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Proceedings of the Regional Peer Reviews of the Assessment of Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps Atlantic Cod (*Gadus morhua*) and Subdivision 3Ps American Plaice (*Hippoglossoides platessoides*)

Meeting dates: November 19–22, 2019
Location: St. John's, NL

Chairpersons: Karen Dwyer and Krista Baker
Editors: Jennica Seiden and Keith Lewis

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

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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 Regional Peer Review process was held in St. John's, Newfoundland and Labrador (NL) from November 19 to 22, 2019, to assess the status of the stock of Atlantic Cod (*Gadus morhua)* and American Plaice (*Hippoglossoides platessoides*) in Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps. The assessments were requested by the Fisheries Management Branch to provide the Minister with detailed advice on the status of the stock to inform management decisions for the 2019 fishing season.

Prior to this meeting, a Regional Peer Review process was held in St. John's, Newfoundland and Labrador, from October 8 to 10, 2019, to assess the methodology for estimating the population size and other stock status indicators of cod in NAFO Subdivision 3Ps. The assessment framework meeting (framework hereafter) reviewed and considered multiple candidate models of population dynamics for 3Ps cod, specifically those that can incorporate multiple data sources (including commercial catch). The data sources available for modeling the 3Ps cod population were determined previously at a data review meeting held in May 2019.

Participation included representatives from Fisheries and Oceans Canada (DFO) Science and Resource Management, L'Institut Français de Recherche pour l'Exploitation de la Mer (IFREMER), the fishing industry, the Provincial Department of Fisheries, academia, and Indigenous Groups.

In addition to these Proceedings, a Science Advisory Report (SAR) as well as Research Documents produced from this meeting, will be made available online by the Canadian Science Advisory Secretariat (CSAS).

PRESENTATIONS

OVERVIEW OF 3PS FRAMEWORK

The discussion began about the outcomes of the framework meetings and whether the previous model was still available for use and whether Limit Reference Points (LRP) were already determined. The previous model was still available for reference for comparison and the LRPs were not set at the previous meetings. This was an attempt to give an overview of the framework; the proceedings had not yet been issued.

OVERVIEW OF PHYSICAL AND BIOGEOCHEMICAL OCEANOGRAPHIC CONDITIONS IN THE NORTHWEST ATLANTIC

D. Bélanger, F. Cyr

Presented by: G. Maillet

Abstract

Oceanographic conditions in NAFO Subdivision 3Ps are influenced by several factors, including local atmospheric climate conditions, advection by the Labrador Current from the east and the warmer and saltier Gulf Stream waters from the south, as well as the complex bottom topography in the region. Near bottom temperatures, while showing significant variability from one year to the next, have exhibited a general warming trend since 1980.

Oceanographic data from 3Ps during the spring of 2019 indicated sea surface temperatures have cooled in 3Ps, consistent with the reduction in air temperatures across the Northwest Atlantic. Data derived indicated sea surface temperatures, except for a cold anomaly in late-spring and early-summer, were generally near-normal or above normal. Bottom temperatures continued to remain above normal in the area in recent years, although the 2019 bottom temperatures were not available at the time of the assessment. An extensive time series of water temperatures from an inshore high frequency monitoring station in the deep Avalon Channel indicated multi-decadal cycles, suggesting the importance of large-scale physical forcing over the region. In addition, higher production of Labrador Sea Water (LSW) through intensification of winter mixing may have also contributed to lower water temperatures throughout the stock area.

Standing stocks of phytoplankton and nitrate inventories, which provide the primary energy inputs to the base of the food web, were not available in 2019 within 3Ps. Data from upstream areas on the Grand Bank in 2019 indicated near-normal deep nitrate inventories and enhanced phytoplankton biomass compared with lower levels observed in previous years. Satellite remote sensing data indicated continued lower magnitude of the spring bloom in 3Ps, consistent with observations on the Grand Bank in 2019. The duration of the spring bloom was longer than normal on the Grand Bank in 2019, but has remained near-normal in 3Ps over the past decade. Delayed timing of the spring bloom observed during 2014–17 returned to near-normal in 3Ps in 2018–19.

Zooplankton biomass on the Grand Bank and Newfoundland Shelf is normally dominated by large, energy-rich calanoid copepods, which represent important prey for planktivorous fish and early life stages of demersal fish such as cod. No spring zooplankton data were available in 3Ps for abundance and biomass indices during 2019. Observations further north on the Grand Bank during spring 2019 indicated near-normal abundance of keystone copepod taxa, but a reduction

in biomass. The limitations of biological data within 3Ps during spring 2019 did not permit us to comment on the overall state of productivity in the lower trophic levels within the stock area.

Discussion

Overview of Physical Conditions

Participants asked how the temperature information presented compared with global warming/climate change. It was explained that there was large-scale forcing in 3Ps, but there were also multiple local influences (e.g., Gulf stream-production of LSW and Labrador current), so it was difficult to compare with the global climate. There were both localized and large-scale effects on 3Ps; however, two decades of sustained warming was comparable with larger-scale trends.

The reviewer asked if there was any projection model available for this particular region. This was being worked on; there was a collaboration in progress on the potential impacts of thermal conditions on biological components, including lower trophic levels.

A participant inquired about the 2019 data. There were 2019 data, but they were not completely ready for presentation. Data for 3Ps were not available for the 2019 spring surveys.

Overview of Biogeochemical Conditions

It was reiterated that there were no spring data for 2019.

Most of the discussion for this presentation concerned zooplankton biomass, the productivity state of 3Ps, and corrected data. The discussion began noting that there was an erroneous calculation of decline in zooplankton biomass estimates from 2015 to 2018. While it has since been corrected, the error has been embedded in previous documents and bullets. The correction needs to be documented in the products of this meeting, so readers of multiple SARs can understand the corrections that have been made.

It was also noted that biomass was not included for St. Pierre Bank for comparison because it was not a long enough time series to apply standardized anomaly calculations. Specific patterns in biomass and abundance of different taxa were shown and the dramatic change in zooplankton biomass overall was highlighted. Future assessments should continue to present this information, highlight it, and address these issues. It is important to be clear and upfront about the history of the data error.

A participant stated that productivity and zooplankton biomass were low in recent years and inquired how this changes our perception of what is going on. The response was that 3Ps biomass was still reduced in terms of zooplankton, but in other areas along the Atlantic Zone Monitoring Program there were increases, so this reduction was localized and patterns may change depending on the area of interest due to local influences. Indices specific to these assessments and stocks need to be produced and the effort to do so must be continued. Upstream areas must also be examined because there are transport mechanisms involved and upstream areas are correlated with 3Ps. The 3Ps hydrographic area is impacted by multiple water masses, which makes understanding zooplankton more difficult. Another participant noted that they expected copepod trends to follow the general zooplankton trends, but that this was not the case. The trends did not appear the same in the anomaly plots because large zooplankton abundance was low but increased near the end of the time series, while smaller copepod abundance, which contributed disproportionately to the total zooplankton abundance, was high but decreased at this time. Therefore, the total zooplankton abundance remained high despite differing trends for the various copepods. Clarification was sought as to whether the conclusions regarding lower zooplankton biomass were specific to 3Ps. This was confirmed although it was noted that there were no relevant 2019 spring data.

A participant inquired about the corrected data and the previous SARs that stated productivity was low and how this influenced advice. They perceived these data as showing a stark difference and inquired whether this was only a 3Ps issue. It was confirmed this was not only a 3Ps issue. Industry suggested this information be made public so that people in various fishing industries could understand what was going on. The participant was under the impression that productivity was low and now has a different viewpoint based on corrected data. It was stated that these data were specific to lower trophic levels. Participants emphasized the importance of the type of species present and that only a small part of productivity was increasing. *Calanus finmarchicus* was low and the type of species present is an important indicator of quality of food. It was agreed that this was a valid point. The reviewer commented that smaller zooplankton are an indicator of lower quality food and this might affect upper trophic levels of fish communities. We need to consider how secondary production translates into fish production (not just total biomass) because composition of zooplankton is important.

Additionally, a participant inquired about the effect fish farms and the treatments used to kill sea lice, etc. were having on organisms such as zooplankton in the water column in Fortune Bay. This could not be addressed here and was beyond the scope of the meeting, but the concerns were understood.

A participant questioned the comment on warming trends in the bullets and that this was not evident in recent years; 3Ps temperature has declined in recent years but this is a local phenomenon. The participant cautioned that conclusions needed to be consistent with the data.

SOUTHERN NEWFOUNDLAND (NAFO SUB-DIV. 3PS): ECOSYSTEM SUMMARY

M. Koen-Alonso, A. Cuff, J. Mercer, and H. Munro

Presented by: H. Munro

Abstract

The ecosystem structure of the NL bioregion can be described in terms of four Ecosystem Production Units (EPUs): the Labrador Shelf (2GH), the Newfoundland Shelf (2J3K), the Grand Bank (3LNO), and southern Newfoundland (3Ps).

Analyses of fishing effort distribution in 3Ps show clear areas of concentration, with differences in the use of space by different fisheries. While the groundfish fishery partially overlaps with Significant Benthic Areas (gorgonian coral and sea pen habitats) along the edge of the shelf, most core fishing grounds do not overlap with these areas. The establishment of the Laurentian Channel Marine Protected Area provided protection for some areas of sea pen habitat, but protection does not currently exist for gorgonian coral habitats in the areas where overlaps do occur.

The overall biomass of the fish community declined in the late 1980s and early 1990s. This decline also involved changes in the structure of the fish community and a decline in fish size. Since the mid-to-late 1990s, the overall biomass of the fish community has not increased significantly, oscillating around an index level of 280,000 tonnes (t). After 2014, total biomass showed reduced levels in comparison to precedent years, but increased in 2018 and 2019. These increases were driven by plankpiscivores and, to a lesser extent, piscivores. Abundance increased in the late 2000s, peaked around 2013, and declined afterwards. This increase was mainly driven by planktivores and plankpiscivores. An increase in abundance was observed in 2019 also driven by planktivores and plankpiscivores to levels similar to those in the late 2000s.

