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Proceedings Series 2009/051 | **Compte rendu 2009/051**

Proceedings of the Meeting of the Newfoundland and Labrador Regional Advisory Process on 3Ps Cod

Réunion du Processus de consultation scientifique régional de Terre-Neuve et du Labrador sur la morue de 3Ps

September 29 – October 2, 2009
St. John's, NL

Du 29 septembre au 2 octobre 2009
St. John's, T.-N.-L.

Meeting Chairperson
Karen Dwyer

Présidente de la réunion
Karen Dwyer

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February 2010 | **Février 2010**

Canada

Foreword

The purpose of these Proceedings is to document the activities and key discussions of the meeting. The Proceedings include research recommendations, uncertainties, and the rationale for decisions made by the meeting. Proceedings 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.

Avant-propos

Le présent compte rendu a pour but de documenter les principales activités et discussions qui ont eu lieu au cours de la réunion. Il contient des recommandations sur les recherches à effectuer, traite des incertitudes et expose les motifs ayant mené à la prise de décisions pendant la réunion. En outre, il fait état de données, d'analyses ou d'interprétations passées en revue et rejetées pour des raisons scientifiques, en donnant la raison du rejet. Bien que les interprétations et les opinions contenus dans le présent rapport puissent être inexacts ou propres à induire en erreur, ils sont quand même reproduits aussi fidèlement que possible afin de refléter les échanges tenus au cours de la réunion. Ainsi, aucune partie de ce rapport ne doit être considéré en tant que reflet des conclusions de la réunion, à moins d'indication précise en ce sens. De plus, un examen ultérieur de la question pourrait entraîner des changements aux conclusions, notamment si l'information supplémentaire pertinente, non disponible au moment de la réunion, est fournie par la suite. Finalement, dans les rares cas où des opinions divergentes sont exprimées officiellement, celles-ci sont également consignées dans les annexes du compte rendu.

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ISSN 1701-1272 (Printed / Imprimé)
ISSN 1701-1280 (Online / En ligne)

Published and available free from:
Une publication gratuite de :

Fisheries and Oceans Canada / Pêches et Océans Canada
Canadian Science Advisory Secretariat / Secrétariat canadien de consultation scientifique
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Ottawa, Ontario
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Correct citation for this publication:

DFO. 2010. Proceedings of the Meeting of the Newfoundland and Labrador Regional Advisory Process on 3Ps Cod; September 29-October 2, 2009. DFO Can. Sci. Advis. Sec. Proceed. Ser. 2009/051.

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SUMMARY

A meeting of the Newfoundland and Labrador Regional Advisory Process (RAP) on Cod was held September 29 – October 2, 2009 in St. John's, Newfoundland. Its purpose was to assess the cod stock in Subdivision 3Ps.

A Science Advisory Report (SAR), which includes summary bullets, was written and reviewed during the meeting. Detailed rapporteur's notes of discussion on each working paper presented at the RAP, in question-and-answer/comment-and-response form, were produced. This Proceedings Report includes an abstract and summary of discussion for each working paper presented, progress on research recommendations from the 2009 ZAP that were reported on, along with a new research recommendations from this RAP.

SOMMAIRE

Une réunion du Processus de consultation scientifique régional (PCSR) de Terre-Neuve et du Labrador sur la morue de 3Ps a eu lieu du 29 septembre au 2 octobre 2009, à St. John's, à Terre-Neuve. Le but de la réunion était d'évaluer le stock de morue de la sous-division 3Ps.

Pendant la réunion, on a formulé et passé en revue un avis scientifique (AS) comportant des points de sommaire. Les notes détaillées prises par le rapporteur pour chaque document de travail présenté pendant le PCSR ont été produites sous la forme de questions/réponses – commentaires/réponses. Le présent compte rendu comprend un résumé ainsi qu'un sommaire de la discussion pour chaque document de travail présenté, sur les progrès accomplis concernant les recommandations en matière de recherche du PCSZ de 2009 et une nouvelle liste de recommandations en matière de recherche, formulées dans le cadre du présent PCSR.

INTRODUCTION

A meeting of the Newfoundland and Labrador Regional Advisory Process (RAP) on Cod was held from September 29 – October 2, 2009 in St. John's, NL to assess the cod stock in NAFO Subdivision 3Ps. The terms of reference (ToR), the agenda, and lists of participants and working papers presented at the meeting are provided in Appendices I through IV, respectively.

Participation included personnel from DFO Science (Newfoundland and Labrador) and Fisheries and Aquaculture Management Branches, and representatives from the fishing industry, FFAW, the Provincial Department of Fisheries and Aquaculture and Memorial University.

Open discussion and debate proceeded during and after each presentation. Consensus was reached on summary bullets of results of the assessment and these are included in the Science Advisory Report (SAR) written and reviewed during the meting.

These proceedings contain abstracts for working papers presented and summaries of the discussion on each. Additional information can be found in the associated SAR and in research documents cited or from contacts provided therein.

PROCEEDINGS

Working Paper Abstracts and Discussion Summaries

Presenter – J. Morgan (on behalf of M. Koen-Alonso)

Presentation title: Ecosystem overview: RV trends for major biological components in NAFO Subdivision 3Ps by M. Koen-Alonso

Abstract – This presentation examines the trends of major fish functional groups based on research vessel (RV) winter-spring surveys for NAFO Sub-Div. 3Ps. These analyses cover the period from the early 1980s until 2008. It also examines trends in shrimp and snow crab since 1996, when the Campelen trawl replaced the Engels trawl used in previous years. As first observation, there is an apparent increase in overall fish biomass between 1983 and 1985, but it is unclear if this sudden increase is real or if it is associated with survey/sampling issues during the initial years of the survey. Nonetheless, there is an important (and real) overall decline in fish biomass between 1985 and 1993. This decline involves most fish functional groups; only plankton-piscivores (dominated by redfish) do not show this negative trend. During this period, declines in abundance are not as marked; prompting a reduction in the average size of fish in several fish functional groups. Although overall biomass appears to show some slight hint of increase during 1994-95, there is no clear trend in the period 1995-2005. Some functional groups may have increase its biomass slightly within this period (e.g. piscivores, small benthivores), but by 2005-06 most functional groups are not much higher to the point they were in 1995. This quasi-stability suggests that, despite the lack of conversion factors between Engels and Campelen gears for most species, the fish community did not recover from the decline in biomass observed during the Engels period. In 2006-2008, there is an increase in overall fish biomass and abundance, but this increase is almost exclusively driven by redfish. Snow crab and shrimp biomasses showed clear declines in1996-98, but crab continued to show a declining trend afterward while shrimp increased in the following years, reaching in 2008 similar levels to the ones observed in 1996-97. The peak in shrimp biomass was observed in 2006. Overall this analysis indicates that the fish community in NAFO Sub-Div. 3Ps clearly

