Fisheries and Oceans Canada | Pêches et Océans Canada
Ecosystems and Oceans Science | Sciences des écosystèmes et des océans

Canadian Science Advisory Secretariat (CSAS)

Proceedings Series 2019/008

Newfoundland and Labrador Region

Proceedings of the Regional Peer Review for the Assessment of Northern Shrimp in Shrimp Fishing Areas (SFAs) 4, 5 and 6

Meeting dates: February 13-15, 2018
Location: St. John's, NL

Chairpersons: B. Healey and C. H. McKenzie
Editor: S. Boyd

Science Branch
Fisheries and Oceans Canada
PO Box 5667
St. John's, NL A1C 5X1

July 2019

Canada

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.

Published by:

Fisheries and Oceans Canada
Canadian Science Advisory Secretariat
200 Kent Street
Ottawa ON K1A 0E6

http://www.dfo-mpo.gc.ca/csas-sccs/
csas-sccs@dfo-mpo.gc.ca

ISSN 1701-1280

Correct citation for this publication:

DFO. 2019. Proceedings of the Regional Peer Review for the Assessment of Northern Shrimp in Shrimp Fishing Areas (SFAs) 4, 5 and 6; February 13-15, 2018. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2019/008.

Aussi disponible en français :

MPO. 2019. Compte rendu de l'examen régional par les pairs de l'évaluation de la crevette nordique dans les zones de pêche à la crevette (ZPC) 4, 5 et 6; du 13 au 15 février 2018. Secr. can. de consult. sci. du MPO, Compte rendu 2019/008.

TABLE OF CONTENTS

SUMMARY

The Regional Peer Review to assess Northern Shrimp *(Pandalus borealis)* in Shrimp Fishing Areas (SFAs) 4, 5, and 6 was held February 13-15, 2018 in St. John's Newfoundland and Labrador (NL). This assessment was requested by Resource Management to inform the development of management measures for the 2018/19 fishing season. The objective was to assess indicators used to characterize stock status of Northern Shrimp in SFAs 4 to 6 (North Atlantic Fisheries Organization [NAFO] Divisions 2G to 3K).

In addition to these Proceedings, publications to be produced from the meeting include a Science Advisory Report and a Research Document, all of which will be made available online by the Canadian Science Advisory Secretariat (CSAS).

INTRODUCTION

The Regional Peer Review to assess Northern Shrimp *(Pandalus borealis)* in Shrimp Fishing Areas (SFAs) 4, 5, and 6 was held February 13-15, 2018 in St. John's, Newfoundland and Labrador (NL). This assessment was requested by Resource Management to inform the development of management measures for the 2018/19 fishing season. The objective was to assess indicators used to characterize stock status of Northern Shrimp in SFAs 4 to 6 (North Atlantic Fisheries Organization [NAFO] Divisions 2G to 3K).

In addition to these Proceedings, publications to be produced from the meeting include a Science Advisory Report and a Research Document, all of which will be made available online by the Canadian Science Advisory Secretariat (CSAS).

PRESENTATIONS

OCEAN CLIMATE CONDITIONS ON THE NEWFOUNDLAND AND LABRADOR SHELF, UPDATE FOR 2017

Presenter: E. Colbourne

Abstract

The North Atlantic Oscillation (NAO) Index, a key indicator of the direction and intensity of the winter wind field patterns over the Northwest Atlantic was weakly positive during 2017. The associated atmospheric pressure fields resulted in a reduced arctic air outflow in the northwest Atlantic during the winter months resulting in near-normal winter air temperatures in many areas. Sea ice extent, although above normal during late spring and of longer duration in some inshore areas, was below the long-term mean in 2017.

Annual sea-surface temperature (SST based on infrared satellite imagery) trends on the northeast Newfoundland Shelf, while showing an increase of about 1°C since the early-1980s, were mostly below normal during 2017, driven by very cold conditions during the spring months. The annual bottom (176 m) temperature/salinity at the inshore monitoring site (Station 27) was below normal by -0.6/-1.5 SD, respectively in 2017. The cold-intermediate layer (CIL; volume of <0°C) during 2017 was above normal off both southern Labrador (2J) and on the northeast Newfoundland Shelf (3K), implying a colder than normal water column on the shelf. The spatially averaged bottom temperature in 2J and 3K also show an increasing trend since the early-1990s of about 1°C, reaching a peak of >2 SD above normal in 2011 but decreasing to near-normal values in 2017.