Fish size (BAB Ratio) declined in the late 2000s and has remained at that lower level, but showed modest improvement in 2018–19. The piscivore functional group used to be highly dominated by Atlantic Cod. Since 2012, Silver Hake increased its dominance, with Atlantic Cod as the third most dominant species after Spiny Dogfish and Silver Hake in 2019. While the overall picture of reduced productivity remains, results from the 2019 survey suggest that some conditions may be improving.

Regarding the order of magnitude of consumption, the fish community in 3Ps is estimated to consume food in the range of 1–2 million t per year. This increased in 2019 to 2–4 million t per year, which was driven by plankpiscivores. Within this envelope, piscivores were estimated to eat on the order of 400,000–900,000 t per year; this increase was driven by the large number of Spiny Dogfish observed in 2019.

Snow Crab was a dominant prey for cod in 2013–16. Since 2017, the cod diet has changed, showing an increased consumption of fish. Although the diet time series in 3Ps were far from complete, the available evidence indicated that cod has a highly variable diet in this region. This suggests that food availability may be highly variable. Although stomach content weights for 3Ps cod suggested a possible change from the declining trend observed in recent years, values remained on the low side. The trend in turbot did not suggest an improvement in foraging conditions. Stomach content weights for cod and turbot suggested that 3Ps may be comparatively more food limited than other ecosystems. The observed differences in trend between these two predators could indicate patchiness/spatial variability in the prey field.

Ongoing warming trends, together with an increased dominance of warm water species and reduced fish sizes across many fish functional groups, indicate that this ecosystem is undergoing structural changes. Although there were some positive indicators for cod (i.e., improvement in biomass and a more piscivorous diet), these signals were not widespread or fully consistent across the fish community. The ecosystem still remains under reduced productivity conditions. Therefore, the available evidence suggests that while there are some positive signs, cod productivity in 3Ps likely remains hindered. In this context, it continues to be advisable to employ higher than usual risk aversion in the management of this stock.

Discussion

The discussion began with a focus on sea pen maps, how they were created, and how the Significant Benthic Areas for sea pens were determined. The maps were produced using kernel density mapping by a group at the Bedford Institute and were based on research vessel (RV) survey data, specifically from the annual multispecies survey conducted each spring. It was believed that a random forest model was used for the analysis, but this needed confirmation. There were concerns about the presence of sea pens in shallower waters.

The conversation then shifted to the redfish diet and whether fluctuations in redfish populations could be correlated with their diet. Redfish are omnivorous, primarily eating plankton, and as they mature, small fish and shrimp. Questions were raised about the observed increase in redfish, with concerns that catchability—particularly the presence of schools—could give a misleading impression of abundance.

Further discussions covered the increased sightings of Spiny Dogfish and redfish, and whether the 3Ps region remains in a low productivity state, as suggested in a summary bullet. Some participants noted that anomaly plots did not reflect this, and a suggestion was made that the increase in Spiny Dogfish could be due to the population migrating from the Scotian Shelf stock to 3Ps. Further discussions with the Bedford Institute were recommended regarding the Spiny Dogfish increase. Participants generally agreed that the anomaly plots did not show a low productivity state and that clarification on this conclusion was needed. The apparent increase in productivity seemed to stem from the influx of redfish and dogfish, transient species that may not necessarily indicate increased overall productivity. Historically, productivity was low, but signals from 2018 to 2019 showed real improvement. However, if Spiny Dogfish were excluded, the biomass anomaly would be weaker, and the same held true for redfish. It was emphasized that two anomalous points should not be extrapolated as a sign of ecosystem improvement unless the trend continues.

FISH DIETS

One participant inquired about the stomach content observations of cod from a low-functioning population (3Ps) compared with a high-functioning one (3O). Responses indicated that prey for cod is highly variable in 3Ps due to fluctuating food availability and includes sandlance and Capelin on the southern Grand Bank. The discussion then turned to food quality, with one participant stating that sandlance is a lower-energy food compared to Capelin. Another participant believed sandlance was comparable to Capelin but intended to verify this. There was agreement that it was difficult to infer the trade-offs between these two prey items without knowing how easy or difficult they were to catch and consume. Additionally, it was noted that recent increases in productivity in 3Ps were driven by episodic events such as the influx of redfish. However, other abundance anomalies were observed in groups like piscivores and medium-to-large benthivores, which had been above average for the last three years. This led to more agreement on the need for clarification regarding the low productivity conclusion.

Regarding American Plaice stock issues, the time series for diet information (2013–19) was not long enough to provide helpful insights into why the stock was not recovering. When asked about the sample sizes for fish diet data, it was confirmed that over one hundred stomach samples were collected per species (~100–140), and a power analysis had been conducted to ensure the sample size was sufficient. However, the sample size was deemed too short-term to offer useful insights for the 3Ps American Plaice population.

A participant then asked whether the stomach content samples were taken from the inshore or offshore, and if inshore, from Area 10 or 11. It was clarified that most of the stomach samples were collected offshore during RV surveys. Another participant suggested there could be two distinct stocks in 3Ps—the inshore and offshore populations—and that the offshore stock moves between NAFO Subdivisions. They suggested this could have implications for understanding diets in 3Ps, as the inshore stock should also be sampled for stomach contents since the offshore stock, where most data come from, moves in and out of the NAFO Subdivision. A question about whether stomach samples were collected during Sentinel surveys was noted and followed up on during a later Sentinel presentation.

The discussion returned to questions about the variability of cod diets in 3Ps and what the data indicated. Participants debated whether cod had a variable diet due to fluctuating food availability or if it was simply a generalist species. Some data suggested that the 3Ps cod diet was more diverse than that of 3O, implying a broader prey base in 3Ps. One participant noted that variability in diet does not necessarily indicate that the species is a generalist, but rather that their diet has changed year to year. Another agreed, stating that cod diets were both varied and variable depending on available prey, but drawing conclusions was difficult due to a disconnect between prey availability and diet. There was also a concern that sample sizes were relatively small, potentially making the observed variation questionable.

One participant cautioned against comparing the diets of cod in 3Ps with other populations, such as those in 3O, due to a lack of knowledge about which population had the optimal diet. Although it was acknowledged that diet varies spatially, the reasons for this variability remained unclear, preventing any firm conclusions from being made. An overall suggestion was made to develop Engel maps that show where samples were taken, trends in sample sizes over time, and where corrections were applied. These spatial trends could help answer questions about diet variability.

Lastly, a participant asked if diet could be related to productivity in terms of mortality and recruitment, and if so, whether advice could be provided based on this. The response was that the situation is complex, involving factors like prey availability, predator density, and catchability. Cod, for example, seem to rely on Capelin in 2J3KL, but not as much in 3Ps, where Capelin has historically been scarce despite a relatively high cod population. More analysis and information would be needed to address this question comprehensively.

REVIEW OF 2018/2019 FISHING SEASON AND 2019/2020 SEASON TO DATE (ATLANTIC COD)

Presented by: S. Dwyer

Abstract

An overview of the 3Ps cod fishery for the 2018–19 and 2019–20 management periods was provided. The summary included an overview of the management plan and measures in place for the fishery including the Total Allowable Catch (TAC), fleet allocations and quotas, gear restrictions, season dates, monitoring requirements, and conservation closures. The summary also included an overview of the total Canadian landings for the stock, as well as landings by the various fleets, for each of the management periods.

Discussion

The discussion primarily focused on the presentation of the data and its interpretation. A participant asked about quotas and Total Allowable Catches (TACs), specifically questioning why there were blanks in the data. The blanks indicated that the "rule of five" (a policy requirement for data release) was not met, meaning the catch information could not be presented. It was then asked if these unreported catches were included in the total, and it was confirmed that they were. It was suggested that a note be added to explain that some data did not meet the "rule of five," so people could understand why these figures were omitted.

There were also questions regarding overages and reallocations. Based on the tables, it appeared that some fisheries in certain areas (e.g., fixed gear in Area 10) had exceeded their TAC. Specifically, there was an overage in 2018 for fixed gear in Area 10, and while some reallocations occurred, the overall fixed gear allocation was not surpassed. Another participant pointed out that the data in the table suggested the inshore fishery had exceeded its quota by approximately 500 tonnes. It was clarified that this was not the case, and there was agreement that the table needed to be adjusted to reflect the correct information. A general suggestion was made to present the data differently, as the current format made it seem like quotas were exceeded.

It was noted that the French quota was not fully utilized due to issues with trawlers, including engine and mechanical problems, and a long wait time for parts. Additionally, there was little interest in cod fishing in the inshore waters around St. Pierre, as harvesters were more active in the sea cucumber and lobster fisheries, with cod primarily being taken for local consumption. A participant asked what percentage of the quota was caught by St. Pierre, and it was confirmed that of the 900-tonne quota, 15% (approximately 100–200 tonnes) was caught. Another participant inquired about the reasoning behind using six hooks; the response to this question required further checking.

A final question concerned the reallocation program and the transfer of quota from Fortune Bay to Placentia Bay. Once the overall quota was caught, the fishery was shut down, meaning some harvesters were unable to catch their quota. The participant expressed concern that this could lead to continuous depletion of the Placentia Bay stock, which was already in decline. Furthermore, no one in western Placentia Bay received reallocations because the quota had already been caught elsewhere. It was concluded that this issue needed to be addressed by Fisheries Management.

