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Proceedings of the regional advisory process on the stock status of Lake Whitefish (*Coregonus clupeaformis*) in Great Slave Lake

January 26-27, 2011
Winnipeg, MB

Chairperson: Dr. Ross Tallman
Editor: Chris Day

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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

A Fisheries and Oceans Canada (DFO) regional science advisory meeting took place on January 26-27, 2011, in Winnipeg, MB, to assess Lake Whitefish (*Coregonus clupeaformis*) stock status in Great Slave Lake (GSL), Northwest Territories. This meeting was held in response to a request from DFO Fisheries and Aquaculture Management (FAM) sector for science advice on the current status and sustainable harvest level for the GSL commercial Lake Whitefish fishery. These whitefish stocks were last assessed in 1992 although between 1972 and 2002 numerous data reports have been published by DFO. Since 1972, DFO has conducted a series of biological observations, including the collection of age structures from fish plants and a study of the effects of reducing the minimum gillnet mesh size. Plant sampling was done for each of the six commercial management areas of the lake. From 1972 to the present, this study represents a comprehensive analysis of all plant sampling data collected from the lake.

Meeting participants included DFO Science and FAM Sectors and two professors from the Universities of Waterloo and Manitoba. Science advice resulting from the meeting is published in the DFO Canadian Science Advisory Secretariat (CSAS) Science Advisory Report series and supporting data and analyses are published in the CSAS Research Document series.

Compte rendu du processus de consultation régionale sur l'état du stock du grand corégone (*Coregonus clupeaformis*) dans le Grand lac des Esclaves

SOMMAIRE

Une réunion de consultation scientifique régionale de Pêches et Océans Canada (MPO) a eu lieu les 26 et 27 janvier 2011 à Winnipeg, au Manitoba, afin d'évaluer l'état du stock du grand corégone (*Coregonus clupeaformis*) dans le Grand lac des Esclaves, dans les Territoires du Nord-Ouest. Cette réunion a été organisée en raison de la demande d'avis scientifique du secteur de la Gestion des pêches et de l'aquaculture (GPA) concernant l'état actuel de la pêche commerciale du grand corégone pratiquée dans le Grand lac des Esclaves et les prélèvements durables pour cette pêche. Ces stocks du grand corégone ont été évalués pour la dernière fois en 1992, bien le MPO ait publié de nombreux rapports entre 1972 et 2002. Depuis 1972, le MPO a effectué une série d'observations biologiques, y compris la collecte de structures d'âge provenant des usines de transformation du poisson et une étude sur les effets de la réduction de la taille minimum du maillage des filets maillants. Un échantillonnage dans les usines a été effectué pour chacune des six zones de gestion de la pêche commerciale du lac. De 1972 à aujourd'hui, cette étude représente une analyse exhaustive de toutes les données d'échantillonnage recueillies dans les usines et provenant du lac.

Les participants à la réunion regroupaient des employés du Secteur des sciences et de la GPA du MPO ainsi que deux professeurs de l'Université de Waterloo et de l'Université du Manitoba. L'avis scientifique découlant de cette réunion est publié dans la série des avis scientifiques du Secrétariat canadien de consultation scientifique du MPO (SCCS), tandis que les analyses des données à l'appui sont publiées dans la série des documents de recherche du SCCS.

INTRODUCTION

Lake Whitefish, (*Coregonus clupeaformis*), is very important to the Great Slave Lake (GSL) ecosystem and the economy of GSL fisheries.

The GSL commercial Lake Whitefish fishery formally commenced in 1945 (Rawson 1947). Five years later, there was a historical peak in combined harvest of over 4,000 tonnes of Lake Whitefish and Lake Trout (*Salvelinus namaycush*), which was the largest commercial harvest in the Northwest Territories. In recent years, the whitefish fishery declined to approximately 1,000 tonnes in 1997 and 500 tonnes in the mid-2000s to the present. These decreases in harvest largely coincided with a decline in Lake Trout harvests and limited economic opportunities for fishers due to low market value for Lake Whitefish.

Since 1972, DFO has conducted a series of biological observations, including the collection of age structures from fish plants and a study of the effects of reducing the minimum gillnet mesh size. Plant sampling has continued to run for each of the six commercial management areas of the lake.

The purpose of the regional science advisory meeting, as described in the terms of reference (Appendix 1), was to discuss the speaker's conclusions and analytical methods used to:

(1) combine information on fisheries biology (sample location, length, weight, age and annual commercial harvest) from routine fish plant sampling done during the 1972-2004 period,

(2) model time-varying growth at age, size structure and condition index, which emphasize the capacity for population self-regulation under changing biotic and abiotic environments, and

(3) analyze the possible drivers of biological variation under changing environmental conditions that may impact variation in whitefish population dynamics and natural development.

