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Évaluation des stocks canadien
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# Proceedings of the Atlantic Zonal Herring Workshop
## March 24-27, 1997
## Moncton, New Brunswick

Dr. Jake Rice
Workshop Chairperson
Canadian Stock Assessment Secretariat
200 Kent Street, Station 1256
Ottawa, Ontario
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Fisheries and Oceans Science
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# ATLANTIC ZONAL HERRING WORKSHOP

## EXECUTIVE SUMMARY

A Zonal Assessment Review on Atlantic herring stocks was held in Moncton from 24 - 27 March, 1997. **There were approximately 40 participants from DFO (Science and Operations Branches), universities, the fishing industry, and Native bands.**

Major assessments were reviewed for herring stocks in **4T, 4R, and 4VWX**.

Several biological aspects of herring management strategies were considered in workshop discussions, including:

- **use of the survey - assess - fish protocol in fisheries on spawning aggregations**
- **use of the survey - assess - fish protocol outside the spawning season**
- **conduct of new / exploratory fishing for herring on the Scotian Shelf**
- **rules for the winter herring fishery in 4Vn**
- **management strategies based on stock-recruit and environment-recruit relationships, being developed in Newfoundland Region.**

## REVIEW OF ASSESSMENTS

### 4T HERRING:

**The assessment of 4T herring stock concluded the spawning biomass of fall spawners was declining**, as the very large 1987 and 1988 cohorts no longer are major contributors to catches. Since the above average 1990 cohort, year-classes have been average or below average. Therefore biomass is expected to continue to decline slightly in the near future.

The key index of stock status is the inshore catch rate index, although the various indicators of stock status gave mixed signals. Industry expressed a number of concerns with the catch rate index, but generally concurred with the overall evaluation of stock status.

The target exploitation rate for this stock is 23%, which was met in both 1995 and 1996. **The $F_{0.1}$ catch in 1997 is forecast to be 49,000 tonnes, which is very close to the value of 50,000 tonnes forecast in the Spring 1996 assessment**.

Spring spawners comprise about a third of the total herring biomass in 4T. **The assessment has greater uncertainty than for the fall spawning component**, but is much improved analytically over previous assessments. Of year-classes presently in the fishery only the 1991 cohort appears

better than average, so **biomass is expected to continue to decline slightly, regardless of harvest level.** Catch rate indices from the inshore fixed gear fisheries indicate a gradual decline.
The **$F_{0.1}$ catch of spring spawners for 1997 is forecast to be 16,500 tonnes, slightly greater than the $F_{0.1}$ catch for 1997 which was forecast in 1996.**

**4R HERRING:**

**The assessment of herring in 4R found the stock to continue to be in good condition.** Many age groups contribute to catches, and herring older than 11 years are not uncommon. These are indicators that the present exploitation rate is sustainable. Indices from both hydroacoustic surveys and index fisher catch rates indicated a stable or growing population. Condition and growth rates both seem to be recovering in the stock. After a period of decline in the southern part of 4R, abundance seems to be stable or increasing along the entire west coast of Newfoundland. Catches have not achieved the quota in any recent year, but both scientists and industry agree that this was due to difficult fishing conditions during periods when herring are aggregated, rather than to inability to find fish.

In addition to 3 Working Papers by DFO staff, industry also made a presentation of their findings on stock status.

**The scientific advice for 4R herring was status quo TAC, which was supported by industry.**

**4VWX HERRING:**

The assessment of 4WX was challenging. **It was agreed to disaggregate the overall assessment into 4 stocks/fisheries:**

- **Southwest Nova bank spawners (which support the major portion of the fishery)**
- **an offshore Scotian Shelf portion**
- **a coastal component comprising a large (but unknown) number of stock units spawning in the coastal bays from Cape Breton to the Bay of Fundy**
- **the Bay of Fundy juvenile fishery**

The **Southwest Nova portion continues to decline, from the high in 1989.** The 1996 quota was 50,000 t, down substantially from TAC levels in the preceding years. 57,000 t was allocated to sectors, and harvested in the fisheries. Catches are comprised primarily of the 1992 cohort, and succeeding year-classes may be weak. There are several indicators of stock status, and none suggest cause for optimism.

**In 1996 the fishery on spawning aggregations was conducted according to a "survey - assess - fish" methodology, whereby industry, scientists and managers worked together primarily on industry boats to evaluate the size of individual aggregations prior to harvesting at or below**

**the level of 20% of each aggregation**. All participants were satisfied with the performance of this approach, and plan to continue to use it in coming fisheries.

**The offshore Scotian Shelf component supports a new purse seine fishery, which harvested nearly 12,000 t in 1996. This fishery is still in an exploratory phase**, and the extent of the resource is unknown. It was noted that foreign fisheries in the 1960 harvested several tens of thousands of tonnes for several years, but there were no herring fisheries through the 1980s. Groundfish trawl surveys indicated few herring on the Scotian Shelf through the 1980s, but recent surveys have found herring to be abundant and widespread. **This suggests the stock is variable, and although there may be substantial yield available for some years, a fishery may not be sustainable over decades.**

**There is little information on the status of the coastal components of 4VWX herring**, although results of a study of herring spawning in Bras d'Or Lakes was tabled. These coastal components have not yet been documented and delineated adequately, and there is an immediate concern about new fisheries developing in these coastal areas. **All participants agreed that all herring fisheries need to be managed in ways which prevent targeting on these small and possibly discrete units, whether during spawning or when they mix with other components at other seasons**.

The **Bay of Fundy juvenile fishery** was thought to have performed as in the recent past.

**Advice on harvest level was provided only for the main Southwest Nova spawning unit. Based on the reliance on a single cohort in the catch and the prospect of weak incoming recruitment, catches in 1997 should not exceed the 1996 catch. The survey - assess - fish protocol should be used to distribute catch among spawning aggregations.**

**The offshore purse seine fishery could continue to conduct exploratory fishing within the Guidelines for Emerging Fisheries.** These Guidelines provide for:

- a slow and controlled increase in effort
- the developing fishery must operate in ways which maximise the acquisition of biological information needed to manage the fishery
- industry contributes significantly to the cost of collection of information and management of the developing fishery

Although there was significant discussion among industry participants about the status of the Southwest Nova resource, and the impacts on fishing practices of preserving coastal components, **industry supported the advice on each of the stock components.**

## BIOLOGICAL ASPECTS OF MANAGEMENT STRATEGIES

**Survey - assess - fish methodology for fisheries on spawning aggregations**:

This technique has many desirable qualities, and it should continue to be used. Greater quantitative rigor is needed in all steps, however. **It should not be used as a tool in setting overall harvest levels until reviewers are satisfied the higher level of rigor has been achieved.** Because the fisheries on spawners comes at the end of the fishing year, the **exploitation rate in this fishery should be reduced from 20% (the overall target exploitation rate), to the rate consistent with the portion of the total quota taken in this fishery.**

**Survey - assess - fish methodology for fisheries at other times:**

Although this approach ensures a single fishing event does not overexploit a single aggregation, there is no assurance that individual feeding (or other) aggregations are not harvested repeatedly. **Outside the spawning period the S-A-F method has value in keeping a fishery from depleting a single aggregation, but is not adequate to ensure conservation of all stock components**, even combined with an overall TAC.

**New fisheries on the Scotian Shelf and coastal areas:**

**These fisheries should expand slowly, and follow the Guidelines for Emerging Fisheries. There should be no new fisheries on coastal spawning aggregations until there is a better scientific framework to ensure such fisheries are conducted in a sustainable way.** Both of these pieces of advice require significant science support and industry partnerships.

**Winter fishery in 4Vn:**

There was significant discussion about the winter purse seine fishery harvesting 4T herring overwintering in 4Vn. To ensure conservation of local coastal components of the 4VWX stock, it was advised that:

- **The winter fishery not begin until November 1 or later**
- **The winter fishery not operate south or east of a line whose location is to be negotiated among industry, science and management**
- **The winter fishery focus on harvesting small fractions of large aggregations, and not large fractions of small aggregations**
- **Catches of the level prosecuted over the past 10 years have not been shown to be detrimental to local coastal components, so the winter fishery should be restricted to the average level of catch over the past 10 years.** (This phrasing was a compromise, agreed to after extended discussion.)

- **The presence of small / young herring in catches could indicate exploitation of local components. In such cases boats should stop harvesting and move to different grounds.**

**For all the Maritime Region issues regarding management strategies, industry generally agreed to the proposed principles, and managers agreed the framework was sufficient for them to develop management plans which were based on conservation and sound science**

**EXPLOITATION RATES BASED ON STOCK RECRUIT RELATIONSHIPS:**

The methods being developed in Newfoundland for using stock recruit relationships and SSB to determine target exploitation rate were reviewed. The review was split into two parts, the concept and the analytical method.

**The conceptual approach was endorsed strongly. It was thought to be more precautionary than an fixed target exploitation rate, by providing a systematic framework for reducing exploitation below $F_{0.1}$ when SSB is low**. Because the influence of temperature and/or salinity on recruitment appears to be as strong as the SSB influence, it was recommended that further analytical work also explore the feasibility and consequences of reduced exploitation rate when the environmental conditions suggested a high likelihood of poor recruitment.

**Insufficient analytical details were available to review the specific model being used in Newfoundland Region**, although it was noted that some of the stochastic aspects requested by SSSC have been incorporated in the revised model. **Direction was given for additional specific analyses to be conducted, and it was suggested that when the work was ready a more complete paper be prepared for review by SSSC.**

Overall the Zonal Assessment Review and Workshop was considered a success by all participants. The science and assessments were of high quality, and management issues were discussed thoroughly. Industry participated actively and constructively, and left with high confidence in the scientific advice.

# ATELIER ZONAL SUR LE HARENG DE L'ATLANTIQUE

## SOMMAIRE

Un examen des évaluations zonales des stocks de hareng de l'Atlantique a eu lieu à Moncton du 24 au 27 mars 1997. **Environ 40 représentants du MPO (Sciences et Opérations), d'universités, de l'industrie de la pêche et de bandes autochtones y ont participé.**

Les évaluations des stocks de hareng de **4T, 4R et 4VWX** ont été passées en revue.

Plusieurs aspects biologiques des stratégies de gestion du hareng ont été considérés lors des discussions tenues dans le cadre de l'atelier, entre autres :

- **l'application du protocole relevé - évaluation - pêche à la pêche de reproducteurs;**
- **l'application du protocole relevé - évaluation - pêche à la pêche après la fraie;**
- **la réalisation de pêches nouvelles et/ou exploratoires du hareng sur le plateau néo-écossais;**
- **les règlements de pêche du hareng d'hiver dans 4Vn;**
- **les stratégies de gestion basées sur les relations stock-recrues et environnement-recrues en voie d'être élaborées dans la région de Terre-Neuve.**

## EXAMEN DES ÉVALUATIONS

### HARENG DE 4T

**L'évaluation du stock de hareng de 4T a révélé que la biomasse de reproducteurs d'automne est à la baisse**, les très abondantes cohortes de 1987 et 1988 n'étant plus les principales sources de poisson. Depuis la cohorte de 1990, dont l'abondance se situait au-dessus de la moyenne, les classes d'âge n'ont montré qu'une abondance allant de moyenne à inférieure à la moyenne. On s'attend donc à ce que la biomasse continue à diminuer légèrement dans un avenir rapproché.

Le taux de capture dans les eaux côtières est le principal indice de l'état du stocks, bien que les divers indicateurs de l'état de ce dernier soient contradictoires. L'industrie a exprimé certaines préoccupations à l'égard du taux de capture, mais était généralement d'accord avec l'évaluation globale de l'état du stock.

