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Proceedings of the Regional Peer Review of the Assessment of the West Coast of Newfoundland (NAFO Division 4R) herring (*Clupea harengus*) stocks in 2020

November 18-20, 2020
Virtual meeting

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Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings may include research recommendations, uncertainties, and the rationale for decisions made during the meeting. Proceedings may also document when data, analyses or interpretations were reviewed and rejected on scientific grounds, including the reason(s) for rejection. As such, interpretations and opinions presented in this report individually may be factually incorrect or misleading, but are included to record as faithfully as possible what was considered at the meeting. No statements are to be taken as reflecting the conclusions of the meeting unless they are clearly identified as such. Moreover, further review may result in a change of conclusions where additional information was identified as relevant to the topics being considered, but not available in the timeframe of the meeting. In the rare case when there are formal dissenting views, these are also archived as Annexes to the Proceedings.

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SUMMARY

This document contains the proceedings of the regional peer review meeting on the assessment of the West Coast of Newfoundland herring stocks (NAFO Division 4R). The meeting, which was held virtually via Zoom on November 18-20, 2020, brought together roughly 40 participants from science, management and the herring fishing industry. These proceedings describe the highlights of the meeting presentations and discussions and outline the recommendations and conclusions resulting from the review.

INTRODUCTION

The Quebec Region of Fisheries and Oceans Canada (DFO) is responsible for assessing a number of fish and invertebrate stocks exploited in the Estuary and Gulf of St. Lawrence. Most of the stocks are periodically assessed as part of a regional peer review process held at the Maurice Lamontagne Institute in Mont-Joli. This document constitutes the proceedings of the West Coast of Newfoundland (4R) herring stock assessment meeting held virtually via Zoom on November 18-20, 2020.

The Resource Management and Aboriginal Fisheries Branch requested science advice on these stocks based on data collected during the 2018 and 2019 fishing seasons. The purpose of this review was to determine whether changes had occurred in the status of the resource that required adjustments to the management plan based on the conservation approach adopted. The ultimate objective was to provide science advice for the management of West Coast of Newfoundland (4R) herring stocks for the 2021 fishing season.

These proceedings report on the main points discussed in the presentations and deliberations resulting from the activities of the regional stock assessment committee. Regional peer reviews are a process open to any participant who is able to provide a critical outlook on the status of the assessed resources. Consequently, participants from outside DFO are invited to take part in the committee's activities within the defined Terms of Reference for this review (Appendices 1 and 2). The proceedings also set out the recommendations made by the meeting participants.

CONTEXT

The meeting chair, Marie-Julie Roux, welcomed participants and reviewed the peer review process and objectives. After the participants introduced themselves, stock assessment biologist Jean-Martin Chamberland began the meeting by introducing his collaborators and presenting the highlights of the previous science advisory report. After briefly reviewing past approaches used to assess the status of 4R herring stocks, he explained that one of the objectives of the current peer review was to validate the current approach. He then outlined a few aspects of herring biology and the 4R stock, which comprises two spawning components: spring spawning herring (April-May) and fall spawning herring (August-September). In addition, he provided a brief description of the fishery.

- It was agreed that the way the management of the fishery was currently divided did not correspond to the stock's spatial structure and likely excludes a portion of the stock.
- Given the need to validate the assessment model in this review, the issue of reference points would not be addressed at this time.

RESOURCE ASSESSMENT

LANDINGS

The biologist presented herring landing statistics by unit area, gear type, and landing date, as well as the spatial distribution of catches. According to the preliminary data West Coast of Newfoundland (NAFO Division 4R) herring catches totalled 7,418 t in 2018 and 15,806 t in 2019, with an annual total allowable catch (TAC) of 20,000 t.

- Industry participants felt that the data presented did not reflect what was really going on, noting that the very cold water temperatures in 2018 would have affected resource availability and that the abundance of small fish in 2019 would have had an impact on

fishing efficiency. They also believed that the poor weather conditions and changes in herring distribution would have had an impact on fishing effort.

- There was consensus on the fact that the landing data for 2018 and 2019 were incomplete, particularly those of 2019. The speed at which the different regions of Fisheries and Oceans Canada make information available appears to vary significantly.
- These comments demonstrate the importance of having access to fishery-independent indicators.
- Environmental data could also provide complementary information.
- It was mentioned that catches in the bait fishery were negligible, and they were not taken into account in this review.

BIOLOGICAL DATA

Annual statistics on the proportions and number of individuals in each spawning stock (spring and fall spawners) were presented, as well as total length frequencies and catch-at-age data. The proportion of landings composed of spring spawners rose from 2.3% in 2014 to 30.0% in 2019, with the 2013 cohort dominating the catches of spring spawners. Since 2014, fall spawners aged 11+ have dominated landings. The 2008 cohort has contributed to the fishery in recent years, but is not as dominant as the 2000 year-class.

