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Proceedings of the Newfoundland and Labrador Regional Peer Review of the 3Ps Cod and White Hake Stock Assessments

October 20-22, 2015

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Rapporteur : Carissa Currie

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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 meeting of the Newfoundland and Labrador Regional Peer Review Process was held October 20-22, 2015, in St. John's, Newfoundland and Labrador, to assess the stock status of Atlantic Cod (*Gadus morhua*) and White Hake (*Urophycis tenuis*) in Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps. This proceedings report includes an abstract and summary of discussion for each presentation, and a list of recommendations. The meeting's terms of reference, agenda, and list of attendees are appended.

Participants at the meeting included staff from Fisheries and Oceans Canada (DFO) Science and Fisheries Management, and representatives from the Newfoundland and Labrador Department of Fisheries and Aquaculture, Memorial University of Newfoundland, and the fishing industry.

In addition to these proceedings, publications to be produced from the meeting include a Science Advisory Report and a comprehensive Research Document for each species, all to be available online on the DFO Canadian Science Advisory Secretariat Website.

Compte rendu de la réunion d'examen régional par les pairs sur la morue franche et la merluche blanche dans la sous-division 3Ps de l'OPANO, région de Terre-Neuve-et-Labrador (2015)

SOMMAIRE

Une réunion du processus d'examen par les pairs de la région de Terre-Neuve-et-Labrador a eu lieu du 20 au 22 octobre 2015 à St. John's (Terre-Neuve-et-Labrador) pour évaluer l'état du stock de morue franche (*Gadus morhua*) et de merluche blanche (*Urophycis tenuis*) dans la sous-division 3Ps de l'Organisation des pêches de l'Atlantique Nord-Ouest (OPANO). Le présent compte rendu comprend un résumé et un sommaire des discussions liées à chaque présentation de même qu'une liste des recommandations. Le cadre de référence, l'ordre du jour et la liste des participants de la réunion sont joints.

Parmi les participants à la réunion, on retrouve des membres du personnel des secteurs des Sciences et de la Gestion des pêches du MPO, ainsi que des représentants du ministère des Pêches et de l'Aquaculture de Terre-Neuve-et-Labrador, de l'Université Memorial à Terre-Neuve-et-Labrador et de l'industrie des pêches.

En plus du présent compte rendu, les publications à produire émanant de la réunion incluent un avis scientifique et un document de recherche exhaustif pour chaque espèce, qui seront tous disponibles en ligne sur le site Web du Secrétariat canadien de consultation scientifique de Pêches et Océans Canada.

INTRODUCTION

The status of Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps Cod was last assessed in October 2014 (DFO 2015). 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 was requested by Fisheries Management to provide the Minister with detailed advice on the status of the stock in order to inform management decisions for the 2016 fishing season.

The status of the White Hake stock in NAFO Subdivision 3Ps was last assessed in 2002 (DFO 2002). The current assessment was requested by Fisheries Management to provide the Minister with advice that will inform management decisions for the 2016 fishing season.

PRESENTATIONS – 3PS COD

PHYSICAL OCEANOGRAPHIC CONDITIONS IN NAFO SUBDIVISION 3PS DURING SPRING 2015 - POTENTIAL INFLUENCES ON ATLANTIC COD

Presenter: E. Colbourne

Abstract

Oceanographic data from NAFO Subdivision 3Ps during the spring of 2015 are examined and compared to previous years and the long-term (1981-2010) average. Sub-zero^{o}C surface water was more widespread during the spring of 2014 and 2015 covering much of Atlantic Canada as far south as Halifax. In the 3Ps region in particular, the surface sea temperature (SST) decreased to 0.8^{o}C below normal values during the spring of 2015.

The average bottom temperature in the 3Ps area is about 2.5 ± 0.44 ^{o}C. Since 2008, bottom temperatures have been increasing, reaching 1.8 standard deviations (SD) above normal at 3.3^{o}C in 2011-12 before decreasing to 1 SD above normal at about 3^{o}C in 2013-15. In the shallower areas, which are influenced by the inshore Labrador Current including St. Pierre Bank, parts of Burgeo Bank and areas to the east, temperatures show a high degree of inter-annual variability with an average of 0.3 ± 0.73^{o}C. In cold years average bottom temperatures are often sub-zero with values increasing since 2008 reaching 1.9 SD above normal in 2011 at 1.7^{o}C. Since then bottom temperatures have decreased to about 1 SD above normal in 2012-13 and to about normal in 2014-15. Bottom temperatures in deeper water of the Laurentian and Hermitage Channels show positive (up to + 2^{o}C) anomalies with temperature values > 6^{o}C in some areas. Deeper slope waters on southeastern St. Pierre Bank were exceptionally warm during the past 4 years with values reaching 7^{o}C-10^{o}C.

The extent of < 0^{o}C water covering the bottom of St. Pierre and Green Banks in the 3Ps region decreased to near-zero in 2010-13 but increased to near 30% in 2015. The areal extent of bottom water in 3Ps with temperatures > 3^{o}C has increased by about 15% from the low of 35% in 1990 covering about 50% of the total survey bottom area.

Variations in the abundance of cod from the Resarch Vessel (RV) surveys in strata directly influenced by Labrador Current shelf water appear to be correlated with bottom temperature (r = 0.6) indicating a potential climate effect on cod distribution in these areas. The distribution plots show a high number of zero survey catches in < 0^{o}C water on St. Pierre Bank and regions to the east of the bank, mainly from 1985 to 1998 but also from 2001 to 2003. During 1999 and 2000 and in more recent years, larger catches became more widespread over St. Pierre Bank as cold (< 0^{o}C) water receded from the area.

Discussion

There was some discussion regarding the oceanographic environment having an overall warming trend as, although this is the case, during the last couple of years (2014-15) bottom temperatures have been around average. It was discussed how the Labrador Current and North Atlantic Oscillation (NAO) could be influencing the bottom temperatures and clarified that the influence of these two factors is mainly observed in shallow waters and in the upper water column. Discussions considered whether predictions could be made about the environmental temperature trends in the area. As it stands, the NAO is very unpredictable and there is no way to tell what will happen in the future.