Le taux d'exploitation cible pour ce stock, qui se situe à 23 %, a été atteint en 1995 et 1996. **Selon les prévisions, les prises 1997 à $F_{0,1}$ devraient atteindre 49 000 t, ce qui correspond presque aux prévisions de 50 000 t obtenues dans le cadre de l'évaluation du printemps 1996.**

Les reproducteurs de printemps constituent environ 33 % de la biomasse totale de hareng dans 4T. **L'évaluation de cette composante est beaucoup moins certaine que dans le cas des reproducteurs d'automne**, bien qu'elle soit meilleure au plan analytique que les évaluations précédentes. Des classes d'âge actuellement recrutées à la pêche, seule la cohorte de 1991 semble plus abondante que la moyenne. On **s'attend donc à ce que la biomasse continue à diminuer légèrement, indépendamment du niveau de récolte**. Le taux de capture aux engins fixes dans les eaux côtières indiquent un déclin graduel. **Selon les prévisions, les prises 1997 à $F_{0,1}$ de reproducteurs de printemps devraient atteindre 16 500 t, un chiffre légèrement plus élevé que les prévisions 1996 des prises 1997 à $F_{0,1}$.**

**HARENG DE 4R**

**L'évaluation a révélé que le stock de hareng de 4R continue d'être en bon état**. De nombreux groupes d'âge alimentent les prises et le hareng de plus de 11 ans n'est pas rare, ce qui indique que le taux d'exploitation courant est soutenable. Les indices obtenus des relevés acoustiques et les taux de capture obtenus dans le cadre du Programme des pêcheurs repères indiquent une population stable ou à la hausse. Les indices de condition et les taux de croissance semblent tous deux s'améliorer. Après une période de déclin dans les eaux méridionales de 4R, l'abondance semble stable ou à la hausse tout le long de la côte ouest de Terre-Neuve. Les prises étaient inférieures au quota au cours des dernières années, mais les scientifiques et l'industrie s'accordent à reconnaître qu'il était difficile de le récolter à cause des mauvaises conditions de pêche lorsque les bancs de hareng se manifestaient et non de l'incapacité de trouver du poisson.

En plus de trois documents de travail présentés par le personnel du MPO, l'industrie a présenté ses résultats sur l'état du stock.

**Les scientifiques ont recommandé que l'on maintient le TAC de hareng pour 4R au même niveau, et l'industrie était d'accord.**

**HARENG DE 4VWX**

L'évaluation du hareng de 4VWX était compliquée. **On a donc convenu de scinder l'évaluation globale en quatre stocks ou pêches, soit :**

- **les reproducteurs des bancs du sud-ouest de la Nouvelle-Écosse (qui alimentent la plus grande partie de la pêche);**
- **la composante hauturière du plateau néo-écossais;**
- **la composante côtière comprenant un grand nombre (inconnu) d'unités de stock qui frayent dans les baies côtières, du Cap-Breton à la baie de Fundy;**
- **la pêche des juvéniles dans la baie de Fundy.**

**La composante sud-ouest de la Nouvelle-Écosse continue à s'appauvrir après avoir atteint un pic en 1989**. Le quota 1996, fixé à 50 000 t, représentait une forte baisse par rapport aux TAC des années précédentes. 57 000 t ont été allouées aux secteurs et récoltées dans les pêcheries. Les prises se composaient essentiellement de la cohorte de 1992, et les classes d'âge suivantes pourraient être peu abondantes. Des indicateurs de l'état du stock, aucun n'indique que la situation s'améliorera.

**En 1996, la pêche visant les bancs de reproducteurs a été effectuée selon le protocole « relevé - évaluation - pêche » en vertu duquel l'industrie, les scientifiques et les gestionnaires travaillent côte à côte sur des bateaux commerciaux pour évaluer la taille de chaque banc de poisson avant de le récolter à un niveau égal ou inférieur à 20 % des effectifs.** Tous les participants étaient satisfaits de la performance de l'approche, et prévoient continuer à l'appliquer aux prochaines pêches.

**La composante hauturière du plateau néo-écossais alimente une nouvelle pêche à la senne coulissante, qui a récolté presque 12 000 t de hareng en 1996. Cette pêche en est encore à l'étape exploratoire**, et l'abondance de la ressource est inconnue. On a noté que, pendant plusieurs années dans les années 60, les pêcheurs étrangers ont récolté plusieurs milliers de tonnes de hareng, mais qu'aucune pêche n'avait été effectuée dans les années 80. Les relevés du poisson de fond au chalut effectués sur le plateau néo-écossais dans les années 80 ont indiqué que le hareng était rare, mais les relevés récents ont révélé qu'il était abondant et répandu. Cela porte à croire que le stock fluctue et que, même si le rendement pourrait être élevé pendant quelques années, le stock pourrait ne pas suffire à alimenter une pêche durable pendant des décennies.

Les résultats d'une étude de la fraie du hareng dans le lac Bras-d'Or sont venus élargir le peu d'information disponible sur l'état des composantes côtières du stock de hareng de 4VWX. Ces dernières n'ont pas encore été documentées et délimitées adéquatement, et le développement de nouvelles pêches dans ces eaux côtières est une source de vives préoccupations. Tous les participants ont convenu que toutes les pêches du hareng doivent être gérées de manière à prévenir que ces petites unités, peut-être discrètes, soient ciblées, que ce soit au moment de la fraie ou lorsqu'elles se mélangent à d'autres composantes pendant le reste de l'année.

**On était d'avis que la pêche des juvéniles dans la baie de Fundy a donné un rendement comparable aux dernières années.**

**Des conseils sur le niveau de récolte n'ont été fournis que pour la principale unité de reproducteurs du sud-ouest de la Nouvelle-Écosse. En se fondant sur la présence d'une seule cohorte dans les prises et la perspective d'un faible recrutement, on a établi que les prises en 1997 ne devraient pas être supérieures à celles de 1996. Le protocole relevé - évaluation - pêche devrait être appliqué pour répartir les prises en fonction des bancs de reproducteurs.**

**La pêche exploratoire pourrait se poursuivre dans le cadre de la pêche hauturière à la senne selon les Lignes directrices pour les pêches nouvelles**. Ces dernières prévoient les éléments suivants :

- une augmentation lente et contrôlée de l'effort;
- la pêche en développement doit s'effectuer de manière à maximiser la cueillette de l'information biologique requise pour gérer la pêche;
- l'industrie contribue sensiblement au coût de la cueillette de l'information et de la gestion de la pêche en développement.

Bien que l'état de la ressource du sud-ouest de la Nouvelle-Écosse et les impacts de la protection des composantes côtières sur la pêche aient été longuement débattus par les représentants de l'industrie, **ils ont avalisé les conseils formulés pour chacune des composantes du stock.**

# ASPECTS BIOLOGIQUES DES STRATÉGIES DE GESTION

**Protocole relevé-évaluation-pêche pour l'exploitation de bancs de reproducteurs**

Le protocole ayant de nombreux côtés désirables, on devrait continuer de l'appliquer tout en faisant preuve, à toutes les étapes, d'une plus grande rigueur au plan quantitatif. **Il ne devrait pas être utilisé comme outil pour établir les niveaux généraux de capture tant que les évaluateurs ne seront pas satisfaits que le niveau maximum de rigueur a été atteint**. Étant donné que la pêche visant les reproducteurs n'a lieu qu'à la fin de la saison de pêche, **le taux d'exploitation devrait être réduit, pour passer de 20 % (taux d'exploitation cible général) à un taux correspondant au pourcentage du quota total de reproducteurs récolté**.

**Protocole relevé-évaluation-pêche pour l'exploitation après la fraie**

Bien que cette approche vise à ce qu'une pêche ne surexploite pas un banc donné, rien ne garantit qu'un banc de hareng, qu'il soit en train de s'alimenter ou non, ne soit visé par les pêcheurs à maintes reprises. **Après la fraie, le protocole RÉP permet d'empêcher les pêcheurs d'appauvrir un banc, mais ne suffit pas à assurer la conservation de toutes les composantes d'un stock**, même lorsque couplé à un TAC général.

**Pêches nouvelles sur le plateau néo-écossais et dans les eaux côtières**

**L'expansion de ces pêches devraient se faire lentement, et ce conformément aux Lignes directrices pour les pêches nouvelles. Les bancs de reproducteurs côtiers ne devraient pas être l'objet de nouvelles pêches tant qu'un nouveau cadre scientifique ne soit mis en place pour assurer qu'elles soient menées de façon durable.** Ces deux initiatives requièrent un important appui scientifique et d'étroits partenariats avec l'industrie.

**Pêche d'hiver dans 4Vn**

La pêche d'hiver à la senne coulissante du hareng de 4T dans 4Vn est l'objet de vives discussions. Afin d'assurer la conservation des composantes côtières locales du stock de 4VWX, on recommande que :

- **la pêche d'hiver ne commence que le 1$^{er}$ novembre ou plus tard;**
- **la pêche d'hiver soit interdite au sud ou à l'est d'une ligne dont les coordonnées seront négociées par l'industrie, les scientifiques et les gestionnaires;**
- **la pêche d'hiver soit axée sur la récolte de petits pourcentages de grands bancs et non de pourcentages élevés de petits bancs;**

- **étant donné que les prises au taux visé pendant la dernière décennie ne semblent pas avoir nui aux composantes côtières locales, la pêche d'hiver devrait être restreinte à la moyenne des prises au cours de la dernière décennie;** (Le libellé de ce dernier élément est le résultat d'un compromis, à lequel on est arrivé après de longues discussions.)
- **comme la présence de jeunes ou de petits harengs dans les prises pourrait indiquer que les composantes côtières sont exploitées, les bateaux devraient, dans ce cas, arrêter de pêcher et se diriger vers d'autres pêcheries.**

**Pour ce qui est de toutes les questions touchant les stratégies de gestion des pêches dans la région des Maritimes, l'industrie accepte généralement les principes proposés, et les gestionnaires conviennent que le cadre est suffisant pour leur permettre d'élaborer des plans de gestion axés sur la conservation et des données scientifiques.**

## TAUX D'EXPLOITATION BASÉS SUR LES RELATIONS STOCK-RECRUTEMENT

Les méthodes en voie d'être élaborées à Terre-Neuve pour déterminer le taux d'exploitation cible en se servant des relations stock-recrutement et de la biomasse du stock de reproducteurs sont passées en revue. L'examen est divisé en deux volets, l'un portant sur le concept et l'autre, sur la méthode d'analyse.

**L'approche conceptuelle est vivement appuyée. On la considère comme étant plus prudente qu'un taux d'exploitation cible fixe car elle établit un cadre systématique pour réduire l'exploitation à un taux inférieur à $F_{0,1}$ lorsque la biomasse du stock de reproducteurs est faible.** Étant donné que l'influence de la température et/ou de la salinité sur le recrutement semble aussi forte que l'influence de la biomasse du stock de reproducteurs, on recommande que toute autre analyse réalisée explore aussi la faisabilité et les conséquences d'un taux d'exploitation réduit lorsque les conditions du milieu laissent supposer une forte probabilité d'un recrutement faible.

**Des détails sur les analyses faisant défaut, le modèle utilisé dans la région de Terre-Neuve n'est pas passé en revue**, mais on note que le modèle révisé tient compte des aspects stochastiques que le CSÉR avait demandé d'inclure. **On demande que d'autres analyses soient effectuées et on suggère que l'on prépare un document plus détaillé aux fins d'examen par le CSÉR lorsqu'elles seront complétées.**

En général, tous les participants considèrent que l'examen des évaluations zonales et l'atelier de travail ont été fructueux. Les données scientifiques et les évaluations étaient de calibre élevé, et les questions de gestion ont été étudiées en profondeur. L'industrie a participé aux travaux de façon active et constructive, et a quitté la réunion très confiante dans les conseils scientifiques.

