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Proceedings of the Newfoundland Regional Advisory Process for Subdivision 3Ps Cod, Div. 3LNO Haddock, Subdivision 3Ps Haddock and Div. 2+3K Redfish

15 - 19 October 2001
Conference Room, The Fluvarium, Nagles Place
St. John's, Newfoundland

22 - 26 October 2001
E.B. Dunne Boardroom, Northwest Atlantic Fisheries Center,
St John's, Newfoundland

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TABLE OF CONTENTS

ABSTRACT **3**

RÉSUMÉ **3**

INTRODUCTION **4**

WORKING PAPERS **5**

APPENDIX I **31**

PARTICIPANT LIST FALL 2001 GROUNDFISH RAP 31

APPENDIX II **32**

WORKING PAPERS AND RAPPORTEURS 32

APPENDIX III **34**

REVIEW BY INDEPENDENT EXTERNAL REVIEWER 34

APENDIX IV **47**

REMIT 47

ABSTRACT

The annual regional assessment of Div. 3Ps cod was held in St. John's Newfoundland 15 - 19 October 2001 in the Conference Room, The Fluvarium, Nagles Place, and 22 - 26 October 2001 in the E.B. Dunne Boardroom, Northwest Atlantic Fisheries Center. In addition, the stock updates for Div. 3LNO haddock, Div. 3Ps haddock and Div. 2+3K redfish were completed. These proceedings contain a summary of the presentations and discussions of that assessment meeting. A total of 23 Working Papers were presented and reviewed. An external independent reviewer, Mr. Coby Needle, FRS Marine Laboratory, Aberdeen provided and evaluation of the meeting. Researchers from the Maurice Lamontagne Institute, Quebec Region participated in part of the meeting because of the purported mixing of cod from the northern Gulf of St. Lawrence into the 3Ps stock area. The highlights of the meeting were an intensive diagnostic evaluation of inputs and multiple sensitivity analyses with respect to alternative sequential population analysis models and their formulations, and the application of three modeling approaches to the extensive tagging data base. Scientific advice was eventually provided in the form of a risk table for alternative TAC options for 2002/2003 derived from 5 models/formulations which were thought to be representative of the uncertainty.

RÉSUMÉ

On a procédé à l'évaluation régionale annuelle de la morue de la division 3Ps du 15 au 19 octobre 2001 dans la salle de conférences The Fluvarium de l'immeuble Nagles et du 22 au 26 octobre 2001 dans la salle de conférences E.B . Dunne du Centre des pêches de l'Atlantique Nord-Ouest, à St. John's (Terre-Neuve). À cette occasion, on a aussi mis à jour l'état des stocks d'aiglefin des divisions 3LNO, d'aiglefin de la division 3Ps et de sébaste des divisions 2+3K. Le présent compte rendu résume les présentations et discussions auxquelles cette réunion d'évaluation a donné lieu. En tout, 23 documents de travail ont été présentés et examinés. Un examinateur externe indépendant, M. Coby Needle, du FRS Marine Laboratory de Aberdeen, a effectué l'évaluation de la réunion. Des chercheurs de l'Institut Maurice Lamontagne, Région du Québec, ont participé en partie à la réunion, étant donné le mélange présumé de la morue du nord du golfe du Saint-Laurent avec celle de la zone de stock du 3Ps. La réunion a notamment permis une évaluation diagnostique intensive des intrants et de multiples analyses de sensibilité concernant divers modèles d'analyse séquentielle de population et leur formulation, ainsi que l'application de trois approches de modélisation à l'exhaustive base de données de marquage. Finalement, des avis scientifiques ont été fournis sous forme de tableau de risques applicable aux divers TAC possibles pour 2002-2003, d'après cinq modèles jugés représentatifs de l'incertitude.

INTRODUCTION

The annual regional assessment of Div. 3ps cod was held was held in St. John's Newfoundland 15 - 19 October 2001 in the Conference Room, The Fluvarium, Nagles Place, and 22 - 26 October 2001 in the E.B. Dunne Boardroom, Northwest Atlantic Fisheries Center. In addition to 3Ps cod, the stock updates for Div. 3LNO haddock, Div. 3Ps haddock and Div. 2+3K redfish were completed. Although part of the Remit for this RAP, the status of 2GH cod was not evaluated due to the paucity of available new data. There was participation from the Department of Fisheries and Oceans, the fishing industry, Memorial University of Newfoundland, and the Fisheries Resource Conservation Council (Appendix I). A total of 23 Working Papers were presented and reviewed (Appendix II). Mr. Coby Needle, FRS Marine Laboratory, Aberdeen provided an external, independent review of the meeting (Appendix III). Researchers from the Maurice Lamontagne Institute, Quebec Region also participated in part of the meeting because of the purported mixing of cod from the northern Gulf of St. Lawrence into the 3Ps stock area and the possible effect of fishing mortality in 3Ps on the recovery of the northern Gulf stock.