UPDATE ON COD SENTINEL SURVEY RESULTS IN NAFO SUBDIVISION 3PS FOR 2014 AND 2015

Presenter: D. Maddock Parsons

Abstract

Unstandardized catch rates for Sentinel Surveys in NAFO Subdivision 3Ps were updated for 2014 and preliminary results were given for 2015. Gillnet catch rates (weekly average number of fish per net) in the most recent years remained low compared to 1996-98 catch rates. Catch rates in small mesh gillnet remained low. Length frequencies of cod caught in small mesh gillnet showed fewer fish at the larger of the two size modes (36-44 cm and 52-56 cm) that this gear catches, since 2000. Linetrawl catch rates (weekly average number of fish per 1,000 hooks) increased from 2000 to 2006, and showed an increase in the number of fish at the 44-54 cm size range from 2002 to 2004. Linetrawl catch rates decreased from 1996 to 1999 and remained lower than the series average until 2006, when catch rates increased. Since then, catch rates in linetrawl have shown a decline and have been below the series mean for the last six years.

Trends in liver and gutted body condition show a seasonal cycle, with condition declining over the winter and early spring, and increasing again over the summer once spawning occurs. Annually, trends in condition have varied over the time series, but in general, have declined from 2004-14. Both length and weight at age have declined in fish age 6 and older since the early part of the time series.

Standardized Sentinel Catch Rates

Sentinel catch rates were also standardized and modeled to account for seasonal and site effects. These standardized catch rates were presented for gillnet and linetrawl control locations. Age aggregated catch rates from sentinel surveys were higher in the early part of the time series for both gillnet and linetrawl, declined over the mid to late 1990s and have remained lower since then. In 2014, both linetrawl and gillnet standardized catch rates were below the series average. In the age dis-aggregated standardized catch rate series, cohorts produced in recent years have been weaker than stronger cohorts in the past (1989, 1997-98 in particular).

Discussion

Industry asked specifically about fish condition in Placentia Bay but as two-thirds of the fish caught come from the line trawl from the western portion of the inshore, making overarching conclusions is challenging for a broad area such as Placentia Bay.

Discussion ensued on whether this index is an appropriate representation of the inshore area. The survey is based on fishermen collecting for DFO so it seems to be a good representation of where the resource is being fished. Industry noted that they are willing to provide more samples if needed in this survey. The proportion of fish sampled is variable so the representation of

sample size and fish size should be taken into consideration. Observations to date in 2015 suggest that there are smaller fish being found in the survey but these are preliminary so caution must be taken when discussing these results.

ECOSYSTEM OVERVIEW: TRENDS IN THE FISH COMMUNITY IN NAFO SUBDIVISION 3PS

Mariano Koen-Alonso, Nadine Wells, Denise Holloway, and Jennifer Mercer

Presenter: M. Koen-Alonso

Abstract

The structure and trends in the fish community of NAFO Subdivision 3Ps were analyzed on the basis of RV biomass, abundance, and biomass/abundance (BA ratio) indices derived from DFO winter and spring surveys in the 1982-2015 period. These analyses involved the characterization of the community by fish functional groups which, for the most part, are defined considering the species size and general trophic characteristics. These functional groups are small, medium, and large benthivores, piscivores, plankpiscivores, planktivores, and shellfish (this last group only includes commercial shellfish species, like *Pandalus* shrimps and Snow Crab). Reliable data on shellfish are only available since 1996, when the fishing gear used in the survey was changed from an Engels to a Campelen trawl. Since there are no conversion factors available for all species, many analyses were carried out partitioning the times series into Engels (1982-95) and Campelen (1996-2015) periods.

Changes in total biomass and internal structure of the fish community were described on the basis of trends over time, and analyzed using Bray-Curtis similarity matrices from standardized and non-standardized RV biomass data. Analyses from non-standardized data allow the consideration of differences in magnitude, while those from standardized data allow a focus on internal structure of the fish community. Hierarchical agglomerative cluster analyses, together with Similarity Profile permutation tests were used to identify significant clusters of years within the Engels and Campelen periods. Changes in abundance were described considering the trends over time by fish functional groups, while the changes in fish sizes were evaluated using normalized anomalies of BA ratios by functional group.

Food consumption by the fish community was explored using a suite of approaches aimed at estimating food requirements and/or average consumption rates [per unit of biomass] for different taxa. A total of eight different consumption sets were defined considering different combinations of consumption models (daily ration and simple allometric models). All these models assume that consumers actually met their expected annual requirements, which could overestimate consumption, but also the expansion of consumption to the population/stock level is based on RV biomass estimates without catchability corrections, which may lead to underestimating consumption. Overall, these approaches considered together are not expected to provide a fine tuned estimate of consumption; instead, the goal is to produce a reasonable envelope for the order of magnitude of food consumption by the fish community.

Diet composition was studied using stomach content analyses from samples collected during DFO RV surveys. Diet studies focused on key fish species, including Atlantic cod. Other related information like the frequency of empty stomachs, and the meal size (approximated by the weight of the food remains in the stomach), were also examined.

Despite the issues associated with changes in timing of the survey (i.e. winter and spring), it is clear that the overall biomass of the fish community increased in the early 1980s, and later declined in the late 1980s and early 1990s. This decline also involved changes in the structure

of the fish community, and a general reduction in fish size. Results from the cluster analysis of the 1982-95 period indicate that the changes in community structure have a coherent temporal sequence, where significant clusters typically aggregate consistent periods of time (i.e. consecutive years).

Since the mid-1990s, the overall biomass of the fish community has not changed significantly, but abundance has. Overall abundance increased until 2013, and declined afterwards. These changes in abundance have been mainly driven by planktivores, and to a lesser extent plankpiscivores in the late 2000s.

Notwithstanding the relative stability of the overall biomass level during the Campelen period (1996-2015), the biomass structure of the fish community has changed during this time. These changes have involved increases/decreases in biomass at the functional group level, but unlike earlier observations, the overall pattern of change in structure does not seem to follow any obvious temporal sequence. Still, trends among some functional groups are significantly correlated (e.g. small benthivores and shellfish are positively correlated, medium and large benthivores are also positively correlated). During this period, fish size (BA Ratio) also showed a further decline in the mid-2000s, and remains at that lower level to this day.