# ATLANTIC ZONAL HERRING WORKSHOP
# MARCH 24-27, MONCTON, NB
# PROCEEDINGS

A Zonal Workshop on Atlantic herring stocks was held in Moncton from 24 - 27 March, 1997. The Workshop consisted of two components; a Zonal Assessment Review of Maritime and Laurentian Region herring stocks, and a discussion of biological aspects of herring management strategies. The agenda is included as Annex 1.

Major assessments were reviewed for herring stocks in **4T, 4R, and 4VWX**.

Several biological aspects of herring management strategies were considered in workshop discussions, including:

- **use of the survey - assess - fish protocol in fisheries on spawning aggregations**
- **use of the survey - assess - fish protocol outside the spawning season**
- **conduct of new / exploratory fishing for herring on the Scotian Shelf**
- **rules for the winter herring fishery in 4Vn**
- **management strategies based on stock-recruit and environment-recruit relationships, being developed in Newfoundland Region.**

There were approximately 40 participants from DFO (Science and Operations Branches), universities, the fishing industry, and Native bands. The list of participants is included as Annex II to this Report.

## REVIEW OF ASSESSMENTS

The highlights of the assessment review and discussion are summarized below. However, the Stock Status Reports and Research Documents for the individual stocks should be used as the primary sources of information on the status of each stock and the scientific basis for determining each status. Those documents are listed with each stock summary.

### 4T HERRING:

**Stock Status Report 1997 B3-01: Southern Gulf of St. Lawrence Herring**
**Research Document 97/30: Assessment of the NAFO Division 4T Atlantic herring stock, 1996 by R. Claytor, C. LeBlanc, A. Sinclair, G. Poirier, L. Paulin**

One major Working Paper was tabled, along with associated appendices. Additional analyses were conducted and results presented during the meeting. Material on the winter fishery for 4T herring in 4Vn was treated in other documentation for a separate agenda item.

**Fall spawners:**

**The assessment of 4T herring stock concluded the spawning biomass of fall spawners was declining**, as the very large 1987 and 1988 cohorts no longer are major contributors to catches. The 4+ biomass declined from 287,000 t in 1995 to 213,000 t in 1996. Since the above average 1990 cohort, year-classes have been average or below average. Therefore biomass is expected to continue to decline slightly in the near future, regardless of catch level.

The key index of stock status was the inshore catch rate index, developed from purchase slips, dockside monitoring records, and a phone survey. Industry expressed a number of concerns that the catch rate index might be biased by the effects of trip limits, changes of season length, and new entrants to the fishery. Analyses were tabled which examined each of these factors, and each was found to be unlikely to bias the index significantly. The various supplementary indicators of stock status included:

- a September bottom trawl survey, which indicated an appreciable decrease in abundance from 1995 to 1996, particularly in St. George's Bay;
- a hydroacoustic survey of Chaleur Bay, which indicated a slight increase in abundance from 1995 to 1996;
- a partial survey of egg deposition on Fishermen's Bank which has not been analysed fully, but shows improved spawning relative to the low level in 1995, although the final index is unlikely to be as high as 1994;
- a phone survey of gill netters, who reported increases in abundances in all areas.

These supplementary indicators taken together give mixed signals about stock status.

The analysis was done with an ADAPT formulation identical to that used in past assessments. The diagnostics of the model fit, including residual patterns, were comparable to past analyses, and indicated the model fit the data reasonably well. A retrospective analysis found no overall patterns, although the 1983 year-class has been consistently overestimated. The Committee agreed to accept the results of the ADAPT run, as a basis for evaluation of stock status and forecast of catches.

A few additional analyses were requested as a result of the review. The fishing mortality induced per unit of effort seems to be increasing in recent years. There is insufficient information to account for this trend, but **the large 1996 residual in the F vs. effort relationship requires further investigation, as a high priority.**

The target exploitation rate for this stock is 23%, which was met in both 1995 and 1996. The weighted 4+ fishing mortality in 1996 was 0.27, which is very close to the target $F_{0.1}$ value. **The $F_{0.1}$ catch in 1997 is forecast to be 49,000 tonnes, which is very close to the value of 50,000 tonnes forecast in the 1996 assessment**. The risk analysis was accepted, and confirmed that a TAC of 49,000 t would be risk neutral (50% risk of $F_{1997}$ exceeding the $F_{0.1}$ management objective). A TAC of 44,000 t would reduce the risk to 20%. The projection for 1998, assuming median recruitment, suggests the catch associated with a risk neutral $F_{0.1}$ would be 44,000 t, with a catch of 38,000 t corresponding to a 20% risk level. There is a high probability of continued decline in SSB at any harvest level.

Among the issues addressed in the subsequent discussion were:

- details of the fit to the ADAPT model, and of analyses of the index catch rate, hydroacoustic, and groundfish survey indices
- representation of year-classes and of spring and fall spawners in various fisheries
- sampling levels and plans for future sampling
- changes in the spatial dynamics of the fishery over time, particularly more fishing in the southern Gulf
- changes in mesh sizes and fishing practices of the gill netters
- levels and sources of pre-recruit mortality
- the sustainability of fisheries on spawning aggregations
- the possibilities of groundtruthing catch rates against index fisher records
- the use of the risk analysis in setting advice for 1997, and what level of risk is "risk averse"

Industry contributed particularly actively to the discussion of the meaning of the catch rate series, changes in spatial and temporal distribution of the fishery, and possible improvements to the index fisher and catch sampling programs. In general industry found the assessment credible, and felt many of their concerns were addressed in the discussion.

**Spring spawners**

Spring spawners comprise about a third of the total herring biomass in 4T. The 4+ biomass declined from 112,000 t in 1995 to 80,000 t in 1996, although the 5+ biomass increased from 74,000 t to 77,000 t. **The assessment has greater uncertainty than for the fall spawning component**, but is much improved analytically over previous assessments, with an ADAPT -VPA formulation completed for the first time.

Of year-classes presently in the fishery only the 1991 cohort appears better than average, so **biomass is expected to continue to decline slightly, regardless of harvest level.** However, the incoming year-class of age 4's may be above average.

The key indicators of abundance were derived from index gillnetters, and from a daily catch monitoring program operated by the Province of New Brunswick, which covers Statistical Districts 73-80. Catch rate indices from the inshore fixed gear fisheries indicate a gradual decline.

Both ADAPT-VPA and simple VPA runs were considered. Both models suggest the stock declined from 1995 to 1996. The different formulations estimate slightly different strengths to the various age groups in the populations, but both models give similar results for 1996. The analytical results suggest a gradual decline in biomass over the past 2 or 3 years, although the stock is estimated to have been slightly larger through the 1990s than was estimated last year. A retrospective analysis found no serious patterns in the present assessment.

The weighted fishing mortality for 4+ herring was 0.34 in 1996, slightly above the target of 0.30. The **$F_{0.1}$ catch of spring spawners for 1997 is forecast to be 16,500 tonnes, slightly greater than the $F_{0.1}$ catch for 1997 which was forecast in 1996 to be 15,500 t.** The risk analysis indicates the 16,500 t to be risk neutral; a catch of 14,200 reduces the risk of $F_{1997}$ exceeding $F_{0.1}$ to 20%.

Among the major points raised in the discussion were:

- the amount of catch covered by the index fishers and wharf monitoring programs
- the shape of the partial recruitment vector
- the magnitude of change in age composition from 1995 to `996, and the possible reasons for it
- atypical spatial patterns in 1996 fisheries, including poor catches in Chaleur Bay for the 5th consecutive year.

A full record of questions and answers is included as Annex III.

**4R HERRING:**

**Stock Status Report 1997 B4-01: 4R Herring**
**Research Document:**

A Working Paper presenting the assessment results was tabled, along with a 1996 Research document presenting data and analyses from a hydroacoustic survey. Industry also made a presentation on their studies and perception of stock status.

**The assessment of herring in 4R found the stock to continue to be in good condition**. Many age groups contribute to catches, and herring older than 11 years are not uncommon. These are indicators that the present exploitation rate is sustainable. Catches have not achieved the quota in any recent year, but both scientists and industry agree that this has been due to difficult fishing conditions during periods when herring are aggregated, rather than to inability to find fish.

There were two major indices of abundance; index fisher catch rates and hydroacoustic surveys. The standardization of the CPUE series from the index fisher program does not fit well, suggesting the index may only track large scale trends. There were also concerns about the level of participation and spatial coverage of the index fishers. This index indicates a slight increase from 1995 to 1996 for both Spring and Fall spawners, after steady declines between 1992 and 1995 (Spring) or 1992 and 1994 (fall).

The hydroacoustic surveys also have some uncertainty, due to the occurrence of herring close to the bottom. The most recent survey was 1995 which used a stratified fixed transect design with a random starting point in each stratum. The survey found herring to be widespread, and extremely dense in some areas (e.g. North Arm of Bonne Bay). Industry also noted extremely dense aggregations of herring were encountered in some places and times, in the fjords along the West Coast of Newfoundland. The geostatistically based biomass estimate from the survey was 84,000 t, with a CV dependent on which statistical method of variance estimation was used. The Committee agree this was likely to be a minimum estimate, as most sources of possible bias would produce underestimates of the stock size.

Notwithstanding the sources of uncertainty, both indices indicated a stable or growing population. Acknowledging that the hydroacoustic estimate is likely to be a minimum estimate due to several factors including the densely patchy and unpredictable distribution of 4R herring and the proximity of many aggregations to the bottom, and that questions remain about the variance estimates associated with the geostatistical methods used in the analyses, the figures in Table 4 and 5 of the Working Paper are accepted. **These figures indicate the 1997 biomass is at least 49,000 t, of which 49% are Spring spawners.**

Several ancillary indicators of stock status were considered. Condition and growth rates both seem to be recovering in the stock. After a period of decline in the southern part of 4R, abundance seems

to be stable or increasing along the entire west coast of Newfoundland. Age and size composition of catches show many age groups to be present in the population. Groundfish trawl surveys gave some information about the distribution of herring in winter (middle of Esquiman Channel) and summer (heads of channels).

The lack of an index of abundance for the stock as a whole, and the large number of age groups in the catch and research samples (suggesting a low fishing mortality) continue to preclude doing a full age structured SPA for this stock. **Nonetheless, on the basis of the age and size compositions of the catches, the positive signs in both abundance indices, questionnaire responses of inshore fishers, and presentation from the purse seine industry fleet, it was agreed that the stock remains in good condition, with harvests at or below a sustainable level. The scientific advice for 4R herring was status quo TAC, which was supported by industry.**

There was a special discussion of the annual delayed opening of St. George's Bay to the purse seine fleet, first implemented in 1994. The delayed opening was implemented because the strong 1987 year class was not seen to be recruiting to that area. The strong 1990 year class is showing strongly in research and gill net samples from St. Georges Bay. **It was agreed that there is no biological justification for continuing the practice of delaying the opening of St. George's Bay to the purse seine fleet for the entire year. However, because herring in that bay were thought to be reduced greatly in the past, and the current upswing is not quantified fully, harvesting should increase slowly, and be monitored carefully.**

Among the issues raised in the discussion were:

- The similarities between fine-scale acoustic survey results and purse-seine fleet experiences
- The need to watch for impacts of new markets on level and distribution of effort
- That there is little evidence of mixing of herring between 4R and western 4S, but there are some similarities in age composition between 4R and eastern 4S. There may be more movement between western 4S and herring in parts of 4T or 4Vn. **It is necessary to resolve the relationship between 4S and 4R fish, and the location (and times?) of the east-west break in 4S herring.**
- The ageing of 1994 and 1995 samples needs to be confirmed or corrected.
- The trends in condition factor seem to be diverging between fall and spring spawners. It would be interesting to know the cause, and industry would be willing to provide data on fat content from catches over the entire period of the fishery.
- Participation in the gillnet index fishery program has reached a very low level. **With the apparent increase in activity in this sector, it is important to increase participation in the program.**
- The hydroacoustic survey seems to treat the fish vs. bottom problem conservatively, but the problem continues to require care in the methods and analyses.
- The hydroacoustic survey design and geostatistical analysis continue to evolve, and major changes require careful review. The change to systematic strata with a random starting point

was agreed to be an improvement. The variances associated with the geostatistical estimates remain an issue of discussion.