A standardized composite climate index for the Northwest Atlantic derived from meteorological, ice and ocean temperature and salinity time series since 1950 reached a record low (cold) value in 1991. Since then it shows a warming trend that reached a peak in 2010 and thereafter decreased to mostly below normal conditions during the past four years.

Analyses show that about 80% of the fishable biomass of northern shrimp during the fall surveys is associated with relatively warm/salty Labrador Slope Water with a temperature range of 2°-4°C. The area of the bottom in this temperature range, referred to as the 'Shrimp Thermal Habitat Index' increased to above normal values during the mid-1990s and have ranged from normal to above normal since then, with the 2017 value near normal in both 2J and 3K.

Discussion

A participant questioned whether temperatures over the past three years appear normal or below normal, and if the warming trend is expected to prevail over the next decade. It was explained that the historic data of the time series suggests that the warming trend might continue another decade and the last two to three years are a divergence of the long-term trend in the Northwest Atlantic. This divergence is believed to be caused by increased cooling in the Labrador Sea. Strong winds and winter convection are among several factors involved in this cooling.

There was a suggestion that a sine wave trend line would better fit the data, even if it gives a different picture. It was agreed that a sine wave could help.

The presenter was asked to clarify the depth used for sea surface temperatures. These measurements were derived by satellite and represent only the top millimeters of the water column and generally occur in response to air temperature. A very high correlation exists between local air and sea surface temperature, with a month delay typically occurring between them.

There was discussion on the decline of ice across the arctic and whether this trend will continue and how that compares to sea ice in this region. Sea ice was described as being different from arctic ice due to its seasonal formation along the Labrador Shelf. The general trend has been decreasing sea ice in this region. Last year was an exception, the bridge that normally forms in Baffin Bay, blocking the ice, did not form and large volumes of arctic sea ice came down the coast to occupy traditional shrimp fishing grounds, impacting sea surface temperatures.

OCEAN PRODUCTIVITY TRENDS IN THE NORTHWEST ATLANTIC

Presenter: G. Maillet

Abstract

Ocean colour data provide good spatial and temporal coverage of near surface dynamics of phytoplankton over the northwest Atlantic. Ocean colour sub-regions ranging from NAFO Divs. 2B (Hudson Strait) to 3K (northeast Newfoundland Shelf) indicate a reduction in total production and intensity of the spring bloom in 2016-17. The timing indices of the spring bloom indicate transition from later onset to near normal in 2017. The duration of the spring bloom is longer in recent years reversing a long-term decreasing trend. The trophic availability index, derived from the intensity and timing indices of the spring bloom, indicate a reduction in the availability of high concentrations of phytoplankton to higher trophic levels in shrimp fishing areas in recent years. This appears primarily due to weaker blooms compared to average conditions. Primary productivity determined from model estimations indicate a general reduction in growth rates of phytoplankton over the last five years. Evaluation of a number of physical indices including sea ice extent, ocean climate indicators, and water temperature, indicate an association with primary and secondary production indices and may represent important drivers in the shrimp fishing areas. The key physical drivers indicate reduced primary and secondary inputs that may have impacted transfer of energy to higher trophic levels across the shrimp fishing areas in recent years.

Discussion

The presenter referred to a new trophic availability index and was asked to clarify some of its indices. The trophic availability index has recently been developed and vetted by the Bedford Institute of Oceanography (BIO) and appears capable of tracking low intensity blooms. The

primary production index is not a measure of phytoplankton growth but is instead a measure of radio-carbon uptake and models have had issues interpreting these measurements. The index utilized the ^{14} C photosynthetic light response, in-situ measurements of ocean colour and sea surface temperature. There are potential data gaps due to the occurrence of ice and cloud cover which prevent the use of high resolution imaging.

