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Proceedings of the Newfoundland and Labrador Regional Advisory Meeting of the Stock Assessment of 2HJ3KLNOP4R Snow Crab

Meeting dates: February 22-24, 2022
Location: Virtual meeting

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Foreword

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

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SUMMARY

A Regional Advisory Meeting for the assessment of Snow Crab (*Chionoecetes opilio*) in Northwest Atlantic Fisheries Organization (NAFO) Divisions 2HJ3KLNOP4R was held virtually via Microsoft Teams on February 22-24, 2022. The purpose of the process was to assess Snow Crab in the Newfoundland and Labrador Region (Assessment Divisions 2HJ, 3K, 3LNO, 3Ps, and 4R3Pn) in order to provide the science advice to inform the 2022 Snow Crab Management Plan.

This Proceedings Report includes abstracts and summaries of discussions from each presentation, reviewer reports, a list of research recommendations, and summaries of discussions pertaining to the Science Advisory Report (SAR) bullets. The meeting's Terms of Reference, agenda, and list of participants are appended.

In addition to these Proceedings, publications to be produced from the meeting include a SAR and comprehensive Research Document, to be available online on the Canadian Science Advisory Secretariat website.

PRESENTATIONS

PHYSICAL CONDITIONS OF THE NL SHELF WATERS

Presenter: Frédéric Cyr

Abstract

An overview of physical oceanographic conditions in the Newfoundland and Labrador (NL) Region during 2021 was presented. The large majority of the environmental parameters presented were above normal (defined as the average over the 1991–2020 climatological period). The annual average air temperature at five sites around the NW Atlantic was above normal, including a record high in Bonavista. When considering the winter period, record high warm temperatures were established at Iqaluit, Bonavista, and St. John's, and the second warmest winter on record was observed in Cartwright. The sea ice season volume and area across the Newfoundland and Labrador shelf was at its third lowest level (after 2010 and 2011) since the beginning of the time series in 1969. Only one iceberg was observed drifting south of 48°N. Ice-free season sea surface temperatures across the NW Atlantic were slightly warmer than normal. Observations from the summer Atlantic Zone Monitoring Program (AZMP) oceanographic survey indicated that the cold intermediate layer (CIL) along Seal Islands, Bonavista Bay, and Flemish Cap section was at its third lowest since 1950 (after 1965 and 1966), indicating warm conditions. This contrasts with 2014–17 where the volume was above normal, indicating cold conditions. Spatially-averaged bottom temperatures in NAFO Divisions 3Ps (spring) and 2J3K (fall) were at their second warmest since 1980, including a record in 3Ps. The NL climate index was at a record high in 2021 (tied with 2010 and 1966).

Discussion

There was a question about why there were missing data from 3LNO in 2021. The presenter responded that the multispecies survey did not occur on the Grand Banks and noted that this would be discussed further in the data limitations presentation.

A participant asked if record high temperatures could be predicted to be seen in 3LNO similar to 3Ps if DFO had the data. The presenter noted that although it was not possible to say for sure, they believed this was likely, due to the Assessment Divisions (Ads) being geographically close and the record high seen at station 27. Additionally, in the shallower Grand Banks, the CIL sits on the seafloor, and since the CIL was small this year, it is likely that 3LNO was warmer than usual.

There was some confusion around the concern placed on decreases in the winter North Atlantic Oscillation (NAO) average when drops have occurred previously followed by a return to a cold climate. It was clarified that the NAO alone is not sufficient to investigate climate. There was a colder than normal period in 2014–17 which is likely masking some of the changes that have occurred since then. This is believed to be the case because despite the index looking similar now to what it was in the 1990s, the climate was much colder in the 1990s. The cumulative effect of temperature builds over time and there has already started to be a reduction in recent years, even with positive NAO index values.

There was a question with regards to pH data coverage. The presenter answered that the time series began in 2014, and in 2021 there was only summer data due to survey coverage issues in the spring and fall. It was noted that this is something that would be beneficial to track long term. There was a comment that the presented oceanographic conditions match what was

observed in Northern Labrador, but this year they are seeing extreme cold bands of weather from the polar vortex.