The graph showing the length at which 50% of individuals reach maturity (L_{50}) annually, by spawning stock and cohort and for all gear types, was presented. Graphs of maturity-at-age (A_{50}) and weight-at-age—which are used as assessment model inputs—were also provided; they are used to convert abundance estimates to spawning stock biomass (SSB) estimates. The two stocks have shown an overall downward trend in mean weight–at-age in herring aged 3+ since the early 1980s as well as a downward trend in the relative condition index since the early 2000s.

- According to participants, the presence of individuals aged 11+ reflect the limited impact of the fishery on the stock.
- Large numbers of small herring have been observed in recent years. However, individuals aged 2 and 3 years are poorly represented in the catch-at-age data because they are not recruited to the fishery until at least the age of 3 or 4.
- Questions were raised about a possible link between larger sizes and a later fishery. The cause and effect relationship could go either way.
- It was suggested that future research should include a review of the classification of spring and fall spawners, given the changes observed in the reproductive cycle.
- Some participants indicated that the decline in weight-at-age observed in the two spawning stocks since 1980 was also occurring in the southern Gulf stocks and on a large scale. This could be linked to environmental factors. The upward trend in small copepods was mentioned as an example; this would favour herring recruitment but would be less energetically efficient for older herring.

ACOUSTIC SURVEYS

A first series of acoustic surveys was conducted between 1991 and 2002 to obtain a herring abundance estimate. The second series began in the fall of 2009 and continued in 2019.

Biomass estimates from the fall 2019 acoustic survey were 47,522 t for spring spawners and 68,796 t for fall spawners.

- A data lag was noted in the table on the spatial distribution of fishing effort. The table was corrected and presented again.
- Questions were raised about the potential bias caused by under-surveyed strata and by the interannual variability in the survey, which could influence catchability (time lag between the survey and the fall fishery, spatial coverage, gear type used). These factors could affect the estimate of total biomass and the abundance-at-age index.
- According to some industry participants, the acoustic surveys do not adequately cover a portion of the stock, which could lead to the underestimation of the biomass index.
- Other participants believed that the major strata were covered every year and obtaining some “data noise” was normal.
- Participants wondered about the validity of the acoustic survey in assessing the stock. A figure showing inconsistent patterns in estimated cohort abundance based on data from the acoustic survey convinced participants that catchability for the acoustic surveys had changed during the 2009-2019 period. There was participant consensus on the need to further examine the impact of the uncertainties raised.

SEQUENTIAL POPULATION ANALYSIS AND ASSESSMENT OF RELIABILITY

Sequential population analyses (SPA) were conducted to estimate relative abundance trajectories. The following inputs were used in the operational model: catch-at-age, weight-at-age, maturity-at-age, and index from the acoustic survey converted to abundance-at-age.

- Participants raised several potential sources of uncertainties: the acoustic index; the premise of constant catchability in the acoustic surveys; residuals; retrospective patterns in and sensitivity analyses of mortality rates (M) that suggest inconsistencies; and freely estimated recruitment that is highly sensitive to recent observations of young individuals.
- There was a need to take a step back in order to better understand the impact of the acoustic survey (uncertainties) on the SPA, so as to better grasp what is expressed by the model.
- According to several participants, some indicators such as catch-at-age could help in assessing the stock’s status. Updating the 2019 landings (15,806 t) would result in greater consistency in the catch-at-age data vis-à-vis the comments made by fishers.
- It was also suggested that an exploitation rate be calculated as an additional useful index. The rates calculated (8%: spring component, 17%: fall component) provide a better assessment of the fishery’s low impact.
- All participants agreed that an effort must be made to better understand the model and its uncertainties and, consequently, a review of the assessment framework for 4R herring appeared to be necessary.
- Participants rejected the assessment model for now and called for a review of the framework.
- Several participants did not seem to have any concerns about recommending the status quo in the current context (e.g., abundant recruitment, presence of individuals aged 20+, low exploitation rate).

ENVIRONMENTAL DETERMINANTS

Principal components analyses (PCA) and generalized additive models (GAM) have previously been used with stock assessment data and overall environmental indices to examine the role of the environment in variations in recruitment to the fall and spring spawning stocks. For the spring spawning stock, the study demonstrated increased recruitment when a typical cold-water zooplankton community was present, while recruitment to the fall spawning stock appeared to be favoured by the presence of a typical warm-water zooplankton community. These results provide a partial understanding of the influence of the environment on herring recruitment. However, the overall environmental indices used are not components that can be predicted. To remedy this situation, a new study is using predictors to understand what may be going on. The results indicate that variations in the condition index are better explained by zooplankton quantity, quality and phenology than by physical variables such as temperature. The condition index is higher in both spawning groups components with early development of *Calanus finmarchicus*, it increases in spring spawners when there is a high ratio of large calanoid copepods to small ones, and it increases in fall spawners with an increase in the abundance of *C. finmarchicus*.