declined between the late 1980s and early 1990s. Since this decline is observed across fish functional groups and includes both commercial and non-commercial species, it suggests than some underlying environmental/ecosystem conditions could have affected the overall productivity of the fish community. This potential change in productivity does not preclude that trends in commercial stocks could have been driven by fishing; in any case the observed trends in these commercial stocks should be the result of both types of pressures acting synergistically. Even though this decline was comparatively not as severe as the ones observed in other regions (e.g. NAFO Div. 2J3KL), still it has not returned to the levels (and size structure) observed in the mid-late 1980s.

This presentation was prepared by the ERI-NERUS program. Contact person: Mariano Koen-Alonso (Mariano.Koen-Alonso@dfo-mpo.gc.ca).

Discussion – There have been shifts in timing of the RV survey from April in 1983-84 to March in 1985-86, to February in 1987- 93, and back to April in 1993-2009. The BA ratio (mean weight per tow divided by mean number per tow) over the time series might have been affected by these shifts. Fish may not be feeding as much during the winter and a lower biomass during winter surveys would be expected. This could be looked at by comparing the winter and spring surveys that were done in 1993. However, the major decline in biomass during the Engels portion of the time series occurred after 1987 when the survey was consistently done in February.

It wasn't clear if all or just index strata or whether inshore strata are included in this analysis. Although the data have been adjusted for differences in swept area, the Engels data have not been converted to Campelen equivalents. The Campelen trawl catches much more small fish than the Engels. Catchability of larger fish is similar, except that it might be somewhat lower for cod. Overall, however, the two series are not comparable and the biomass level during the Engels period (1983-1995) relative to the Campelen period (1996-2009) is unknown for all species considered in this analysis. Nevertheless, there was a downward trend in biomass during the Engels series, and during the Campelen series there has been a slight increasing trend, except for a spike due to redfish in one species group. These trends apply only to the various fish communities – no shellfish, benthos or plankton are included. Fish groups include many species and it is not presently known which species may be driving trends. The stacking plots used to display results are not clear and it would be useful to display them differently to make trends within and between the various species groups clearer. Its purpose, however, has been to show overall productivity in the ecosystem rather than focus on individual species or groups.

Since catches in the Engels and Campelen series are not comparable, it is not possible to conclude that productivity has been lower in the recent period than during the 1980s. Also, the suggestion that the fish community in 3Ps has still not returned to the levels and size structure observed in the mid-late 1980s, as well as other similar statements, go beyond the analysis of the data.

Presenter – D. Maddock Parsons

Presentation title: Update of Sentinel Survey Results in NAFO Subdivision 3Ps for 2009 by D. Maddock Parsons and R. Stead

Abstract – In 2009, 13 enterprises in NAFO subdivision 3Ps continued to collect biological, catch and effort data on Atlantic Cod in Sentinel Surveys. Data are updated only to mid-September (due to the timing of the assessment) and therefore results are preliminary. Standardization of the data for time and location effects was not possible (due to having only part of the survey year completed), therefore these preliminary results are based on unstandardized data. Of the three gear types employed in the survey, the two gillnet gears (5 ½" and 3 ¼") both showed similar catch rates to the preceding few years, still much lower than the earlier part of the time series. Linetrawl catch rates improved from 2008, and continued the general increasing trend seen since 2000 when the catch rates had declined steeply from 1997, the highest in the series. Length frequency distributions in all three gear types were similar to recent years.

Discussion – Complete Sentinel survey data up to 2008 were reviewed at the ZAP. At this time data for 2009 (up to mid-September) are ~ 80% complete for gillnets and ~ 40% for linetrawls – results are preliminary. Unstandardized catch rates are up slightly in the linetrawl fishery.

The RV survey has shown a strong 2006 year class, but there is no indication that these have shown up yet in the 3.25" gillnets used in the Sentinel survey. This is consistent with data from the larger mesh gillnets which don't seem to track the survey very well either. However, especially in years that the fishery is supported by relatively weak year classes, the weekly breakdown shows that large catches tend to come near the end of the year, and the 2009 Sentinel survey has not yet started at certain locations. Small (14") fish (probably the 2006 year class) have been showing up in the commercial linetrawl fishery of late and will eventually show up in the Sentinel survey.

Water hauls (zero catches) were high in the first year (1995) of the Sentinel survey, largely because of a February start in Placentia Bay, but dropped considerably thereafter. Water hauls have been a common feature and changes from year to year have not been interpreted. This has not been analyzed in any way and should not be considered in isolation from other data from the survey.

Presenter – B. Healey

Presentation title: Assessment of Cod in NAFO Subdivision 3Ps by B. Healey, E. Murphy, J. Brattey, N. Cadigan, D. Maddock Parsons, M. J. Morgan, R. Rideout, and J.-C. Mahé

Abstract – Several sources of information were used to update the status of cod in NAFO subDivision 3Ps. This stock was most recently assessed during the Zonal Cod assessment meeting held during February and March of 2009. Results from the DFO 2009 bottom-trawl multi-species survey, logbook information through 2008 (for vessels <35' only) and sentinel results for 2009 (year-to-date) were the only sources of new sources information available since the previous assessment.

A detailed description of recent commercial fisheries was provided. Commercial catches by Canada and France combined for the 2007/08 and 2008/09 management years were 12,900 t and 12,600 t, respectively. The TAC was reduced to 11,500 t for the 2009/2010 management

year, but considering that most of the effort has yet to take place, it is too early to assess the impact of this TAC on stock status.

Updated Catch per unit of effort (CPUE) information was available only for Canadian vessels <35'. Estimated gillnet catch rates for <35' vessels declined sharply from 1998 to 1999, and have subsequently remained relatively constant at a much lower level. The <35' line-trawl CPUE increased by more than 50% over 2002 to 2006. The CPUE index has since declined but remains relatively high.