BIOGEOCHEMICAL CONDITIONS OF THE NL SHELF WATERS

Presenter: David Bélanger

Abstract

Biogeochemical oceanographic conditions on the Newfoundland and Labrador Shelf were presented and interpreted against long-term (2003–20 for satellite data, and 1999–2020 for AZMP in situ observations) mean conditions in the region. Satellite observations of ocean colour indicated an early onset of the spring phytoplankton bloom on the NL Shelf (NAFO Divisions 2HGJ3K) and eastern Gulf of St. Lawrence (3Pn4R), and near-normal or slightly late bloom timing on the Grand Banks (3LNOPs). Integrated nitrate (50–150 m) and chlorophyll a (0–100 m) inventories have been generally increasing since the mid-2010s with chlorophyll remaining on average at near-normal levels for the 2018–20 period. The low chlorophyll values for 2021 can be explained by the missing data from the canceled spring and fall AZMP surveys in the index calculation. The abundance of total copepods, largely driven by the small copepod taxa such as *Pseudocalanus* spp., and non-copepods decreased during the second half of the 2010s. The abundance of the large, energy-rich, *Calanus finmarchicus* copepods increased during the same period with a positive impact on overall zooplankton biomass. The recent trend in zooplankton biomass and community structure toward higher biomass and higher abundances of large species, including *Calanus finmarchicus*, and lower abundances of smaller copepod and non-copepods, contrasts with the situation observed during the 2005–15 period and may have a positive impact on energy transfer to upper trophic levels.

Discussion

There was no discussion.

STRUCTURE, TRENDS AND ECOLOGICAL INTERACTIONS IN THE MARINE COMMUNITY OF THE NEWFOUNDLAND-LABRADOR BIOREGION

Koen-Alonso, M., R. Deering, J. Mercer, and J. Desforges

Presenter: Mariano Koen-Alonso

Abstract

The ecosystem structure of the Newfoundland and Labrador bioregion can be divided into four Ecosystem Production Units (EPUs): the Labrador Shelf (NAFO Divs. 2GH), the Newfoundland Shelf (2J3K), the Grand Bank (3LNO), and southern Newfoundland (3Ps). These EPUs coarsely represent functional ecosystems, and are used as geographic boundaries for the estimation of fisheries production potential (FPP) using ecosystem production potential models. Estimated FPP distributions, together with proxies for the current productivity state of the EPU, have been used to provide guidance on upper limits for total catches using the total catch index (TCI) by fish functional guilds within the 2J3K and 3LNO EPUs. These functional guilds are higher level aggregations than the fish functional groups used to describe ecosystem status and trends; for example, the benthivore guild includes all benthivore fish functional groups (small, medium, and large) plus the shellfish functional group (i.e., shrimp and Snow Crab). During 1998–2015, total catches in 2J3K for the benthivore guild (where Snow Crab is included) were above their TCI. Catches of benthivore and other functional guilds in 3LNO have also seen levels above their

corresponding TCIs. During the 1995–2020 period, these ecosystem units have experienced fishing levels that have the potential of eroding ecosystem functionality.

The ecosystem structure of the Newfoundland Shelf and Grand Bank changed in the 1990s with the collapse of the groundfish community, and the increase in shellfish. Even with the increases in shellfish, total biomass never rebuilt to pre-collapse levels. Build-ups of total biomass have been observed from the very low levels of the immediate post-collapse period, especially since the mid-late 2000s. After the mid-2010s, the build-up process stalled and declines were observed, but recent surveys (2018–21) seem to suggest that condition could be improving. While recent signals appear promising, it remains unclear if they will translate into sustained rebuilding.

Ecosystem structure has shifted from shellfish dominated to finfish dominated in 2J3K. While 3LNO and 3Ps were never dominated by shellfish, the fraction of shellfish in both EPUs has declined. Among finfishes, some of the changes include the increased dominance of warm water species like silver hake and Atlantic Halibut in 3Ps and 3LNO.

Total biomass remains below pre-collapse levels across EPUs, indicating that ecosystems in the NL bioregion continue to experience overall low productivity conditions. In this context, Snow Crab has shown signals of improvement across EPUs in recent years, especially in 3LNO. The only area that remains at record low levels is 2J within the 2J3K EPU.

In terms of consumption and diets, the trends in stomach content weights of key fish predators mimic the trends in total Research Vessel (RV) Biomass, supporting the idea that total biomass trends appear mostly driven by bottom-up processes (e.g., broad limitations in food availability/productivity). Snow Crab appears as an important prey for cod and thorny skate across ecosystem units, especially in 2J3K and 3Ps, but an important decline in Snow Crab dominance in the diets was observed in 3Ps since 2017. Snow Crab consumption has declined in 3Ps but remains high in 2J3K and 3LNO.