SENTINEL SURVEYS 1995–2018: CATCH RATES AND BIOLOGICAL INFORMATION ON ATLANTIC COD IN NAFO SUBDIVISION 3PS

Presenters: L.G.S. Mello, D. Maddock Parsons, and M.R. Simpson

Abstract

Catch rates and biological information for Atlantic Cod from the Sentinel survey Program in the NAFO Subdivision 3Ps were updated for 2017, and preliminary results presented for 2018. Temporal trends in gillnet (small 3¼ inch mesh, large 5½ inch mesh) and line trawl (LT) unstandardized catch rates were similar for all gears. The highest values were at the beginning of each time series, with sharp declines after 1997 and oscillations around or below the series' mean catch rate thereafter. Mean catch rate for small mesh gillnets was consistently higher than that of large mesh gillnets for the entire time series: peaking at 142 fish/net in 1996, and then averaging 11–36 fish/net; except for its lowest value of six fish/net in 2011. Large mesh gillnets yielded the lowest mean catch rate of all gears: declining from 49 fish/net in 1997 to less than nine fish/net since 2000. Mean catch rate for LT peaked at 223 fish/1,000 hooks in 1996, and fluctuated around 100 fish/1,000 hooks until 2010 (except in 2006), prior to reaching its lowest value of 62 fish/1,000 hooks in 2014–15. Sentinel catch rates for large mesh gillnet and LT at fixed and experimental locations were standardized using Generalized Linear Models. Age-disaggregated standardized catch rates for recent year classes were generally weaker than those in the past. Age-aggregated catch rates were higher at the beginning of each time series for both gears, declined over the mid-to-late 1990s, then remained at their lowest levels, decreasing below the series' mean of 6.4 fish/net (large mesh gillnets) in 1999, and 86 fish/1,000 hooks in 2009 (LTs). Gillnet and LT catch rates for 2017 were 2.5 fish/net and 47.5 fish/1,000 hooks (fixed sites), and 2.3 fish/net and 53.7 fish/1,000 hooks (experimental sites), respectively.

Length frequencies of Atlantic Cod measured in Sentinel surveys indicated that the small mesh gillnet was the least selective gear (retaining small and large fish from multiple length classes), whereas large mesh gillnet and LT captured larger fish in specific size ranges and few overlapping length classes. Fish lengths from small mesh gillnet showed several modes ranging between 37–43 cm and 53–60 cm throughout the time series, while those from large mesh gillnet and LT ranged between 60–68 cm and 42–61 cm, respectively. Indices describing the physiological condition of Atlantic Cod varied at both seasonal and annual scales: the liver (hepatosomatic index) and gutted body condition (Fulton's K condition factor) declined over winter and early spring (while the gonadosomatic index increased), then improved over summer after spawning. These trends varied annually over the time series, but generally declined in 2004–17.

Discussion

A participant asked whether there were differences in the number of zero catches between the fixed and experimental sites. This could be examined in the future. Following up on the previous presentation about fish diets, a participant inquired whether stomach content analyses were conducted in the Sentinel survey. It was confirmed that stomach content analyses were performed, but the data had not been presented previously. This was flagged for future examination.

Participants sought clarification on why there had been less Sentinel survey coverage in recent years and whether it was due to a decrease in the number of participants, sites, or communities involved. It was primarily due to fewer participants (reduced from 16 or 17 to 10 or 11), though there was also some annual variability in community involvement. Some communities had no representatives. A participant noted that catch rates could vary based on which communities participated, and if there was lower coverage in certain portions of the time series, this could affect the data. Other participants pointed out that some sites had been removed over the years. Sentinel was working on modeling to reduce this kind of temporal and spatial variability, though the overall trend in catch rates remained consistent—high at the beginning and very low in the middle and end of the time series.

Another participant asked if anything could be done to retain the same harvesters each year to maintain the integrity of the sampling program. It was believed that the union selected the harvesters, and the reasons for fewer communities being surveyed were unclear.

One participant inquired whether standardized indices were calculated by calendar year or quota year. It was confirmed that they were calculated by calendar year. A suggestion was made to compare the indices for both calendar and quota years to determine if the time period had any effect.

The presenter asked why there were differences between gear types and areas. There was some uncertainty about this; it was only known that hooks were generally used before the moratorium, while gill nets were predominantly used at most sites after the moratorium.

ASSESSMENT OF ATLANTIC COD IN NAFO SUBDIVISION 3PS

Presenters: D.W. Ings, D. Varkey, R.M. Rideout, M.J. Morgan, J. Champagnat, and J. Vigneau

Abstract

Total landings for the 2018–19 management year (April 1–March 31) were 4,742 t or 79% of the TAC. This marks the tenth consecutive season that the TAC has not been fully taken.

Standardized catch rate indices for data from vessels <35 feet (ft) which fished in the inshore (i.e., unit areas 3Psa, 3Psb, and 3Psc) were presented along with separate indices for vessels >35 ft. The percentage of the total cod catch for the <35 ft sector represented in the logbooks decreased over time, from about 70% in 1997 to about 25% in recent years. This was considerably less than logbooks from vessels >35 ft where approximately 60% of the landings were covered. Catch rates in gillnets from both logbook series were consistent in showing initial declines; then, catch rates were stable to 2017. The 2018 catch rates for vessels >35 ft fleet increased considerably more than those from the <35 ft fleet. Catch rates from LTs were variable over time for vessels <35 ft, with the 2018 value among the lowest in the time series. However, these data were derived from only 24 logbooks.

A catch rate index for gillnets based on at-sea observer (ASO) sampling was also presented. Results were consistent with those from the logbook time series for vessels >35 ft, showing stable catch rates following initial declines and a sharp increase in 2018. Note that <1% of landings were represented by ASO sampling in most years.

RV surveys were conducted annually during spring and provided fishery independent data on the status of the resource. Survey abundance estimates were generally higher over 2009–17

than during the previous decade, but the 2019 value was below the time series average. The biomass estimate was variable over much of the post-moratorium period, but showed a general decline over 1998 to 2019, with the exception of the high value in 2013. The 2019 biomass value was among the lowest in the time series.

Sampling of RV catches indicated negative trends or reductions in many biological parameters. Generally, length-at-age was well below average during the last seven years. Mean weight-at-age increased from the mid-1990s to mid-2000s, but has generally decreased since then with the last seven years well below the time-series average. Measures of cod condition were mostly below average during the last six years. Also, age at 50% maturity generally varied between six to seven years during the early part of the time series, but declined sharply during the early to mid-1980s and has varied at a lower level (~five years) since that time.

Discussion

Catch-at-Age

A participant pointed out that there were year effects for commercial catch weights-at-age; there was a spike in all weights/ages in some years. There were clearly some year effects and this highlighted why switching to a modelling approach to calculate stock weights was appropriate. A follow up question was what sort of year effect could have produced this. This could have been the result of sampling at a time of year when fish were heaviest. Another participant pointed out that all fish aged 8–14 weighed approximately 2 kg in 2012, and this could not be possible. The reason for the low weights in 2012 was not determined during the meeting. Another participant highlighted other reasons such as gear type and growth rates which could have an effect on catch weights, but agreed that the catch weights in 2012 were peculiar and needed to be examined since they were lower weights at older ages. The data were checked and confirmed not to be in error.

A participant noted that sampling of the commercial catch used to be well distributed throughout the season and that commercial sampling was not opportunistic. They also inquired about DFO’s commercial sampling unit. DFO still has a commercial sampling unit and they sample during peak fishing times, although there were gaps in the sampling coverage which are more likely when catches are small. A participant suggested that catches were reduced and this may have contributed to data gaps. In more recent years, the ASO program has been conducted by private industry and there have been issues in obtaining ASOs.

Logbook Data, Catch Rate Index

Discussion began around the <35 ft vessels. A participant stated that the gillnet index was pretty consistent while the LT index varied and questioned whether it was worthwhile to plot commercial gillnet and LT indices together with the Sentinel index. This could be done, but generally they were fairly consistent. The initial decline may have been off slightly, but they were generally the same.

Regarding the >35 ft vessels, a participant inquired about which index was included for the assessment model and asked if logbook data were used and if so, which logbook data series. Neither logbook data series was used in the current assessment. Sentinel gillnet and LT data were used.

Another participant inquired about the origin of the policy on the rule of five. This is a Treasury Board policy. A few participants expressed concerns with the rule of five because it was an impediment for the stock assessment as not all data could be looked at. These concerns were flagged but could not be changed here.

Observer Data

A participant pointed out that there was a low coverage rate for 2013. They suggested an examination of the relationship between ASO data and catch weight-at-age estimates. The ASO data were used for catch-at-age calculations and are the primary source of data for the offshore given the lack of gillnet catch in this area.

RV Survey (Distribution and Biomass/Abundance Updates)

Discussion on biomass/abundance focused on the presentation of data with a participant questioning if it was more informative to present the data as concentrations rather than totals because the total amount for regions and strata could be quite different. This was a reasonable suggestion and would be considered the following year. The basis for the breakdown of the regions was unknown.

Age Composition, Size-at-Age (Length, Weight, and Condition), Age-at-Maturity

The 2018 spike in age-at-maturity was questioned as a participant recalled that spikes were common in 3Ps and 3NO. Otolith agers have seen lots of variation in size-at-age for 3Ps, which is unusual.

Another participant inquired whether variation in age-specific fish condition was examined; there was concern that condition was age-specific and questioned whether modeling targeted older or younger ages. These were relative conditions and age was not taken into account. A length-weight relationship was fit to all fish in all years and the relative condition was the weight of individual fish divided by the predicted weight of fish. There was some modelling to remove the year effect. Overall, age-specific condition was not looked at but this was a valid question.