The Outlook section of the stock status report constituting the main conclusions of the 3Ps cod assessment was agreed on in plenary in the second week of the RAP. Remaining work on the 3Ps cod SSR and the SSR's for the two haddock stocks and for redfish were completed by smaller task groups subsequent to the formal meeting.

These proceedings present summaries of the working papers presented at the meeting as well as brief summaries of the discussions which constitute the peer review process.

WORKING PAPERS

Working Paper 1: Review of 3Ps cod – John Brattey and Peter Shelton

A review of recent information on the biology, fishery, tagging, genetics, assessment and management of the 3Ps cod was presented. The importance of the 1989, 1990 and 1992 year classes in the post moratorium population and the resulting fishery was emphasised. Subsequent year classes are weaker, but he 1997 and 1998 year classes look promising. The information on the most recent yearclasses will be updated in this assessment. The GEAC data only comprised 3 years and was not used formally as input to the model in the 2000 assessment. It will be considered in the current assessment. Sentinel data forms an important input to the model. While the genetic data have not shown much differentiation, there is important information on stock structure and fish movements from the tagging data.

Discussion (Rapporteur - Peter Shelton)

A question was asked regarding the data on the movement of cod from the inshore to the offshore. While offshore tagged fish are recovered in the inshore, the reverse does not seem to take place very often. The response was that this is probably partly a result of timing of tagging activity (spring) with respect to the seasonal movement of fish.

The comment was made that uncertainty in the past assessments of the 3Ps cod stock has not taken into account model uncertainty. This was acknowledged, although it was noted that the 16 QLSPA runs carried out in the past assessment constituted a form of sensitivity analysis and several of these runs could be considered to comprise different models or hypotheses regarding the stock.

A question was asked about the importance of the sentinel data to the model calibration. It was noted that with or without the sentinel data, the model estimates of population size were similar. There may be an effect on the uncertainty – this can be checked.

Working Paper 2: Oceanographic conditions in NAFO Subdivisions 3Pn and 3Ps during 2001 with comparisons to the previous year and the long-term (1971-2000) average – Eugene Colbourne

Oceanographic data from NAFO subdivisions 3Pn and 3Ps during the spring of 2000 and 2001 were examined and compared to the long-term (1971-2000) average. The temperature and salinity data are presented in several ways, as vertical transects across the major banks and channels, horizontal bottom maps, time series of areal extent of bottom water in selected temperature and salinity ranges and as time-series of temperature anomalies. Temperature anomalies on St. Pierre Bank show anomalous cold periods in the mid-1970s and from the mid-1980s to mid-to-late 1990s. During the most recent cold period, which started around 1985, temperatures were up to 1^{o}C below average near bottom and up to 2^{o}C below the warmer temperatures of the late 1970s and early 1980s in the surface layers. Temperatures in deeper water off the banks

during all years show significant variations, but remained relatively warm with values in the 3-6°C range compared to the much colder values (often sub-zero °C) on St. Pierre Bank during most years. Beginning around 1996 temperatures started to moderate, decreased again during the spring of 1997 and returned to more normal values during 1998. During 1999 and 2000 temperatures continued to warm to above normal values over most of the water column. During the spring of 2001 however, temperatures cooled significantly over the previous two years to values observed during the mid-1990s. The areal extent of <0°C bottom water increase significantly from the mid-1980s to mid-1990s, but decreased to very low values in 1998-2000. During 2001 it increased again, returning to values observed during the mid-1990s. Since 1995 the areal extent of bottom water with temperatures >1°C has been increasing, reaching pre-1985 values by 1999-2000. During 2001 however the area of warmer water decreased significantly compared to the pervious 2-years. On St. Pierre Bank <0°C water completely disappeared during 1999-2000 but increased to near 30% during 2001. The area of near-bottom water on the banks with temperatures >1°C was about 50% of the total area during 1998 the first significant amount since 1984. This increased to about 70% during 1999 and to 85% during 2000 but decreased to a very low value during 2001. In general, this analysis showed significant variations in water mass characteristics particularly on St. Pierre Bank during the past several years, with the cold, near constant salinity, water from 1990 to 1997, changing to warmer-saltier conditions during 1998 and 1999 and decreasing to fresher, but still warm conditions during 2000. During 2001 salinities increased to above normal values while temperatures generally decreased to below normal values.