In terms of the potential impacts of predation on Snow Crab, predation mortality shows declines from the peak values observed in the mid-late 2010s across all EPUs, and with predation mortality in 3LNO (in 2020) still an order of magnitude lower that the estimated predation mortalities in 3Ps and 2J3K. In terms of trends within EPUs, predation mortality still remains among the highest levels in 2J3K and 3LNO, but it has dropped to its lowest value since 1995 in 3Ps. Within 2J3K, predation mortality is substantially higher in 2J than in 3K.

In summary, the ecosystems in the NL bioregion continue experiencing overall low productivity conditions, likely driven by bottom-up processes (e.g., food limitation). The groundfish rebuilding that started in the mid-2000s has stalled, with declines observed in the mid-2010s. Recent ecosystem signals appear promising (e.g., biomass trends, stomach content weights), but it is unclear if they will translate into sustained rebuilding. However, Snow Crab is showing signals of improvement across EPUs in recent years, especially in 3LNO. The only area that remains at record low levels is 2J within the 2J3K EPU. Predation mortality shows declines from the peak values observed in the mid-late 2010s across all EPUs. While predation mortality remains high within the 2J3K and 3LNO time series, it has declined to the lowest value since 1995 in 3Ps. Across EPUs, predation mortality in 3LNO in 2020 was still an order of magnitude lower than the estimated predation mortalities in 3Ps and 2J3K. While predation mortality rates remain among the highest observed in some EPUs, it is unclear if predation constitutes an important driving factor of Snow Crab dynamics. Despite this uncertainty, the observed declines in predation pressure would imply that, under favorable environmental conditions, Snow Crab prospects could be expected to improve.

Discussion

It was questioned why seals were not mentioned as predators of Snow Crab. The presenter responded it was because fish consume three times the amount of crab that seals consume, so focusing on fish predators was more informative for the model. Most seal species that consume shellfish do not have very high populations, and the harp seal, which has a high abundance, is not known to be a consistent predator of Snow Crab. This was followed by another question about how seal populations are surveyed, and it was clarified that harp seals are monitored with aerial surveys and diet data is obtained through stomach samples collected by sealers.

A similar question was raised about wolffish not being considered as Snow Crab predators. It was expected that wolffish were consuming small crab, however there was no stomach content data from wolffish so there was no information on their consumption. It was noted that this is something that may be explored in the future. Wolffish were included in the scaling, so if wolffish populations increased, then that would be reflected in the data. There was speculation that wolffish found in crab pots were consuming the bait and not crab, as the crab found in pots would likely be too large for wolffish to consume.

There was discussion on how Snow Crab in 2J were doing from an ecosystem standpoint. Relative consumption was the same as in previous years, however the impact on the performance of the population was expected to be higher due to the Predation Mortality Index (PMI). It was questioned if the PMI over-emphasizes predation as a driver when other factors could be driving changes in biomass. The presenter explained that the method used to calculate the PMI is a classically used method. It is purely a measurement of the expected relative impact that predation has on the population over time, it does not claim that predation is the most important or dominant driver.

There was clarification requested on the definition of ‘low’ with regards to the current biomass of the fish community. It was clarified that low biomass is derived from a comparison to a moving average of historical data in the area. This was followed up by a question with regards to the normative level of biomass that an ecosystem should produce. The response was that this number does not exist. However, if an ecosystem previously was capable of sustaining biomass over a number of years, but is no longer able to, this tells us that fundamental processes may have changed.

There was concern raised that the measurement error and process error in estimates for the PMI could be skewing the current period and reference period. The response was that this index continues to be refined and it is good to reference the historical catches to support the survey. Historically, much larger catches were harvested for up to 20 years, therefore there must have been greater biomass than is present currently.

DATA LIMITATIONS AND SHIFTING FOCUS ON DATA INPUTS

Presenters: Julia Pantin and Darrell Mullowney

Abstract

In 2021, there was reduced DFO trawl survey coverage in NAFO Divisions 2HJ3K in the fall, and no DFO trawl survey was conducted in Divs. 3LNO. To determine the impacts of reduced coverage in 2HJ3K, 25 historical datasets were created by randomly removing sets from the time series to result in the same number of sets per strata each year as in 2021. Biomass estimation was conducted on the 25 datasets and compared to the exploitable biomass index presented at the 2021 stock assessment. The reduced coverage of the DFO trawl survey may result in overestimation of the exploitable biomass index, particularly in 2HJ. A comparative

model analysis was conducted to estimate the 2021 exploitable biomass index in 3LNO in the absence of trawl data for 2021. Seven models were investigated, and exploitable biomass index predictions were presented. An average of the predictions from the seven models was proposed as the estimate to be used in the stock assessment.