There was discussion as to the magnitude of which primary production may be changing. There have been more late blooms the last couple of years; however the bloom occurred early in 2017. The duration of blooms has increased and although the trend has been below normal it has been moving towards normal.

STRUCTURE, TRENDS AND ECOLGICAL INTERACTIONS IN THE MARINE COMMUNITY OF THE NEWFOUNDLAND-LABRADOR BIOREGION, WITH EMPHASIS ON THE ROLE OF SHRIMP

Mariano Koen-Alonso, Nadine Wells, Jennifer Mercer, Denise Holloway, Corinna Favaro, Pierre Pepin, and Geoff T. Evans

Presenter: M. Koen-Alonso

Abstract

The Newfoundland and Labrador Bioregion has been divided into four ecosystem production units (EPUs), the Labrador shelf (2GH), the Newfoundland Shelf (2J3K), the Grand Bank (3LNO), and southern Newfoundland (3Ps). These EPUs coarsely represent functional ecosystem units, and some EPUs have been used as geographic boundaries for the estimation of fisheries production potential (FPP) using ecosystem production potential models. Estimated FPP distributions, together with proxies for the current productivity state of the EPU, have been used to provide guidelines on total catch ceilings (TCCs) for the selected ecosystem units. TCCs represent an upper limit for sustainable total catches by species aggregates representing functional nodes in the ecosystem. These nodes closely match the fish functional groups used to describe the status and trends of the fish community, but they do not map them perfectly; these nodes represent a higher level of aggregation. Results from comparing catches with estimated TCCs indicate that fisheries in 2J3K are concentrated on the benthivore node (which includes shrimp and snow crab), and that even though 2016 catches are below the TCC, recent catch levels have been at or above the guideline limit. Catches in 3LNO have been more evenly distributed among the piscivore (which includes turbot, cod, redfish), and benthivore nodes, and with a “boom-and-bust” type of dynamics for the suspension feeding (SF) benthos (this node includes species like clams and scallops). Catches on the benthivore node are near its TCC, but catches on piscivores and SF benthos are above their TCCs. Under current low productivity conditions, the increasing trend in catches could move 3LNO into an ecosystem overfishing state.

In terms of ecosystem structure and trends, the ecosystem changes observed in the 1990s involved the collapse of the groundfish community, not just cod, and the increase in shellfish. Consistent signals of rebuilding of the groundfish community appeared in the mid to late-2000s, and coincided with the beginning of the shellfish decline. The finfish biomass in the 2010s had been relatively stable until 2014-15, when it started to show signals of decline. This signal appears earlier in the Grand Bank (3LNO), but today is also evident in 2J3KL, including an important decline in Atlantic cod in 2017. Overall declines in total biomass in 2J3K and 3LNO are in the 30-35% range from the 2010-13 level. It seems that the conditions that led to the start of a rebuilding of the groundfish community have eroded. This may be linked to the

simultaneous reductions in capelin and shrimp availability, as well as other changes in ecosystem conditions (e.g. declines in zooplankton levels in recent years).

Further north in NAFO Div. 2H, although the RV survey time series is incomplete and the signal is not fully consistent, it appears that the overall biomass has decreased in 2015-17. This overall decrease has been driven by a decline in plank-piscivores (redfish). Unlike 2J3K, the fish community in this Division remains highly dominated by Shellfish (shrimp). Small and medium benthivores have declined in recent years, while large benthivores are on the rise. There is no clear trend among piscivores. This functional group is highly dominated by turbot in this area. Unlike southern regions, the planktivores signal is dominated by oceanic species like lanternfishes and black herring, hinting at potential pelagic connections between the shelf and the nearby Labrador Sea ecosystem. Although the signal for this functional group is noisy, it still shows very low biomass levels in the last three years. Within the context of a noisy time series, Shellfish seems to be at a slightly lower level than in the 2000s and early 2010s.