Research vessel surveys are conducted annually in spring and provide fishery-independent data on the status of the resource. After seven years of generally consistent declines in both survey abundance and biomass, spring survey results indicate a 75% increase in abundance and 138% increase in biomass between 2008 and 2009. This is not biologically possible (numbers of fish in a given year-class cannot increase over time); hence the 2008 and/or 2009 results are subject to a "year-effect", an atypical survey result that can be caused by a number of factors which may be unrelated to absolute stock size. Thus the current status and recent trends in the stock are somewhat more uncertain due to the nature of the change in the survey index between 2008 and 2009. The distribution of catches in 2009 was similar, with the survey totals dominated by tows around/on Burgeo Bank and also in the Halibut Channel.

Previous assessments noted that the 2006 year-class appeared to be relatively strong in the RV surveys at both age 1 (in the 2007 survey) and also at age 2 (2008 RV survey). During the 2009 survey, the 2006 year-class (age 3) was relatively strong compared to age 3 data from previous surveys, and catches of this year-class were distributed across a large portion of the surveyed area. More recent year-classes appear to be of average strength (based upon the limited observations available thus far). Biological sampling of research vessel catches indicate that mean length and weight at age has declined in recent years. Data on cod condition (liver index), available since 1994, indicate similar patterns as noted for mean length and weight at age. Estimates of proportion mature indicate some increases in the age at which 50% of females are mature in recent cohorts, but that these estimates are much lower than those for cohorts prior to the mid-1980's.

Relative year-class strength for the 1994-2007 cohorts were estimated from DFO and GEAC survey data. Results indicated that the 1997, 1998 and 2006 year-classes were much stronger than all other year-classes. However, as noted, the 2006 year-class will not fully recruit to the fishery until 2011, and estimates are based only upon survey information at ages 1 and 2.

Discussion – Overall, about 50% of logbooks for the inshore fishery are being returned. The quality control process reduces the data so that only 23% of the gillnet and 31% of the linetrawl catch was covered by the logbooks used in the analysis of catch rates. There are reasons other than logbooks not being returned why much of the catch is not captured in this analysis. Cod quota taken as by-catch in other fisheries, for example, are not included.

Catch samplers indicate that much of the gillnet catch is reported as taken on linetrawls – it could be as much as one third of the gillnet catch in 3Ps. This practice is driven by a price differential as much as 10 cents/pound higher for linetrawl-caught fish – this is a possible source of mis-information that could end up in the analysis of logbook data. However, fishers indicate that the logbook data are not distorted by this practice, rather what is reported to buyers is distorted to take advantage of the higher price.

There is high variability in plots of annual residuals for standardized catch rates in the inshore fishery, along with differences in trends between different areas – this is expected. The data are not area weighted and there is no measure of the size of different inshore areas. The residuals are not large deviations and show that the trends in catch rates over time have been slightly different from one inshore location to another.

There are many factors that could be involved – migrations, feed, seasonality – and high variability in catch rates in these fixed-gear fisheries is the norm. Stock components available to widespread inshore locations would differ and local catch rates would not reflect an overall stock trend. Rather they reflect movements of fish and inter-annual variation in movement patterns within the inshore area. These differences could also reflect differences in the abundance, availability and movements of bait fish within the inshore area.

There have been major changes in the RV survey over the time series. Spatial coverage has changed (inshore strata added in 1994 and 1997) along with timing (switch from winter to April in 1993) and a switch to a different trawl (Engels to Campelen) in 1996. The survey index for the Engels period is expressed in Campelen equivalents based on comparative fishing done when the Campelen trawl was introduced. There is limited coverage of Placentia Bay. The inner and western portions of the bay are not covered by the strata added at the mouth of the bay. Just how far into the bay the survey extends in a given year depends on the random set allocation for inner-most inshore strata.

A strong year effect is evident in the 1997 survey, the first year with the additional inshore strata. A year effect is an atypical survey result that can be caused by a number of factors (e.g. environmental conditions, movement, degree of aggregation, etc.) which may be unrelated to absolute stock size. It was decided that the long-term average of the various indices since then should consistently start with the 1998 survey.

It was felt that movements of cod into and out of 3Ps are the main contributor to year effects in the survey. These include excursions of 3Ps cod outside the survey area at the time of the survey (inshore and at the boundary with 3O), as well as incursions of Gulf fish, especially in winter. Movement of fish across boundaries is probably more of an issue for 3Ps than elsewhere, and large annual changes in these movements appear to be involved. Variations in the timing of movements in and out of the survey area in relation to the time of the survey mean that the portion of the stock available to the survey is not consistent from year to year. This may be a major source of uncertainty in the 3Ps survey.

In graphs presented there appeared to be differences between the abundance index and area-weighted mean number per tow, but these should be the same if area covered is the same. In terms of spatial coverage, the only problem with the survey time series being used now is the incomplete survey in 2006. In other years there may have been differences in number of sets but all strata were covered with the minimum 2 sets. With use of index strata, there is consistency over the series and trends in mean numbers and mean weights per tow should be identical to biomass and abundance.

An examination of the age-structure of the 2009 results showed that for many cohorts, abundance in 2009 was greater than the survey abundance for 2008. This should not occur for age groups that are fully selected by the trawl. In fact, there were increases in mean number per tow across all ages up to age 9 in the 2009 survey (compared to the 2008 results for common cohorts).This causes uncertainty. It could be due to a year effect. The 2008 index may be too low or 2009 too high or both. There was nothing very different in the plots of bottom temperature

between 2008 and 2009 that could explain the difference in the 2009 survey. While it was a little warmer in 2009, temperatures were within the range preferred by cod.

With the shift in age composition in 2009, the proportion at age of the 2006 year class went down, but it is still relatively high in terms of absolute survey abundance. Ages 11-13 increased in the survey in 2009 as well. Catches of these older fish were relatively low but spatially distributed like the younger fish and not just from a single set or stratum. The differences in individual cohorts between 2007 and 2009 are generally not large, however, this shift needs to be highlighted and explained in terms of what it might mean in terms of management advice. The 2006 year class is comparable to the strong year classes of 1997 and 1998. They apparently have started showing up in the linetrawl fishery this year, and will be even more susceptible to that gear in 2010 – this should be brought to the attention of management. They are not likely to contribute to the mature population until age 5 in 2011. Any caution to managers to protect this year class until then would have to relate to small fish (< 45 cm) protocols and discarding.