2019 TAGGING AND TELEMETRY UPDATE: 3PS COD

Presented by: G. Robertson

Abstract

A summary of the tagging program in 3Ps was provided, focusing on recent tagging efforts and updating information from 2019. Since 2007, 21,477 t-bar tags have been deployed, 17,452 low ($10) reward and 4,025 high ($100) reward tags. Many of those tags have been deployed in upper Placentia Bay (3Psc), with good numbers also deployed in upper Fortune Bay (3Psb). Tagging efforts in 2019 were about average when compared with recent years, with 1,060 low reward and 255 high reward tags deployed in July and August, but the spatial coverage throughout coastal 3Ps was better. A focus of the 2019 tagging efforts was to tag in areas traditionally not well covered, so tagging at the 3Pn and 3Psa boundary was done for the first time since 2007. As expected, the main gear that returned tagged cod in 3Ps was gillnets, followed by handlines. Tagging location in coastal 3Ps was related to recapture locations, fish were most likely to be recaptured in the Subdivision where they were initially tagged, even in the years after initial tagging. Reporting rates of tagged fish continue a slow decline, but still exceed 0.60 in the inshore and offshore fisheries. The recreational fishery contributes relatively low numbers of reported tags in 3Ps (~10% tags returned since 2007 came from recreational fishers). In 2019, an acoustic telemetry project was initiated in upper Placentia Bay, with the 14 receivers placed to covered likely exits points from upper Placentia Bay; 38 cod were implanted with acoustic tags in July 2019.

Discussion

The discussion around the tagging update covered various topics. It began with questions about recoveries of 3Ps tagging, particularly whether the recoveries were exclusively from 3Ps or if any were observed outside of 3Ps. It was clarified that the recoveries were only for fish tagged in 3Ps. If there had been a concentration of fish recovered in 3L, it would have appeared on the heat map. Another participant asked how many fish tagged in 3L moved into 3Ps/Placentia Bay. While some fish tagged in 3L did move into 3Ps, exact proportions could not be provided. A question was raised about whether telemetry could detect the direction of fish movement. It was explained that while a denser array and specific tags could determine direction, the current setup of the arrays did not allow for this.

A question was also raised about the cost of deploying tags compared to the rewards offered for their return. While the rewards were not insignificant, they were small compared to the cost of vessel time. Several questions followed about the return rates of high-reward tags and double-tagged fish (fish tagged with two yellow tags). It was assumed that 100% of high-reward tags were returned, but fish have not been tagged with two yellow tags for about 15 years. Double tagging had not been repeated because earlier studies showed that tag loss was not trivial, but this factor was already accounted for in the model. Current telemetry work uses double tags (one pink and one yellow), indicating a fish with an acoustic tag.

Two final questions were asked: whether the current work supported previous findings and whether there were any seasonal contributions to 3Ps from other stocks. The data did not suggest significant changes in fish movements since the 1950s or 1960s, though it was acknowledged that knowledge remains incomplete. In terms of seasonal movements, few studies have been conducted on all tagging efforts. However, two key trends emerged from the existing work:

1. fish movement is highly variable, with fish moving in many different directions, and
2. it is difficult to generalize their movements, as fish appear to behave differently at different times of the year.

It was hoped that telemetry data would help clarify general movement patterns. One participant supported the second point, noting that Sentinel data suggest fish move to different locations at different times of the year. These preliminary findings highlighted the need to distribute tagging more broadly.

CONDITION-CORRECTED NATURAL MORTALITY FOR ATLANTIC COD IN NAFO SUBDIVISION 3PS

Presented by: P.M. Regular

Abstract

Starvation is a ubiquitous process in nature as all animals depend on finite resources to survive. Food resources often vary seasonally and, as such, individuals must endure times when they rely on energy reserves to fuel the basic processes of life. Limited food resources can ultimately lead to starvation-induced mortality and, depending on the scale of the food limitation, this can have population-level consequences. Previous research has indicated that starvation-induced mortality may be revealed by estimating the proportion of individuals experiencing severe emaciation in the population. Using data from both the RV and Sentinel Surveys, an index of starvation-induced mortality was derived from proportion of cod in poor condition. The greatest proportions of cod in poor condition were observed through the critical spring period and, as such, the most starvation-induced mortality presumably occurs at this time. This index of

starvation-induced mortality appears to be increasing in recent years (since ~2004) and the trends correspond with tagging-based estimates of natural mortality (M). These results indicate that starvation-induced mortality represents a non-negligible component of the M experienced by the stock and implies that prey availability may be a factor limiting the productivity of cod in 3Ps.

Discussion

At the start of the discussion, it was clarified that the condition-based index (referred to as the condition index) was not used as a direct input for mortality (M). Instead, with the help of an estimated parameter (mpara), it described the strength of the relationship between the condition index and mortality for both immature and mature fish, providing a time-varying estimate of mortality. A participant asked if this was the same model presented at the framework meeting, which was confirmed.

Several questions were raised regarding the experimental literature that informed the condition-corrected M (hereafter referred to as condition-corrected M). One participant noted that mortality due to starvation doesn't happen instantly; it takes time for a fish in poor condition to die. They asked how a condition threshold could be translated into mortality. The response was that no field or experimental estimates existed on the time to death, so it was unknown. This presented a problem for the model, which operated on a monthly scale and assumed mortality occurred within a month if the condition index was below 0.85. However, if a fish in poor condition (condition index <0.85) took longer than one month to die, survival rates would be underestimated. While this could affect the magnitude of the condition index, it would not impact the overall trend in the condition index or the resulting condition-corrected M from the model. The fraction of low-condition fish would be multiplied by an estimated parameter (mpara) to calculate the contribution to condition-corrected M, which was generally agreed upon.

Another participant asked about the initial condition of the fish used in the experiment, specifically whether healthy fish were starved, or if the fish were already in poor condition due to factors like disease or injury. The response was that a range of conditions was used in the lab experiments. The experiments showed that fish in poor condition were highly susceptible to parasites, while healthy fish had a 100% survival rate when starved. In the wild, a fish in poor condition during winter, spring, or spawning might never recover, becoming more vulnerable to parasites (like sea lice). Stronger fish were less likely to be part of this vulnerable group. One participant remarked that starvation of fish in 3Ps seemed like a foreign concept, but they acknowledged that the model was necessary to grasp the concept and its implications. It was clarified that the model's purpose was simply to inform mortality (M) based on tagging data. While some participants didn't see a direct link between tagging mortality and condition-corrected M, the statistics indicated reasonable correspondence.

A third participant questioned the use of experimental data from a three-month period applied to a monthly timescale, asking if this discrepancy had been addressed. They agreed that time-varying M was a reality, but they felt this specific approach was not agreed upon during the framework meeting. The response was that the discussions at the framework focused on the magnitude and timing of M, but no definitive conclusions were reached. It was pointed out that whether a three-month or one-month scale was used, the overall trend remained the same. The estimated parameter (mpara) was determined by the model, and only the magnitude of condition-corrected M would change. Moreover, there were limited options for estimating M, and this method was considered a cautious approach to estimating time-varying M.

Some participants noted that explaining mortality caused by starvation to the fishing industry might be challenging, as it was widely believed that seal predation was a major factor in cod mortality (M) in 3Ps. It was clarified that the condition index accounted for predation and parasitism, with starvation being just one component of M. Another participant asked why tagging data weren't used to estimate M, given the confounding factors involved in time-varying M. The response was that the condition index estimated some of the variation in M, whereas tagging data couldn't provide estimates for the current or previous year. Additionally, the sample size for the condition index was much larger than that for tagging data, making the condition-corrected M a stronger approach for projections. This was the first attempt to explain variation in M, but it wasn't the final solution. One participant agreed, noting that using independent data to estimate M was preferable to assuming a constant M. Another participant stressed that estimating M couldn't be fully resolved during this meeting, as it remained an area of active research. Mortality (M) was the only parameter where changing it had a significant impact. Moving forward, more resources could be allocated to better estimate time-varying M, as it was known that M fluctuated over time. One participant suggested that the issue wasn't with the analysis itself, but with how it was described. It was recommended that condition-based M be framed as an index of predation and parasitism. There was general agreement that the mortality estimate could be presented differently, and it was reiterated that this was just the first step.

Finally, a participant asked about the parameterization of M and whether autocorrelation posed a problem. It was noted that the model estimated an autocorrelation parameter.

FISH, FOOD & ALLIED WORKERS (FFAW) AND HARVESTER UPDATE

Presenter: E. Carruthers and harvesters

Abstract

No abstract provided.

Discussion

One participant commented on observations from the offshore commercial fishery. The fish caught were typically around 20–24 inches in length and about seven years old, with a few large fish but not many smaller ones. They could not provide information on the stomach contents of the fish. Similar to the inshore fishery, catch rates in the offshore fishery have declined over the past few years to the extent that quotas were not met.

Another participant noted that the harvester-reported data reflected what the DFO groundfish data had shown.

3PS COD ASSESSMENT MODEL

Presented by: D. Varkey

Abstract

Total landings for the 2018–19 management year (April 1–March 31) were 4,742 t or 79% of the TAC. This marks the tenth consecutive season that the entire TAC has not been taken.

Survey abundance and biomass estimates from the DFO RV spring survey were below average during 2016–19. Sentinel gillnet catch rates have been very low and stable since 1999. Sentinel LT catch rates have been below average for the past eight years and the 2018 catch rate was the lowest in the time series.

A new integrated state space model resulting from the 2019 3Ps cod framework was used to assess the status of the stock and estimate fishing mortality (F). This model incorporates catch

(1959–2019), time-varying M informed by trends in cod condition, and includes abundance indices from bottom trawl surveys conducted by Canada (1983–2005, 2007–19), France (1978–91), industry (Groundfish Enterprise Allocation Council [GEAC], 1998–2005), and standardized catch rate indices from the Sentinel gillnet and LT surveys (1995–2018). An advantage of the new model over the survey-based assessment (SURBA) model used previously, is the ability to estimate fishing M.