From a predation and impacts perspective, total food consumption by predators (medium and large benthivores, piscivores, and plank-piscivores fish functional groups) in 2J3KL, total food consumption by predators have been relatively stable in 2011-15, but has started to decline since. Predation on shrimp showed an increasing trend until 2011, and has decreased since. Predation mortality increased rapidly in 2008-11, and decreased afterwards. Still, current predation level is around double of the level in the mid-1990s and early-2000s. The potential relative impact of fishing with respect to predation has been variable in the 1995-2017 period. It represented 5-20% of predation in 1995-97, it grew to be 35-84% in 2002-03, and since 2013 represents around 15-40% of the predation impact, but it has been declining in 2016-17.

In terms of shrimp productivity in 2J3KL, shrimp per capita net production has declined since the mid-1990s. Consistent with previous results, fishing has detectable indirect impacts on shrimp net production with lags of 2-4 years, and predation has impacts with lags 1-3. Environmental forcing also appears as a significant driver, but the precise linkages seem less clear. Large scale and persistent conditions, as captured by the cumulative composite environmental index (CEI) appear associated with shrimp per capita net production; however, interannual variations associated with the CEI and/or specific metrics of the spring phytoplankton bloom, while still significant and/or borderline significant, do not show a consistent pattern with previous analyses. Based on the current results, and the observed trends in the identified drivers, shrimp per capita net production would be expected to remain around current values in the coming 2-3 years. Even though some drivers suggest potential improvements beyond that horizon; it would be unwise to read too much that far into the future without better understanding of the interactions among the different ecological processes involved.

The build-up of shrimp was driven by a combination of favorable environmental conditions and reduced predation. Shrimp is an important forage species, and the trend in predation mortality in the near future is highly associated with the availability of alternative prey like capelin. Present low availability of shrimp and capelin are likely hindering groundfish recovery. Under current ecosystem conditions (i.e. low stock size, high predation pressure, unfavourable environmental conditions), fishing pressure could now be more influential on stock declines than it was in the past. There seems to be little scope for fishing pressure.

Discussion

The participants questioned assumptions that exist in the ecological survey. A level of uncertainty was built into the model to account for factors which included changes in gear. The fisheries production potential in a healthy ecosystem is calculated as 20% of total productivity. Furthermore, the presence of shellfish in the survey has not been considered relevant the past

few decades due to the dominance of groundfish. There was some discussion about the impact of the model assuming that catachability for all species is equal, when in reality this value varies across species. For example, there was a weak signal for capelin in the 2H bottom trawl survey even though a general distribution survey is better suited for Capelin. The ecological survey is in effect a snapshot of the marine community during the fall and low quantities of organisms could just be the result of the surveys timing. Although there is no information for the same areas during spring, the assumption is that the snapshot would be similar in terms of diet even with more variables present. Overall, the ecological survey assumes the systems have the same level of stability and production over time.

A question was asked about importance of the spring bloom for shrimp recruitment and if there was a date calculated for the bloom and what emphasis can be placed on it because we cannot control nature. These dates can be calculated from the data and the model can be scaled to zero to characterize a bloom as early or late. However, the implications of early and late blooms on shrimp remain unknown. A key unknown is the relative weight of the bloom in relation to that of predation and general environmental conditions.

There was discussion on cumulative index and smoothing of data following a participant's question of why two successive field surveys were used to calculate the primary net production. One consideration was to use data five years apart and this lead to the suggestion of using a five year running average. The presenter smoothed the environmental data but was unsure if smoothing was necessary for the predation and fishing indices.

CURRENT RESEARCH INTO LONG-TERM TRENDS IN NORTHERN SHRIMP ABUNDANCES

Presenter: E. Pedersen

Abstract

Very little is currently known about the abundance of Northern Shrimp (*Pandalus borealis*) on the Newfoundland and Labrador shelves prior to the beginning of the 1995 Campellen research vessel (RV) survey. To determine how current changes in Northern Shrimp populations compared with pre-1995 levels, we developed three indicators of prior population biomasses, and assessed the extent to which the three indicators were providing comparable information on biomass changes in the pre-1995 period and on current stock levels.