- If the goal is to maintain large herring in the catch, exploitation rates other than $F_{0.1}$ may be more appropriate. This issue should be explored if catches expand and the TAC becomes restrictive.
- It should be long term goal to develop a full age structured assessment of this stock.

A full transcript of the discussion is included as Annex IV.

**4VWX HERRING:**

**Stock Status Report 1997 B3-03: 4VWX Herring**
**Research Document 97/61: Evaluation of the stock status of 4WX herring**
**by R.L. Stephenson, M.J. Power, F.J. Fife, G.D. Melvin, S. Paul**

Eleven Working Papers and three appendices were tabled for review in the assessment of the 4VWX herring stock. Another Working Paper on the 4Vn winter seine fishery was deferred for consideration with the management strategies issues.

**Stock Structure:**

The assessment of 4WX was challenging. **There was extensive consideration of the proper units for assessment and management of the stock complex.**

The information on larval distribution, historical distribution of the fisheries, and age composition of the catches in various fisheries supports a modification of the current management unit. **For the purpose of the stock assessment, this information suggests that the fisheries in 4WX should be divided into four components:**

**-SW Nova Scotia Spawning Component**
**-Coastal Nova Scotia Spawning Components (including coastal 4V)**
**-Offshore Scotian Shelf Banks spawning component**
**-SW New Brunswick migrant juveniles.**

It is noted that management approaches in the past five years have, to some degree, already recognized these spawning components. The SW Nova Scotia Spawning Component and the New Brunswick migrant juvenile component were already recognized explicitly in previous management plans. The other two components are new. However because of the differences

observed in age composition, indications are that mixing of offshore Scotian Shelf and nearshore coastal spawners with the larger SW Nova Scotia Spawning Component is modest. **These four components should be recognized explicitly when designing data collection programs, and management approaches should include measures to provide more protection to smaller components.**

The current view is that the Coastal Nova Scotia Spawning Component includes the coastal waters of Cape Breton, up to Cape North.

For Grand Manan, juvenile fish taken in weirs are considered to be part of the SW New Brunswick migrants from SA5. However, other gears (seines and gillnets) generally take older fish which are considered to be part of the SW Nova Scotia Spawning Component. While some of the age 2 catch by weirs could be from the SW Nova Component, this approach for the attribution of the catches to their spawning components has not been found to cause difficulties to this point. It was considered reasonable to continue the approach.

**There will always remain some mixing between the main stock components. The topics of concern are 1) mixing in winter time (the SW Nova Scotia Component will mix with coastal components), 2) the mix of juveniles at the mouth of the Bay of Fundy, 3) and the danger that small, localized spawning concentrations be eliminated if not identified and protected.**

**Survey-Assess-Fish Protocol**

The in-season **Survey-Assess-Fish methodology** was an import aspect of the 1996 fisheries. It was discussed in detail, to evaluate if and how to use the results in this assessment. These surveys provide a snapshot of some spawning aggregations, not, initially, a complete census of the resource. **There is an incomplete coverage in time and space and, therefore, these surveys cannot provide an overall estimate of the biomass.** Fishermen have seen many more aggregations of fish than those documented and estimated through the various techniques (skipper's estimations, contouring, acoustic).

It was pointed out that this approach must ensure that the same fish are not counted twice. If the current view that herring spawn on the SW banks in waves at least 8-10 days apart is correct, the protocol of spreading surveys by 8 to 10 days on the spawning grounds should avoid re-sampling the same spawning fish. **Participants agreed that the survey-assess-fish practice was acceptable for in-season use on the southwest Nova banks, to distribute the allocation among spawning aggregations.**

There was extensive discussion about the contouring techniques used to derive biomass estimates from the sounder records. Several participants pointed out that results of contouring techniques could be highly dependent on certain input parameters and interpolation algorithms. **While the contour maps from the S-A-F procedures are useful to look at distribution of the resource,**

**the statistical properties of the biomass estimates generated from them at this time may not be optimal and could be biased**. Other techniques in spatial statistics should be used instead to provide biomass estimates and their variances, although there is debate about the most suitable method. The contouring approach used at present could only provide a rough estimate of biomass.

Industry representatives pointed out that in-season estimates are likely to be on the conservative side for a number of reasons. For instance, the fat content changed in monitoring the offshore "patch", which means that 3 or 4 different bodies of fish were sampled during the survey time. Others pointed out that we are not seeing 100% of the fish at any one time. Industry feels that, at the very least, the approach can be used to relay some "minimum number" that can be used to guide decisions on catch levels.

It was noted that this approach of in-season surveys was adopted to set the fishing level for "one night", not for evaluating the absolute size of the stock. However, some consider that the approach also provides an independent, minimum estimate of the summer-fall aggregations of herring in SW Nova. The surveys cover all areas where we know spawning takes place. The groundtruthing of acoustic estimates enhances our confidence in using the in-season biomass estimates. Consideration of this point was deferred until the discussion of management strategies.

It was noted that the approach could be improved by replacing the categories (i.e. differentiation into light, moderate, heavy categories) by the actual estimates of the schools recorded. **More work in this area is encouraged, along with work on the other quantitative steps involved in estimating densities and areas occupied by schools.**

There is a general concern that the in-season approach is not directly applicable to other herring stocks which may not have similar characteristics for their spawning aggregations. **In particular, areas or stocks where spawning aggregations are not as well defined or as well known. would not be amenable to this approach.**

Fishermen are supportive of using the estimate as a minimum estimate of biomass. They do not believe that the estimates are "dangerously biased" but that they are acceptable as a first approximation. Also, the value of this approach in terms of added protection for the spawning stock must fully acknowledged.

**The Committee recommended that further research be done to develop estimates of variance for the in-season biomass estimates. Also, several improvements are needed in the methods used to produce quantitative estimates from hydro-acoustics, rather than just designations of the sets as "light", "moderate" and "heavy".**

**Southwest Nova Spawning Component:**

The **Southwest Nova portion continues to decline, from the high in 1989**. There was significant biological uncertainty about the size of the resource in 1996. The 1996 quota was 50,000 t, down substantially from TAC levels in the preceding years. The management plan allocated 57,000 and all allocations were harvested. There was thought to be substantial undocumented catch, although this undocumented catch may have come from coastal as well as SW Nova spawning components.

The 1992 year class is dominant in the catches, although the 1993 year class also appears to have some promise. The 1995 year classes may be weak. Fish older than age 5 are not well represented in the catches. Good spawning was observed in most traditional areas, except Seal Island.

**In 1996 the fishery on spawning aggregations was conducted according to a "survey - assess - fish" methodology, whereby industry, scientists and managers worked together primarily on industry boats to evaluate the size of individual aggregations prior to harvesting at or below the level of 20% of each aggregation**. All participants were satisfied with the performance of this approach, and plan to continue to use it in coming fisheries. This assessment review also considered that in-season management has provided this stock with additional safeguards against overexploitation of individual spawning components. **The Committee accepted the in-season survey estimate of aggregate spawning biomass was about 192,000t, but only as a general estimate, noting the qualifications in section on the Survey - Assess - Fish methodology.**

The other major indicator of stock status was the larval abundance index, which is highly variable but has been used in previous assessments. The 1996 value of the index is midway between the 1995 and 1994 values; all three values are lower than the values between 1988 and 1993. An attempt to disaggregate this index by the age composition of the spawning population was also reviewed. Year class effects were found to be weak but significant, and the index predicted cohort strength better at older ages than at younger ages.

The ADAPT fit is poor for the last two years, with large residuals. Variance estimates are also high, with coefficients of variation of the order of 60%. If these results are used in catch projections, they would translate into considerable uncertainty. The Committee concluded the results should not be used for catch projections. Overall, the ADAPT results are driven by the Larval Index which, in hindsight, has been a poor indicator of spawning biomass. While consideration should be given to cast these results in terms of risk analysis, the Committee recommended that a retrospective analysis first be done so as to evaluate if further work is warranted.

**The retrospective analysis showed strong trends, suggesting that the ADAPT formulation, tuned to the larval index, did not provide an accurate and consistent estimate of stock status over time.** Several possible causes of the strong retrospective pattern were suggested, including changes in q, m, or discarding levels, but there is inadequate information to evaluate the

possibilities. There seems to be a particularly strong anomaly between 1993 and 1994. Industry noted this was a year of particularly poor feeding conditions for herring, and low fat content. **On the basis of the poor fit, the strong retrospective pattern, and questions about the tuning index, the Committee agreed that the biomass estimate from the ADAPT run would not be a reliable basis for advice on harvest level. The estimate of 300,000 is likely to be an overestimate of biomass, by an unknown amount.**

**The Committee based the advice on the biological and fisheries information which had been available, noting the biomass was likely to be between the ADAPT overestimate of 300,000 t and the in-season spawner estimate of 192,000 t. Age-structure information suggest that recruitment is poor. Few old fish are present in the samples. A conservative approach will be needed until there is evidence of stronger recruitment.**

**The aggregate estimate of 192,000 t from the spawning bed sounding surveys would correspond to the abundance before the fisheries on spawning beds. Therefore this rough estimate of spawning biomass was reduced by approximately 27,000t for a crude year-end estimate of escapement. Allowing for below average recruitment, a status quo catch in 1997 was thought to be the largest catch that could be advised, and such a catch would not be inconsistent the target exploitation rate. The survey - assess - fish methodology should be used in fisheries on spawning aggregations, and should provide extra protection of individual spawning aggregations, assuming that roe fisheries continued to harvest approximately half the total catch.**

**Offshore Scotian Shelf Component**

**The offshore Scotian Shelf component supports a new purse seine fishery, which harvested nearly 12,000 t in 1996. This fishery is still in an exploratory phase**, and the extent of the resource is unknown. The purse seine fleet used the survey - assess - fish methodology, and took most of the catch from The Patch area of the Shelf. The overall survey activity was opportunistic rather than systematic, and both the Committee and industry agreed the 1996 survey results should not be used as a basis for biomass estimation of herring on the Scotian Shelf. The age composition of catch samples is indicative of a stock that is lightly exploited.

It was noted that foreign fisheries in the 1960s harvested several tens of thousands of tonnes for several years. Effort was reduced in the mid-1970s because of extension of fisheries jurisdiction and other economic considerations, and there were no herring fisheries through the 1980s. Groundfish trawl surveys indicated few herring on the Scotian Shelf through the 1980s, but recent surveys have found herring to be abundant and widespread, and that herring have spawned on the Shelf in recent years. **This suggests the stock is variable, and although there may be substantial yield available for some years, a fishery may not be sustainable over decades.**

**From a conservation standpoint, it appears to be important to continue to distribute the fishing effort during the exploratory period.**

**The Department and industry need to build up a strong base of information over time that would allow a better assessment of the extent of the resource in a few years. In particular:**

- **The Committee supports the industry proposal for more surveys in the offshore area, including collection of biological samples from aggregations.**
- **The Committee considers that it is important to carry out research on inshore and offshore mixing.**
- **The offshore aggregations in 4Vs are likely part of the same stock component and it was recommended that the evidence for this be reviewed next year.**

**A fishery at this stage should proceed cautiously. There appears to be room for development of a fishery beyond what was harvested in 1996. This development needs to be done in consultation with the industry, management, and science. In particular, there is a need to develop an integrated developmental five-year plan for this fishery. The Guidelines for Emerging Fisheries should be used as a framework in development of that five-year Plan.**

**Coastal Components of 4VWX herring:**

**There is little information on the status of the coastal components of 4VWX herring**, although results of a study of herring spawning in Bras d'Or Lakes was tabled. That stock component seems to be declining seriously. However, several possible causes were suggested for the declines, and insufficient data were available to evaluate the actual role of each possible cause. **The Committee did agree that fishing gear in the Bras d'Or Lakes should be deployed at levels and in times and places which ensure reasonable levels of escapement of adults to spawning sites. Because the spawning sites appear localized and scattered, this objective will require interactions among managers, biologists, and harvesters on quite local scales.** Because of the diversity of possible causes of the decline in the local stock component, there is no assurance this measure alone will lead to improvements in the status of the component.