The age 1 index in the 2009 survey is fairly high compared to the 1997-98 year classes and, although it was dominated by a single tow in Fortune Bay, a large portion came from tows elsewhere. It was spread throughout the survey area, but compared to the 2006 year class at age 1, it was not as evenly distributed and there were not as many large tows. The evidence for a strong 2008 year class is not as good as it was for the 2006 year class in 2007. There is further uncertainty regarding its relative strength because of the possibility of year effects in 2008-09.

Plots of biological indicators from RV sampling include some data from the 1970s and early 1980s for which there has been no conversion. High values in that period when coverage was much less may be an artifact, although trends might not be affected. The data are for index strata only and the differences are not as great as if all the data had been used. Nevertheless, consideration is needed on whether the early data should be part of trends or included in the long-term means to which recent values are compared.

A comparison of weights at age over time in survey and commercial catches was presented which addressed a research recommendation from the ZAP. The patterns were similar in each data set, but those from the survey were based on much less data and showed more noise. The commercial data were derived from length converted to weight using a length-weight relationship, whereas the RV data were based on weights of individual fish, a level of detail not captured for commercial catches which also contributes to noise in the survey data.

A length-at-age plot showed that the growth rate of young fish especially is lower in the last three years than in the past, in fact growth to age 4 is the lowest in the time series. The 2003, 2004 and 2005 cohorts are about 5 cm smaller at age 5 than the 1997-98 cohorts, and are the slowest growing cohorts in many years.

Also, the proportion of females mature at age for the three recent cohorts is among the highest observed. However, the age at 50% mature has been increasing, and possibly moving towards levels considered more typical of historical conditions. In three size groupings above 35 cm, the liver index, a measure of condition, was among the lowest observed since the early 1990s. A graph for all sizes $\geq$ 20 cm showed an increase between 2008 and 2009 but was still lower than many years.

While it has been suggested that slow growth is consistent with high fishing mortality because the fastest growers are cropped off by the fishery, in 3PS it is considered more likely to be associated with environmental/ecological conditions. In the past capelin were much more abundant in 3Ps than in recent years. They are presently scarce in Placentia Bay as well as in Fortune Bay and the most abundant bait fish for cod is sand lance. A study some years ago on growth and feeding of cod in Placentia Bay showed that capelin availability explained most of the variability in growth even though cod feed on a wide variety of prey. This is consistent with the decline in growth rate being driven by a change in environmental conditions.

Slow growth, poor condition, early maturation and limited food supply suggest that overall stock health (productivity) has been low in recent years. However, it is too early to say if there has been real biological change in the 3Ps cod stock. There is uncertainty about recent cohorts because of limited data. Estimates of biological indicators have wide, asymmetrical error bars with the upper limit tending to be large. The changes observed are within the trend of the recent past.

There has been inconsistency in the age groups included in the estimation of Z using SURBA. It was decided that ages 4-11, rather than ages 4 or 5 to 12, would be used consistently for this purpose. Estimates of Z are based entirely on survey numbers at age from one year to the next – there no data from the fishery involved. Z's are highly variable because of noisy survey data and the focus is on trends and longer-term averages rather than absolute values. Total mortality increased steadily after the moratorium up to 2005 but has varied without trend over the recent period. Estimates for 2005-08 average .5 and .66 (40-50%) for the flat and domed catchability assumptions, respectively. This high level of mortality is a concern.

Although there is uncertainty about year effects in the 2008 and/or 2009 surveys, the biomass increase in 2009 indicates that the declining trend up to 2008 did not continue. The impact of the reduction in TAC from 13,000 to 11,500 t for 2009-10 might not be detectable, however, the 2009 survey indicates improvement in the stock at the higher TAC. Clearly though, the upcoming fishery will be supported mainly by the weak cohorts that preceded the strong 2006 year class. Also, cohorts about to enter the fishery have been slow growing which means more fish will be required for a given TAC resulting in a higher F.

Presenter – J. Brattey

Presentation title: <u>Cod tagging in 3Ps – a brief update</u> by J. Brattey

Abstract – Since the previous assessment in February 2009, further tagging has been conducted and approximately 2,500 cod were tagged with Floy t-bar anchor tags and released in Placentia Bay. The 2009-10 fishery is only partially completed and it was not possible to calculate exploitation rates for the current fishing year. To date a total of 98 tags had been received from tagging experiments conducted in 3Ps since 2007, including 53 from those release in 2009 (2% return). Updated plots of the distribution of tag returns from the 2009 fishery did not reveal any unusual patterns

Discussion – When tagged fish are caught while tagging operations are being carried out in the vicinity of concentrated commercial fishing activity, as sometimes happens in the bottom of Placentia Bay, fishers presume these are fish tagged within the last few days and wonder how results are affected by recaptures so soon after tagging. While researchers try to avoid that kind of situation, results are not affected as long as the tags are returned. Such recaptures are removed and not counted as tagged fish in the population when calculations are done.

It is unusual to recapture a tagged cod until at least a couple of weeks after tagging and only a few tagged fish are recaptured within the year of tagging. Apparently, their behavior is affected for a while before any are caught again. Any tagged fish caught near a tagging operation are more likely to be from tagging in previous years.

It was felt that more could be done with tagging data and perhaps it would be useful to have a research recommendation about further analyses. A general research recommendation had been made at the ZAP as follows: Integrate tagging results more directly into stock assessment models (multi-year research). It was agreed that this
recommendation satisfied the concerns and should simply be carried forward.

Presenter – J. Morgan

Presentation title: Spawning time in 3Ps cod – by J. Morgan and R. Rideout

Abstract – This WP addressed the following ToR for the assessment of 3Ps cod: 'There is currently a spawning period from March 1 – June 30 for the offshore and April 1 – May 30 for the inshore. Since some fleets have requested to fish cod during these times, are these spawning times still accurate? What is the impact of cod removals in the range of 500t in March and April.'

Data from the DFO multispecies survey from 1972-2009 were analysed to determine time of spawning of cod in 3Ps. Data for the offshore and inshore strata of the survey were modelled separately. In addition the proportion of female fish in various maturity stages in April was calculated for inshore and offshore strata separately.

The data from the DFO survey do not show any trends that would indicate a shift in spawning time. The current spawning closure in the offshore appears to encompass most of the spawning period. Spawning time could not be estimated from the inshore but previous studies have found spawning fish from March to August.