The first indicator used was prior targeted shrimp trawls, conducted in three channels (the Hawke Channel in northern SFA 6, and the Hopedale and Cartwright Channels in SFA 5), which were matched with trawls in the current RV survey that had a similar distribution of spatial locations and depths, to allow between-trawl comparison. Both sets of matched trawls were transformed into estimated biomass per square km. The second indicator used was offshore vessel catch per unit effort (CPUE) from the same three channels. For both CPUE and trawl biomass, yearly mean estimates were derived using a generalized additive model (GAM) with smooth terms for both year effects and spatial location, to account for varying spatial coverage between years. The third indicator was developed by regressing current estimated RV survey biomass on the fraction of shrimp in cod diets across NAFO Divs. 2J3KL, and using this model to predict what shrimp biomass would have been given observed diet fractions from 1979 to 1994.

All three indicators were consistent with shrimp biomass rising in both SFA 5 and 6 from 1990 until the current survey period (to a peak of between 4 and 10 times the biomass of the 1979 to 1990 period), and declining in SFA 6 from 2009 onward back to a level similar to the 1979 to 1990 average.

Discussion

The presenter was asked to explain how conclusions regarding SFA 6 could be drawn from analysis of the Hawke Channel. Both commercial and trawl surveys were reported to be restricted to the Hawke Channel, and this typically contains a large faction of the regions shrimp biomass. This does limit broader conclusions for the prior targeted shrimp trawl and offshore CPUE indicators. Analysis of cod diet, the third indicator, was conducted across all of SFA 6 and represents a broad scale index.

The methods used in the analysis of cod stomach contents were questioned by participants. Between 95 and 200 cod stomachs were sampled annually across Divisions 2J3KL. Total shrimp abundance in the stomach was described as a stronger statistical measure than presence/absence. Diet analysis did not consider fish size thereby increasing the probability of false positives and the sample size was considered to be relativity noisy. The presenter indicated that similar analysis could be completed with turbot, likely creating a relatively similar picture.

There were questions about the deployment of the trawl. The presenter believed that tows from the old and new surveys were of similar tow heights, however, different foot gear was employed in the new survey. The absence of rock hopper gear in the old surveys meant difficulty sampling rocky terrain.

There was discussion around the development of models. The logic of using the high biomass period was questioned. This period is used because detectability goes down as abundance goes down and the use of the high biomass period is to avoid this effect as much as possible. The presenter indicated that there are issues with how sensitive a model can be and what might confound the data along with scaling issues and normalizing. However, long-term goals for these models include revisiting reference points, more quantitative predications, drivers, limit points, predation levels and better presence/absence indices. The hope is to develop several robust models to be used together in stock assessments.

The presenter also demonstrated a new potential model to estimate available shrimp habitat based on depth, temperature, and latitude, estimated using a generalized additive model (GAM) based on the presence or absence of a substantial quantity of shrimp in the groundfish RV survey. One participant was surprised to see shrimp being caught at a depth of 500 m. The model used 10 Kg shrimp as a minimum amount to be considered “present.” The presenter noted that this quantity of shrimp does occur at these depths on rare occasions, but these depths would still be considered relatively marginal habitat by the model.

ASSESSING CONNECTIVITY OF SHRIMP POPULATION ON THE NEWFOUNDLAND AND LABRADOR SHELF

Presenter: N. Le Corre

Abstract

Applying a biophysical model within Newfoundland and Labrador management areas (SFA 4 to 7), we investigated connectivity processes during the long pelagic larval phase (two to three months) of *Pandalus borealis* and key drivers of larval dispersal in different environmental conditions. We selected three years representative of contrasting North Atlantic Oscillation phases and hierarchically assessed the impact of the timing of release (yearly and daily), release location, and vertical migration behaviour on shrimp larval dispersal. We estimated the role of those biological characteristics for long larval dispersal processes by comparing dispersal kernels, travelled distances, and connectivity matrices. Our simulations suggest that

northern shrimp larvae may travel several hundreds of kilometers prior to settlement, connecting all the different areas along the eastern coast of NL (SFAs 4 to 7), with northern populations providing potential settlers to southern populations. Moreover, we identified geographic release locations of larvae and larval behaviour as important drivers of larval settlement success and retention patterns. Larvae released from shallow areas achieved much higher settlement success than larvae released from offshore areas, irrespective of the year of study. The influence of release year, geographic location, and larval behaviour on potential settlement success in suitable areas observed in our study illustrates the roles played by ocean circulation and some biological factors in patterns of larval connectivity and retention for the northern shrimp.