The DFO-Industry collaborative post-season (CPS) trap survey has undergone a significant survey redesign moving from a fixed station design focused on prime fishing areas to a 50% fixed station and 50% random station design. With the incorporation of all stations into exploitable biomass estimation, a directionality in the time series scalars used to adjust time series biomass was apparent. To address this, linear regressions were used to normalize the error structure around a central tendency during this shifting period. By incorporating all stations and using this method for adjusting exploitable biomass estimates, the trap survey exploitable biomass index is now more in line with the trawl exploitable biomass index.

Discussion

Missing/Lighter Survey Coverage

There was a question about whether the Hopedale Saddle closure was sampled, and it was confirmed that surveys are conducted inside closed areas.

There was a question about why the reduced coverage may result in an overestimation of the exploitable biomass index, but not in some of the other indexes. The response was that despite missing many sites, the survey was conducted in areas with high catches. Thus, the areas that were missed could have been the location of non-exploitable categories of crab (e.g., female, pre-recruits), which would explain why those trends have increased noise.

There was a request for clarification on the criteria required to consider the reduced coverage biomass estimate an ‘over-estimation’. It was stated that there was no concrete value, however, the general pattern was that the reduced coverage biomass values were higher than those of complete surveys, so it was important to indicate the potential for the 2021 survey data to overestimate biomass.

A participant questioned how population density in an area would impact the effects of a light survey. When population density is high, the effect of a light survey is less of a danger, but when population densities are already low in an area, caution must be exercised with regards to the estimate.

There was lengthy discussion with regards to the models used in the absence of the spring and fall surveys in 3LNO. It was agreed that using the envelope of models was the best course of action to fill in the missing values. Other options mentioned included having no value or using the same value as the previous year. It was noted that it will be made apparent in biomass figures that this value is not a continuation of the time series. There was a question raised about whether all of the models were believed to be equally likely and defensible. It was explained that the central tendencies of all of the models’ biomass predictions were fairly consistent and that all of the models are defensible to some degree. Additionally, there was a question about the level of impact the estimated value will have on AD 3LNO. It was explained that this value will be going into the Precautionary Approach (PA) where it will be 1 of 4 biomass inputs, so it will be buffered, and slight changes in the value will not dramatically alter the answer. It was suggested to explore the sensitivity of the PA to explore how robust it is. It was also suggested to use the median of the models instead of the mean since the values are a little skewed. This advice had overall support and the median will be used going forward. There was a suggestion to use the average difference between the trawl and CPS survey and use that to estimate the value of the trawl survey in 3LNO, since the CPS survey was the only data that was collected in

2021. The final consensus from the meeting was to use the CPS survey value instead of the mean or median of the models.

There were also questions about specific models. There was a question asking why the trawl index from last year was not used as a model. It was clarified that model one (M1) used the trawl index pre-recruit data. There was a question about the possibility of using areas bordering 3LNO for a prediction. The presenter responded that model two (M2) was a function of 3K and 3Ps which both neighbour 3LNO. It was proposed to confirm the legitimacy of M2 by applying the same model to areas where there was data to compare predicted biomass with actual biomass. This was not done, but would be possible. With regards to model four (M4), there was a question about what was driving the downturn, since this model showed a decline when most of the others were increasing. The model predicted only one more year of increase, so it is possible the population may have peaked. With regards to the Delury Fisheries Depletion model (M5), there was a question as to why the standard 80% survival was used, despite there not being many natural predators for legal-sized crabs. This is because the actual survival is not known, and this number has been historically used in fisheries as an average. This survival applies to all age classes, so this value is not unreasonable. There was a question about whether the models' over-predictions were random or systemic. Residuals of each model were reviewed, and no models had clear residual issues. Overall, it was concluded that the value derived from the CPS survey is supported by seven imperfect models. There was a request for the research document to describe each of the models in detail, and another request to further refine the models for future years, in case more survey gaps occur.

Trap Survey

There was a question about what kind of trap the CPS trap survey uses, and the answer was commercial crab traps.

There was a question about the temporal coverage of the survey. It was clarified that the survey occurs post-season starting at the end of August and concluding at the end of October and uses 12 hour soak times. A comment was made that the soak times may not always be accurate for inshore due to weather.

A participant asked if a scalar of 1, seen in some years, meant that everything was caught. The presenter responded that a scalar of 1 means the survey is precise. In other words, it means that the survey is measuring the resource the same as the other metric of stock size (the Delury Depletion estimator).