Discussion – There has been criticism that management allows fishing in the offshore in January when a lot of spawning is going on. However, this analysis found the earliest indication of spawning in 1987 when 20% of the fish were spent on day 65 (early March). Spawning may go on for a month or more in individual fish, so it is possible there may be some spawning in late January/early February in some years. However, they may have large gonads in January and be mistaken for spawning fish. Observer data for the offshore also provides evidence that there is no spawning in January-February. There was no indication in the analysis of a trend to spawning earlier in the year.

The s-shaped curves of proportion spent in relation to time of year are from RV survey data which are extrapolated beyond the survey time each year. There were no estimates for 1987-1993 when the survey was in February because there were no spent fish taken and the proportion spent can not be modeled if there are no spent fish in the sampling. The timing of the survey does have some impact on estimating proportion spent, but the key is that at some time of the year the proportion spent will go to 1. This modeling could not be done based on spawning fish because time of spawning varies a great deal between individual fish and the proportion never goes to 1. To work, the model requires sufficient difference in the proportion spent within the 2-week timeframe of a survey in a given year. The short survey makes it more difficult to fit the model and is the reason why there are so few years it can be done.

Spatial variation in age (size) at maturity throughout the survey area within the time of a survey may also affect this modeling, but there are insufficient data to determine if there are different spawning periods in different parts of 3Ps. Individual fish spawn at different times and in batches over extended periods, and spatial variability could be part of the inter-annual variation in the spawning time curves.

Large aggregations of fish occur in offshore areas of 3Ps during winter and there has been a suggestion that trawlers are dragging through these during the winter fishery.
While it isn't known if these are pre-spawning or over-wintering aggregations, cod tend to form large groups prior to spawning. They don't necessarily spawn where large groups are located. In other areas, fish form large groups on the edge of the Bank and move up onto the Bank to spawn. Spawning also occurs during migrations. These aggregations then may or may not have something to do with spawning.

The TOR which triggered this review of spawning time states that there is a spawning period (i.e. closed time) from April 1 to June 30 for the offshore area of 3Ps, however, the closure is actually from March 1. The TOR also asked for the impact of removals in the range of 500 t in March and April. The issue is what will happen if fish are taken out of the population during spawning time as opposed to disrupting the fish while spawning. However, there was no basis for drawing any conclusion one way or the other regarding the impact of removals during the spawning period.

The foregoing lead to a more general consideration of the best time of year to catch fish, which is when they weigh the most because that would result in higher yields and fewer fish removed from the population. The TAC is based on round weight. Fish are landed head on/gutted and a conversion factor is used to determine equivalent round weight. Fishing when the head on/gutted weight is highest would result in the fewest fish removed for a given TAC. It has been shown and verified at the plant in Arnold's Cove during processing that the highest head on/gutted weight occurs during fall/winter and the effect of time of fishing was found to be large. The implication is that the impact on the stock of a given TAC would be less if fish are removed during the fall-winter period unless larger fish were being targeted at that time. Large fish are the prime spawners and have the best quality eggs, however, the closure avoids catching spawning fish and is seen as a good compromise.

Presenter – F. Deschamps

Presentation title: 2008 cod fishing campaign in 3Ps Saint Pierre and Miquelon inshore fishery by F. Deschamps

Abstract – For the first time, this year, the Fishing Resource Committee, from Saint Pierre and Miquelon, provided a perspective on the inshore fishery by conducting a questionnaire of fish harvesters. A total of 9 harvesters (for a total of 13 license holders) participated on this survey. Harvesters said that catch rates and abundance were the same than in 2007. Harvesters said cod were smaller, were found in an average distribution, and were in good condition. When asked about the baitfish species, there was no clear consensus on the different species. For this year, the questionnaire was derived from a similar questionnaire presented by the FFAW fish harvesters in the February 2009 ZAP meeting in St. John's. The fishing resource committee will work on a new questionnaire for next year.

Discussion – It was noted that there had been very few responses to most of the questions on baitfish, but there was no indication whether or not the responders knew the answer or whether they would not respond because they knew baitfish were very scarce. However, sometimes harvesters just wouldn't know if there were lots of certain baitfish or not depending on what gear they were using.

Responses were very similar to an FFAW questionnaire. Both groups of harvesters agreed that sand lance were plentiful.

Presenter – N. Cadigan

Presentation title: <u>SAS SURBA for 3Ps cod – 2009 RAP</u> by N. Cadigan

Abstract – SURBA is an age-based model that can be used to estimate total mortality rates and relative population size based on survey catch-at-age indices. The basis of SURBA is a simple separable model of total mortality at age *a* in year *y*: $Z_{a,y} = s_a f_y$. Population size (*N*) is modeled using the standard cohort model, $N_{a+1y+1} = N_{ay} \exp(-Z_{ay})$. Parameters are estimated using survey indices (I_{ay}) that are assumed to be related to population size via the observation equation $I_{ay} = q_a N_{ay} \exp(-pZ_{ay} + \varepsilon_{ay})$, where $pZ_{a,y}$ is the fraction of total mortality that occurs before the survey takes place, *q*'s are parameters for the survey catchability, and ε's are observation error terms. Note that beginning of year population size, $N_{a,y}$, is projected forward to the time of the survey by applying the fraction of total mortality.

In a SURBA model, population size is confounded with survey catchability. To remove this confounding, *q*'s were fixed at 1, 2, and 5 for ages 1-3, and 10 for ages 5-12. Hence, SURBA provides population size estimates that are relative to the assumed scale of the survey *q*'s. The scale of the SURBA recruitment estimates at age 1 is the same as the survey index scale at this age because $q_1 = 1$. A run with a "dome" pattern in *q*'s was presented to check the robustness of stock size trends to the assumption about catchabilities. In the dome run, q_a = 1, 2, 5, 10, 10, 10, 9, 8, 7, 6, 5, 4 for a = 1,…,12.