Discussion

Several participants indicated that the material presented was valuable. It provided a full set of possibilities for determining settlement and showed a level of connectivity among SFAs 4-7 which has not been fully understood. There was a recommendation to not make statements implying that the location of larval settlement is unknown because settlement may have occurred everywhere but only be detectable in areas where the larvae did not die. The presenter agreed but indicated the assumption, based on these models, is that most settlement occurs in shallow water.

A participant speculated that the low biomass in SFA 6 could be due to a lack of recruitment. Strong currents from the North (SFAs 4 and 5) carry a lot of cold water into SFA 6 and potentially push the shrimp into deeper water, impeding transport and successful settlement. This approach to recruitment has not been explored in model or recruitment studies in SFAs 4-6.

There was discussion on the potential of back tracking larval dispersal from known settlement areas to identify the origins of their recruitment. This could easily be accomplished; however, there are limitations due to the lack of available shallow water recruitment data in regions where surveys are not being conducted. It was suggested that old data be re-examined for this purpose. Ideally this could be used to produce a map indicating areas where there is high probability of originating recruitment.

ASSESSMENT OF SFA 6 NORTHERN SHRIMP

Presenter: K. Skanes

Abstract

There is concern for the current status of this resource. The fishable biomass index declined by 16% from 2016 to 2017 and is at the lowest level in the survey time series. The female SSB index declined by 19% from 2016 to 2017 and is currently in the Critical Zone for the second consecutive year, based on the PA Framework. This follows three consecutive years of the female SSB index declining while in the Cautious Zone. The IFMP states that the exploitation rate should not exceed 10% while the female SSB index is in the Critical Zone.

Fishery removal effects may become relatively high given the low level of net shrimp production after predator removals of shrimp in recent years. Thus, fishing mortality can be very important for determining whether gains (production) exceed losses (predation and fishing) and hence whether the stock increases or decreases. Recent environmental and ecosystem conditions along with harvest rates have not permitted the stock to increase.

Discussion

Participants questioned why the reference points had changed. It was explained that the values had shifted slightly because there were changes in the program used to estimated biomass indices. The methodology used in reference point calculations was unchanged.

A question asked for clarification of the decrease in total biomass index. The decrease was 26% and this prompted some participates to speculate about the size and gender of the recruits. A participant asked about recruitment and the response indicated little is known on that topic right now; there have been no clear relationships between small shrimp in SFA 6 and subsequent fishable or female shrimp 1-3 years later.

There was a discussion on the aging of larval shrimp. From 2016 to 2017, 1,700 larvae were shipped to UNB for analysis. The analysis found a high amount of variability in the age relative to the size of the shrimp. Similar results were described to have occurred in Greenland. It appears that aging, particularly through the use of eye stocks, may remain problematic and is believed to be due to the irregular molting patterns (by size, maturity, and timing) of shrimp.

ASSESSMENT OF SFA 5 NORTHERN SHRIMP

Presenter: K. Skanes

Abstract

The fishable biomass index increased by 31% and the female SSB index increased by 3% between 2016 and 2017, both are near their long-term mean. Female SSB index is in the Healthy Zone within the PA Framework with a 12% probability of being in the Cautious Zone. If the 22,000 t TAC is maintained and taken in 2018/19, then the exploitation rate index will be 15.7%.

Discussion

The presenter was asked to explain why this year's preliminary catch data along with the previous two years appeared to be much lower than the total allowable catch. It was explained that the catch was not lower; the data used in the models is comprised of available observer data and not total catch. Observer data is compiled from multiple sources using varied formats and this makes compilation and analysis time consuming and often delayed. The expectation is that not all the observer data is in the data set.

There was discussion pertaining to the limitations of the effort data. Effort was reported to have dropped from 12,000 to 4,000 hours over a two year period based on observer data and may not properly reflect the catch per unit effort actually occurring. The CPUE model does not necessarily reflect actual effort because it relies on observer data, which may be incomplete at the time of data analysis. The CPUE model included 64% of the data in 2016/17 and 66% in the year prior to that.