It was asked why the biomass from the trawl was noticeably higher than the biomass of the whole area in 3K and the response was that the mechanism is not known.

There were discussions regarding the Torngat survey. It was asked how the trawl survey lines up with the Torngat survey, and the response was that direct comparisons have not been made. However, both sets of data (from the trawl and trap surveys) in Torngat should be representative of the area. Following this, it was suggested the Torngat survey be made more comparable with the CPS survey since they are both collaborative surveys. The response was that the biomass estimate includes all trap data (CPS, DFO inshore trap surveys, and the Torngat data).

A participant asked why there are typically less commercial-sized crab found in small mesh pots compared to large mesh pots. Speculations were made, but the mechanism is not known.

There was a question if the impact of missing areas in the trap surveys has been explored, similar to how it was done for the decreased survey coverage in 2HJ and 3K with the 25 test data sets. The answer was that this has not been explored.

There was a comment emphasizing the importance of getting collaborative surveys completed, and there was a question about the possibility of contracting out private vessels to assist federal trawl surveys. No one in the meeting was in a position to make this decision, however, the requirement of comparative fishing when introducing new vessels was noted.

DIVISIONS 2HJ3KLNOP4R OVERVIEW – STANDARD ASSESSMENT

Presenter: Julia Pantin

Abstract

The status of the Snow Crab (*Chionoecetes opilio*) resource surrounding Newfoundland and Labrador NAFO Divs. 2HJ3KLNOP4R is assessed using a variety of metrics. The resource is assessed at larger-scale Assessment Divisions (ADs), which are comprised of combinations of NAFO Divisions. Data from multi-species bottom trawl surveys conducted during fall in ADs 2HJ, 3K, and 3LNO Offshore and spring in ADs 3LNO Offshore and 3Ps provide information on trends in biomass, recruitment, production, and mortality over the time series. Multi-species trawl survey indices are compared with other relevant indices toward inferring changes in resource status for 2022 and beyond. These other indices are derived utilizing data from harvester logbooks, at-sea observers, the dockside monitoring program, and inshore and offshore trap surveys, as well as oceanographic surveys. There was no spring or fall multi-species trawl survey in AD 3LNO in 2021 and there was reduced coverage in the fall trawl survey in ADs 2HJ and 3K. Analyses were undertaken to investigate the impact of reduced coverage in 2HJ3K, and comparative modelling was conducted to investigate exploitable biomass estimates for AD 3LNO. For 2021, a trap survey exploitable biomass index was used as the basis for exploitable biomass in AD 3LNO. Snow Crab landings remained near 50,000 t from 2007 to 2015, but steadily declined to a 25 year low of 26,400 t in 2019. In 2021, landings increased to around 38,000 t. Overall effort increased slightly in 2021 to under 3 million trap hauls per year. Overall catch per unit effort (CPUE) was at a time-series low in 2018, but has greatly increased since then and was above the time-series average level in 2021. The overall exploitable biomass has increased from historic lows in both trawl and trap surveys over the past 4 years in all ADs, except 2HJ. Exploitation rate indices (ERI) were near time-series lows in all ADs in 2021, except AD 2HJ and 4R3Pn. With status quo removals in 2022, ERI is expected to decrease or remain low in all ADs, except 2HJ, where it would be over 60%. Total mortality in exploitable crab has decreased in all ADs in recent years. It remains highest in AD 2HJ. There is no updated total mortality estimate for AD 3LNO in 2021, but the presence of old-shelled crab in the trap survey data suggests total mortality remains low. Pre-recruit abundance indices suggest favourable prospects for recruitment into the exploitable biomass over the next 2–4 years, however multiple streams of evidence suggest further improvements may be limited and recruitment may have peaked. Elements of the Precautionary Approach (PA) Framework presented in this assessment are tentative and therefore, the PA Framework is considered provisional. Limit Reference Points (LRPs) defining the critical zone for the three stock status metrics have been established by a peer-reviewed Science process, but Upper Stock References (USRs) defining the cautious and healthy zones and Harvest Control Rules (HCRs) have not been finalized. In 2022, all ADs are projected to be in the healthy zone of the provisional PA Framework, except AD 2HJ, which is projected to be in the cautious zone. These projections assume status-quo landings. AD 4R3Pn is not included in the provisional PA Framework.