The age composition of samples from catches from these coastal stock components appear relatively broad, and are consistent with a stock that is lightly exploited. There is no abundance estimate for this component. To build an information base to provide advice on these coastal spawning aggregations there are several research / data collection needs:

- document spatial and temporal attributes of fishing effort along the coastal areas
- set up a catch monitoring system
- document the location and size of spawning groups, including their spawning sites and their degree of mixing with other coastal stock components and with offshore and Southwest Nova spawning components

These coastal components have not yet been documented and delineated adequately, and there is an immediate concern about new fisheries developing in these coastal areas. **All participants agreed that all herring fisheries need to be managed in ways which prevent targeting on these small and possibly discrete units, whether during spawning or when they mix with other components at other seasons.** It **is recommended that there be no new fisheries on any coastal spawning components, without prior evaluation to ensure that the proposed fishing level is consistent with the available resource. There should be no sudden increase in effort of any fleet sector on any coastal aggregation as the resultant exploitation rate on some spawning components could be large and unsustainable.**

**Bay of Fundy Juvenile Fishery**

The **Bay of Fundy juvenile fishery** was thought to have performed as in the recent past. No new information was tabled or reviewed on these fisheries.

**SUMMARY OF ADVICE ON HERRING IN 4VsW:**

**Advice on harvest level was provided only for the main Southwest Nova spawning unit. Based on the reliance on a single cohort in the catch and the prospect of weak incoming recruitment, catches in 1997 should not exceed the 1996 catch. The survey - assess - fish protocol should be used to distribute catch among spawning aggregations.**

**The offshore purse seine fishery could continue to conduct exploratory fishing within the Guidelines for Emerging Fisheries.** These Guidelines provide for:

- a slow and controlled increase in effort
- the developing fishery must operate in ways which maximise the acquisition of biological information needed to manage the fishery
- industry contributes significantly to the cost of collection of information and management of the developing fishery

Although there was significant discussion among industry participants about the status of the Southwest Nova resource, and the impacts on fishing practices of preserving coastal components, **industry supported the advice on each of the stock components.**

## BIOLOGICAL ASPECTS OF MANAGEMENT STRATEGIES

This discussion began with a presentation by Alan Sinclair, on recent developments regarding fisheries management strategies. These developments arise from several interrelated sources, including the UN Conference on the Environment ("the Rio Conference"), the FAO Code of Conduct for Responsible Fishing, and the UN Convention on Straddling Stocks and Highly Migratory Species. The "precautionary approach" is the common theme in these agreements, and the presentation focused on what implementation of a "precautionary approach" might mean for fisheries assessments and management strategies. Key issues are the treatment of uncertainty in assessments , and the assurance of risk avoidance in management actions.

### SURVEY - ASSESS - FISH METHODOLOGY FOR FISHERIES ON SPAWNING AGGREGATIONS:

The details of this methodology, and much of the Committee's discussion of the issue, are reviewed at the beginning of the section on the assessment of 4VWX herring.

**With regard to its usefulness as a tool in management of fisheries on spawning aggregations, the Committee agreed this technique has many desirable qualities, and it should continue to be used.**

Greater quantitative rigor is needed in all steps, however. The specific areas of concern are discussed in the earlier section, but include:

- design of survey tracks when mapping aggregations
- calibration of sounder / sonar records to abundance
- interpolation or contouring algorithms
- abundance estimation from sounder records and interpolation results
- variance estimation around abundance estimates
- assurance of independence of successive aggregations being surveyed

**The survey - assess - fish methodology should not be used as a tool in setting overall harvest levels until reviewers are satisfied the higher level of rigor has been achieved.**

The roe fisheries on Southwest Nova spawners comes at the end of the fishing year. Therefore, these aggregations should be assumed to have already suffered a partial fishing mortality consistent with the proportion of the TAC harvested in other fisheries on this stock component. Hence, to keep the overall exploitation rate on individual aggregations at or below the target level, the exploitation rate on spawning aggregations needs to be no higher than the proportion of the target exploitation rate allocated to the roe fishery. **The exploitation rate in this fishery should be reduced from 20% (the overall target exploitation rate), to the rate consistent with the portion of the total quota taken in this fishery.**

## SURVEY - ASSESS - FISH METHODOLOGY FOR FISHERIES AT OTHER TIMES:

The survey - assess - fish methodology was developed for use on spawning aggregations. Properly applied, the Committee agrees that the methodology can make an important contribution to ensuring individual aggregations are not over-exploited. However, part of "properly applied" is having an assurance that an individual aggregation is only harvested once per annum with the method. If the spawning aggregations behave as reported at the Workshop (a "spawning wave" forms; is surveyed, assessed, and fished; spawns; and disperses out of the area), and the roe fishery only harvests spawning waves, then this criterion is met.

There is no assurance this criterion will be met outside the spawning season. Feeding aggregations may stay together for some time, and be exposed to repeated fishing events. Even if the survey - assess - fish methodology ensures each encounter results in a fishing event at the appropriate exploitation rate for that fishery, repeated encounters may result in high exploitation rates.

**Hence, the Committee concluded that although the survey - assess - fish approach ensures a single fishing event does not overexploit a single aggregation, there is no assurance that individual feeding (or other) aggregations are not harvested repeatedly. Outside the spawning period the S-A-F method has value in keeping a fishery from depleting a single aggregation, but is not adequate to ensure conservation of all stock components, even combined with an overall TAC.** It is highly desirable that fisheries outside the spawning period distribute their catches widely, as well as harvest proportions of aggregations at or below the target exploitation rate for the fishery.

## NEW FISHERIES ON THE SCOTIAN SHELF AND COASTAL AREAS:

Committee concerns are reviewed in the section of the 4VWX assessment dealing with coastal spawning components and Scotian Shelf spawning components. Those sections should be consulted when considering any new fisheries on these components. **In both cases the issues concern the very limited information base available on the stock components, and the possibility of over-fishing fairly discrete, local spawning aggregations**, either during the spawning period or in other seasons.

In the case of coastal spawning components, it is particularly important to document all spawning localities, and the degree to which these local aggregations mix with other components outside the spawning season. In the case of the Scotian Shelf component, there is a special concern regarding the longer term sustainability of any fisheries on this stock component, and the potential effects of harvesting on the natural levels of fluctuation this stock appears to show over several decades.

**To summarize the conclusions in the earlier section, fisheries on the Scotian Shelf should expand slowly, and follow the Guidelines for Emerging Fisheries. There should be no new fisheries on coastal spawning aggregations, nor expansions of effort in existing fisheries until there is a better scientific framework to ensure such fisheries are conducted in a sustainable way.**

**Both of these pieces of advice require significant science support and industry partnerships.** Consultations for developing the necessary framework should be initiated promptly.

**WINTER FISHERY IN 4Vn:**

There was significant discussion about the purse seine fishery harvesting 4T herring overwintering in 4Vn. Two working papers were tabled on this topic, one on the 4Vn Winter fishery itself, and one on decisions rules for over-wintering fisheries. The second working paper included results of a model which explored several aspects of fisheries on a mixture of stocks, under different assumptions of stock dynamics, stock mixing, and fishing practices. **In the model, many different assumptions and scenarios could lead to over-harvesting of local spawning aggregations.** A summary of the model and related discussion is included as Annex V.

The winter purse seine fishery in 4Vn is considered to be harvesting spring and fall spawners from 4T, and the 4Vn winter quota is taken off the 4T quota annually. This decision was initially justified by analyses of tagging data, length frequencies, and hydroacoustic surveys. At the time the management decision was made to treat winter 4Vn purse catches as 4T fish, it was acknowledged that there were coastal stock components in 4Vn, and that it was possible that the winter purse seine fishery could deplete such components, if the fishery were prosecuted without adequate precautions. In that context a number of constraints have been placed on the fishery, which have been perceived by industry to be disruptive and *ad hoc*, and whose effectiveness has been challenged.

Among the constraints have been:

- timing restrictions, to delay fishing until a large amount of 4T fish have migrated into 4Vn;
- size restrictions, assuming that any immature herring in 4Vn are from local spawnings, so catches of small herring would be a sign the fishery was not harvesting fish from 4T;

- area restrictions, to prevent the purse seiners from operating in areas where young fish were likely to be present, or where there were other arguments that fisheries might be targeting on herring which were part of the coastal 4Vn spawning components.

Examination of size composition data from catches indicate that a large proportion of catch samples are consistent with the fishery harvesting 4T fish. However, occasional samples suggest other stocks are being harvested at least in a few sets each year. Likewise, most catches each year are from areas which are likely to contain herring from 4T, based on limited hydroacoustic survey data, and catch sampling. Again, there are occasional catches from other sites, however.

There was extended debate regarding many aspects of this fishery and management regime, including :

- the degree to which the various management measures, singularly and together, succeeded in keeping the purse seine fishery from exploiting local spawning aggregations;
- the necessity for the measures, singularly or together, to achieve that goal;
- the potential and the actual impacts of the occasional alleged catches of local spawners on herring biodiversity;
- the degree to which every local spawning aggregation should be ensured protection;
- appropriate exploitation rates for mixed stock fisheries.

It became clear that key information was not available, and it would be impossible to resolve many of the issues under debate. Among the key unknowns are:

- the number, size, and distribution throughout the year, of coastal spawning aggregations in 4Vn;
- the degree to which coastal spawning aggregations mix with migrant herring, and with other local spawning aggregations, in winter;
- the exploitation rate coastal spawning aggregations could sustain;
- the sustainable exploitation rate for mixed stock fisheries in this area.

**There was consensus that until much more scientific information was available on particularly the first two unknowns, it would not be possible to provide a scientifically based resolution to the points of contention.**

A summary of the questions and answers arising during this discussion are included as Annex VI.

Notwithstanding the important unresolved questions, following the discussion it was possible to build an advisory framework for this fishery, which was supported by consensus.

It was acknowledged that coastal stock components occur in this area, and are more vulnerable to over-exploitation than the 4T over-wintering fish. **It is a legitimate goal to manage these winter fisheries in ways which have a high likelihood of avoiding aggregations of local spawners, and of detecting small stock components in catches when they are encountered. When these herring are detected, fishing should cease or change in ways which avoid their exploitation.**

Measures which would contribute to achieving that goal in an operational way:

- **The winter fishery should not begin until November 1 or later. If there is interest in fishing at an earlier date, evidence must be presented which demonstrates that the migration of 4T fish into 4Vn is well along.**
- **The winter fishery should not operate south or east of a line whose location is to be negotiated among industry, science and management.**
- **The winter fishery should focus on harvesting small fractions of large aggregations, and not large fractions of small aggregations.**
- **Catches of the level prosecuted over the past 10 years have not been shown to be detrimental to local coastal components, so the winter fishery should be restricted to the average level of catch over the past 10 years. This is a weak basis for a harvest limit, but until there is better information about the coastal components and the composition of winter catches the need to be precautionary should be given high weight in the management of these fisheries.**
- **The presence of small / young herring in catches could indicate exploitation of local components. In such cases boats should stop harvesting and move to different grounds.**

## EXPLOITATION RATES BASED ON STOCK RECRUIT RELATIONSHIPS:

One Working Paper was tabled on this topic. A stock classification system for Newfoundland herring stocks was first proposed in 1995. Through broad consultation and further scientific investigations, the proposed system developed into one which linked exploitation rates to recruitment estimates, given spawning stock levels. The system provided a mechanism to reduce fishing mortalities at low stock levels without fishery closures, while reducing the risk of recruitment over-fishing.