SURBA is a highly parameterized model (even when *q* values are fixed) and it is useful to control the variation in some parameter estimates. Shrinkage penalties were applied to reduce the between year variation in f_y's. A formulation preferred at the 2009 February cod ZAP was based on high shrinkage that resulted in smoothly varying estimates of f_y's. A similar level of shrinkage was used in the runs presented here. A small amount of shrinkage was also applied to the between age variations in s_a's

The model was applied to the expanded Campelen index (including 'new' inshore strata) for 3Ps cod, for the years 1983-2009 and ages 1-12. This model provides estimates of the size of the stock component in the survey area and at the time of the survey. This is thought to represent a large part of the 3Ps stock in total. The survey index prior to 1997, which was based only on offshore strata, was adjusted to account for the new inshore strata. This adjustment decreased mean numbers per tow at older ages by a small amount. These ages do not occur as frequently in the inshore compared to the offshore, and their mean number per tow from only offshore strata give an over-representation of their average abundance in offshore plus inshore strata.

The results indicated that biomass in the survey area increased until 2001, decreased steadily to 2008 (35% decrease in total), but increased in 2009 by 25% (compared to 2008). Estimates of spawning stock biomass (SSB) increased until 2003-04, decreased steadily to 2008, and

changed little in 2009. The 2009 value was 55% of the average SSB in 2003-04. Total mortality rates (averaged for ages 6-12) increased steadily from about 0.3 to 0.65 during 1997-2005 and have been stable since then. Results for the 'dome' sensitivity run were very similar, except that total mortality rates in 2005-2008 were about 0.50.

Discussion – The model analyses the survey biomass and SSB indices. Ages 1 and 2 are not included in the 1983-1995 Engels data (zero weight). They are included in the Campelen data and given an estimation weight of 1 but a stock weight of zero, which is why stock biomass is 3+ biomass. In this analysis, the 2006 year class (age 3 in the 2009 survey), which was not available for the analysis presented at the ZAP, was included as part of the biomass. This should explain at least some of the increase in the 2009 estimate of total biomass, although the greatest effect of adding the 2009 data was on the earlier period. However, compared to the ZAP analysis, the mature ages were more affected, and there appeared to be differences in maturity between this and the ZAP analysis.

The main difference in results of the RAP/ZAP analyses was in the predicted survey index. It was pulled up for 2008-09 and down for the late 1980s – early 1990s period in the new analysis. However, the differences between this analysis and the one presented at ZAP relates mainly to the way smoothing was done in the model. In terms of fitting the model, the new analysis explains just as much of the variation. Nevertheless, it was agreed that this needed to be looked at further for an explanation of the differences and considered again later in the meeting.

The survey time series used in the model goes back to 1983. The Engel trawl data for 1983-1995 have been converted to Campelen trawl equivalents. This Campelen adjusted index is scaled (bumped up) to account for the addition of new inshore strata to the survey in 1997. The scaling is based on mean numbers per tow at age for 1997-2009 for the offshore+inshore strata compared to the offshore-only strata.

Penalty functions (shrinkage) are applied in the model to reduce or smooth between age variation in mean number per tow at age as well as between year variation in year effects in the survey. The amount of penalty can be varied between model runs. Because of uncertainty about catchability of older fish in the survey trawl, the model is run with two different assumptions – in one (flat) catchability remains high with increasing age, in the other (domed) catchability is reduced with increasing age.

The SSB level of 1994 has been established as the limit reference point for 3Ps cod. The SURBA model estimates SSB over the survey time series relative to the LRP. It showed that in 2009 the SSB is very close to the limit reference point.

Presenter – N. Cadigan

Presentation title: <u>SAS SURBA for 3Ps cod</u> by N. Cadigan

Abstract – Several inconsistencies were apparent when comparing results from SURBA models presented at the fall 2009 cod RAP and the winter 2009 ZAP. These involved differences in SSB and model fits.

It was found that the maturities used in the ZAP were not correct. The age of the fish was incorrect and was the true age less one (a cut-and-paste problem). The correct maturities were used in this assessment. This was the major difference in the comparison of results between the two assessments. The difference in model fit was related to an error in the way a plot was

produced for the winter ZAP. This error was corrected for this assessment. Another minor difference was the way in which the shrinkage penalty terms were applied. A slightly different approach was used in the initial analyses for this assessment; however, it was decided to use the same approach as in the ZAP which is equally valid.

The preferred model formulation results (i.e. no dome) indicated that biomass in the survey area increased until 2001, decreased steadily to 2008 (35% decrease in total), but increased in 2009 by 25% (compared to 2008). Estimates of spawning stock biomass (SSB) increased until 2003-04, decreased steadily to 2008, and then decreased a lesser amount in 2009. The 2009 value was 44% of the average SSB in 2003-04. Total mortality rates (averaged for ages 6-12) increased steadily from about 0.37 to 0.65 during 1997-2005 and has been stable since then. Results for the 'dome' sensitivity run were very similar, except that total mortality rates in 2005-2008 were about 0.50.

Discussion – It was determined subsequent to the consideration of differences in SURBA results between the analyses presented at the ZAP and initially at this RAP that the maturities used in the ZAP analysis had been off by an age. There was also an error in the total observed vs predicted (model fit) plot presented at the ZAP. Both of these errors had been corrected for the RAP analysis.

In was concluded, however, that the error in maturities would not have changed the perception of the stock at the ZAP. At the ZAP it had been determined that the 2008 SSB was at the LRP, whereas based on the correct maturities it would have been slightly below – this wouldn't have changed anything in terms of advice. In the SAR produced at the ZAP, it stated that the 2008 SSB was near the LRP and there was a high probability (50%) that it was below, which is pretty much what it would have been with the correct maturities.

The updated survey adjustment (inclusion of mean numbers per tow from the 2009 survey) applied to the 1983-1996 offshore-only indices had little effect on the extended/offshore survey ratios. It affected ages 1 and 2 mostly and these are not very influential because they are given zero weight for 1983-1995 (i.e. Engels portion of the time series) in the analysis. For the relevant parts of the adjustment the error bars are identical.

Although there was no plot showing the effect of the new penalty terms used in the RAP analysis, examination of the various plots showed that it was very small. The new penalty provides no improvement to model fit. It was an arbitrary choice related to how the penalty terms are applied in smoothing. While there is a rationale for making the change, it was considered that it could not be adequately peer reviewed at this meeting. Given there was no good reason to deviate from the penalty terms used in the ZAP analysis, it was decided that a model run with the old penalty terms would be used for this RAP.

Compared to the ZAP, the perception of the stock now in terms of SSB is the same (at LRP with high probability of being lower) but is different in terms of biomass (~50% greater than LRP with low probability of being less). Biomass increased in the 2009 survey for several cohorts, including the strong 2006 year class, and this increased biomass in the model output for several recent years. There is some uncertainty about the 2006 year class being fully recruited to the survey gear, but the observed increase for other cohorts is biologically impossible, which means that the survey is off in either 2008 or 2009, or both years. The SURBA analysis splits the difference between the low 2008 and high 2009 indices.