Recent changes include clear declines in biomass in small benthivores, planktivores, and shellfish over the last five years. Piscivores show a relatively stable overall biomass level, but experienced important changes in internal structure. Cod used to be the exclusive dominant species within this functional group, but silver hake has increased its dominance, and currently shows biomass levels similar to cod.

Taking into account all these changes together, it seems that the fish community in 3Ps shows evidence of some level of internal structure and coherence, but it also shows signs of lessening in that internal cohesion in the most recent period. The noisier patterns in recent years could be linked to increasing import/export processes and/or increased variability in these fluxes. Therefore, and in terms of ecosystem identity, the marine community in NAFO Subdivision 3Ps possesses enough elements to characterize it as a functional ecosystem, but one that is heavily influenced by neighboring systems (Grand Bank, Gulf of St. Lawrence, and Scotian Shelf).

Regarding the order of magnitude of consumption, the fish community in 3Ps is estimated to consume food in the range of 1-3 million tonnes per year. Within this envelope, piscivores are estimated to eat in the order of 200-800 thousand tonnes per year.

Cod diet in the spring of 2015 continues to be dominated by Snow Crab, with sandlance as the second most important prey. Predation on Snow Crab is more important in larger cod. Although time series of cod diet data in 3Ps are far from complete, the available evidence indicates that cod has a very variable diet in this region. This suggests that food availability may be highly variable, and potentially limiting.

In the 2013-15 period, other predators like American Plaice, turbot, and Yellowtail Flounder had sandlance as a dominant prey; capelin was also an important prey in some of these predators. None of them preyed upon Snow Crab to the same degree as cod.

When comparing 3Ps with neighboring 3O for cod and other predators, it seems clear that, although variable, sandlance is an important prey in the broader area, while the high reliance of cod on Snow Crab appears as a 3Ps-specific phenomenon.

Examination of meal sizes and frequency of empty stomachs indicate that current meal sizes are of similar or larger magnitude than the ones observed in the 1980s prior to the 1990s decline, while the frequency of empty stomachs is also low. Meal sizes were clearly smaller, and the frequency of empty stomachs much larger, during the mid-1990s. These observations

suggest that availability of any food type may have been a factor in the early 1990s decline. Current status appears to be more likely related to food quality, although availability of higher quality food may also be at play.

In comparative terms, cod meal sizes are smaller in 3Ps than in the neighboring 3LNO ecosystem. This observation gives credence to the interpretation that the variability in 3Ps cod diet could be associated with potential constraints in prey availability.

In summary, the 3Ps fish community can be considered a reasonably defined ecosystem functional unit, but it also appears susceptible to external influences. Ongoing warming trends, together with the increasing dominance of warm water species, recent declines in planktivores, and the reduced fish sizes across fish functional groups suggest that this ecosystem is undergoing structural changes, and potentially experiencing reduced productivity conditions. Although complete understanding of these changes, and their full implications for piscivores like cod and white hake, are still lacking, the available evidence suggests that current productivity may be reduced. In this context, it would be strongly advisable to exercise higher than usual risk-aversion in the management of these stocks.

Discussion

The last statement above generated some discussion It was explained that the ecosystem has changed its structure in recent years, including factors such as declines in fish size, increases in sandlance, and ocean warming. It was commented that cod diet is now composed of junk food species such as Snow Crab that are not rich in nutritional value. All these factors suggest a food limited environment.

It was asked what time period cod are feeding on Snow Crab and if the crab are abundant or scarce. The stomachs analyzed came from the spring survey and the abundance of Snow Crab depends on the area being fished. It was noted that a spring diet may not be representative of the whole year and fall stomach analysis could provide an alternative look at condition as the cod are adding up energy reserves for the following year.

There was discussion regarding the northward movement of Silver Hake and that 3Ps is the first area where Silver Hake/ cod distribution changes would be observed. It was stated that cod do not eat Silver Hake, however, it is unknown whether Silver Hake eat young cod. It was noted that cod and Silver Hake do not seem to overlap in the water column as they occupy different depths.

A question on the purpose of the correlation analysis was raised, and whether examination of lagged correlation would be more appropriate in order to search potential signals between the species groupings. The presenter responded that the work was an initial attempt to explore potential correlations and that lagged correlation would be considered in future.

Questions were raised about the number of empty guts and the size of the meals being found in the cod stomachs. It seems that there is more of a quality issue taking place in the diet rather than a quantity issue, as they prey upon numerous species. The amount of empty stomachs observed seems to be less than in past years.

REVIEW OF 2014/15 COD FISHING SEASON AND 2015/16 SEASON TO DATE

Presenter: D. Coffin

Abstract

An overview of the 3Ps cod fishery was provided. The summary included:

- the Total Allowable Catch (TAC);
- the fleet allocations;
- the individual quotas by management area;
- the Canadian catch; and
- the percentage taken by both the inshore and offshore fleets over the previous three years.

The management measures including; the small fish protocol, gear requirements, monitoring requirements, and seasonal closures were summarized. The presentation outlined the changes in the number of licenses issued, and the number active participants in recent years.

Discussion

Comments were made that the quota has not been taken because of market buyer issues and some fisherman say the cod are not in the area they are fishing. Industry said the fish seem to be in good condition but are scarce, and commented that the cod might not have come inshore due to low abundance of capelin.

CATCH AND SURVEY TRENDS FOR 3PS COD

Presenters: R. Rideout/ D. Ings

Abstract

The TAC for 3Ps cod was set at 11,500 t for five consecutive management years (2009-10 to 2013-14) before increasing to 13,225 t for the 2014-15 management year and 13,490 t for the 2015-16 management year. Reported combined landings by Canada and France have been substantially below the TAC since the 2009-10 season. During the 2014-15 season, approximately half (54%) of the 13,225 t TAC was landed. Of the 7,166 t landed during the 2014-15 season, 5,613 t was taken by Canada (including 13 t from sentinel surveys), and 1,553 t was landed by France.