The method uses an environmentally dependent Ricker stock - recruit relationship, applied to stock, recruit, over-wintering water temperature, and salinity data from four stocks of Newfoundland herring, using data from 1964 to 1986 year-classes, as estimated in the 1996 assessments. All model fits were significant, with all three variables (biomass, temperature, and salinity) each related to recruitment at $P < 0.05$ for all stocks.

Based on the stock - recruit plots, 4 zones are delineated. The boundary between zones 2 and 3 was the SSB associated with maximum recruitment. The boundary between zone 1 and 2 was the SSB corresponding to the point on the ascending limb of the stock recruit curve where recruitment is 50% of the maximum value. The boundary between zones 3 and 4 was set to make the widths of zones 2 and 3 equal on the SSB axis. In zone 1, F should remain $< 0.05$; in zone 2, $0.05 < F < 0.10$; in zone 3, $0.10 < F < 0.20$; in zone 4, $F => 0.20$.

This work has been reviewed at various stages of development within the Newfoundland RAP process, and by SSSC. SSSC recommended that a risk analyses be included in the approach, and this presentation included additional analyses undertaken in response to that recommendation.

The Committee split its review into two parts, the concept and the analytical method.

**The conceptual approach was endorsed strongly. It was thought to be more precautionary than an fixed target exploitation rate, by providing a systematic framework for reducing exploitation below $F_{0.1}$ when SSB is low**. It was noted that several documents on implementing a precautionary approach to advice argue that to be precautionary one should assume the presence of a stock recruit relationship unless there is strong evidence to the contrary, rather the reverse, which has been the custom in past.

**Because the influence of temperature and/or salinity on recruitment appears to be as strong as the SSB influence, it was recommended that further analytical work also explore the feasibility and consequences of reduced exploitation rate when the environmental conditions suggested a high likelihood of poor recruitment, as well as when SSB is low.**

**Prevention of recruitment over-fishing is an important objective in fisheries, and we generally lack tools, guidelines, and mechanisms to achieve this objective. Regions are encouraged to continue to pursue operational tools, guidelines, and mechanisms for this objective. This might be a topic for a National Workshop.**

**Insufficient analytical details were available to review the specific model being used in Newfoundland Region**. The Region is strongly encouraged to continue development of this approach, and when ready, present another Working Paper, with full detail on analytical methods, to SSSC.

The fits reported in the paper seem implausibly high (some $r^2$ as high as .94). There were also questions about the units of recruitment and possible scaling factors. Details of these analyses require careful checking, and should be included in the next paper for SSSC.

In the risk analysis, the relationship between the uncertainty in recruitment and the advised F is not apparent, so the "risk analysis" may always produce risk neutral estimates within the overall system. This linkage should be checked carefully.

Although it was noted that some of the stochastic aspects requested by SSSC have been incorporated in the revised model, the stochasticity seems to be present only in the projection step of the method. **The uncertainty in the individual SSB and recruitment values used in the parameterization also must be incorporated into the analyses**. There are several possible ways to pursue addressing this uncertainty in the parameterization step, including re-sampling methods,

direct analytical treatment of the variance estimates of the stock and recruit values and S-R model parameters, and non-parametric density estimation methods (where instead of defining boundaries by properties of the Ricker curve, boundaries might be limiting probabilities of low or high recruitment. Not all these methods need to be explored, but some methods must be used to address the uncertainty in the model and data, not just the in for forecast.

**Because it appears that the effects of temperature and salinity on recruitment are as strong as the effect of SSB, the paper to be presented to SSSC should include residual plots of model fits to all three variables, not just SSB.**

**If it proves feasible to relate target exploitation rate to environmental variables, these results should be included in the paper for SSSC as well.**

Overall the Zonal Assessment Review and Workshop was considered a success by all participants. The science and assessments were of high quality, and management issues were discussed thoroughly. Industry participated actively and constructively, and left with high confidence in the scientific advice.

**ANNEX 1**

AGENDA - HERRING WORKSHOP

Monday, March 24 - ZONAL RAP

13:00 - 13:15 - Introductions & Objectives
13:15 - 17:00 4T Herring - Major Assessment (Claytor)

Tuesday, March 25 - ZONAL RAP

08:30 - 12:00 - 4 WX Herring - Major Assessment (Stephenson)
13:00 - 16:00 - " (including Scotian Shelf component)
16:00 - 17:30 - 4Vn Herring - including Bras d'Or Lake (Stephenson / Claytor)

Wednesday, March 26 -

08:30 - 11:55 - 4R Herring (McQuinn)
11:55 - 12:00 Update on 5Z Herring (Melvin)

13:00 - 14:30 Workshop on Assessment and Management Strategies Used in the Canadian Atlantic

A: Presentation of Working Papers

The precautionary approach (A. Sinclair)
Review of in-season management for 4WX herring (Melvin)
Decision rules for "over-wintering fisheries" (Claytor)

14:30 - 16:00 - Assessment re-runs and advice
16:00 - 18:00 - B: Discussion of in-season and Scotian Shelf management issues

Thursday, March 27 -

08:30 - 10:30 C: Stock-recruit targets, assessment, and management (Wheeler)
10:30 - 12:30 D: Discussion of Winter fishery in 4Vn.
12:30 - 13:00 Review of SSR outlines.

## ANNEX II

**List of Participants**

| | |
|---|---|
| Jake Rice | DFO - Ottawa |
| Dan Lane | University of Ottawa - Faculty of Administration |
| John Wheeler | DFO - St. John's, Newfoundland |
| Mike Power | DFO - St. Andrews, New Brunswick |
| Rodney Ingalls | Castalin - Grand Manan, New Brunswick |
| R. G. Stewart | AHFM Co-op - Yarmouth, Nova Scotia |
| Donna Larkin | SW Seiners - Pubnico, Nova Scotia |
| E. John Boone | St. George, New Brunswick |
| David Bollivar | Sea Freeze Foods Inc. - Dartmouth, Nova Scotia |
| Olin Gregan | Gulffish /Seafreez - Miramichi City, New Brunswick |
| Tim Kaiser | SPANS - Dartmouth, Nova Scotia |
| Gary Melvin | DFO - St. Andrews, New Brunswick |
| Claude LeBlanc | DFO - Moncton, New Brunswick |
| Allen Clay | FEMTO - Nova Scotia |
| Greg Organ | North of Smokey Fishermen's Association - Neil's Harbour, Nova Scotia |
| Ken Rodman | DFO - Halifax, Nova Scotia |
| Jean-Francois Martel | Regroupement Gaspé sud - Cap d'Espoir ( Québec) |
| Shelley Denny | Eskasoni Fish and Wildlife Commission - Eskasoni, Nova Scotia |
| Ghislain Chouinard | DFO - Moncton, New Brunswick |
| Denis Rivard | DFO - Ottawa, Ontario |
| Ross Claytor | DFO - Moncton, New Brunswick |
| Greg Egilsson | Gulf Nova Scotia Herring Federation - Pictou, Nova Scotia |
| John Neilson | DFO - Moncton, New Brunswick |
| Jack Fife | DFO - Moncton, New Brunswick |

| | |
|---|---|
| Stacey Paul | DFO - Moncton, New Brunswick |
| Fernand Friolet | DFO - Moncton, New Brunswick |
| Dominique Gascon | DFO - Institut Maurice-Lamontagne |
| Don Aldous | Pelagic Research Council - Nova Scotia |
| Paul Blades | SPANS - Dartmouth, Nova Scotia |
| Ian McQuinn | DFO - Institut Maurice-Lamontagne |
| Louise Lefebvre | DFO - Institut Maurice-Lamontagne |
| Alan Sinclair | DFO - Moncton, New Brunswick |
| Gloria Poirier | DFO - Moncton, New Brunswick |
| Bill Barry | Sea Freeze Foods Inc. - Dartmouth, N.S. |
| Laurent Paulin | DFO - Moncton, New Brunswick |
| Réginald Comeau | UPM - Tracadie Sheila (Nouveau-Brunswick) |
| Francois J. Beaudin | UPM/MFU - New Brunswick |
| Mike Sinclair | DFO - Bedford Institute of Oceanography |
| Robert Haché | FRAPP - Shippagan (Nouveau-Brunswick) |
| Rob Stephenson | DFO - St. Andrews, New Brunswick |
| Gary Melvin | DFO - St. Andrews, New Brunswick |
| Clarence Bourque | DFO - Moncton, New Brunswick |
| Guy Cormeir | MFU - Shediac, New Brunswick |

ANNEX III

**Presenter: Ross Claytor**
**Rapporteur: John Wheeler**

## Herring in 4T

Q: What does multiplicative model graph show?
A: Good fit to the data for fall spawners.

Q: What does it mean if age 4s are below the line?
A: Predicted is greater than observed.

Q: What was major year class in the spring 1996?
A: Age 5 from the 1991 year class.

## Description of Fishery

C: Change in gillnets from 2 1/4 to 2 3/8. What impact?
A: Could be a slight difference.

Q: Purse seine fishery in the spring, is it an overwintering fishery?
A: Late April and early May pre-spawning.

Q: Percentage of spring and autumn spawners in the spring.

C: Location of purse seine fishery in the spring, no consistent pattern in last two or three years -- hard to predict where fishery will occur -- feed problems in recent years.

Q: Does percent of fall spawner increase later in the spring fishery?
A: Sampling not intensive enough to determine it.

Q: Where there observers in spring fishery?
A: Not in 1996.

C: Proportion of fall spawners 25 - 30% in spring -- differs from observations in 4VN.

C: Sampling in spring fishery improved in 1996 -- last year more representative.

C: No description of sampling in working paper; should be included.

Q: Any plans to increase sampling in the spring?

A: Think that percentage of autumn spawners is greater than 25 - 30% as fishers don't observe many roe bearing fish and fat contents are low < 10%. If so, could it be possible that spring spawner have already spawned?

C: Samples can be broken down by maturity stage to determine if increased sampling is required.

C: Processing plants in southwest Nova Scotia take samples -- same thing can be done in southern Gulf.

C: In future, plot purse seine distributions

Q: Why was there an overrun in 1996 in the spring?
A: Monitoring system not efficient enough to close the fishery in time.

C: CPUE series not out of line in 1996 - more effort in the spring fishery in New Brunswick area but not in Escuminac.

Q: Why does fishery begin so early now and have a different pattern? Are they cycles of nature?
A: Spring fishers say there is great abundance but fishery was restrictive.

Q: Could overrun be due to unexpected switch in percentage of spring and autumn spawners?

A: Opposite observation in Bay de Chaleur. Herring used to be available in the spring, now don't show up until the fall - important that TACs be checked carefully along parts of the coast.

C: Spatial dynamics very important to split catch between spring and autumn spawners. Purse seine fleet with 23% of TAC catches mixture of spawning types whereas gillnets catch spring spawners in spring and autumn spawners in the fall.

C: Management plan is a balancing act through the year -- should be described in document.

Q: Great demand for bait in 1997. How will this be accounted for?

**Fall Abundance**

C: Document changes in the 1996 fall fishery.

C: Increased mesh sizes in the fall -- should be fewer smaller fish.