In the past, modeling using survey data had difficulty tracking year classes, dealing with year effects and so on – these difficulties still exist for the SURBA model which uses the same data. SURBA does an assessment of the stock component that is surveyed. It does not include what might be outside the survey area at the time of the survey. Survey variability is smoothed by SURBA by using information all along each cohort – it extracts a signal from the noise. The main difficulty with VPA in the past related to scaling biomass in order to project absolute values because of problems determining catch. SURBA is not dependent on catch, it estimates biomass relative to a reference point.

Modeling provides better insight into what is happening in a stock than just looking at noisy survey data. However, it is necessary to understand constraints of the SURBA model, how it is different from models used previously, as well as why it is now being used. There are different perspectives on the status of modeling several years ago and why use of ADAPT and VPA was discontinued. A major problem in the past was several projections with very different perceptions of the stock and implications for management advice depending on use of the flat or domed assumptions about catchability of older fish in the survey – this has been debated at length. It is important now to ensure that advice is not dependent on model runs using one versus the other assumption. At present, the assessment of current stock status is robust to that assumption and both provide the same perception of the stock. Unfortunately, in most stock assessments the model used for this kind of analysis is chosen on the basis of familiarity and not necessarily appropriateness or suitability. There are often better approaches or models that are not well enough understood by the individuals involved. At the time the decision was made to stop using VPA analysis for 3Ps cod, it was recommended that a workshop be held to determine how best to proceed with model development for the future. This has not happened.

SURBA was used at the ZAP this year. Its main contribution is the Z calculations because it does not require catch information which involves a lot of uncertainty. It provides a ratio of survey biomass relative to the LRP, which has been defined as the 1994 SSB survey index for 3Ps cod. An absolute value is not provided for the LRP, but one can be derived from the survey SSB and the SURBA ratio for a given year.

There is a 20 – 40 % probability that SSB in 2009 is below the LRP. These percentages represent the lower confidence intervals of model runs for the flat and domed survey catchability assumptions. The P.A. requires no directed fishing if there is not a low probability that the stock is in the critical zone. However, consensus could not be reached on what should be advised if SSB is in the critical zone. Given that the P.A. framework in place describes management actions to be followed under different stock conditions, it was considered appropriate to not provide specific harvest advice.

The SURBA analysis is not the entire basis of this assessment. However, it does play a role in the assessment of stock status. Caveats to explain the model, what it does and why it is being used will be required.

Presenter – J. Morgan (on behalf of P. Shelton)

Presentation title: <u>Some PA-related notes for consideration at the 3Ps cod assessment, Fall 2009</u> by P. Shelton

Abstract – DFO has recently announced a new policy on sustainable fisheries that includes: "A fishery decision-making framework incorporating the Precautionary Approach". This framework applies the three zone approach previously adopted by DFO under the Precautionary Approach:

Healthy, Cautious and Critical Zones. The removal rate should be reduced on a stock that falls below the Healthy Zone.

As defaults, this framework specifies 40%Bmsy as the Blim or boundary between the Cautious and Critical Zones, 80%Bmsy as the Upper Reference Point or boundary between the Cautious and Healthy zones, Fmsy as the Fishing Mortality Limit Reference Point (Flim), a decreasing fishing mortality as the stock declines in the Cautious Zone and no fishing when the stock is in the Critical Zone.

A number of possible proxies are suggested in the framework document for situations where MSY related reference points cannot be directly estimated. Although risk tolerances are discussed, they are not in relation to the risk of transgressing the limit reference points but rather in terms of the tolerance for further decline in each of the zones.

With regard to 3Ps cod, the 2004 assessment established Brecovery as a suitable proxy for a Blim . This was defined as the VPA estimates of spawner biomass at the beginning of 2004, either 36kt or 13kt depending on the model applied. The 2005 assessment updated these estimates to 40kt or 12kt . In the absence of current VPA assessment, these estimates can no longer be applied in an absolute sense. They could, however, still be applied in a relative manner using other assessment models such as SURBA.

There is increasing emphasis on defining sustainable fisheries from those that are not sustainable (e.g. eco-certification). MSY-based reference points are an accepted standard for determining whether a fishery is sustainable. Sustainable fisheries are generally considered to have: F<Fmsy , B>X%Bmsy where X is generally in the range of 50-80%, a very low (<10%) risk of falling below Blim with Blim set between 30% and 50%Bmsy, and a low (<20%) risk of exceeding Flim (Fmsy). Rebuilding plans are required if B<X%Bmsy. These plans should be explicit and should aim to rebuild to Bmsy within a prescribed period of time.

DFO Fisheries Management has developed a “sustainability checklist” which includes more than 100 questions to be completed. Initially this checklist was intended to report out on the sustainability status of Canadian fisheries and to assist in eco-certification endeavors. Although the checklist has now been completed for a number of stocks, the data are not available for analysis outside of FAM and will be used for reporting-in to mangers rather than for communicating out. In contrast to the complex DFO sustainability checklist, the US National Marine Fisheries Service maintains a public “Sustainable Fisheries Index” (SFI) which is updated quarterly and which is based on simple 4 point system determined by 5 questions. A total of 230 US stocks have sufficient data to score the index and the total score is accumulated across stocks. As scientific data improves on the other stocks, the cumulative index will increase. It will also increase as depleted stocks begin to recover.

Discussion – A suggested feedback harvest control rule in which the TAC for a given year is based on change in survey biomass, catch, exploitation rate, etc. would ensure that some portion of the stock is left. It would include the year over year variation in the RV survey which might not be a good way to accomplish the goal of low variation in average annual catch typically favoured by industry. Nevertheless, these are variables that could be explained.

In a paper published in Science, a Bmsy-based approach using the 2004 assessment suggests that the 3Ps cod stock is very near Blim. However, a low exploitation rate indicates it is in a recovery zone and expected to rebuild. This is currently considered very optimistic. A special session at the ZAP concluded that Bmsy currently could not be measured. There was a

research recommendation (at the ZAP) for a special workshop to consider what Canada is going to do about providing advice in relation to Bmsy, and any consideration of it for 3PS cod should come after that workshop.