Two examples further demonstrating how effort can be impacted year to year are ice coverage and economic value of the shrimp. In the first example, fishing effort would likely focus initially in the most desirable areas and be limited only by processing capacity. Ice moving into this region, causing the fishing grounds to become inaccessible, would cause an increase in effort as less desirable areas must be sought out and fished. Secondly, the price received for larger shrimp in a given year may influence how harvesters target shrimp. Targeting shrimp with a higher economic value could increase profits but simultaneously increase effort due to impacts on the overall search time. Overall, participants felt there needs to be a better understanding of the

actual effort. Presently only the actual time trawling is reflected in the effort data and search time is excluded.

ASSESSMENT OF SFA 4 NORTHERN SHRIMP

Presenter: K. Skanes

Abstract

The fishable biomass index decreased by 13% and the female SSB index changed little from 2016 to 2017. Female SSB index in 2017 was in the Healthy Zone, slightly above the USR within the PA Framework, with a 56% probability of having been in the Cautious Zone and a 3% probability of having been in the Critical Zone.

Discussion

One participant noted the success of harvesters this year, as 100% of the TAC from SFA 4 had been landed. There was significant discussion on landings data and the fact that quota transfers are not reflected in the Science tables or graphs. The presenter was uncertain if that could be accounted for in future assessments.

Participants discussed how to convey that the point estimate of the biomass estimate of Northern shrimp was in the Healthy Zone with a high probability of the estimate being in the Cautious Zone. Biomass estimates from the summer Shrimp survey have typically been quite variable. In certain years, including 2017, the biomass index was primarily influenced by a low number of large survey catches such that the uncertainty (i.e. error bars) around estimates is higher. This was the fifth straight year of decline of female SSB and there was much concern expressed among participants as the stock is approaching the Cautious Zone. At the same time, some participants showed little concern because as they highlighted that the stock was still in the Healthy Zone.

RESEARCH RECOMMENDATIONS

- Further investigate the relationships between gross and net production in relation to environmental drivers and predation, including time lags. This potentially includes exploring the use of running averages instead of the cumulative Composite Environmental Index to describe large scale and persistent environmental conditions.
- In addition to studying biomass changes, investigate changes in population structure (i.e. size, maturity, etc.) to determine stock health.
- Further research on larval dispersal and connectivity among SFAs, particularly the transport of larvae between SFAs 4-6 and areas north of SFA 4. The results of this research could potentially be incorporated into integrated models.
- Further studies on developing a recruitment index.
- Investigate shrimp diet and shrimp’s reliance on phytoplankton and/or zooplankton.

APPENDIX I - TERMS OF REFERENCE

Assessment of Northern Shrimp in Shrimp Fishing Areas (SFAs) 4, 5 and 6

Regional Peer Review - Newfoundland and Labrador Region

February 13-15, 2018
St. John's, NL

Chairpersons: Brian Healey and Cynthia McKenzie, DFO Science

Context

The last full stock assessment of Northern Shrimp (*Pandalus borealis*) in Shrimp Fishing Areas (SFAs) 4, 5 and 6 was completed in February 2017 (DFO 2017). The current assessment was requested by Resource Management to inform the development of management measures for the 2018/19 fishing season.

Objectives

Assess indicators used to characterize stock status of Northern Shrimp in SFAs 4 to 6 (Northwest Atlantic Fisheries Organization [NAFO] Divisions 2G to 3K).

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document

Participation

- DFO - Science and Resource Management Branches
- Government of Newfoundland and Labrador - Department of Fisheries and Land Resources
- Indigenous groups
- Academia
- Fishing Industry
- Other invited experts

References

DFO. 2017. An assessment of Northern Shrimp (*Pandalus borealis*) in Shrimp Fishing Areas 4–6 and of Striped Shrimp (*Pandalus montagui*) in Shrimp Fishing Area 4 in 2016. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2017/012.