Meeting Participants (Appendix 2) included DFO science and management and professors from the Universities of Waterloo and Manitoba. The meeting generally followed the Agenda (Appendix 3). A draft Research Document was distributed to the participants several weeks prior to the meeting. This proceedings summarizes the meeting discussions and the key conclusions reached. A power point presentation was presented by the speaker, and the Research Document and Science Advisory Report were peer reviewed at the meeting.

DISCUSSION

Following introductions of the participants, the chair provided a brief introduction to the meeting, a summary of the request for science advice and an overview of the Agenda. A power point was presented which summarized the results of the speaker's research and detailed discussion followed.

HYDROLOGY

Several questions were asked about the hydrology of GSL following findings that it may be correlated with whitefish population parameter trends. The Slave River inflow was discussed because it empties into management area III. There was a question as to the location of the Bennet Dam which affects Slave River outflow into GSL. According to fishers this dam affects the GSL fishery. The Bennet Dam is situated on the Peace River which flows into the Slave

River. It was mentioned that in the Salt River, a tributary of the Slave River, water levels fluctuate from very high to almost completely dry. A participant stated that dams generally affect base productivity and possibly larval survival and, to a lesser degree, the characteristics of adult fish like those analysed in the study. Participants asked whether or not the timing of the Talston River Dam installation correlates with a decline in west basin fish stocks such as Inconnu (*Stenodus leucichthys*). It was concluded that such a correlation did not exist. The Talston River is a much smaller system than the Slave River and flows into GSL south of the Slave River delta. A further concern was raised when a participant stated that a fisher believes that the Pine Point Tailing pond is leaking into southern waters of GSL but it was not discussed further because no information was available on the leakage or, if it was occurring, on its impact. Although Slave River discharge did have some effect on a growth coefficient, the participants felt that this relationship was interesting but required substantial further analysis with several climate and hydrology variables other than discharge alone. They stated that the analysis should start with a hypothesis which is then tested.

EXPERIMENTAL DESIGN

All whitefish samples were grouped, prior to analysis, by commercial management area. The relevance of this choice was called into question by participants who asked if the areas were biologically discrete. It was explained that it was necessary to group data by area because it was collected and recorded by area. A participant suggested that the areas could be aggregated by broader limnologically discrete areas rather than the management areas. The significance of closed areas labelled on the GSL map was explained to the participants. Some concerns were raised in regards to whitefish movement between areas because it may have confounded the analysis which assumed that a given whitefish sampled in an area had been there throughout its entire life. Participants asked if more modern tagging technology could be used to better understand GSL whitefish movement. In a similar vein, one member pointed out that isotope analysis of scale samples could be used to determine stock ID and trophic level. All meeting particpants felt that the harvest figures needed to be redone as bar charts or line graphs. The participants collectively emphasized the importance of documenting the reasons for whitefish harvest decline and to collect data to back up these reasons.

MODEL CHOICE AND ANALYSIS

The speaker stated the two broad objectives of his analysis. They were to:

1) review spatiotemporal variations in Lake Whitefish length, weight, age, condition indices and length at age/growth, and
2) test for correlations among temporal patterns in population biology, population production, exploitation and environmental variations.

Three growth models and a variety of standard statistical methods were employed to complete the analysis. Please refer to the Research Document or Scientific Advisory Report for details.

Comments from the participants were challenging and the following list of concerns and noted gaps in the analysis were raised; there was general agreement on the following points:

- Concerns that the models forced the dependent variable through the origin which may affect the predicted parameters of the models.
- Uncertainty analysis is needed to examine the effect of aging error on variations of the von Bertalanffy growth model used for the analysis. The speaker commented on aging errors and stated that overall age distributions have not changed across decades and areas, and that all scales were read by the same reader.