Commercial logbook data (< 35' sector) suggest that gillnet catch rates have been low and stable since 2000. Linetrawl catch rates have shown more temporal variability but have been stable around the time series average since 2009. Total catches reported in these logbooks accounted for only 42% of the catch taken by this sector of the fishery in 2014. Data from the > 35' vessels were examined for spatial and temporal patterns. For all three gears (otter trawl, gillnet and linetrawl), there was substantial spatial concentration in landings and a reduction in the number of areas reporting high landings over the time-series.

The DFO RV survey covers most of the stock distribution, and survey trends are considered to broadly reflect stock trends. Survey biomass estimates for most of the post-moratorium period up to 2004 were higher than those of the early 1990s, but not as high as those of the 1980s. Biomass estimates in recent years have generally been low, with six of the last nine years being below the 1997-2015 average. Survey catches in 2015 were highest in the Halibut Channel, except for one unusually high survey catch on Burgeo Bank. Survey abundance estimates were

low during the 2000s but have increased somewhat in recent years with six of the last seven years being at or above average. In particular, the 2013 estimate was very high but characterized by a high degree of uncertainty.

Discussion

It was asked if the model being used to estimate catch per unit effort from logbooks is similar to the one used in the Sentinel survey. The models are different: the sentinel model uses number of fish while this one uses fish weight.

It was commented that the change in spatial distribution should be addressed to determine the change in catch and if it has changed by a significant amount.

It was noted that the mortality value (z) seems very high for this stock and it was questioned why this is the case. It was stated that the fishery is only catching 50% of the TAC, and concern was expressed about what would result if 100% was caught considering this high mortality.

It was noted that surveys are catching a lot of younger fish (although the gear is less selective for smaller sizes/younger ages) and the short to medium term prospects of the stock depend on these recruits. In 2006 there was an abundance of younger fish but this did not carry over into older ages. Whether this is due to the high mortality, some kind of stressor in the environment or gear selectivity is still unknown. It was noted that this is occurring with other fish species (other than cod) as well.

There was concern that the feeding condition of the cod may be leading to low productivity and reduced growth of the stock.

It was commented that the survey results are at odds with the harvesters' observations and maybe the SURBA inputs should be re-visited in order to account for the age effects. It was suggested to look at cohort strength over a lifetime to try to distinguish between cohorts in order to determine initial numbers and then how fast they disappeared/ died. There was some discussion regarding the value of this exercise and whether it should be a research recommendation for the 2016 assessment.

SURVEY BASED ANALYSIS (SURBA) FOR 3PS COD

Presenter: B. Healey

Abstract

Recent assessments of 3Ps cod have applied cohort models to age-disaggregated results from DFO RV surveys. The model (Cadigan 2010) assumes that total mortality can be decomposed into an age and year effects. Assumptions about survey selectivity are required to relate survey observations to the model estimates. This model applies a 'flat-top' assumption (i.e. fish equally selected above a given age).

Stock size was estimated using survey data from 1983-2015 and results indicate the spawning stock biomass (SSB) has declined since 2012 and is currently estimated to be 41% above the Limit Reference Point (LRP; $B_{Recovery}$ = SSB1994). The stock is therefore in the Cautious Zone of the DFO Precautionary Approach (PA) Framework. The probability of being below the LRP in 2015 is low (p = 0.05). Concern is expressed that there are few older fish in the SSB. Recruitment has improved over the last decade with most cohorts at or above the time-series (1983-2014) average. In particular, indications are that the 2011 and 2012 cohorts are strong. Estimated total mortality has generally been increasing since 1997 to near the time-series

maximum. Over 2012-14, it averaged 0.65 (48% annual mortality), which is high especially considering that reported landings have been about half of the TACs over this time period.

As a result of improved recruitment and recent increases in the proportion mature-at-age, 82% of the 2015 SSB is comprised of fish of ages 4-7. The reliance on young spawners may be a concern given that younger fish produce fewer and smaller eggs/larvae that may have reduced survival.

Year-effects are evident in the SURBA residuals, consistent with the large inter-annual changes in survey estimates. In particular, most of the 2014 and 2015 residuals are negative (predicted values exceed observed), contrasted with 2013 results, where all but one residual value is positive. Accordingly, there is some retrospective pattern in the current assessment, notably in total mortality and spawner biomass. The estimated mortality patterns over the recent period has changed, with mortality now increasing while at a relatively high level, compared to a stable and decreasing trends in mortality estimated in the previous two assessments. In the present assessment, the estimated spawner biomass in 2014 has been revised downwards (1.6 x Blim in 2014 assessment compared to 1.4 x Blim in the current assessment). These changes are due to both changes in the mortality estimates as well as new biological parameters used to compute the spawning biomass.

Projection of stock numbers to 2016 was undertaken, with projection inputs taken as recent averages. Five projection scenarios were considered, with total mortality over 2015-17 fixed constant at one of: 80%, 90%, 100%, 110% and 120% of current values (defined as most recent three year average, i.e. 2012-14). Projection results indicate that the 2016 SSB increases in all cases (ranging from 23-46% above the 2015 estimate) but remains within the Cautious Zone. These increases are driven by the relatively abundant 2011 year-class. In each projection scenario, 2011 year-class (YC) is at least 50% of 2016 SSB, which is an atypical composition of the mature population.

Discussion

Concern was raised as to how SURBA handles a large tow from the survey and that the ages of that tow might be over represented. It was noted that the survey indices are computed using standard methods and this is not robust to large-set outliers. The population model is not informed by the individual tows but the overall survey index at age.

It was suggested that mortality values (z) should be re-visited as they may be too low currently, resulting in estimates of recruitment that are too high.

The increase in SSB in the model is to be considered with caution as there are a lot of young fish and it is the largest jump in SSB seen in the time series.