A new biomass LRP was determined for the stock based on the relationship between spawning stock biomass (SSB) and recruitment estimated from the model. The LRP is 66,000 t of SSB.

Using the new assessment model, SSB at January 1st, 2020, is estimated to be 16 kt (12–21 kt). The stock is in the Critical Zone (24% of the biomass limit reference point [B_{lim}] (18–32%) as defined by the DFO Precautionary Approach (PA) framework. The probability of being below B_{lim} is >99.9%. The new model and the revision of the basis for defining the LRP has led to a change in the perception of status of this stock. The stock is now estimated to have been below B_{lim} since the early 2000s. The estimated F rate (ages five to eight) has ranged between 0.12 and 0.21 since 2010 and in 2019 was 0.21 (0.15–0.30), with an assumed catch of 4,453 t. M was estimated to be 0.49 (0.41–0.58) (ages five to eight) in 2019. Values during the last four years are the highest in the time series. Recruitment (age two) estimates have been below the long-term average since the mid-1990s. Projection of the stock to 2022 was conducted assuming fishery removals to be within +/-30% of current levels, assuming a catch of 4,453 t for 2019, and with no catch. Under these scenarios, there is a probability >99% that the stock will remain below B_{lim} between 2020 and the beginning of 2022. The probability of stock growth to 2022 from 2019 is less than 1% across catch scenarios (+/-30% of current levels), and is 16% when there are no removals. M plays an important role in projections for this stock. If rates of M are appreciably different from those used, projected outcomes will differ from values reported above.

Bottom temperatures in 3Ps remain above normal, and the spring bloom continues to be reduced in magnitude. Zooplankton biomass in 3Ps was near-normal in 2017 and 2018 after four years of low production, with an increased proportion of smaller species. Data were unavailable from 2019. Ongoing warming trends, together with an increased dominance of warm water fishes, indicate that this ecosystem continues to experience structural changes. Reduced growth and condition indicate that cod productivity in 3Ps is reduced.

Consistency with the DFO decision-making framework incorporating the PA requires that removals from all sources must be kept at the lowest possible level until the stock clears the Critical Zone.

Discussion

Hybrid Model Updates

The beginning of the discussion focused on the catch bounds with an inquiry regarding the rationale for using the same catch bounds during the moratorium as at other times. Since the catch during the moratorium was very small (700 t), the bounds are also small during this period.

There was some discussion about widening the catch bounds in the recent period because of the recreational fishery. There was also a suggestion to check whether the model estimates of catch were ever equal to the upper catch bounds.

Another participant inquired if the lower bounds pre-moratorium had something to do with fish not being in 3Ps. The response was that due to the Canadian and French dispute over 3Ps cod in the early 1980s to early 1990s, wide catch bounds were required to account for the discrepancy between reported landings to NAFO and those finally accepted. One participant noted that during that time, 3Ps was an international fishery and involved countries other than France.

A participant asked again about the landings hitting the bounds around 1993 and 2009 and, while this did not necessarily mean it was wrong, it may be affecting the estimation of the catch and the reasoning for the bounds must be clear and justified for these two periods. The response was that if the bounds were made bigger, it means the landings data are not trusted. The bounds could be widened in 2009 because they were touching but it was stressed that the model needs some information or fitting it would become problematic, i.e., the model could be given too much room to do whatever it wants. The catch bounds and possible biases were informed through a literature review, interviews with harvesters for traditional knowledge, and information from NAFO.

Condition-Corrected M

There was some discussion about the formulation of the model, the associated units, and confusion over the presentation but these concerns were clarified. In particular, there was a suggestion that the model formulation not include an exponent, i.e., that the condition-corrected M be additive ($M = 0.3+(mpar_a *nMcy)$ compared with $M = 0.3 \exp (mpar_a *nMcy)$ where $\exp = e = 2.718$). The response was that the additive formulation (without an exponent) could result in a negative M (i.e., less than zero mortality), which is impossible.

There was also concern about the model making biological sense. A participant noted that a key component of the model was that condition was used additively on a natural log (ln) scale in the stock assessment model. Mathematically this made sense, but it was questioned if it made sense biologically in terms of the units (M versus ln M). This concern was clarified because the exponent was dimensionless, and therefore, the units on both sides of the equation were equal. The presenter also responded that condition was only an index and informed the overall estimate of M. If the condition of a given fish was below a given threshold, it was assumed that they die and this informed the M estimate. It was stressed that this was only an index of poor-conditioned fish that modified the baseline mortality.

Another participant was concerned about how variability in the condition index affected estimates of M. Specifically, if the condition-corrected natural M was small (<1), it made little difference if it was formulated on a log scale or not. At larger values, it made a big difference. It was clarified that $mpar_a$ was bounded by 1 so larger values were not possible. Further, the presenter outlined ways to determine if these values become problematic and that this approach was similar to other accepted stock assessment models (i.e., Northern Cod Assessment Model [NCAM]). The participant accepted this explanation, but the participant still questioned why there was not a complete estimate of ages in the M parameter, i.e., why were fish being grouped by ages for the condition-based approach. The response was that the decisions were based on available data for calculating these parameters and comparisons with tagging M. Specifically, for the larger fish, the 6+ ages came from 45 cm and above from tagging lengths and it was desirable to keep this analysis comparable with the tagging data being examined. There was nothing in the tagging data for ages 2–5 and that is why they were separated out.

A participant found the formulation of the condition-corrected M to be very parsimonious but sought clarification on what type of outputs would help evaluate estimates of $mpar_a$. It was noted that if the $mpar_a$ parameter was very small then condition had little influence on M, i.e., if $mpar_a$ was zero, then M = 0.3 which is the baseline. Further, it was explained how differences in $mpar_a$ influenced M. It was pointed out by the participant that estimates of $mpar_a$ were not zero which indicates its explaining some aspects of M. It was ascertained that any problems should show up in the process errors.

Another participant followed up on this concern noting that the model did not allow a baseline other than 0.3 and questioned why the baseline was not estimated in addition to the effect of condition. The response was that the baseline could not be estimated, only a sensitivity analysis on condition could be conducted. All other models evaluated at the framework were done at 0.3 and constant across all ages at all times. The only thing that could be done was a sensitivity analysis on the baseline of M, for example 0.2 or 0.4. The whole scale of the model would shift with a different M. It was because it was anchored on a baseline, and if the baseline was taken away it could not be estimated. This approach was a standard approach in fisheries assessment models.

The last part of the discussion focused on an ecological perspective from a participant highlighting that the form of the relationship between true mortality and the starvation index was not known. This parameterization was simple and efficient, but it was suggested (as a research recommendation) to investigate this further and that understanding the form of the relationship could be done with the tagging data. This participant was comfortable with this as a first step moving forward though because it was a very cautious approach. There was some general agreement with these statements.

Fishery Catchability and the Role of the Sentinel Survey

There was considerable discussion about the inclusion of the Sentinel survey in the model. Concerns were raised about the weight given to the Sentinel survey relative to its coverage compared with the RV survey, and whether this was logically consistent. Issues were also noted with model diagnostics, suggesting that the RV survey was underfitted at younger ages. Additionally, concerns were expressed about the model's recruitment estimates not fully reflecting the strength of the 2011 year class.

The primary concern was that incorporating the Sentinel survey into the model diminished the value of the RV survey, especially in relation to younger ages in recent years. The RV survey covered a broader area, had more sets, and a higher overall sample size, whereas the Sentinel survey focused only on the inshore area, had fewer sets and sites, and targeted older fish. Consequently, it was spatially limited, had a smaller sample size, and did not sample young cod effectively. It was mentioned that one reviewer at the framework meeting expressed uncertainty about using the Sentinel index for these reasons. However, the goal of the integrated stock assessment was to utilize as many robust data sources as possible. The data had been carefully considered at the Data Review and Framework meetings (excluding gillnet data), where it was decided to run the model both with and without the Sentinel survey LT data to determine which version provided the most defensible results. It was subsequently decided to retain the Sentinel survey LT data in the model because

1. the retrospective analysis improved significantly with the Sentinel survey LT data,
2. the Sentinel survey LT covered the inshore area, which the RV survey did not, and
3. the Sentinel survey LT data aligned with logbook data, providing a broader representation of the population.

In short, it was concluded at the framework that there were valid reasons to include the Sentinel survey LT data in the model, and no compelling reason to exclude it. However, it was acknowledged that the reasons for the Sentinel survey LT data influencing the model as it did were unclear and required further investigation, although it was beneficial for both retrospective analyses and projections. Discussion then focused on adjusting the weighting of the surveys based on area coverage. A participant suggested that the significant deviation from the RV survey trend since 2009 required a mechanistic understanding, questioning the Sentinel survey LT data versus the RV survey data. It was agreed that weighting the datasets was a sensible approach, but it could not be accomplished during the meeting (note that it was later decided to explore weighting; see the final paragraph for more details). The need for spatio-temporal standardization of all surveys was also highlighted as an area of active research.