It is suggested that the DFO sustainability checklist be updated as part of the annual stock assessment and the results reported in the SAR. Regarding management strategies in a sustainable fisheries framework, though, it was considered that they would have to be developed at a level beyond the RAP.

There were no conclusions reached about the status of 3Ps cod in this consideration of the P.A. It was intended to provide food for thought regarding a decision-making framework for sustainable fisheries generally.

Progress on research recommendations from 2009 ZAP reported at 2009 RAP

1. Some discrepancies exist in age determinations by France and Canada. Otolith exchanges should be carried out to address this.

Age readings by individuals at the DFO labs in St. John's and Mont Joli and at IFREMER are underway. Results are expected by the end of 2009.

2. There has been a decline in weights-at-age in the older fish taken in the commercial fishery, but this was not seen for the younger fish. It has been assumed that this difference is due to gear changes that result in catching larger sizes of the younger fish thus masking any declines. RV data should be examined to see if patterns observed are real or an artifact of gear compositions.

This is underway but is one of a number of research recommendations that will take several years to complete. The patterns are consistent in each data set, but those from the survey are based on much less data and show more noise. The commercial data are derived from length converted to weight using a length-weight relationship, whereas the RV data are based on weights of individual fish, a level of detail not captured for commercial catches. This is an important point in considering this research recommendation.

3. Investigate options for using the Telephone Survey of Fish Harvesters in 3Ps to assess the accuracy of commercial catches. In doing this, it would be useful to understand what portion of the landings is covered by the interviewed people.

This won't be available until next year.

4. Provide index consistency plots, between ages and surveys, and other standardized pre-screening diagnostics. Focus on consistency within and among indices. How are disparate indices to be dealt with? Abundance data should be synthesized in one plot.

This is an ongoing process and some has been done, but there is nothing to present in this update. The 2009 RV and Sentinel data can't yet be compared because the fishery is still ongoing.

5. Integrate tagging results more directly into stock assessment models (multi-year research).

During discussion of the tagging results presented at this meeting, it was felt that more could be done with tagging data. Rather than a new research recommendation about further analyses, it was agreed that this recommendation from the ZAP would satisfied the concerns and should simply be carried forward.

New research recommendation from 2009 RAP

1. Investigate recent changes in growth of 3Ps cod and how it relates to productivity and determine its implications for fishing mortality.

Appendix I: Terms of Reference

Meeting of the Newfoundland and Labrador Regional Advisory Process (RAP) on 3Ps Cod
Admirals Green Clubhouse,
460 Allandale Road, Pippy Park, St. John's NL
September 29 – October 2nd and October 5-6th, 2009

TERMS OF REFERENCE

Chairperson: Karen Dwyer, Research Biologist, Groundfish Section, Science Branch, Aquatic Resources Division, DFO, NL Region.

Objectives for the 3Ps Cod Assessment:

- Assess and report on the current status of the 3Ps cod stock. In particular, assess current spawning biomass, total (age 3+) biomass, exploitation rate, natural 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 the year classes subsequent to the relatively strong year classes of 1997 & 1998 as it relates to the long term growth and sustainability of the stock.
- To the extent possible with available information, provide information on the strengths of year-classes expected to enter the exploitable populations in the next 1-3 years.
- Highlight major sources of uncertainty in the assessment, and where appropriate, consider alternative analytical formulations of the assessment.
- Assess the implications on the stock by fishing at selected TAC levels: 10,000t, 11,500t, 13,000 t, and 15,000 t.
- There is currently a spawning period from April 1 – June 30 for the offshore and April 1 – May 30 for the inshore. Since some fleets have requested to fish cod during these times, are these spawning times still accurate? What is the impact of cod removals in the range of 500t in March and April.
- Report on results of tagging and the distribution of this stock in other areas (eg.3L/3Pn).

Expected Outputs:

A science advisory report (SAR), proceedings report, and associated research documents will be produced as a result of this meeting.

Expected Participation:

DFO Science NL Region and other Regions
DFO Fisheries and Aquaculture Management
Fishing Industry
Provincial Department of Aquaculture (DFA)
Aboriginal Organizations
Non-governmental organizations

Appendix II: Agenda

Div. 3Ps Cod RAP Meeting Agenda
Sept. 29-Oct. 2 (Admirals Green Clubhouse, Pippy Park)/ Oct. 5-6 2009 (NAFC, as required)

Tuesday 9 AM

Opening/Chair remarks
Introductions/Work plan/brief conclusions from ZAP 2009/TORs
Ecosystem update (Koen-Alonso)
Catch and Survey Trends (Healey)
Catch
- Commercial fishery (review)
  - Log books
    - <35 ft (2009 results to date)

Sentinel (Maddock Parsons)
  - 2009 results (to date)

Survey
Oceanographic update
  - Biomass/Abundance updates
  - SSB
  - Exploitation rate proxy
  - Mortality
  - Age composition, size at age (length, weight and condition), age at maturity
  - Distribution
  - Recruitment

Tuesday PM

Research Recommendations (Healey)
Tagging Update (Brattey)
Spawning time TOR (Morgan)

Wednesday AM

SURBA/Limit Reference Point (Cadigan)
Saint Pierre Fishing Resource Committee Questionnaire

Wednesday PM

SAR

Thursday – Friday

SAR

Appendix III: List of Participants

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Appendix IV: List of Working Papers Presented

1. Ecosystem overview: RV trends for major biological components in NAFO Subdivision 3Ps by M. Koen-Alonso

2. Update of Sentinel Survey Results in NAFO Subdivision 3Ps for 2009 by D. Maddock Parsons and R. Stead

3. Assessment of Cod in NAFO Subdivision 3Ps by B. Healey, E. Murphy, J. Brattey, N. Cadigan, D. Maddock Parsons, M. J. Morgan, R. Rideout, and J.-C. Mahé

4. Cod tagging in 3Ps – a brief update by J. Brattey

5. Spawning time in 3Ps cod –TOR by J. Morgan

6. 2008 cod fishing campaign in 3Ps Saint Pierre and Miquelon inshore fishery by F. Deschamps

7. SAS SURBA for 3Ps cod – 2009 RAP by N. Cadigan

8. SAS SURBA for 3Ps cod by N. Cadigan

9. Some PA-related notes for consideration at the 3Ps cod assessment, Fall 2009 by P. Shelton