COD TAGGING UPDATE

Presenter: J. Brattey

Abstract

Cod tagging in NAFO Subdivision 3Ps was continued through to 2015. During 2008-11 tagging coverage was restricted to Placentia Bay (3Psc); however, coverage was expanded to include Fortune Bay (3Psb) in 2012-14 and Hermitage Bay (3Psa) in 2013. Total numbers of tagged cod released have increased from 963 in 2011 to ≥ 3,900 in 2013. Annual exploitation rates (= % harvested) were estimated for the inshore region (3Psa, 3Psb, 3Psc) and for various size groups of cod, based on recaptures of cod released within the preceding two years. Cod released within six weeks of the fishery opening or during the current fishing season were not

used to estimate harvest rates. The numbers of tags returned were adjusted by annual estimates of tag reporting rate based on a high-reward tagging study. The single tag reporting rate for the inshore of 3Ps during 2014 was 0.70 and averaged 0.77 during 1997-2014. The numbers of tagged cod available for capture at the time of the fishery each year was estimated after accounting for initial tagging mortality, tag loss, assumed natural mortality (M = 0.2), and recaptures in preceding years adjusted by the tag reporting rate. The estimates are influenced by the sizes of cod tagged due to selectivity of commercial fishing gear and larger cod (> 60 cm) tend to be more readily selected by gillnets than smaller ones; estimates for 2014 were similar to those for 2013 and ranged from 10% to 16% depending on cod size groups. The harvest rates for 2014 based on cod > 60 cm at tagging were 14% and 15% in 3Psb and 3Psc, respectively. Only 54% (approx.) of the TAC was taken in 2014; if the full TAC was taken harvest rates would have approximately doubled given that most of the unharvested TAC was available to the inshore sector. Only 2.7% (of 566 recaptures since 2011) from cod tagged in Placentia Bay were recaptured in 3KL. Tagging in the western portion of the inshore (3Psa) indicated considerable movement between 3Pn and the extreme west of 3Psa, whereas cod tagged further east in Hermitage Bay tended to move eastward into Fortune Bay. Recent tagging suggests exploitation of 3Ps cod in neighbouring stock areas (3KL/3Pn) is not a major issue for management. Overall the tagging indicates extensive movement between coastal areas among 3Ps cod tagged inshore, but more limited offshore movement.

Discussion

Many comments focussed on where tagging took place and if it was in the fishing industry's specific area. It was asked if any tagging had been done on Burgeo Bank and St. Pierre Bank, and if so, were fish caught in Fortune Bay or Placentia Bay? There has not been any tagging offshore in recent years but in the past there was some in the Halibut Channel, with many recaptures in Placentia Bay but very few in Fortune Bay or the western portion of the inshore.

It was asked what the literature suggests about exchange between 3Ps and 4R (Gulf) stocks and how the data is handled when a large catch is encountered. If there is a large survey catch in 3Ps (Burgeo Bank) DFO would look at the age structure to see if there is evidence of a strong year class. DFO would also look at data from the Gulf Region's assessment to see if it is also strong there. If not, that indicates cod are from the 3Ps stock but if similar, there is more uncertainty as the likelihood of mixing between these stocks is higher.

It was asked why so few fish were tagged in 2015 and the response was the overall lack of resources. It was commented that 2015 was a very poor year for fish in Placentia Bay which normally has a good fishery, especially in the Western portion of the Bay.

Comments were raised that mortality could be calculated from the tagging data but this would be challenging. Based on the tagging data, there is a 10-15% exploitation rate. However, as only about half the TAC has been taken in recent years the take home message is that there is a small exploitable biomass of 3Ps cod. It was noted that the exploitation rate is based only on the inshore component of the stock, not the 3Ps stock as a whole.

A harvester asked if any of the fish tagged in Placentia Bay were caught in 3L, and what percent of tags from 3Ps are going into 3L. Only 2.7% of the recaptures came from 3L. It was also asked if any of the tags from Bay Bulls are being caught in 3Ps, specifically in Placentia Bay. The response was that they are, and probably a higher percentage than in the other direction but this makes sense as there is a larger fishery there.

It was asked if inshore tags are being caught in offshore areas. Some are but the extent is unknown at this point. It was also asked if the dragger fleet catch fish in the offshore winter

fishery. There are not many recaptures but some tags from Placentia Bay and Petty Harbour and Bay Bulls were taken from overwintering fish aggregations in the Halibut Channel.

COD SPAWNING TIMES IN RELATION TO 3PS SPAWNING CLOSURE

Presenter: R. Rideout

Abstract

A seasonal closure of the entire 3Ps stock area (typically March 1 to mid-May) occurs annually and is intended to prevent fishing during the cod spawning season. Fishing was permitted in March, 2014 and 2015 to provide harvesters with increased flexibility in accessing the resource. At least some harvesters believed the time of spawning to be delayed in recent years and that the timing of the closure might therefore be inappropriate. In 2015, fish collected from the Halibut Channel area (Southern 3Ps) by industry in March and from the DFO multispecies survey in April-May were examined in detail in order to evaluate their reproductive status. Results suggested that fish in this region did not spawn in March in 2015 but some individuals were late in the development process and likely near the start of spawning. Data and biological samples from the 2015 DFO Survey (April/May) suggested spawning began sometime in April/early May. Modelling of the day at which 50% of female fish in the survey data were spent (D50) demonstrated annual variability in spawning time but no trend toward later spawning in recent years. It is important to note that these results apply to a specific area in a specific year and that decisions regarding spawning closure times should consider the potential for spatial and interannual differences in spawning time

Discussion

Industry asked if the cod that were assessed as spawning were in spawning aggregations and undergoing vertical migrations in the water column (a common characteristic of fish actively spawning) as there were concerns that they might have escaped the gear. This was not a concern due to the evidence of spawning biological characteristics that last for weeks in cod.

It was asked to what extent skipped spawning was observed. There is a substantial amount of skipped spawning occurring in 3Ps and this is a concern, as skipped spawning is generally linked to energetic challenges. Studies have been conducted in the past to investigate skipped spawners and energetics, but none in recent years so it might be useful re-visit the proportion of skipped spawners.

There is concern from some in industry that because cod aggregate to spawn and they may be more vulnerable, they want to avoid the spawning aggregations and therefore the closure should be investigated in more detail. This will be assessed at a later date. However, some industry representatives would like to continue the spawning study as there has not been a lot of data collected; the small amount of data is due to the low fishing effort.

The goal of this study was to determine if fish are spawning in March. The peak spawning time was not determined and more/ longer periods of spawning data were recommended.