RESULTS OF HERRING FISHERS SURVEY ON SPAWNING GROUND IN 4R AND 4S

To provide a better understanding of the species' reproductive ecology, a survey was conducted in 2019 to locate the species' main spawning grounds in 4R and 4S. An overview of the survey results was presented.

- Industry representatives noted that some key spawning grounds were not represented.
- According to the survey, bait fishing seemed to be more widespread than what was reported in the logbooks. However, some fishers may have been inactive.
- It was pointed out that the survey did not allow observations to be situated in time (years).
- The various categories of observations (spawning herring school, herring in spawning condition, herring eggs, "white water") led to some confusion.

CONCLUSIONS

IDENTIFYING AREAS OF FUTURE RESEARCH

Participants considered research aimed at the following objectives to be a priority:

- Improve biological sampling during the acoustic survey.
- Develop a gillnet index fishery.
- Increase the understanding of the acoustic survey.
- Review the method of classifying spring and fall spawners.
- Review the assessment framework.
- Improve the concordance rate between the age estimates made by the two otolith readers, particularly for ages 9+.

INTERIM YEARS

The review of the assessment framework should take place before the next science review, which is scheduled for the winter of 2022.

KEY POINTS

The key points were presented, and commented on by participants. Some points were modified in order to remove superfluous elements, or to add details that were considered to be important by participants.

- Given the uncertainties raised by participants, most of the discussion focused on the key points associated with the acoustic survey and SPA.
- Participants decided not to use the abundance index obtained from the acoustic survey data to provide advice on stock status.
- Participants agreed to reject the model, but not the precautionary approach; however, the reference points would have to be reviewed.
- A review of the assessment framework was recommended.

The meeting's main conclusions were formulated as follows:

There is evidence of changes in catchability of the acoustic survey in recent years indicating that the survey may not consistently provide a reliable index of abundance.

Further investigation of the assessment model used as the basis of the advice confirmed existing concerns over model sensitivity to time-varying survey catchability and other input assumptions (constant natural mortality) and model's inability to reliably estimate recruitment. As a result, the model was rejected as the basis of the advice. A review of the assessment framework for 4R herring is recommended.

The available evidence up to 2019 (commercial catch-at-age, age and length at maturity, abundance of young fish, low exploitation rate in 2019) indicate that current harvest levels do not pose significant risk to herring stocks in 4R in the short term. This conclusion should be revisited following a review of the assessment framework.

APPENDIX 1 – TERMS OF REFERENCE

Assessment of the West Coast of Newfoundland (NAFO Division 4R) herring (*Clupea harengus*) stocks in 2020

Regional Advisory Meeting – Quebec Region

November 18-20, 2020
Virtual meeting

Chairperson : Marie-Julie Roux

Context

The west coast of Newfoundland (NAFO Division 4R) herring (*Clupea harengus*) fishery is managed by a Total Allowable Catch (TAC) associated with both spawning stocks. The current TAC of 20,000 t was set in the early 2000s. The TAC split between the various fleets is as follows: 55% for large seiners (> 65 '), 22% for small seiners (<65 ') and 23% for fixed gear.

A first series of acoustic surveys was conducted between 1991 and 2002 with the objective of assessing the abundance of the two spawning stocks. A second series of surveys was initiated in the fall of 2009.

During the assessments of the two 4R herring spawning stocks in 2016 and 2018, the increasing time lag between the acoustic survey and the fall commercial fishery, as well as the absence of another abundance indicator, raised serious doubts about the consistency of the catchability of the acoustic survey and the absolute values of the estimated biomasses. The structure of the operational model and its ability to properly simulate stock dynamics were also questioned during these two assessments.

Resource Management and Aboriginal Fisheries Branch has requested a scientific advice on these stocks based on data collected during the 2018 and 2019 fishing seasons. The objective of the review is to determine whether changes that have occurred in the stock status necessitate adjustments to management plans based on the conservation approach used.

Objectives

Provide a scientific advice on the spring and fall spawning herring stocks status in NAFO Division 4R (Newfoundland's West coast) for the 2021 fishing season, based on:

- Commercial fishery and scientific survey data:
    - commercial fishery statistics following the 2018 and 2019 seasons;
    - an update of the main biological indicators;
    - the biological characteristics of the catches from the Teleost survey;
    - results of the 2019 August and fall acoustic surveys;
    - Results of a survey on the location of spawning ground
- Trajectories of relative abundance estimated by the VPA (operational model), as well as a detailed diagnosis of the VPA in order to rule on its validity.
- Ecosystem approach: effects of the environment on stock productivity indices (recruitment based on commercial fishery catch-at-age and condition index)
- Perspectives and/or recommendations for 2021 based on available data.

Expected Publications

- Science Advisory Report

- Proceedings
- Research Document

Expected Participation

- Fisheries and Oceans Canada (DFO) Science and Fisheries Management
- Newfoundland and Labrador provincial government representatives
- Fishing industry
- Academia

APPENDIX 2 – LIST OF PARTICIPANTS

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