- If there are doubts about aging error occurring, try removing the oldest ages prior to analysis.
- A formal test for allometry should be done because the speaker referred to growth patterns in the north area of GSL as allometric.
- Use length as a covariate to compare adjusted mean weights among areas.
- Unlike the speaker's conclusion that decreases in length weight relationships are associated with small mesh size changes, most others at the meeting thought that they were not. They suggested that other methods could be used to test these trends.
- Why does condition decrease in management area 1 West (1W) from May to September? General replies from participants were that fishing removed the fish in better condition first or that spring immigration of large whitefish, in good condition, from a closed zone to the west of 1W may have caused this. Pooling data, across all years for May to September, may mask the significant year effect on condition, therefore, the aforementioned decrease may not be significant.
- Between year changes in condition could also be explained by differences in sample sizes and when they were collected.
- Growth in fork length and weight were then discussed and there was general agreement that there is no evidence of growth bifurcation into different morphotypes and there is a lot of variance so there doesn't seem to be a need to do separate assessments. They felt that the same conclusions could be made for the growth in round weight analyses.
- Participants generally agreed that there seems to be changes in the correlation between K and L infinity but cautioned that because of the above-described concerns given earlier on the von Bertalanffy equation. Instead they suggested that differences between areas in growth could be pursued with other statistical methods that may not involve growth models.
- Rather than the models presented, repeated boot strapping and ANCOVA may be used for testing differences between areas in length weight relationships.
- After boot strapping and ANCOVA are done, the authors may be able to group management areas and develop hypotheses as to why some are similar and some are different.
- Use residual analysis to determine if regression is appropriate.
- In management areas which have experienced lower harvests (deeper more northerly waters of GSL), density dependence may have decreased growth rates. However, one participant stated that it is very hard to demonstrate density dependence in salmonids.
- An accumulation of older fish in under fished management areas caused an increase in mean age observed for these areas.
- Is the condition variance from 0.5 to 3 due to outliers in the data set? The speaker also believed that this was true and agreed that it should be revisited as a potential cause of these trends.

CONCLUSIONS

SPEAKER'S CONCLUSIONS

- Isometric growth patterns appeared for whitefish sampled from southern shore management areas.
- The mesh size of fishing nets can significantly affect the mean size and condition index of whitefish, especially the 127 and 133 mm mesh sizes.
- Significant reductions in mean fork length and round weight were found which suggested a reduction in growth rate throughout the sampling years (1972–2004).
- The von Bertalanffy growth model was best fit with a combination of time varying growth rate and the existence of an asymptotic length.
- Growth model parameters were significantly related to exploitation rate, annual Slave River discharge patterns and condition index. This finding suggests that further research on these relationships will be required before they can be included in an integrated fisheries management plan.

PARTICIPANTS CONCLUSIONS

Participants proposed that the following two points should be added to the conclusions:

- Declines in harvest over the past 20 years are believed to be attributed to socioeconomic reasons and not due to a decline in whitefish stocks.
- The parameters of GSL whitefish stocks suggest stability.

Participants agreed with the findings that, GSL commercial Lake Whitefish quotas assigned to each of its six management areas are sustainable with recent harvests being well below quotas due to poor socioeconomic conditions. Isometric growth patterns appeared for whitefish sampled from southern shore management areas. The author of the study concluded that the mesh size of fishing nets can significantly affect the mean size and condition index of whitefish, especially the 127 and 133 mm mesh sizes. Significant reductions in mean fork length and round weight were found which suggested a reduction in growth rate throughout the sampling years (1972–2004). The von Bertalanffy growth model was best fit with a combination of time varying growth rate and the existence of an asymptotic length. Growth model parameters were significantly related to exploitation rate, annual Slave River discharge patterns and condition index. This finding suggested that further research on these relationships will be required before they can be included in an integrated fisheries management plan. Participants proposed that two points should be added to the conclusions. They were that declines in harvest over the past 20 years are believed to be attributed to socioeconomic reasons and not do to a decline in whitefish stocks and that the parameters of GSL whitefish stocks suggest stability. Concerns were expressed by participants in regards to certainty of the author's conclusions. They based their concerns on the choice of models used, particularly the Von Bertalanffy growth equation, the lack of clear hypotheses and the use of commercial areas to group the data rather than not grouping or grouping in some sort of limnological context.

REFERENCES CITED

Rawson, D.S. 1947. North West Canadian fisheries surveys in 1944-45. Chapter V: Great Slave Lake. Bull. Fish. Res. Bd. Can. No 72: 45-85.