HARVEST CONTROL RULE THROUGH SIMULATION FOR 3PS COD

Presenter: P. Shelton

Abstract

In 2014, in keeping with the DFO Sustainable Fisheries Framework (SFF) and Decision Making Framework (DMF) policies of 2009, DFO adopted a Conservation Plan and Rebuilding Strategy

(CPRS) for rebuilding and sustainably managing 3Ps cod. The CPRS was applied to "inform" Canada's position at the bilateral meeting with France in the setting of the 2015 TAC and it is anticipated that it will again be applied in this role with respect to the 2016 TAC. The CPRS is expected to be compliant with the objectives of the SFF and DMF and a full review of whether or not it is achieving these objectives is being planned for after March, 2016. In preparation for this review, the harvest control rules (HCRs) that comprise the CPRS were tested through simulation to determine whether or not the CPRS is likely to achieve the SFF/DMF objectives under a range of likely conditions, including uncertainties. Results thus far suggest that performance of the CPRS depends on which Zone you start in (Critical, Cautious, and Healthy), steepness of the stock-recruit relationship, the amount of process and observation error, and whether or not the perceived SSB limit reference point equals the true (simulated) limit reference point. In general, the CPRS works better when process and observation errors are low, but performance deteriorates as the errors increase. It was found that in most cases the CPRS results in the SSB tracking slowly up towards the Healthy Zone with fishing mortality (F) tracking slowly down towards F_{msy}. There may be concern that these responses are generally very slow under the conditions tested, compared to the much more rapid response in an un-fished case. Yield was found to be generally less than the MSY level under a range of conditions, while under some conditions the SSB over-rebuilds and fishery, in terms of catches, declines to well below MSY. Under anticipated levels of uncertainty (process and observation errors) it may be hard to achieve < 10% risk of falling below Blim or to achieve a < 30% risk of exceeding F_{msy}.

Discussion

There were questions regarding how the simulations work and what data is used. The simulations are done based on reasonable ranges of values for each parameter in order to obtain a population size estimate.

A question was raised as to why only a portion of the parameter space was explored (i.e. not a fully factorial design). The presenter indicated it would be possible but has not been completed at this time.

There was a suggestion to explore mortality at different times in the life-cycle of the fish such as at age 0.

It was asked if one of the scenarios can describe the stock at the moment with the SSB going up but with a large number of young fish. At this time it is unknown.

There were comments to encourage the simulations to continue and more concrete decisions and advice to be given at the next meeting.

COD FISHERY, INDUSTRY INPUT AND FFAW QUESTIONAIRE UPDATE

Presenter: E. Carruthers

Abstract

Fish harvesters attending the assessment meeting reported smaller fish in 2014 and were concerned by the absence of large fish both in the commercial fishery and in the RV data. Approximately 45% of the TAC was not caught in 2014. Consequently, fish harvesters were concerned that taking the full TAC would negatively impact the stock. The abundance of grey seals in Fortune Bay and in areas to the west appears to be high and harvesters were concerned about the potential for higher mortality and lower quality associated with seal abundance.

Canadian fixed-gear fish harvesters' perspectives on the 2014 fishery were compiled based on the results of the telephone survey conducted by the FFAW. Most fish harvesters surveyed reported that the 2014 abundance was similar to 2013 or was more abundant than in 2013. Catch rates were reported as better than average compared to historically. All harvesters fishing St. Pierre Bank reported cod were in good condition and larger fish were reported from the Bank. The abundance of baitfish (herring, capelin, squid and mackerel) was reported as being at a low level and decreasing throughout 3Ps. The exception was sandlance abundance on St. Pierre Bank, which harvesters reported as having good abundance and increasing.

Discussion

It was noted that the Industry Perspectives section included in previous versions of the Science Advisory Reports was being moved into the "Other Considerations" section of the SAR to conform to the National template. There was some discussion in this regard but industry was reassured that their contribution would be added to this section of the SAR in verbatim, as in previous years.

Comments were raised when comparing the years in the telephone survey; are the fisherman fishing in the same areas when comparing the survey among years?

Discussion ensued regarding biases in the telephone survey in that the participation rate may have changed. This 2015 survey yielded 30-50% less respondents than last year (2014). A suggestion to reduce the bias (if it exists) was to incorporate inshore and offshore questions.

Harvesters present at the meeting noted that for the current year to date, catches have been poor. It was stated that there is interest to see how the telephone survey next year reflects these observations.

COD PROJECTIONS AND FINAL DISCUSSION

A three-year projection is too unpredictable due to the high mortality rate (z), making the SSB potentially variable in the coming years and, therefore, a projection will be provided for only one year.

There is concern that only 50% of the TAC has been taken in recent years, and uncertainty around what would happen if the full TAC was caught. Also, it was not clear how the harvest control rule takes this into account.

There was much discussion regarding how to provide the science advice to managers given the recent (October, 2014) adoption of the CPRS by Canada. It was suggested to provide the CPRS TAC but also outline other considerations or exceptional circumstances, for example: explain the z-multipliers/projections; statement that although SSB is projected to increase, half of the SSB in 2016 could be comprised of one (2011) year class. It was noted that other considerations would not mean that the CPRS TAC should not be followed.

COD SAR BULLETS

- The DFO survey covers most of the stock area and is designed to provide an index of stock size. Therefore, consistent with recent assessments, a cohort model (SURBA) based on this survey was used to infer overall stock trends.
- The stock is currently in the cautious zone as defined by the DFO PA Framework. The spawning stock biomass (SSB) has declined since 2012 and is currently estimated to be 41% above the limit reference point (LRP; $B_{Recovery} = SSB_{1994}$). The probability of being below

the LRP in 2015 is low (p = 0.05). Concern is expressed that there are few older fish in the SSB.