Discussion (Rapporteur - Dale Parmiter-Richards)

It was acknowledged that oceanographic conditions are important in assessing stock status, especially with regards to fish growth and distribution.

The base time period used to compute the averages and reference anomalies up to 2000 was defined as the 30-year time period form 1961-1990. The author clarified that the current base period for the 2001 analysis was advanced to 1971-2000. This follows the convention of the World Meteorological Organization and recommendations from the NAFO Scientific Council.

During 2001 temperatures decreased significantly over 2000 values at both the surface and near-bottom, reaching values typical of the early 1990s. Given the observation of warm (1997 onwards) and cold periods (1984-mid-1990s) of long duration (10-15 years), it was noted that the results from 2001 may be just a “blip” on a continuing warming trend. The colder conditions observed during 2001 may be the result of increased advection rates from the eastern Newfoundland shelf and reduced vertical mixing.

Surface and mean bottom temperature and temperature anomalies can be expanded to include intermediate levels as well. The tables to support these figures and absolute temperatures can be incorporated into the paper.

The warmer water is from the south and shelf-slope regions and it is very variable in the offshore region.

The oceanographic data is obtained during the bottom surveys (Feb-May). The amount of variability over this time period is reflective of what happens during the year as the bottom variability is low and there is not much change over a month or two near the bottom. i.e. variability is quite minor. Peter Smith (DFO) may have some additional data on this area from moored instruments. It was also suggested that there are two surveys during the winter and spring of 1993 that could be used to check seasonal variability. It was also pointed out that in areas where the data wasn't consistent from year to year (eg. eastern side of Placentia Bay) the information was excluded. With regards to the sentinel temperature data, they are slowly being entered into the system and any data that has already been input was considered in this analysis.

Generally, patterns in North Atlantic Oscillation (NAO) trends in five-year averages are correlated with trends in the ocean environment in the Northwest Atlantic.

The question was posed regarding the existence of any relationship between salinity and temperature? The author responded that the relationship has been identified in this area. The salinity data are only available since 1990, which may be insufficient to detect long-term trends or relationships.

It was commented that caution should be utilized in trying to place too much faith in oceanographic indices with respect to processes affecting the 3Ps cod stock. Clarification is needed regarding how oceanographic information can be used in stock assessments and it must be determined if the cooling seen in 2001 is significant. Yearly based trends and trends over a five-year time period have to be considered. There is a correlation between the spatial distribution of fish and temperature change. There is a workshop scheduled for March 2002 (Fisheries Oceanography Committee) to discuss how to incorporate oceanographic data into stock assessments. It was commented that oceanographic data could be used to understand variation in the surveys even if models of fish population dynamics are, as yet, unable to make use of environmental inputs.

Working Paper 3: Sentinel surveys 1995-2001: Catch per unit effort in NAFO Subdivision 3Ps – Dawn Maddock-Parsons and Rick Stead

Sentinel enterprises collected catch rate and biological information on inshore cod resources in 3Ps for 1995-2001. Data were presented on weekly catch rates and annual relative length frequencies (number at length divided by amount of gear) by year and gear type. Catch rates in 2001 were comparable to the 2000 data, the lowest in the series for both gillnet and linetrawl.

Discussion (Rapporteur - Rick Stead)

It was noted that the data show some interesting trends in 2001 thus far. The data are for about half of the allocated number of weeks for the sentinel program – i.e. half the data are still to come for 2001.

In response to a question is was clarified that the control and experimental sites use the same gear and that only the control (fixed) site data were used in statistical analysis to provide an index for model calibration.

It was noted that there are some significant gaps in the time series for particular sites/gear types. The explanation is that this is a consequence of fishers using different gear types at certain times of year and limited funding which means some weeks have to be skipped.

Quebec Region participants raised the question of a lack of a mobile sentinel survey on Burgeo and St. Pierre Banks. The explanation is that the Newfoundland sentinel program was designed to cover areas out to the 100 m. contour using traditional inshore fixed gears. Newfoundland Region does not have a mobile sentinel program but does make use of industry surveys carried out under scientific survey protocols.