APPENDIX 1. TERMS OF REFERENCE

The status of Lake Whitefish (*Coregonus clupeaformis*) in Great Slave Lake

Central and Arctic Regional Advisory Meeting

January 26-27, 2011
Winnipeg, Manitoba

Chairperson: Ross Tallman

Context

The Lake Whitefish commercial fishery on Great Slave Lake, Northwest Territories, Canada, has been operating since 1945 and is managed by Fisheries and Oceans Canada (DFO) with input from the Great Slave Lake Advisory Committee (GSLAC). Lake Whitefish account for 70 to 95% of the total annual harvest combined with Lake Trout. The Lake Whitefish fishery is controlled by quotas which are assigned to each of the seven management areas of the lake. The fishery has been subsidized since the development of the Freshwater Fish Marketing Corporation in 1969 and is considered to be economically marginal. Annual harvest levels of both species peaked in 1948-49 at 4,288 tonnes, declining steadily to approximately 1,500 tonnes in 1968-69 and remained at this level until the early 1990s. Since then, the annual harvest has been steadily declining to 340 tonnes in 2008-09. Since the inception of the fishery, a series of biological observations, including the collection of age structures from fish plants and sporadic surveys to produce an abundance index, have been conducted by DFO. All available data during 1972-2004 are being considered for the current Lake Whitefish status assessment.

DFO Science was asked by Fisheries Management to provide science advice on the sustainable harvest level for Lake Whitefish for each subdivision in Great Slave Lake. The initial step in the process to develop science advice was to integrate the accumulated biological and fishery-related information into a Lake Whitefish stock assessment dataset. Two Science advisory meetings are planned to provide advice on Lake Whitefish. The current meeting is being held to review the historic information available for this fishery to better understand population dynamics and the effects of harvesting on Lake Whitefish in Great Slave Lake. A second meeting will be held in the near future to update the assessment with the results of ongoing research and to provide specific advice on sustainable harvest levels.

Objectives

1. Review spatiotemporal variations in Lake Whitefish length, weight, age, condition indices, and age-based growth;
2. Examine the potential associations of temporal patterns in population dynamics with changes in the population production, exploitation and abiotic environmental factors.

Expected Publications

A Canadian Science Advisory Secretariat (CSAS) Research Document will be produced from the working paper presented and reviewed at the meeting. The advice from the meeting will be published as a CSAS Science Advisory Report. A proceedings report summarizing the deliberations of the participants will be published in the CSAS Proceedings Series.

Participants

Invitations will be sent to GSLAC members, DFO Science and Fisheries Management and external experts from the University of Waterloo, Canada, and the Chippewa Ottawa Resource Authority, Michigan USA.

APPENDIX 2. LIST OF PARTICIPANTS

Name	Affiliation
Chris Day	DFO Science, Central and Arctic Region
Brian Dempson	DFO Science, Newfoundland and Labrador Region
Stacey Frame	DFO Fisheries Management, Central and Arctic Region
Colin Gallagher	DFO Science, Central and Arctic Region
Darren Gillis	University of Manitoba
Kimberly Howland	DFO Science, Central and Arctic Region
Deanna Leonard	DFO Fisheries Management, Yellowknife Region
Michael Power	University of Waterloo
Grant Pryznyk	GSL Advisory Committee
Marie-Julie Roux	DFO Science, Central and Arctic Region
Ross Tallman (Chair)	DFO Science, Central and Arctic Region
Melanie Toyne	DFO Science, Central and Arctic Region
Xinhua Zhu	DFO Science, Central and Arctic Region

APPENDIX 3. AGENDA

REGIONAL ADVISORY PROCESS FOR GREAT SLAVE LAKE WHITEFISH STOCK STATUS

Freshwater Institute DFO, Winnipeg Manitoba, January 26-27, 2011

Wednesday 9:00 am @3-55 Oceans Board Room FWI

09:00 Ross Tallman: Welcome and Open Remarks

09:05 Ross Tallman: Introductions, Review of Agenda, RAP Explanation, Responsibilities and Comments from Participants

09:15 Ross Tallman: Review Terms of Reference

09:30 Presentation by Xinhua Zhu—Changing Biological Characteristics of Lake Whitefish in Great Slave Lake

10:00 Break

10:15 Discussion on Presentation

12:00 Lunch

Wednesday 13:00 pm @3-55 Oceans Board Room FWI

13:00 Begin Review Stock Advisory Report (SAR) Draft

Background

Length and Weight Relationship

Condition Index

Size Composition

15:00 Break

15:15 Continue Review Stock Advisory Report Draft

Model Construction

Prior Specification

Model Convergence Diagnosis

Growth Patterns

16:30 Drink

Thursday 9:00 pm @3-55 Oceans Board Room FWI

9:00 Continue Review Stock Advisory Report (SAR) Draft

Possible Drivers of Biological Variation

Conclusion and Advice

10:00 Break

10:15 Continue Review Stock Advisory Report (SAR) Draft

Other Considerations

Next Stage Work Plan

Summary Bullet Agreement

12:00 Ross Tallman: Closing Remarks and Adjournment