity is the determinant character. There is a potential application for relative gonad-weight.*	Ovaries fill body cavity. Yellowish in colour. Eggs large, round; some transparent but do not flow. *Size and visibility of the eggs is the determinant criteria between those stages.*
VI	Testes ripe, testes white and sperm flowing freely. *At this stage, stress induced extrusion of sexual product can happen. Initial analysis suggests that freezing may substantially reduce the incidence of free flowing attribute of this stage.*	Ovaries ripe. Eggs transparent and flowing freely.
VII	Spent herring. Testes bloodshot but may contain remains of sperm.	Spent herring. Ovaries baggy and bloodshot, empty or containing only a few residual eggs.
VIII	Recovering spents. Testes firm and larger than virgin herring on Stage II. Walls of testes striated; blood vessels prominent, testes wine red in colour (this stage passes into Stage III). *Differentiation between stage III and VIII is difficult. In general, gonads at stage VIII are smaller and blood vessels are more prominent. However on the basis of present description, the transition period from VIII to III is not clearly defined. Since this is the major problem encountered maturity designation it is the area that should be examined most intensively. This problem might be resolved by relating histological analysis to some relative index of gonad weight.*	Recovering spents. Ovaries firm and larger than virgin herring on Stage II. Eggs not visible to naked eye. Walls of ovary striated, blood vessels prominent, ovaries wine red in colour (this stage passes into Stage III).

Table 2. Spawning types most probably encountered for each month of the year.

Spawning type	JAN	FEB	MARCH	APRIL	MAY	JUNE	JULY	AUG	SEPT	OCT	NOV	DEC
I												
II												
III				A*	A*	A/S*	A/S*	S	S	A/S*	A/S*	A/S*
IV				S	S	A/S*	A	A	A	A/S*	S	S
V				S	S	S	A	A	A	A	A	S
VI				S	S	S	A	A	A	A	A	A
VII				S	S	S	A/S**	A	A	A	A	A
VIII				A/S**	S	S	S	A/S**	A	A	A	A

* Subject to some index of gonad development.

** Date of capture will have to be considered before assigning maturity stages.

[1] The diagonally identified part of the table represents the cases where the spawning type is not definitive.