Working Paper 4: Sentinel set selection – Don Stansbury

Following discussions at the Zonal Cod Assessment Meeting in Rimouski Quebec in 1999, selection criteria are applied to the sentinel data in order to standardize the inputs and improve statistical model fits. For gillnets only data for months 7 to 11 and with soak time between 18 and 24 hours are used, whereas for linetrawls only data for months 8 to 11 and soak time less than or equal to 12 hours are used in the model. The soak time criteria are an attempt to minimize the impact of short and long sets on the analysis without explicitly taking into account the function response of catch over time (which is non linear because of gear saturation). The month-of-year-criteria are an attempt to focus on months for which sufficient data are available across years to allow for the removal of a seasonal effect on the data. Application of these selection criteria currently results in the discarding of a large amount of the sentinel data (only about a third of the data are actually used in fitting the model). The trends in the model estimates are sensitive to the application of the selection criteria.

Discussion (Rapporteur - Rick Stead)

The question was posed: “Is imposing such a narrow selection window the proper approach or should we be using more or all of the data?”. It was suggested that precision would increase when all data are included because of larger sample size, however the index may be less accurate. It was suggested that the debate may not be very important if the SPA was insensitive to the sentinel data as calibration indices. In response, it was noted that while this may be true, the sentinel data are also evaluated directly as indices of stock status, not only in the SPA model.

A participant from the Quebec Region noted that the combined act of applying selection criteria and of not using the experimental site data resulted in the use of only about 15% of the data collected in the Newfoundland Region sentinel program.

The meeting discussed whether the soak time window criteria should be amended to include more of the data. Fishermen participating in the meeting queried the science underpinning the assumptions regarding gear saturation for gillnets. They suggested that most of the soak times fell within a 24 hour time frame and that saturation would not influence how the net fishes over this time frame. Fishermen from some areas traditionally set gillnets for longer periods than those from other areas. Shorter soak times can occur when nets are not set until late in day on the first day of a fishing period and are then hauled next morning.

An apparent increase in gillnet catch rates between 24 and 36 hours was noted in the data, but it was concluded that this may just be an artifact of more sets falling into this time window.

The Chair stated that the default decision would be to repeat the approach used in the last assessment, but that the meeting appeared to be suggesting that all sets retrieved the following day should be used, i.e. all sets between 18 and 32 hours should be used.

A question was posed as to whether or not line trawls lose fish with longer soak times. Fishermen were of the opinion that fish twist off or get eaten, therefore catch rate drops with longer soak times. Some fishermen felt that if the gear are set overnight that the catch rate would not change perceptibly between 12 and 24 hours. However, there would be concerns if the gear fished for two overnight periods.

The RAP finally agreed that soak times between 12 and 32 hours would be appropriate. In ensuring the best use of the available data.

Working Paper 5: Commercial catch for 2000/2001 – Eugene Murphy

Landings were summarized by month, for inshore and offshore, each gear sector separately, for both 2000 and 2001 (January to September). Inshore catches have come mostly from gillnets with substantial landings in all months except April and May. Line-trawls were fished inshore mostly during September-December. In the offshore, otter trawl (and Norwegian seine) fishing by Canadian trawlers and vessels chartered by St. Pierre and Miquelon to fish the French quota was concentrated mainly during the first and last quarters of the year. There was also a substantial offshore gillnet catch in 2000 with landings totaling over 4,000 t taken mostly during June-December. Overall, landings in 2000 were dominated by the directed gillnet fishery with the remaining catch taken by otter trawl, followed by line-trawl, hand-line, and trap. The gillnet fishery was pursued over a longer period of the year than the traditional gillnet season for 3Ps, most notably during January –March. Also more fishers west of the Burin Peninsula were reported to be using gillnets in 2000 rather than the traditional line-trawl.

Samples of length and age composition of catches were obtained from the inshore trap, gillnet, line-trawl and hand-line fisheries and the offshore otter trawl, gillnet, and line-trawl fisheries by port samplers and fishery observers. Sampling of the catch in 2000 was intensive, with 11, 800 otoliths collected for age determination and over 198,600 fish measured for length. The sampling was well distributed spatially and temporally

across the gear sectors. Substantial landings in from inshore fixed gears were sampled intensively, particularly line-trawl and gillnet. The smaller number of samples from hand-line and offshore line-trawl catch reflects the smaller catches from these gears in 2000. Sampling for 2001 will be reviewed in the next assessment.

Discussion (Rapporteur – Joanne Morgan)

Otter trawl catch-at-age is actually a combination of Norwegian Seine and otter trawl catches. The frequency is bimodal and this could be a result of this combination. Age sampling from the Norwegian seine is limited.