Discussion

During the discussion on low survey coverage in 4R, there was a question about why closed parts of this area were not removed, as was previously done on the Grand Banks where there was no activity. The response was that it is important to collect data in areas where closures are not permanent so that the state of the ecosystem can be monitored. It was also noted that sometimes these blocks were not completed due to issues getting at-sea observers.

In relation to the earlier presentation on data limitations and shifting focus on data inputs, a participant asked why the fishery does not have the same magnitude of pre-recruits in 3LNO as was seen in model 3 (M3). The presenter responded that the mechanism for this disconnect is not known, but that it is possible that they are still not in the fishery for an unknown reason, or there could be some ambiguity between shell conditions.

It was noted that there appeared to be a good linkage between the trap and trawl surveys, but that a longer time series is needed to support this.

There were discussions about AD 2HJ. There was a request made to split 2J North and 2J South. While the conclusion was that it was not advisable to further refine the ADs, it was noted that figures in the appendices are broken down into different crab management areas. Next, it was asked that since there are little if any crab in the trawl in 2J North, if there was a complete dependence on the post-season trap survey data. It was clarified that the negligible trawl catches were in 2H where there is minimal fishing activity. A participant noted that the exploratory fishery in 2H last year caught very few crab, which seemed to complement the data. There was a comment about how odd it was that the CPUE in 2HJ shows the opposite trend when including all stations compared to the core stations. An increase in CPUE was also seen in the trawl data. However, the large magnitude of difference could be because including all areas tends to increase catch rates for all categories of crabs (e.g., female, smaller crab). There was also low coverage in the 2J CPS survey, so it could be an effect of survey coverage. Following this, it was noted that in the small mesh trap figure, the CPS survey is used to represent all of 2HJ. A second request to make the Torngat survey more comparable to the CPS survey was made, to get a larger picture of 2HJ. Subsequently, there was a question about why reducing exploitation in 2HJ in recent years has not seemed to have an impact on exploitable biomass in the area. It was explained that the predation mortality index in 2HJ is high as well. A participant asked if it was possible to model what the future of 2HJ looks like with other environmental factors included. It was explained that environmental factors and predation have delayed effects on the stock, so if they are the driving signals, they will manifest into the stock later in time. The exploitation rate and mortality rate are consistent with each other, so it is likely that the fishery has a dominant influence. A 60% exploitation rate as seen in 2HJ is high for any fishery irrespective of what is happening in the environment. There is surplus mortality on top of this that gets systematically higher as the exploitation rate increases. There was concern expressed about not seeing crab in highly trawlable areas.

There was a comment that some of the map figures appear misleading because it looks like there are no crab in some areas, when this is an artifact of the low trawl survey coverage in 2021. It was explained that the reduced coverage of the trawl survey will be detailed in the Research Document (RES) and bullets, and that it is also visible from the points on the map that there was thinner coverage.

It was asked if fishing mortality (F) had been investigated independent of other factors, and it was confirmed that the exploitation rate is the measure of F.

There was a question about why discards and CPUE have been trending upward together in 3LNO in recent years when this trend is not the norm. The response was that the reason is not

known. CPUE data is from logbooks and discard data is from observer measurements. In some instances, observers are deliberately sent out for soft shell protocol (not preferred), which could lead to higher estimated discard rates. Some participants felt this observed trend in the data does not accurately reflect what is happening on the water. There was a suggestion that this phenomenon is from differences in soak times in recent years; however, the group was reminded that these are standardized indices, so they include soak time.

There were lengthy discussions related to the provisional PA Framework. There was a request for clarification on the weighting for the decision-making rule. It was clarified that predicted CPUE is the most heavily weighted, then predicted discards, followed by egg clutch. There was a request that the table for the weighting have a more detailed description of the scoring system in the caption. A question was asked what value of removal was used from the projected 2022 point in the 'projected stock status' figure. It was explained that the 2022 removal is 'status quo', so the same as 2021. Following these questions, there were discussions about what parts of the PA Framework to put in the SAR. It was noted that the working group is not at a consensus yet and the PA Framework is still preliminary, so there was concern about interpretation by the public and harvesters. On the other hand, it was noted that some versions of the PA Framework figures are important for transparency if used to help inform harvest decisions and to meet the Terms of Reference for the meeting. There were requests to include the graphs with the upper stock limits with the wording that it is provisional because this shows progress from last year and changes in upper stock references. The consensus of the group was to include the predicted CPUE, predicted discards, and egg clutch figures with the upper stock limit changed to a dashed line with a mention about it being provisional in the figure caption. For the stock status plot, the consensus was to change it to a time series of stock health scores without ERIs and HCRs, as these are still being finalized. This decision was favoured because it shows how the PA Framework relates to the history of the stock. There was discussion about what terminology should be used for the decision-making rule weighting table to avoid it sounding finalized. It was agreed that a scoring system for determining stock status was appropriate terminology.