In addition to the above concerns about the influence of the Sentinel survey LT on model outcomes, several specific issues were raised:

1. A participant suggested displaying the amount of process error injected into the model results. It was agreed to examine the two types of discrepancies on one graph.
2. Another participant pointed out that the survey index-at-age was primarily driven by ages three and four, where most of the biomass was observed recently. While ages three and four comprised a large portion of the abundance, they did not account for the biomass. Concerns were raised about the selectivity patterns for older-aged fish, especially in the terminal years of the model. The presenter agreed that ages two to four were underestimated in the RV survey. The inclusion of the Sentinel survey LT index caused the predicted value of the RV survey to be lower than if these data were not included. Without the Sentinel survey LT data, the RV index predictions fit the observed data much better. It was suggested that using either the Sentinel survey LT or RV survey data was a valid point for discussion and could be explored as a research recommendation.
3. A third participant raised the issue of using experimental data from a three-month period and applying it to a monthly scale, questioning whether the experimental time period had been applied correctly. It was noted that while the model runs with and without the Sentinel survey LT data had shown similar trends, the inclusion of the Sentinel survey LT data provided a more accurate fit for younger ages. The model's sensitivity to this data was acknowledged, but no solid conclusions were reached.
4. Another participant noted a conflict between the Sentinel survey LT and RV survey results. It was confirmed that the two indices showed opposite results at the end of the time series, with higher mortality rates observed recently, which was reflected in the model. The participant also questioned the spike in F-at-age before the moratorium and how it interacted with catch limits during the mid-1990s. It was suggested that this might be a model artifact due to zero landings during the moratorium. This issue was addressed in the modeling with a random walk process. Similar observations were noted in a different model for 3LNO American Plaice, indicating a common response to the moratorium.
5. Concerns were raised about the large 2011 year class, which was dominant in the fishery but did not appear strong in the RV or Sentinel surveys. It was noted that it is not uncommon for a strong year class to appear weaker in subsequent surveys.
6. An inquiry was made about providing advice based on running two models—one with and one without the Sentinel survey LT data—to offer a range of outputs and assess uncertainty. While this concept was considered sound and aligned with ensemble modeling approaches, it was not practical at present due to the need for timely advice. It was logged as a research recommendation for future exploration.
7. Another question was whether it would be beneficial to remove the GEAC and French surveys from the model. It was noted that the French survey had no effect, while the GEAC survey could potentially influence the model due to its short duration and possible competition with the RV survey. The GEAC survey would be excluded to see if it provided more weight to the RV survey. The main focus remained on the decision to include the Sentinel survey LT data.

After considering these issues, it was decided to focus on the accuracy of the retrospective analysis (using Mohen's rho) rather than solely on the model fit. The model would be reexamined after the projections were presented, and re-weighting of the surveys was also considered (see below).

Following the discussion, the assessment team took a break to make changes to the model and evaluate how weighting the two types of surveys affected the outcomes. Preliminary weighting schemes for the Sentinel survey LT were proposed, but concerns about the subjectivity of this approach were raised. It was decided that a robust weighting scheme could not be developed within the meeting's timeframe. A participant revisited the 2011 recruitment spike, noting that excluding the Sentinel survey LT data showed a different recruitment pattern (more recruits). Extensive examination of M, productivity, recruitment, and the retrospective analysis with and without the Sentinel survey LT data led to the decision to include the Sentinel survey LT data in the model. This inclusion showed the same recruitment trends, albeit with lower magnitude. Using multiple surveys and catch-at-age data to determine trends should increase confidence in the model outcomes. It was noted that before 2010, both models behaved similarly, diverging only in 2010. Including the Sentinel survey LT data allowed the model to reproduce its dynamics in recent years, suggesting the use of pre-2010 data for recruitment information in determining the LRP. Harvesters reported similar patterns in the Sentinel survey in recent years, indicating that fish were not migrating inshore. The general conclusion was to include the Sentinel survey LT data in the assessment model without forced bounding, while clearly outlining the sources of uncertainty and the work needed to address these issues.

3PS ATLANTIC COD LIMIT REFERENCE POINT

Presented by: D. Varkey

Abstract

Abstract not provided.

Discussion

The data presented showed a breakpoint and comments on the method to obtain the breakpoints were requested.

One participant requested to see the raw data (the mean tows per recruit) to see if the SSB from the model with an estimated recruitment from the RV survey showed the same pattern because all they saw was that after 2000 everything was depleted. Another participant expressed concern about this request because the whole point of using a stock assessment model is to understand the stock based on all available information, not just the raw data from the RV survey. Another participant pointed out that this was a big signal and statistical theory suggests that big signals should be picked up regardless and concluded that no matter where the breaks were, it was an unreachable target for the near future. So this participant was not in favour of doing any more analyses at this stage of the meeting. They were certain the probability of the SSB being above B_{lim} would be low. It was agreed that the 3Ps cod stock is currently in a poor state and the LRP should reflect this. Another participant pointed out that some data from the mid-1990s (1996, 1997, and 1998, timing since the moratorium) were in the Cautious Zone and we could get back at least to that point in the Cautious Zone in the near future using these break points. There was general agreement on this point. Plots were then shown, but only containing data up to 2010 of the Sentinel survey LT included and excluded. They showed no difference for the status of the stock and it was concluded that we were in a poor state and both models showed this. Attention was brought to the fact that the previous B_{lim} (50,000 t set in 1994 (moratorium period)) was well below this new provisional B_{lim}.

One participant wanted it noted that they were concerned about the Upper Stock Reference Point (USRP) and Cautious Zone being achievable even though this was not going to be established at this meeting. It was pointed out establishing an USRP was not the purpose of this meeting, and that Resource Management sets the USRP under the PA.

After this discussion, overall, there was general agreement that using this method of breakpoints to determine the LRP was a better method than eyeballing stock recruit scatter because it used an algorithm and was objective. Additionally, setting the LRP at 65,000 t was considered reasonable given the breakpoints, the data gap, and what it looks like before and after. However, a research recommendation was made to link the LRP to system productivity or environmental factors in the future because the definition of biological reference point is an ecological concept and should ideally be based on the productivity of the whole ecosystem. It was agreed to explore doing this in the future.

Projections

Most of the discussion for the trends and projections focused on clarification on what was being projected, how many years should be projected, and what years should be used to make the projections.

Participants sought clarification on how M and R were being projected forwarded and the variables used to inform these projections. It was clarified that the projections were calculated using averages, specifically sampling from the mean for the last three years with the SD from the mean and assuming normal distributions. All variables, except for maturities, in the projection (i.e., stock weights, catch weights) were for the last three years. The maturities were from the cohort-based maturity model that had the projection into the next three years until 2022. The most important assumption was that the M projected forward was the M for the last three years, which was the highest it has ever been. Because M had been really high in these years, it was part of the reason projected SSBs were lower and this assumption that the current poor conditions would continue. Various means to project M were discussed but it was pointed out that at the framework review, this approach, i.e., that average mortality for the last 3 years, would be used but other options could be explored in the future. For R, it was determined that 2015–17 (and not 2017–19) had to be used to make the projections because in the most recent years there was often a concern with the retrospective analysis and the 2017–19 year classes had not shown up in the surveys yet. However, it was noted that using 2015–17 to project R would not affect the projections much but needed to be corrected.

Another participant sought clarification on assumptions surrounding the catches for the 2019 data because not all of the data were present for the interim year and inquired whether the current year estimate was also in the projection or if an assumption would be made for this year. The response was that 2019 was also in the projection. When projecting into year one, the error is taken from the current year forward. Further clarification was sought by another participant about the interim year. It was explained that because not all data were available because (due to the timing of the assessment) there was no Sentinel survey and only partial landings and catch-at-age data available for the current calendar year. Therefore, whatever data had been received to date were augmented with data from previous years. For example, 80% of landings were reported by October, so this value would be increased by another 20% to estimate the total 2019 catch. Further, standard analyses were conducted to test this very critical assumption because there was concern about not having all the data in the projection year. From the analyses it was found that the CIs and estimates for the SSB and average F projections were slightly different, but they were within the bounds of each other. Overall, the best way forward was to include the 2019 survey. It was agreed that this was clear but would have to be in the SAR and explained.

One participant inquired about how many years the projections should be made for, stating three years are requested but given the nature of M at the current time and debate around the model, should only one year be projected. After much discussion, participants agreed that three-year projections should be provided as they are used for rebuilding plans, the high M value is not likely to change, and R is not going to make any difference in the projections. If M were to change, it could be revisited in the next years assessment.

There was much debate over what year the actual projections were for as management makes recommendations to the minister based on the fishing year which starts on March 31st, while population dynamics models all operate in a calendar year as this is how fish are actually aged. Discussion surrounded how to break up the data for the model to match the fishing year, but this was extremely complicated. The general consensus was that three-year projections would be provided to management. Specifically that the projection was to the beginning of the calendar year 2022, not the end of the calendar year 2022. This latter point needed to be fully communicated to Fisheries Management as they provide recommendations to the minister based on the fishing year, not the calendar year.

Risk Tables

A participant asked if the population would be under the new LRP for a long time. This was confirmed but it was pointed out that the stock would remain low due to the high M and high LRP; even without the high M, it would remain under the LRP for a long time. Another participant suggested that it was important to remember that the assumptions are the same for all scenarios; it was agreed that this was a good point. It was also noted that levels in the table for 2020 were informed from the 2019 estimates, i.e., the values for 2020 are based on assumptions about what would happen in 2019 and not all of the data for 2019 were available at the time of the meeting.

Clarification was sought on whether the years in the Risk Tables signified the projections at the beginning of the year (January 1st). There was some discussion on the difficulty of interpreting the tables due to differences in how science and management used the term “year”. Science uses the 1st of the calendar year while management uses March 31st of the year, and this causes problems for providing advice. It was suggested that a research recommendation be made to align science and management years. It was suggested that the current approach was adopted in 2000 to align with the fishing season because it took so long for decisions on TAC to be made using the previous way.

MODEL-BASED STOCK WEIGHTS FOR 3PS COD

Presented by: D. Varkey and D. Ings

Abstract

An overview of a presentation from the 2019 framework meeting on stock weight-at-age (Proceedings of the Newfoundland and Labrador Regional Peer Review of the 3Ps cod Stock Assessment; Oct 17–18, 2017) was provided.

Discussion

There were no comments on this presentation.