- Recruitment has improved over the last decade with most cohorts at or above the time-series (1983-2013) average. In particular, indications are that the 2011 and 2012 cohorts are strong.
- Estimated total mortality has generally been increasing since 1997 to near the time series maximum. Over 2012-14, it averaged 0.65 (48% annual mortality), which is high especially considering that reported landings have been about half of the TACs were taken over this time period.
- Projection of the stock to 2016 was conducted assuming mortality rates will be within ± 20% of current values (2012-14 average). Projected SSB increases in all cases (ranging from 23-46%) but remains within the Cautious Zone. These increases are driven by the relatively abundant 2011 year-class.
- Based on the Conservation Plan and Rebuilding Strategy adopted by Canada the calculated TAC for 2016/17 would be 13,043 t.
- Recent trends in mean size and weight at age, fish condition, and age at maturity are at or near their lowest observed levels, suggesting reduced productivity of this stock. This is consistent with broader ecosystem trends which also suggest decreased productivity.

COD RESEARCH RECOMMENDATIONS

- Investigate cod consumption by seals, and get an estimate of the seal population in the area;
- Determine the sources of mortality in 3Ps cod and why the z is high;
- Look into pre-spawning as well as spawning, determine the timing of peak spawning to merit the current closure.

PRESENTATIONS – 3PS WHITE HAKE

3PS WHITE HAKE: BIOLOGICAL AND FISHERY OVERVIEW

Presenter: M. Simpson

Abstract

White Hake in NAFO Subdivision 3Ps and Divisions 3NO inhabits the southern Grand Bank and St. Pierre Bank of NL, associated with the warmest bottom temperatures (> 4^{o}C). White Hake is a demersal gadoid species, subject to ongoing mortality in directed and bycatch fisheries conducted by Canada (Divs. 3NOPs within its Exclusive Economic Zone) and other countries (in the NAFO Regulatory Area of Divs. 3NO). The DFO-NL spring survey abundance index for Divs. 3NOPs peaked in 2000, due to a very large 1999 year-class. Annual NAFO-reported landings from Subdiv. 3Ps averaged 619 tonnes in 1994-2002, increased to an average of 1,450 t in 2003-07 (following recruitment of the 1999 year-class to the fishery), then decreased to a 338 t average in 2008-14. Since 2003, the Subdivision 3Ps biomass index has been in decline, while recruitment remains low.

Available evidence suggests that current White Hake productivity, like other piscivores, may be hindered in Subdivision 3Ps, therefore it is advised that higher than usual risk-aversion be

considered in the management of these stocks. If White Hake in Subdivision 3Ps is to recover, it will be due to favourable changes in environmental conditions that allow successive years of good recruitment. The most effective way to assist in rebuilding the White Hake population is to conserve as much spawning biomass as possible.

Discussion

It was asked how the abundance of White Hake was derived and if there was a lot of variance around the abundance estimate. The abundance was derived using a STRAP estimate and there was not a substantial amount of variance.

There was discussion on whether Subdivision 3Ps should be added with 3Pn in the NAFO assessment, as there is no distinguishing feature or division for the stock areas.

White Hake are extremely low in abundance, are fished out very quickly and COSEWIC has recommended them for listing. The fishery is currently unlimited, therefore a TAC needs to be set. It was recommended to use the status quo or the average for the last three fishing years because the current fishing does not seem to be affecting the biomass (stable). The table appeared to agree with this reasoning although it was pointed out that the ecosystem is changing and there is the potential for a food limiting environment.

WHITE HAKE FINAL DISCUSSION

Overall White Hake are stable but need to be managed due to the increasing economic value. The 3Ps stock would be better managed if not separated from the surrounding stocks and assessed in conjunction with the NAFO 3NO meetings.

WHITE HAKE SAR BULLETS

- Since 2009, NAFO reported landings from Subdivision 3Ps averaged 310 t annually, while NL-ZIFF-reported landings averaged 243 t and were predominantly from White Hake-directed gillnet (71%) and longline (25%) fisheries.
- Using the past three years as status quo, current landings from Subdivision 3Ps are below their historic levels. In Subdivision 3Ps, status quo landings was 261 t (195.5-328.5 t, range ± 25%), while the status quo was 18 t (13.5-22.5 t, range ± 25%) for Subdivision 3Pn.
- Biomass of this stock increased in 2000-03, generated by the large recruitment in previous years. Subsequently, the biomass index has declined.
- Recruitment in 2000 was very large, but no large year class has been observed since then. Recruitment was higher in 2011, but not comparable to the very high recruitment observed in 2000.
- Relative fishing mortality (Rel. F) has fluctuated, but increased considerably in 2003-05. Current estimates of Relative F are near average.
- Available evidence suggests that current White Hake productivity, like other piscivores, may be hindered in Subdivision 3Ps, therefore it is advised that higher than usual risk-aversion be considered in the management of these stocks.
- If White Hake in Subdivision 3Ps is to recover, it will be due to favourable changes in environmental conditions that allow successive years of good recruitment. The most effective way to assist in rebuilding the White Hake population is to conserve as much spawning biomass as possible.

WHITE HAKE RESEARCH RECOMMENDATIONS

- Age determination should be conducted on otolith samples collected during annual Canadian surveys (1972-2014+); thereby allowing age-based analyses of this population.
- Collection of information on commercial catches of White Hake should continue and also include sampling for age, sex and maturity to determine if this is a recruitment fishery.
- Survey conversion factors between the Engel and Campelen gear should be investigated for this stock.
- Continue work on the development of population models for this stock to help quantify B_{lim} and provide short term biomass projections for this stock.

REFERENCES CITED

Cadigan, N. 2010. Trends in Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps Cod (*Gadus morhua*) stock size based on a separable total mortality model and the Fisheries and Oceans Canada Research Vessel survey index. DFO Can. Sci. Advis. Sec. Res. Doc. 2010/015. iv +

DFO. 2015. Northern (NAFO Divs. 2J3KL) Cod Stock Update. DFO Can. Sci. Advis. Sec. Sci. Resp. 2015/018.

APPENDIX I: TERMS OF REFERENCE – 3PS COD

3Ps Cod Stock Assessment

Newfoundland and Labrador Regional Peer Review Process

October 20-22, 2015
St. John's, NL

Chairperson: Darrell Mullowney

Context

The status of Northwest Atlantic Fisheries Organization (NAFO) Subdivision 3Ps Cod was last assessed in October 2014 (DFO 2015). 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 Fisheries Management to provide the Minister with detailed advice on the status of the stock in order to inform management decisions for the 2016 fishing season.