REVIEWER REPORTS

Reviewer One

Reviewer one noted that thinking about how to manage stocks at the edges of their range moving forward will be important, and continues to be important. They were satisfied with the methods used to fill in the gaps in survey data, and how the PA Framework was progressing. They felt this satisfied the objectives in the Terms of Reference.

Reviewer Two

The second reviewer outlined what they believed were the main points from these meetings. Firstly, they noted that the NAO index seemed to be similar to how it was in the 1990s, but the impact on the sea temperature seemed to be different, so something has happened. They stated that it is important to remember the change in zooplankton to something with more energy, and to monitor the responses to these changes. They believed it would be interesting to put together all of the different assumptions related to the bioregion and ecosystem predictions and to use these to try to understand what is happening in 2HJ. They stated that it would be beneficial to try to link all of these different results presented to give more central information to the public and to people who do not have all of the individual details from the meeting. Following this, they thought it important to consider if future recruit predictions are too high for the system to sustain, even with positive trends.

They noted that, in relation to using the models to fill in the gaps for the missing 3LNO survey, seven models were shown. However, many other models (e.g., with different parameters) were likely run prior to the selection of these models, so a lot more work was done than the seven models shown. Also, it would have been beneficial to have more explanations of the complex models because they are not always easy to comprehend, and giving more information to allow more people to be involved is always beneficial.

This reviewer was satisfied with the conversation surrounding the PA Framework because it well-characterized what has happened in the past year for the stocks.

RESEARCH RECOMMENDATIONS

- Monitor for potential impacts of ocean acidification on Snow Crab.
- Continue investigations of discard mortality.
- Further investigations of predation and environmental drivers on Snow Crab.
- Continue alternative modeling work to fill gaps in cases of data deficiencies.
- Investigate impacts of low observer coverage on estimates of F, discards, and incidence of soft shells.

Discussion

It was mentioned that exploring the impacts of missing areas in the new CPS survey should be done in the future, but that it was not substantial enough to be a research recommendation.

Understanding the impacts of predation was especially of interest in 2HJ where there is increased predation.

SCIENCE ADVISORY REPORT BULLET DISCUSSION

Overall – Divisions 2HJ3KLNOP4R

For the second bullet summarizing ERIs, there was discussion about why the exploitation rate is so high, even after quotas have been reduced. The calculation for this uses the biomass and what the removals are, so the exploitation rate is high because the biomass is very low with minimal recruitment in recent years.

There was some concern about the lack of summary points per AD. The AD bullet was incorporated into the overall section because there was only one. Additionally, there was concern about consecutive years of missing surveys. This will be noted as a data limitation in the SAR.

Environment and Ecosystem

For the third bullet summarizing ecosystem productivity, the main discussion focused on the suitability of stating that the community is dominated by finfish when considering that cod is at a low stock level in 3Ps. It was clarified that this means that most of the current biomass is finfishes but does not mean that the biomass is as high as it has been historically. A participant noted that there needs to be more research on the productivity state, as it is a knowledge gap that is not explained well and there needs to be research to clarify what exactly a ‘low’ or ‘high’ productivity state entails.

APPENDIX I – TERMS OF REFERENCE

STOCK ASSESSMENT OF 2HJ3KLNOP4R SNOW CRAB

Regional Advisory Meeting – Newfoundland and Labrador Region

February 22-25, 2022

Virtual Meeting

Co-Chairpersons: Travis Van Leeuwen and Kristin Loughlin, DFO Science

Context

The status of Divisions 2HJ3KLNOP4R Snow Crab was assessed in 2021.The current assessment was requested by Fisheries Management to provide current information on the status of the resource and to provide the science advice that will be used in the 2022 Snow Crab Management Plan.

Objectives

- To assess the status of Snow Crab in Divisions 2HJ3KLNOP4R;
- To determine the impacts of various harvest levels on stock status; and
- Consider ecosystem status where the assessed stock occurs based on an overview including relevant summaries of oceanographic conditions, biological community structure and trends, and pertinent knowledge of ecological interactions (e.g., predator, prey) and stressors (e.g., anthropogenic impacts).