APPENDIX II – AGENDA

Assessment of Northern Shrimp in Shrimp Fishing Areas (SFAs) 4, 5 and 6

Chairpersons: Brian Healey and Cynthia McKenzie

February 13-15, 2018

Memorial Room - Northwest Atlantic Fisheries Centre
80 East White Hills Road, St. John's

Tuesday, February 13

Time	Topic	Presenter
09:00	Opening remarks and overview of Regional Peer Review Process	*Chairpersons*
-	Presentation: Ocean climate conditions on the Newfoundland and Labrador Shelf, update for 2017	*Eugene Colbourne*
-	Presentation: Ocean productivity trends in the Northwest Atlantic	*Gary Maillet*
-	Presentation: Structure, trends and ecological interactions in the marine community of the Newfoundland-Labrador bioregion, with emphasis on the role of shrimp	*Mariano Koen-Alonso*
-	Presentation: Current research into long-term trends in Northern Shrimp abundances	*Eric Pederson*
-	Presentation: Assessing connectivity of shrimp populations on the Newfoundland and Labrador shelf	*Nicolas Le Corre*
-	Presentation: Assessment of SFA 6 Northern Shrimp	*Katherine Skanes*
-	Drafting of Science Advisory Report (SAR) bullets for SFA 6	*All*

Wednesday, February 14

Time	Topic	Presenter
09:00	Presentation: Assessment of SFA 5 Northern Shrimp	*Katherine Skanes*
-	Drafting of SAR bullets for SFA 5	*All*
-	Presentation: Assessment of SFA 4 Northern and Striped Shrimp	*Katherine Skanes*
-	Drafting of SAR bullets for SFA 4	*All*
-	Research Recommendations	*All*
-	Upgrading of Working Paper	*All*

Thursday, February 15

Time	Topic	Presenter
09:00	Continuation of Discussion (if required)	*All*
-	Closing/Next Steps	*Chairpersons*

APPENDIX III - LIST OF PARTICIPANTS

Name	Affiliation
Derek Butler	Association of Seafood Producers
William Coffey	DFO – Science, NL Region
Krista Baker	DFO – Science, NL Region
Leigh Edgar	DFO – Resource Management, National Capital Region
Brittany Beauchamp	DFO – Science, National Capital Region
Dwight Russell	Harvester
Erin Carruthers	Fish, Food and Allied Workers Union
Bobby Noble	Harvester
Nelson Bussey	Harvester
Jerry Ward	Northern Coalition
Sean Boyd	Rapporteur
Derrick Dalley	Ueushuk Fisheries Ltd./Innu Nation
Darren Sullivan	DFO – Science, NL Region
Cynthia McKenzie	Co-Chair
Brian Healey	Co-Chair
Katherine Skanes	DFO – Science, NL Region
Erika Parrill	DFO – Centre for Science Advice
James Meade	DFO – Centre for Science Advice
Ellen Careen	DFO – Resource Management, NL Region
Geoff Evans	DFO – Emeritus
Mariano Koen-Alonso	DFO – Science, NL Region
Eric Pedersen	DFO – Science, NL Region
Nicolas LeCorre	DFO – Science, NL Region
Wojciech Walkusz	DFO – Science, Central and Arctic Region
David Deslauriers	DFO – Science, Central and Arctic Region
Andres Beita	Marine Institute
Tom Dooley	Government of Newfoundland and Labrador - Department of Fisheries and Land Resources
Brian McNamara	Newfoundland Resources Ltd.
Todd Broomfield	Nunatsiavut Government
Robyn Morris	Torngat Wildlife, Plants & Fisheries Secretariat
Derek Osborne	DFO – Science, NL Region
Jen Duff	DFO – Communications
Eugene Colbourne	DFO – Science, NL Region
Gary Maillet	DFP – Science, NL Region
David Belanger	DFO – Science, NL Region
Annette Rumbolt	DFO – Resource Management, NL Region
Darrell Mullowney	DFO – Science, NL Region
Julia Pantin	DFO – Science, NL Region
Bruce Chapman	Canadian Association of Prawn Producers
Laura Wheeland	DFO – Science, NL Region
Bob Rogers	DFO – Science, NL Region