AMERICAN PLAICE ASSESSMENT

Presented by: J. Morgan

Abstract

There has been a moratorium on direct fishing of American Plaice since September of 1993. Since then, there has been only bycatch of American Plaice in other fisheries. Catch has been less than 200 t in all but one year (2017) since 2011. From the mid-1980s to 1990 there was a large decline in both biomass and abundance indices. Indices of stock size were lowest in the early-1990s. There was a general increase over the 1992–2011 period for both biomass and abundance indices with both indices varying essentially without trend since. The average abundance over the last three years is only 39% and biomass only 20% of the average from 1983–85. Ageing is not available for this stock for the last several years. Length frequencies from the survey from 2009–13 were examined for indications of recruitment in recent years. A year class can be followed from 2008 and another from 2013. Despite the appearance of these year classes, from 2008–19 there were few fish greater than 30 cm, indicating that these year classes have not survived to older ages. The surplus production model used to assess the status of the stock estimated that a Maximum Sustainable Yield (MSY) of 2,879 t can be taken from a biomass of 70,290 t at a F of 0.041. Stock size estimated from the surplus production model decreased fairly steadily from the late 1960s to a low in 1994 of less than 10% of the biomass at Maximum Sustainable Yield (B_{MSY}). Biomass increased slowly from 1994 to 2008, but has not increased since. B_{lim} for American Plaice in NAFO Subdivision 3Ps was 40% B_{MSY}. Biomass of the stock in 2019 was estimated to be 65% below B_{lim} putting the stock in the Critical Zone. The probability of being below B_{lim} is high (0.98). Current median F was estimated to be 24% of F_{lim} and the probability of being above F_{lim} (F_{MSY}) was low (0.03). The stock has shown little or no growth since 2008. Projections of stock size were conducted to the beginning of 2023 under conditions of zero catch, current F, current F plus 15%, and current F minus 15%. Although the stock was projected to grow under all scenarios, at the end of the projection period there was a high probability of being below B_{lim}, even under zero catch. There was no catch scenario which would give a high (95%) probability of stock growth. To increase the probability of stock recovery, there should be no directed fishing and bycatch should be kept to the lowest possible level.

Discussion

Model

The discussion started with an inquiry about the data that exist for aging and whether historical or length data could be used for aging. There have been no aging data since 2013; additionally, 2011 and 2012 might not be up to date. Caution should be used around using historical data and length data because warm years may influence growth and throw off age–length relationships.

A participant noted that the lack of small sizes in the early part of the time series was due to catchability and that input was a biomass index. However, the Engel and Campelen portions of the time series were separate inputs to the model with separate catchability. Total biomass and exploitable biomass were compared and were the same. It was then inquired whether a recruitment index based on age–length could be developed. This had not been pursued but could potentially be done for Campelen onwards.

A participant asked if the process error declined since 2005. Only very small trends existed; there were no large trends overall. It was then asked whether there were any plans for a SURBA model. The current model was sufficient and catch advice could be provided.

Additionally, SURBA results would be similar but over a shorter time frame and aging would be needed to develop a SURBA model.

The discussion then focused on size and maturation with an inquiry from a participant about whether American Plaice was getting smaller with earlier maturation. American Plaice was maturing at an earlier age and smaller size but age at maturity had not been updated yet. However, it was unlikely that it would have changed. A participant commented that the same trends in smaller sizes for different species/stocks were being seen. The response was age and size at maturity is heritable and natural selection could be a factor and possibly working on other species. Another participant pointed out (using a graph based on pre-COSEWIC size at maturity data) there were slight declines in both males and females since 2012.

A participant inquired whether the differences between the 2014 and 2019 result was because of different priors or because a longer time series was available in 2019 and data were updated. This was not really investigated so it was possibly a combination of both, but there was very little difference in parameter estimates between the two model runs.

A participant asked what the expectation was for this stock given global warming because American Plaice was near its range limit. The greatest abundance of American Plaice has historically been on the Grand Bank, and there are less as you go south. They are very temperature tolerant especially to low temperatures but will stop eating. No experiments have been conducted on high temperature tolerances.

There was a question about why the stock was not increasing if catches were so low. It was agreed that it was a good question as to why catches were low and that we need to understand why this stock was not recovering. Another participant asked if anything was known about competition with Thorny Skate. Nothing was known about competition with Thorny Skate, but any number of factors could be affecting recovery including competition, temperature, etc. Examining spawning time could be a research avenue to explore. No research has been done on this stock for some time because there were no resources.

The discussion then turned its focus on M. It began with a question about what M was for this stock. It was 0.2 but aging needed to be done. For this particular model, there was no M but it, along with recruitment, growth etc., was wrapped up in the intrinsic rate of population growth (r). One participant suggested that this could be a great baseline stock for developing a rebuilding plan because of the demonstrated change in productivity and asked if we could change the LRP because of the demonstrated decrease. 3Ps American Plaice was not on the list for a rebuilding plan. The LRP could be changed if r and carrying capacity (K) were split over the time series. However, it was current policy to use as long a time period as possible to develop LRPs because changes in productivity in the future could not be predicted. Another participant inquired about starvation (as presented for cod) and if it was affecting M. Condition had not been looked for this stock in a while, but would be worth exploring. The threshold for American Plaice needed to be determined. Condition is important for age at maturity and fecundity but there was no information on starving to death.

The concern was raised that something serious must be happening in 3Ps because American Plaice had not been fished in a long time and was still not recovering (and that the same was seen for lumpfish). Another participant highlighted this was not the only American Plaice stock that had not increased for unknown reasons (3LNO as well) and that why they were not surviving to bigger sizes needed to be determined. Diet was suggested as a possible reason but not enough was known about its main prey source sandlance. Obtaining sandlance data was in progress, even just getting presence/absence data. Resources were a limiting factor. It is known that American Plaice can go a long time without eating. Industry commented there were some large fish but they were not worth catching because of cost. A participant suggested examining diet data for all predators of sandlance to determine sandlance abundance.

Projections

A participant inquired whether F had changed much and if it was worth doing a projection with a higher F. The reply was that a projection was not required because F was really low. Fishing would likely not be an issue either in the future because of low prices in the fishery.

A participant then asked a management question about whether there was a bycatch cap. There was no cap in general and no bycatch, but bycatch restrictions were usually set to 250 t.

Additional Work

A general note was made that the influence of temperature on productivity was examined (R-sq = 0.11).

An overall recommendation was made that there be an Oceanography and Ecosystem RPR before assessment periods for each NAFO Division to develop ecosystem bullets. The ecosystem overview would still be presented at each assessment.

REVIEWER REPORT

Presented by: F. Zhang

This meeting, together with the Data Review and Framework for 3Ps cod, has been very important. Major decisions and changes have been made for the whole stock assessment. There are two major components to these changes. First is that there is a new stock assessment model. Some things are positive but there are some challenges. One of the positive attributes of the model is that it incorporates ecological information to derive natural M and but this into the stock assessment model. This is a novel approach and a breakthrough for stock assessments. One of the challenges is how to incorporate this information into the stock assessment model requires further research such as the functional relationship, the influence of the condition index on natural, and sources of M (i.e., predation). If this information is available, it should be integrated into the model. However, the current model is a first but very important step towards a better understanding of M.

Another challenge is the integration of different sources of information. SURBA used the RV survey while this model uses all available information which is very important. However, different surveys have different signals, often in different directions which makes stock assessment difficult-hence the lengthy debate. One spatial-temporally standardized index will be a key research priority in the future and should resolve many debates. indicating that the stock and these can indicate different thing, especially about calculating M.

Another issue was the new LRP which is a big and important change. The previous LRP was very arbitrary and surprisingly, kept for more than 10 years which is unusual. The new LRP is more scientific and has more of a biological basis which is good progress. The obvious potential problems require more research to develop some more standardized procedures about how to define the LRP which could be applied to other stocks. The procedure should make sense biologically and practically. In the stock assessment model, ecological information was incorporated. This could be important for the LRP, i.e., the productivity of the system, could be a future research direction.

The model and LRP essentially changes the numerator and denominator of the whole assessment simultaneously and this is not trivial, i.e., our perception of the stock has completely changed. However, these changes are necessary because the methodology is stronger and more logical. The Reviewer did not want to comment on social, political, and economic impacts.

Discussion

A participant asked for clarification about creating a new, single index. The reviewer responded that different survey indices have different spatial coverage and occur at different times of the year, it would be helpful to standardize the indices spatially and temporally to have one coherent index to represent the whole population. This is important for any stock with contrasting indices. This work is occurring in the Gulf Region.

There was some discussion about the utility of dynamic and stochastic reference points. It was noted that there had been efforts to calculate time-varying stock recruit relationships in an effort to have multiple reference points for different stock levels, but they could not separate the time series into two different regimes. The reviewer noted that these efforts were more like a smoother for the data and that the suggested approach (i.e., hidden Markov model) should better allow parameters to vary with different states (i.e., regimes).

RESEARCH RECOMMENDATIONS

3PS COD

- Examine the causes of the high natural mortality including predation (i.e., seals). Continue research into cod mortality and ecosystem influences.
- Conduct research on the best ways to use the survey and catch indices in the model, e.g., weighting, spatial–temporal standardization, time-varying catchability, and which age ranges are used from each index. Investigate interactions among Sentinel, RV, and other indices in the model.
- Conduct a thorough review of the Sentinel indices.
- Data requirements in terminal year.
- Explore the effects of long-term ecosystem change on cod productivity.
- Examine trophic linkages in 3Ps using available data (i.e., the stomach analysis data for Sentinel survey, RV survey data).
- Further understanding of the 3Ps stock and interaction with adjacent stocks (see previous SARs) using tagging, telemetry etc.
- Research into variation in cod maturity.
- Explore domed shape catchability for RV survey in the model.