Expected Publications

- Science Advisory Report
- Proceedings
- Research Document

Participation

- Fisheries and Oceans Canada (DFO) Science and Fisheries Management
- Province of Newfoundland and Labrador - Department of Fisheries, Forestry, and Agriculture
- Government of Nunatsiavut
- Indigenous Groups
- Fishing Industry
- Academia
- Other invited experts

APPENDIX II – MEETING AGENDA

Regional Advisory Meeting: Stock Assessment of 2HJ3KLNOP4R Snow Crab

February 22-24, 2022

Chairpersons: Travis Van Leeuwen and Kristin Loughlin

Tuesday, February 22

Activity	Presenter
Opening, Terms of Reference and Introductions	Co-Chairs
Opening Remarks from the Regional Director of Science	A. Mansour
Presentation: Physical conditions of the NL shelf waters	F. Cyr
Presentation: Biogeochemical conditions of the NL shelf waters	D. Bélanger
Presentation: Structure, trends and ecological interactions in the marine community of the Newfoundland-Labrador bioregion	M. Koen-Alonso
Presentation: Data limitations and shifting focus on data inputs	J. Pantin & D. Mullowney

Wednesday, February 23

Activity	Presenter
Continued Discussion of Presentation: Data limitations and shifting focus on data inputs	J. Pantin & D. Mullowney
Presentation: Divisions 2HJ3KLNOP4R Overview – Standard Assessment	J. Pantin

Thursday, February 24

Activity	Presenter
Continued Discussion of Presentation: Divisions 2HJ3KLNOP4R Overview – Standard Assessment	J. Pantin
Reviewer Conclusions	-
Research Recommendations	ALL
Science Advisory Report Bullets	ALL
Upgrading of working paper to research document	ALL
ADJOURN	Co-Chairs

APPENDIX III – LIST OF PARTICIPANTS

Name	Affiliation
Kristin Loughlin	DFO-NL – Science
Travis Van Leeuwen	DFO-NL – Science
Dale Richards	DFO-NL – Centre for Science Advice
Diane Johnston	DFO-NCR – Centre for Science Advice
Janet Lucas-Cantwell	DFO-NL – Centre for Science Advice
Hilary Rockwood	DFO-NL – Centre for Science Advice
David Small	DFO-NL – Resource Management
Laurie Hawkins	DFO-NL – Resource Management
Mark Simms	DFO-NL – Resource Management
Martin Henri	DFO-NL – Resource Management
Ryan Critch	DFO-NL – Communications
Aaron Adamack	DFO-NL – Science
Atef Mansour	DFO-NL – Science
Brian Healey	DFO-NL – Science
Brittany Pye	DFO-NL – Science
Darrell Mullowney	DFO-NL – Science
Darren Sullivan	DFO-NL – Science
David Belanger	DFO-NL – Science
Elaine Hynick	DFO-NL – Science
Elizabeth Coughlan	DFO-NL – Science
Erika Parrill	DFO-NL – Science
Frédéric Cyr	DFO-NL – Science
Jessica Desforges	DFO-NL – Science
Julia Pantin	DFO-NL – Science
Kaitlyn Charmley	DFO-NL – Science
Katherine Skanes	DFO-NL – Science
Krista Baker	DFO-NL – Science
Lottie Bennett	DFO-NCR – Science
Mariano Koen-Alonso	DFO-NL – Science
Robert Deering	DFO-NL – Science
Sanaollah Zabihi-Seissan	DFO-NL – Science

Name	Affiliation
Sarah Loboda	DFO-Quebec – Science
Stephanie Boudreau	DFO-Gulf – Science
Steve Snook	DFO-NL – Science
Will Coffey	DFO-NL – Science
Anna Tilley	Fisheries, Forestry and Agriculture NL
Andrew Careen	Fish, Food and Allied Workers Union
April Wiseman	Fish, Food and Allied Workers Union
Brian Careen	Fish, Food and Allied Workers Union
Chad Strugnell	Fish, Food and Allied Workers Union
Darren Boland	Fish, Food and Allied Workers Union
Erin Carruthers	Fish, Food and Allied Workers Union
Jim Chidley	Fish, Food and Allied Workers Union
Miranda McGrath	Fish, Food and Allied Workers Union
Trevor Jones	Fish, Food and Allied Workers Union
Derek Butler	Association of Seafood Producers
Todd Broomfield	Nunatsiavut Government
Rob Coombs	Nunatukavut Community Council
Craig Taylor	Torngat Secretariat
Ron Johnson	Torngat Fish Co-op
Martial Laurans	French Research Institute for Exploitation of the Sea
Scott Grant	Memorial University – Marine Institute