Objectives

- Provide an ecosystem overview (e.g., environment, predators, prey) for the stock area.
- Assess and report on the current status of the 3Ps Cod stock. In particular, assess current spawning biomass relative to baseline conservation thresholds (B_{lim}), total (age 3+) biomass, exploitation rate, natural mortality, total mortality, and biological characteristics (including age composition, size at age, age at maturity, and distribution). Describe these variables in relation to historic observations.
- Further to the previous assessment, 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 populations in the next 1-3 years.
- Provide annual projections to 2018 based on the assessment of trends in the abundance index, biomass index and other stock indicators, including associated risk analyses. Specifically, these analyses will include an assessment of the trends in the stock and in the risks compared to B_{lim}.
- Highlight major sources of uncertainty in the assessment, and where appropriate, consider alternative analytical formulations of the assessment.
- Report on results of tagging and the distribution of this stock in other areas (e.g., 3L/3Pn).
- Summarize the data collected during the spawning closure in 2015.
- Calculate the suggested TAC as per the harvest control rules, which have been approved as part of the "3Ps Cod Conservation Plan and Rebuilding Strategy".

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document

Participation

- Fisheries and Oceans Canada (DFO) (Science, Fisheries Management)
- Fishing Industry
- IFREMER (French Research Institute for Exploitation of the Sea)
- Provincial Department of Fisheries and Aquaculture (DFA)
- Academia
- Aboriginal groups
- Non-government organizations

References

DFO. 2015. Stock Assessment of NAFO Subdivision 3Ps cod. DFO Can. Sci. Advis. Sec. Sci. Advis. Rep. 2015/001.

APPENDIX II: TERMS OF REFERENCE – 3PS WHITE HAKE

3Ps White Hake Stock Assessment

Newfoundland and Labrador Regional Peer Review Process

October 20-22, 2015
St. John's, NL

Chairperson: Darrell Mullowney

Context

The status of the White Hake stock in NAFO Subdivision 3Ps was last assessed in 2002 (DFO 2002). The current assessment is requested by Fisheries Management to provide the Minister with advice that will inform management decisions for the 2016 fishing season.

Objectives

- Provide an ecosystem overview (e.g., environment, predators, prey) of the stock.
- Assess and report on the status of the stock based on commercial fishery statistics (overall landing distribution, breakdown by fishing gear and directed species) and biological data resulting from the commercial sampling program (size structure).
- Analyze historical data from the research surveys up to 2015 (abundance index, biomass, recruitment, size structure and geographical distribution of catches).
- Identify B_{lim}, or a proxy for B_{lim}, for this stock and report on the current spawning stock biomass relative to B_{lim}.
- Provide annual projections to 2018 based on the assessment of trends in the abundance index, biomass index and other stock indicators, including associated risk analyses. Specifically, these analyses will include an assessment of the trends in the stock and in the risks compared to B_{lim}.
- Perspectives for 2016 based on available indicators.
- Establish a full assessment review period as well as interim-year guidance.
- Provide guidance on inter-framework review activities, including the procedure and frequency of providing fisheries management advice and events that would trigger an earlier-than-scheduled assessment.

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document

Participation

- Fisheries and Oceans Canada (DFO) (Science, Fisheries Management)
- Fishing Industry
- IFREMER (French Research Institute for Exploitation of the Sea)
- Provincial Department of Fisheries and Aquaculture (DFA)
- Academia

- Aboriginal groups
- Non-government organizations

References

DFO 2002. White Hake in Division 3L, 3N, 3O and Subdivision 3Ps. DFO Science Stock Status Report A2-06.

APPENDIX III: AGENDA

Regional Peer Review Process for Subdivision 3Ps Cod and White Hake

Memorial Meeting Room,

NAFC, St. John's

October 20-22, 2015

Chairperson: Darrell Mullowney

Tuesday, October 20 (0900-1700)

Activity	Presenter
Opening/Chair remarks (0900)	D. Mullowney
Introductions/ ToR	D. Mullowney
Environmental /Oceanographic Update	E. Colbourne
Fish community trends for 3Ps	M. Koen-Alonso
Review of 2014/15 fishing season and 2015/16 season to date	D. Coffin
Catch and Survey Trends for 3Ps Cod Catch • Total landings • Logbook data, catch rate index	R. Rideout/ D. Ings
Survey • Biomass/Abundance updates • SSB • Age composition, size at age (length, weight and condition), age at maturity • Distribution	R. Rideout
Sentinel Program • Data overview & standardized index	D. Maddock Parsons
Tagging Update	J. Brattey
Population Dynamics • • SURBA – Survey-based analysis • • Short-term Projections	B. Healey
Spawning time in relation to the 3Ps spawning closure	R. Rideout

Wednesday, October 21 (0900-1700)

Activity	Presenter
Continue with Cod assessment (if additional time is required)	Rideout/Healey
Further work on the 3Ps Harvest Control Rule through Simulation	P. Shelton
Industry Perspective (SPM)	C. Fontaine
FFAW Questionnaire update	E. Carruthers
Drafting of Cod SAR/Summary Bullets	ALL

Thursday, October 22 (0900-1700)

Activity	Presenter
Subdivision 3Ps White Hake	M. Simpson
Drafting of SARs/Summary Bullets (Cod and Hake)	ALL

APPENDIX IV: LIST OF PARTICIPANTS

Name	Affiliation
Darrell Mullowney (Chair)	DFO Science
Jim Meade (CSA Office)	DFO Science
Erika Parrill	DFO Science
Sherrylynn Rowe	MI-CFER
Dave Coffin	DFO-FAM
Brian Healey	DFO Science
Dawn Maddock Parsons	DFO Science
Danny Ings	DFO Science
Gary Maillet	DFO Science
Karen Dwyer	DFO Science
Dennis Slade	Icewater Seafoods
Basil Daley	Icewater Seafoods
Joanne Morgan	DFO Science
Don Power	DFO Science
Joel Vigneau	IFREMER Science
Eugene Colbourne	DFO Science
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Rick Rideout	DFO Science
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