Q: Has the efficiency of gillnetters improved over time?
A: Gillnetters claim that fishers have intentionally reduced their CPUE: catch rates are catch per trip. Most fishing areas are well-defined.

C: No efficiency changes.

C: Daily limits restrict number of nets -- 5 to 6 nets sufficient.

Q: Why do phone surveys in 1996 not follow abundance trends for the fall?
A: May be schools of juveniles that fishers are seeing.

Q: Does traffic on water affect movement of fish?
A: Less fish in Miscou area -- matches assessment.

Q: What is the mortality of pre-recruits?
A: Very low in gillnets and purse seiners are under size restrictions, so this is not an explanation for large 1991 year class.

Q: When will analysis of sonar data be available?
A: Begin this summer -- role in assessment uncertain for next year.

Q: Why is fishing for roe on spawning beds allowed?
A: Wait for harvesting strategies discussion!

C: Add question to index fishers to record their observations on abundance; ground truth it against their catch rates -- compare their observations with phone survey.

C: Greater proportion of spring catch in 1996 from P.E.I. It would be good to look at number of nets -- number of nets by area is available.

Q: What is the effect of limits on numbers of trips? Is it keeping catch rates artificially low?
A: Catch limits have only changed in one area in 1996 so there is no effect.

C: There are no reasons to believe that catch rates are wrong.

C: Index from groundfish survey needs to be examined. It should be noted that there is a divergence in indices this year.

C: Year class tracking required in groundfish survey data.

C: Changes in research vessels don't coincide with major changes in abundance.

Q: No herring were seen by survey in St. Georges Bay in 1996. Is there a correspondence to the fishery?
A: No, not the case.
C: The only other time this occurred was when stocks were low; if assessment is accepted, then 1996 research vessel survey cannot be explained.

C: Industry doesn't want to put too much credence in 1996 point.

C: It would be useful to look at age distributions from research vessel survey to explain drop in 1996.

C: Acoustic survey prior to 1996 didn't cover distribution of the stock and thus is subject to changes in fish distribution.

C: ADAPT residuals for ages 4 and 6 show some trend. The age 4 trend is opposite to change in mesh size fished.

Q: Have you looked at F vs effort for fixed gear?

C: Whole assessment depends on acceptance of fixed gear index, and will be affected by any changes in Q. Separate fishing mortality due to fixed gear and look at F.

Q: What data are available from Fisherman's Bank?
A: No data available for 1996.

C: Spawning behaviour changed in 1995 and 1996 in Chaleur Bay. Herring seemed to spawn in deeper water.

Q: On Fisherman's Bank, there were low estimates in 1991 and 1995, and the 1991 year class was estimated to be small. What will happen to 1995 year class, and is the survey useful?

C: Fact that older ages exist in the catch suggest that Fs are reasonable.

C: Retrospective analysis suggests rapid rate of decline, and without evidence of strong recruitment, this trend is not likely to change. The stock will continue to decline even at low Fs.

C: Combine spring and fall spawner data for entire time series.

Q: How should managers and industry react to declining stocks?
A: Look at period in early 1980s when stock was lower to see where stock may be heading.

Q: How to account for risk analysis?
A: There appears to be no major concern for this stock. There is some indication from retrospective analysis of a rapid decline but indication of recruitment from anecdotal evidence and acoustic surveys suggests that the stock is not in trouble.

C: Can use risk analysis to provide a range of projections to managers rather than a point estimate.

C: Action to introduce risk at this point in order to reduce 1997 TAC is too extreme.

C: The slope of the risk analysis determines certainty of biomass estimate -- the steeper the better

C: 50,000t for fall spawners is not risk aggressive. It would be good to include risk analysis in SSR

C: Risk analysis can be run for 1998.

**Spring Abundance Indices**

Q: How much of spring landings are accounted for by index gillnetters and wharf monitoring?
A: Minimum of 60-70% should be included in document.

C: The assessment is a step forward this year in estimating spring spawners.

Q: Did you use dome shape vs flat top partial recruitment?

Q: Have the new entrants into the fishery in last few years affected q's?
A: Index gillnetters tend to be experienced.

C: There has been a large change in age distribution between 1995 and 1996.

C: Age distribution may not represent "real" stock which spawned off P.E.I.

C: N.B. caught 9,000 of 16,000 t, i.e., > 50% of allocation.

Q: Was the 1991 year class good in all areas?
A: Simple VPA vs ADAPT partial recruitment show a large difference.

C: ADAPT not a good fit for mature age groups.

Q: Does the retrospective analysis suggest that spring spawners are underestimated?
A: No response of overestimating from simple VPA but overestimate from ADAPT.

C: The risk analysis captures uncertainty of estimate of spring spawners. PSARC is not as certain and few year classes available.

C: The pattern of the fishery in 1996 atypical. There have been poor catches in Chaleur for fifth year. A poorer model fit, a greater uncertainty, and consequently a need to be more risk adverse.

C: Is there a trend in weight at age? Provide a plot.

**ANNEX IV**

# 4R Herring Assessment

## Ian McQuinn
## Proceedings of the meeting,
## Moncton - March 26 1997

## Presentation

Two documents were tabled:

Working Paper: Assessment of the West Coast of Newfoundland (NAFO Division 4R) Herring Stocks, (1973-1996) by Ian McQuinn and Louise Lefebvre

Res. Document: An Evaluation of the acoustic backscatter of western Newfoundland herring with a comparison of classical statistics and geostatistics for the estimation of variance. DFO Atl. Fish. Res. Doc 96/58, by Ian McQuinn and Louise Lefebvre.

**Introduction:**

There are both spring spawners (S/S) and fall spawners (F/S) in the 4R herring management unit.

**The Fishery**

- Total landings below advice for last 10 years or so.
- Mostly from purse seines.
- There has been temporal changes in landings from North to South.
- It was concluded in 1994 that there was too much effort/catch in St.-George's Bay hence the bay was closed to the purse seiners (technically, the opening was delayed).

**Index of abundance**

Index fishermen (IF)

- Program exists since 1984.
- Standardised CPUE of IF separated by spawning components.
- Was reduction in CPUE for S/S in St.-George's Bay, but not felt elsewhere in the catch.

- Standardization model does not have a good fit; they may not represent very well precise state of the population, only large scale trends.

Questionnaire

- Comments from previous years indicated decline in S, but not in N. Comments from 1996 indicate that herring appears more abundant in S now.
  ⇒ Industry comment: that this reflected reality.

**Catch age & at length**

- They had difficulty determining ages in 93-95 (possibly because of cold water which affected growth pattern), this lead to an underestimate of real ages.
- There are several significant Y-C for both S/S and F/S.
- The S/S 1990 Y-C is now quite apparent in the catch at length, although it did not enter the fishery in the same year for the different areas & gears.
- In the catch at length of F/S, it is difficult to follow modes; they don't appear to get the same fish from year to year.
  ⇒ Industry comment: that F/S seem to be made of two stock/components: a late summer "stock" and a "fall" stock. There is something unique about 4R: F/S and S/S are always mixed, but we have different groups of S/S and F/S.

**Biological indicators**

- *Condition factor*: There was a big drop in 1993-1994 corresponding to a cold period in the GSL. They are now back to normal. Low values of 93-94 not as low as values of mid 70s.
- *Gonadosomatic index*: The production of gonad products did not seem affected by lower condition, remaining ≈constant throughout this period (based on length).
  ⇒ Q: Has growth decreased during this period? A: Yes.

- Seasonal view of the fishery: There is much variation with seasons and areas, even on a small scale.
  ⇒ Industry comment: Bonne Bay & Bay of Island are the centre of herring [distribution] on the west coast of Nfld. It is abundant now. It is also believed that they move up and down the channel and that they approach the shore [where fished] only intermittently. In 1996, the young fish seemed to dominate.

- Based on groundfish (GF) surveys, herring are at in the middle of Esquiman channel in winter (Gadus Atlantica). They also appear to be bigger in N. In summer (Alfred Needler), fish are at the heads of the channels. S/S move from offshore to spawn in spring, whereas F/S remains offshore; in summer both move offshore to feed, and return inshore in fall to feed.

**Hydroacoustic Surveys:**

- A quick survey was done offshore St.-George's Bay in May 1995, piggybacking on a GF survey. Most fish were seen below the thermocline. Industry commented that they had a hard time catching fish then.
- Fall surveys have been conducted since 1989; in earlier years, they were done in Nov., but they are now conducted in Oct. Fish are more spread out then & the weather is more conducive for acoustic surveys.

  ⇒ Industry commented that we cannot have estimates of spawning components from the acoustic surveys because they are always mixed when they are along the shore, at the period when the surveys are conducted.

- All surveys are conducted in water < 100 m. In 1995, fish were hard against the bottom on top of banks where water is warmer. They avoided the gullies where water temperature was colder (in CIL).
- North Arm of Bonne Bay was full of fish: Sounder screen turned red, but this was probably not herring as echogram was not typical (plankton)?. Industry representatives commented that they saw the same thing and felt (were sure) that it was herring.

**Presentation from Industry**

Mr. Bill Barry (from Seafreeze Foods Inc.) made a brief presentation on some observations that he and the captains of the vessels of his fleet made in recent years.

1. Ian McQuinn did a real good job dealing with fisherman.

2. Why is the TAC not caught? Because we get only 12 or 15 days of fishing in the fall because of weather and fish distribution.

3. They received lots of comments from skippers of the type:

   *"The night we saw most fish [on sounder] – we did not catch any;*
   *the night we caught most fish – we did not see any [on sounder]"*

4. In North Arm [of Bonne Bay], they caught 4,000 t in 4 days. Being protected from winds, it is an area easy to fish. Following a quick calculation (involving the volume of purse seines and of North Arm), he estimated that there were 360,000 t of herring in North Arm.

- Comment: that it appears that herring in 4R have some natural refuges to protect them from exploitation.

Mr. Barry finally made the point that they had the ability to contribute to the research ($ & vessels) and he stressed the need to collaborate with science.

## Discussion

The chairperson oriented the general discussion of the assessment by asking a series of specific questions pertaining to the advice that we need to provide.

**Are we comfortable with the fact that the TAC is not caught?**

*Quota is not restrictive, and the fact that the TAC is not caught is usually interpreted as a sign of trouble. This does not seem to be the case for 4R herring; in this case, it appears to be caused mostly by bad weather in fall. There has been a change in fishing effort (number of boats).*

- Q: stated that he agreed with the statement and asked why TAC had been lowered in 1994:
  A: TAC is now biologically based.
- Comment: that new markets were developing and that we should watch closely for pressures to increase effort.

Nobody at the meeting objected to the chairman's statement.

**Comments on age structure?**

*It seems that we have a good spread of age classes and the stock seems healthy. Year classes stay in the fishery for a number of years (indication of a well managed stock).*

- Q: What are the relationship with 4S herring.
  A: Year classes dominant in 4R are the same in eastern 4S, but they don't seem to mix with fish in western 4S. Northern 4R S/S catches in the fall may be due in part to migrating fish from E 4S, but also local components. The area in 4S suitable for herring in fall (Z&T) is very small and they need to move somewhere. Relationship of W 4S fish is less clear. Abundance seems to move up & down in that area.
- Comments: that herring from (W) Newfoundland are different from those in S Gulf & Nova Scotia, on external appearance and texture of the flesh.
- Q: Catch at age is a problem in 1995 (& 1994 rapporteur com.) that needs to be remedied.
  A: work is already underway.
- Q: Acoustic survey estimates should be broken down in S/S & F/S based on the samples collected during fishing.
  A: Done, results are broken down by Y-C and length classes over the years.