3PS AMERICAN PLAICE

- Do different r and K values over the time series provide for better model fit.
- Update ageing data with the intent to explore other models; calculate Z from survey (when catch is low, Z ~ M).
- Influence of temperature, ecosystem productivity, competition (Thorny Skate), and prey (sandlance) on American Plaice population dynamics.
- Update length–weight analysis to explore trends in condition.

- Explore spawning time.

APPENDIX I – TERMS OF REFERENCE FOR 3PS ATLANTIC COD

Assessment of Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps Atlantic Cod

Regional Peer Review – Newfoundland and Labrador Region

November 19–22, 2019
St. John's, NL

Chairperson: Karen Dwyer
Co-Chairperson: Krista Baker

Context

The status of Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps Cod was last assessed in October 2018 (DFO 2019). The main objectives were to evaluate the status of the stock and to provide scientific advice concerning conservation outcomes related to various fishery management options.

An Assessment Framework was conducted for 3Ps Cod in October 2019 to peer-review multiple models of population dynamics.

The current assessment is requested by the Fisheries Management Branch to provide the Minister with detailed advice on the status of the stock in order to inform management decisions for the 2020–21 fishing season.

Objectives

- Provide an oceanographic and environmental overview for the stock area. If possible, this information should be integrated into the advice.
- Determine whether the population model used to provide advice for 3Ps cod includes a time-varying estimate of natural mortality.
- Determine an appropriate Limit Reference Point (LRP) for 3Ps Cod.
- Assess and report on the current status of the 3Ps cod stock. In particular, assess current spawning stock biomass (SSB) relative to baseline conservation thresholds (LRP), total biomass, exploitation rate, fishing and natural mortality, and biological characteristics (including age composition, size at age, age at maturity, and distribution). To the extent possible, describe these variables in relation to historic observations.
- Analyze recent year class strength relative to previous observations, as it relates to long-term growth and sustainability of the stock. To the extent possible, provide information on the strengths of year classes expected to enter the exploitable population in the next 1-3 years.
- Provide annual projections to 2022 of SSB relative to the LRP (with 95% CIs), assuming total removals are 1.0 times, ± 15%, and ± 30% of the 2018–19 value, and associated risk analyses.
- Identify the level of removals that provide a positive trajectory of SSB over the short to medium-term (3–5 years) with a 0.50, 0.75, and 0.95 probability.
- Highlight major sources of uncertainty in the assessment.
- Report on results of tagging and the distribution of this stock in other areas (e.g., 3L/3Pn).

Expected Publications

- Science Advisory Report

- Proceedings
- Research Document(s)

Expected Participation

- Fisheries and Oceans Canada (DFO) (Science and Fisheries Management Branches)
- French Research Institute for Exploitation of the Sea (IFREMER)
- Provincial Department of Fisheries and Land Resources
- Fishing Industry
- Academia
- Indigenous groups
- Non-government organizations

References

DFO. 2019. Stock Assessment of NAFO Subdivision 3Ps Cod. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2019/009.

APPENDIX II – TERMS OF REFERENCE FOR 3PS AMERICAN PLAICE

Assessment of Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps American Plaice

Regional Peer Review – Newfoundland and Labrador Region

November 19–22, 2019
St. John's, NL

Co-Chairs: Karen Dwyer and Krista Baker

Context

The status of Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps American plaice was last assessed in January 2014 (DFO 2014). The main objectives were to evaluate the status of the stock and to provide scientific advice concerning conservation outcomes related to various fishery management options.

The current assessment is requested by the Fisheries Management Branch to provide the Minister with detailed advice on the status of the stock in order to inform management decisions for the 2020-23 fishing seasons.

Objectives

- Provide an oceanographic and environmental overview for the stock area. If possible, this information should be integrated into the advice.
- Assess and report on the current status of the 3Ps American plaice stock. In particular, assess current biomass with respect to its Limit Reference Point (LRP).
- Analyze length frequencies to provide an indication of recent year class strength.
- Provide annual projections to 2023 of biomass relative to the LRP (with 95% CIs) under scenarios of F = 0, F current, and F current ± 15%, as a well as associated risk analyses.
- DFO's Precautionary Approach (PA) Framework indicates there is a zero tolerance for preventable decline when the stock is in the critical zone. Identify the level of removals that provide a high probability (0.95) of stock growth over the short to medium-term (3–5 years).
- Highlight major sources of uncertainty in the assessment.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document(s)

Expected Participation

- Fisheries and Oceans Canada (DFO) (Science and Fisheries Management Branches)
- French Research Institute for Exploitation of the Sea (IFREMER)
- Provincial Department of Fisheries and Land Resources
- Fishing Industry
- Academia
- Indigenous groups

- Non-government organizations

References

DFO. 2018. Stock Assessment of NAFO Subdivision 3Ps Cod. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2017/051.

APPENDIX III – AGENDA

Assessment of Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps Atlantic Cod (*Gadus morhua*) and Subdivision 3Ps American Plaice (*Hippoglossoides platessoides*)

Chairperson: Karen Dwyer
Co-Chairperson: Krista Baker
Editors: Jennica Seiden and Keith Lewis

November 19–22, 2019

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

Tuesday, November 19

Time	Topic	Presenter
09:00	Opening remarks and overview of Regional Peer Review Process	*K. Dwyer*
-	Environmental and Oceanographic Update	*G. Maillet*
-	Fish community trends (Atlantic Cod and American Plaice)	*H. Munro*
-	Review of 2018/2019 fishing season and 2019/2020 season to date (Atlantic Cod)	*S. Dwyer*
-	Sentinel program (Atlantic Cod)	*L. Mello*
-	Catch • Total landings • Catch at age	*D. Ings*
-	Logbook data, catch rate index	*D. Ings*
-	Observer data	*D. Ings*
-	Survey • Distribution • Biomass/Abundance updates • Age composition, size at age (length, weight, and condition), age at maturity	*D. Ings*
-	HYBRID Model Updates and Discussion	*D. Varkey*

Wednesday, November 20

Time	Topic	Presenter
09:00	3Ps Atlantic Cod Population Dynamics – Model Results	*D. Varkey*
-	3Ps Atlantic Cod Limit Reference Point (LRP)	*D. Varkey*
-	Tagging Update	*G. Robertson*
-	3Ps Atlantic Cod Assessment	*D. Ings*
-	External Reviewer Comments (3Ps Atlantic Cod)	*F. Zangh*
-	Drafting of Atlantic Cod SAR/Summary Bullets	*All*
-	Drafting of Atlantic Cod Research Recommendations	*All*

Thursday, November 21

Time	Topic	Presenter
09:00	American Plaice assessment	J. Morgan
-	Drafting of American Plaice Summary Bullets	*All*
-	Drafting of American Plaice Research Recommendations	*All*

Friday, November 22 (if necessary)

Time	Topic	Presenter
09:00	Final Review of Summary Bullets (Atlantic Cod and American Plaice)	*All*
-	Final Review of Research Recommendations (Atlantic Cod and American Plaice)	*All*
-	Discussion of Res Doc and SAR Document Outputs.	*All*
-	Closing Remarks and *ADJOURN*	*K. Dwyer*

Notes:

- Health breaks will occur at 10:30 a.m. and 2:30 p.m. Coffee and tea can be purchased from the cafeteria.
- Lunch (not provided) will normally occur 12:00-1:00 p.m.
- Agenda remains fluid – breaks to be determined as meeting progresses.
- This agenda may change.

APPENDIX IV – LIST OF PARTICIPANTS

3Ps Atlantic Cod Assessment – November 19–22, 2019

NAME	AFFILIATION
Brandon Ward	NL Gov – Fisheries and Land Resources
Brian Careen	Harvester
Brian Healey	DFO Science
Brittany Keough	DFO Science – Centre for Science Advice
Carolyn Miri	DFO Science
Chelsey Karbowski	Oceans North
Clayton Moultan	Harvester
Dale Richards	DFO CSA Office
Dan Baker	Harvester
Danny Ings	DFO Science
Devan Archibald	Oceana
Divya Varkey	DFO Science
Erin Carruthers	FFAW
Eugene Lee	DFO Science – Centre for Science Advice
Fan Zhang	MI
Gary Maillet	DFO Science
Geoff Evans	DFO Science – Emeritus
Greg Robertson	DFO Science
Hannah Munro	DFO Science
James Baird	NLGIDC
Jennica Seiden	DFO Science – Groundfish
Joanne Morgan	DFO Science
Joel Vigneau	IFREMER
Jonathan Babyn	DFO Science
Juliette Champagnat	IFREMER
Karen Dwyer	DFO Science
Keith Lewis	DFO Science
Kris Vascotto	AGC
Krista Baker	DFO Science
Krista Tucker	DFO Science

NAME	AFFILIATION
Laura Wheeland	DFO Science
Luiz Mello	DFO Science
Paul Regular	DFO Science
Rajeev Kumar	DFO Science
Roanne Collins	DFO Science
Shelley Dwyer	DFO Resource Management

3Ps American Plaice Assessment – November 22, 2019

NAME	AFFILIATION
Brandon Ward	NL Gov – Fisheries and Land Resources
Brian Careen	Harvester
Brittany Keough	DFO Science – Centre for Science Advice
Carolyn Miri	DFO Science
Clayton Moultan	Harvester
Dan Baker	Harvester
Danny Ings	DFO Science
Devan Archibald	Oceana
Eugene Lee	DFO Science – Centre for Science Advice
Fan Zhang	MI
Gary Maillet	DFO Science
Greg Robertson	DFO Science
Hannah Munro	DFO Science
Joanne Morgan	DFO Science
Joel Vigneau	IFREMER
Juliette Champagnat	IFREMER
Justin Strong	FFAW
Karen Dwyer	DFO Science
Kris Vascotto	AGC
Krista Baker	DFO Science
Laura Wheeland	DFO Science
Paul Regular	DFO Science
Shelley Dwyer	DFO Resource Management