The WG concluded that the good number of year-classes persisting for a long time in the population was representative of a healthy stock. Also, the 1990 YC seems abundant & widespread. **It was also concluded that we need to resolve the relationship between 4S and 4R fish and the E/W break in 4S.**

**Is the level of sampling representative of the fishery?**

Yes.

**Biological indicators: Condition factor.**

*This was a concern, but the condition appears to have recovered.*

- Comment: There seem to be a slight downward trend in Condition for F/S.
  Comment: There also seem to be a diverging trend between Condition of F/S and S/S.

We are not particularly alarmed, but it would be interesting to know why.

- Industry comment: Do you get information from industry on fat content? It is something that we measure constantly for our business. It is something that can be quite easily arranged & we are quite willing to do so.

**Biological indicator: growth rates & size at age.**

*Lengths at age are somewhat less now; this need to be followed but there is nothing in it that could be interpreted as an early warning signal.*

**Indices of abundance: Index Fishers (IF).**

Q: The fall index seems to track the 79 and 87 Y-C but not the 90Y-C.
A: the number of participants is declining, and may not be representative anymore. Only 3 fishers left (from a high of 7) and the areal coverage is much reduced.
The effort level is so low now that we can question the reliability of this index. **However, since the gillnet fishery seems to be picking up, it is important to increase the index fisher program now.**

**Index of abundance: Questionaires**

There is indication of a turnaround in S, continuing good results in N. Improvement overall..

**Index of abundance: Purse seiners.**

None

**Index of abundance: hydroacoustic survey.**

a) Coverage & Design.

- Comment: There is a concern because in the North (about half the estimated biomass) fish were all hard against bottom: Are all these fish herrings? Are all the rocks removed?
- Comment: There is judgement involved in doing this type analysis of hydoacoustic data and the removal of the bottom is not automatic.

Although we may have some concerns as a general rule when lot of the biomass is near or on bottom, the analyses were conducted following the standard techniques and the WG was satisfied that the hydroacoustic estimates were the best that could be achieved and were reasonable estimates of herring abundance.

b) Survey as conducted.

*In recent years the coverage was nearly complete as it should be.*

- Comment: What are the implications of the change from a random to systematic (with random starting point) design for the purpose of using geostatistical tools? Answer: it is preferable because geostatistics are more suited for the herring distribution; it is also harder to miss concentrations with regular spacing; finally geostatistics have better precision than regular statistics.
- Comment: Agree that systematic is better than random for geostats. CV's are not comparable and the reduction of CV should not be a goal *per se*. It was also suggested to use parallel transects (in relation to the coastline) in addition to perpendicular transects. Answer: this is not a trivial matter, but we are looking into it.
- Comment: Geostatistics underestimate the real variance because of design, but this is an active field of research - this appears to be less of problem in herring than in groundfish for example. The mean estimated by geostats is usually an underestimate, whereas is usually overestimated by classical stats. The techniques used here are respectable.
- Comment: Why do we looked at the 1995 survey and not the 1996? Answer: there was none! The 1995 is the best so far (hence the emphasis). The number (84,000 t) is certainly a minimal estimate; $F_{0.1}$ correspond roughly to the existing TAC (20,000 t).
- Comment: Have you looked at abundance from a constant stratum? Answer: no, but changes in timing make this is useless because the amount of movements between areas.
- Comment (*on the reference to $F_{0.1}$*): Generally agrees with the productivity of the stock and the outlook for the future. We may want to look at exploitation rates other than those set for conservation reasons to answer the need for big fish by industry.

It was agreed to suggest that current exploitation rate is low (probably < $F_{0.1}$), and if it were to increase to $F_{0.1}$, the size structure of the stock may change. If a management goal is to get big fish, lower exploitation may become an appropriate exploitation strategy.
The WG accepted the estimates in tables 4 & 5 of the WP (biomass estimates from hydroacoustic surveys) with the usual caveats for geostatistics & hydroacoustic.

**Analytical assessment.**

None.

- Comment: I would like to see an analytical assessment (i.e., VPA) on herring. Recognise that there is no time series of abundance, and there is need to develop one (upgraded index fisher). Ian's goal in life should be to present an analytical assessment of this stock before we all retire.

## Bottom Line

*The stock is generally healthy, the TAC is not restrictive, and we should recommend* status-quo. *After 20 years of fishing, there is a wide age distribution.*

## St.-George's Bay.

The fishery for seiners in St.-George's Bay has been delayed until after fish had left (since 1994), bringing a practical closure. This was implemented because of concerns about the status of that specific stock component (*i.e.,* lack of 1987 Y-C). It was suggested that we could reopen fishing to seiners in the bay, because status was improving with the arrival of the abundant 1990 Y-C.

**Do we have biological reasons to maintain closure?**

*The evidence points out that it would be wise to spread the catch, but the status of herring component in St.-George's Bay is no longer of particular concern. Catch should not exceed 3,000 t, and any fishery should be monitored closely.*

- Comment: (following a lengthy discussion of the number): There is a concern that the stock was greatly reduced in the past, and we don't have much basis to provide a number even if the stock is on the upswing. We should take a prudent approach: it should be a go slow approach and it should be monitored closely.

Following another lengthy discussion of the management of this fishery, it was agreed by the WG to provide the advice as per the comments above and let the manager apply it wisely.

# ANNEX V

## Decision Rules for Over-wintering Fisheries

There are three areas in the Maritimes Region where herring are harvested in over-wintering aggregations - 4Vn, Chedabucto Bay and off Halifax. The typical situation encountered in these fisheries is that of a large stock migrating into the over-wintering area which is occupied both by smaller resident stocks and/or stock(s) migrating from another area. In order to maintain the fishing mortality on each stock component harvested in the over-wintering area within target levels, it is necessary to understand what conditions will lead to over-exploitation of the various stocks in the mix and to define harvesting rules to prevent this occurring. These rules would be put in place for the duration of the season, and their effectiveness evaluated in the subsequent RAP meeting. Any changes to the subsequent year's rules would be made at that time. This is contrary to the in-season management used in 4WX, where changes to the decision rules are made 'in-season'. Ross Claytor presented a working paper that both outlined the general principles to guide the harvesting of over-wintering fisheries and decision rules specific to the 4Vn winter fishery.

### General Principles

Through computer simulation, it was shown that the degree of inter-stock mixing was a critical determinant of the exploitation rates experienced by both large and small stocks in the area. If mixing was random, exploitation rates on the large and small stocks would be, on average, equal, in this example set at 5%. However, as the relative size of the larger stock increased, the variation in exploitation rates around the average on the smaller stock would also increase, so much so that high exploitation rates (greater than 16%) on the small stock would be expected about 5% of the time.

If the stocks remained relatively segregated in the over-wintering area, and the TAC set to attain 5% exploitation rate on the large stock, one could expect very high rates of exploitation (10-75%) on the small stock.

During the discussion, knowledge of the degree of mixing was raised. For instance, in 4Vn, the basis of this knowledge is the length/age information collected from the fishery and used in the assessments. This may not provide as reliable indices of stock mixing as other methods (e.g. ototith fingerprints, genetic markers). Notwithstanding this, the issue of stock-specific effects due to stock mixing was acknowledged as being very important. On the Pacific coast, for instance, there has been considerable debate among harvesters on the impacts of harvesting specific salmon stocks.

Questions were asked as to the impact of adding a third stock to the situation, to which the reply was 'generally same result as the two stock situation'.

While the group accepted the results of the simulations and the need to avoid over-exploitation of local, small stocks, the main issue was seen as our knowledge of just how well mixed (or not) the herring stocks were in the over-wintering areas. For instance, one participant mentioned that in 4Vn, while the herring stocks appear mixed in Aspy Bay, this may not be the case further south. This raised considerable discussion. It was pointed out that, whereas Science has been stating for years the need to undertake herring stock structure studies, progress against this objective has been slow. There is still considerable uncertainty on our knowledge of stock structure and mixing.

- **It was recommended that studies be undertaken to quantify the degree of stock mixing in the over-wintering and other areas.**

It was noted that knowledge of the age/size structure of the catch from each stock in the mix would help in the evaluation of harvesting impact on each stock.

- **It was recommended that where possible the catch at age be provided for each stock exploited in the over-wintering fisheries.**

## ANNEX VI - QUESTIONS AND ANSWERS ARISING DURING DISCUSSION OF 4Vn WINTER FISHERY.

**26 March, 1997**

**4Vn Herring, including Bras d'Or Lake**

**Presenters: Rob Stephenson, Ross Claytor, Shelley Denny**
**Rapporteur: John D. Neilson**

Questions During the Presentation

Q. What was the % immature in the overall fishery?
A. About 285 of 4200 t landed was immature.

Q. What is the stock affinity of the fish taken during the surveys?
A. At this point, no attempt is being made to attribute stock origin to the fish caught during the surveys.

Q. In July, where is the resident stock? In Bras d'Or Lake?
A. Not sure, could be in Bras d'Or Lake.
Supplemental: Later in the year, residents could mix with the overwintering aggregation.

Q. What is the size of fish in the July RV catches.
A. Not sure.

Comment: When comparing the fall spawner age composition of 4T vs 4Vn, different abundance of older fish was noted.

Comment: It was noted that 4Vn fall spawner age composition is similar to 4T. Other discussants disagreed, pointing in particular to the 1995 data.

Q. Could differences in gear composition and hence selection give rise to some of the observed differences?
A. Some comparisons were from population length frequencies as reconstructured from the assessment.

Q. Could inadequate sampling be the cause of apparent differences in age composition of spring spawners in 4T and 4Vn?
A. Yes, it is possible.

At this point, there was a discussion of the questions which were intended to be addressed by the 4Vn presentations. The question of interest appeared to be "When and where could you conduct a 4T fishery in 4Vn with negligable impact on the resident stock".

Comment: For years, no fishery in 4Vn because concerns that it was a mixing area. Those concerns appear to have been forgotten.

Presentation on Bras d'Or Lake Herring

Based on an interview study, it was shown that there had been a reduction of traditional herring spawning areas within the Bras d'Or. Also, there were indications of increasing effort.

Q. What was the fishery removing prior to 1996?
A. No hard data, but estimates of about 500 t were mentioned.

Q. When does the outmigration of Bras d'Or Lake Herring occur?
A. Thought they don't stay under the ice, but then there are some reports of some fishing occurring through the ice. Could leave lake any time after June. Although the population is largely spring spawners, a smaller fall spawning component was mentioned.

Comment: A tagging study has been proposed for this population.

Q. What about fishing effort immediately outside Bras d'Or, sufficient for tagging study?
A. Yes.

Q. What is the evidence that fish actually move out?
A. Evidence certainly exists, but considerable uncertainty regarding timing and proportion.

Q. What about the growth of Bras d'Or fish?
A. Data available in the working paper, quick examination indicated similarity to 4T.

Comment: It was noted that an expression of concern from this meeting could help Fisheries Operations improve herring management for the population.

Decrease in spawning grounds was discussed. It was pointed out that we don't know what happened from 1981 (time of the Crawford study when the problem was first identified) and the present study. Therefore, we could not draw a direct link to the increased effort having resulted in loss of spawning components. Others pointed out that a direct cause-effect argument was unnecessary. This was agreed, and other possible sources of the problem were discussed, including pollution effects. Regarding the latter, while impacts were possible, no data for this area exist.

Comment: After 1979, spring spawner component in 4Vn was much reduced. Could it be attributable to the reduction of the Bras d'Or lake stock?

A. Age composition of 4Vn and Bras d'Or don't match.

Comment: We need to encourage the tagging investigation.

The discussion then returned to management units, and the question of extending coastal 4VW to 4VWX.
Several speakers spoke with concern about the increasing need to micromanaage small stocks and the inherent increased demands for science that this will generate. Others noted that the requirements are real, and legislated as part of the new acts governing DFO's work, including the Oceans Act and Endangered Species Act.