Catch-at-age for 2001 in this working paper was computed up to the end of March 2001. It was discussed whether or not the analysis should be extended as far as available data would allow (end of September). This would provide more catch-at-age information for use in the projection (the remainder to 31 March 2002 would still have to be assumed). The RAP decided to extend the catch-at-age to as late in the year as the data would allow.

Misreporting by gear in 2001 has become a problem because there was a cap on gillnet catch, providing an incentive to report the catch as coming from some other gear. This problem is made worse by the fact that fishermen are allowed to carry more than one gear at a time on their vessels. (The gillnet cap restriction was relaxed at some point during the 2001 fishing year). Handline catch in particular has increased in 2001 and it is difficult to determine if this increase is real or if it is at least in part misreported gillnet catch. The occurrence of this misreporting received some verification from fishermen in the meeting. The assignment of catch to the wrong gear type will result in the use of wrong length frequencies and age/length keys for a portion of the catch. This will result in more error or variability in the catch-at-age and more uncertainty in the population model output. Comparison of length frequencies from the sentinel gears to length frequencies from the commercial fishery may shed some light on which length frequencies are from the gear from which they are reported.

The sentinel data were examined to see if there was some relationship between soak time and discarding, but no relationship has been found in the analyses conducted to date. There is some small amount of data from logbooks but not enough to do much analysis. Observers could record length frequencies of discards, but most of the catch in 3Ps is taken by vessels less than 35ft for which there is no observer coverage. As well, discarding may be limited with an observer on board. For the greater than 35 ft sector length frequencies from observed and unobserved trips could be compared. The consequence of unreported catch is generally that stock size is underestimated and so the TAC is lower than it could be for the equivalent level of risk.

On the issue of the how the weight of fish in a sample is derived, it was explained that if the sample weight and the computed sample weight from length-weight relationship differs by 20% then the length-weight relationship is used. An examination of the product of the numbers at age in the catch and the average weights at age for the catch showed considerable differences, when summed across ages, to the total catch weight

for several years going back to the late 1960s. It was decided that this was not just a plus group effect (the catch at age is curtailed at age 14 and no plus group is included). because both positive and negative differences occur. This problem greatest in the data for the period prior to 1977. It was decided that the short term catch (from 1977 onwards) should be used in the current assessment, but that the long-term catch problems needed to be resolved since these data were important in establishing precautionary approach reference points.

Working Paper 6: RV Survey data for 2001 – John Brattey, Eugene Murphy and George Lilly

Canadian research vessel bottom trawl surveys were conducted from 1972-1982 by the research vessel A. T. Cameron using a Yankee 41.5 otter trawl. Surveys from 1983 to 1995 were conducted by the Wilfred Templeman, or the sister vessel the Alfred Needler, using the Engel 145 Hi-Lift otter trawl. Since 1996, the survey has been conducted by the Wilfred Templeman using the Campelen 1800 shrimp trawl. Data collected with the gear used in 1983-1995 were converted to Campelen equivalents based on comparative fishing experiments.

The survey biomass index is variable but shows a declining trend from the mid-1980s to the early 1990s and a general upward trend in the more recent period. The biomass index for the entire survey area in 2001 was 86,000 t, approximately 40% higher than the 2000 survey. To account for mixing with 3Pn4RS cod, the survey index was split into two series, Burgeo Bank (western portion) and the remainder of the 3Ps area (eastern portion), as in the previous assessment.

In terms of mean numbers of fish per tow, the survey catch rate index for the western (Burgeo) portion of 3Ps shows no trend during 1993-2001. The 1998 survey encountered large numbers of 3-5 year olds that were not strongly represented in subsequent surveys in this area. The survey catch rate index for the eastern portion of 3Ps is variable, but shows a declining trend from the mid-1980s to the early 1990s. There is a general upward trend since the early 1990s. The 1995 catch rate index was strongly influenced by a single large catch and the 1997 survey did not encounter aggregations of fish that were observed in subsequent surveys and commercial catches.

In the April 2001 survey, cod were less widely distributed across the top of St. Pierre Bank compared to 1999 and 2000; this change in distribution correlates well with the return to cooler temperatures in 2001. As in previous years, largest catches were localized in the southern Halibut Channel, Fortune Bay, on the northwest corner of St. Pierre Bank, and in the Burgeo Bank-Hermitage Channel area.

The most numerous ages in the 2001 survey were 3 and 4 (1997 and 1998 year-classes). Among older ages, the 1989 year-class is also well represented. However, survey catches over the post-moratorium period have consistently shown few survivors from year-classes prior to 1989.

Growth, calculated from length-at-age in research trawl survey samples, has varied over time. For the period 1972-2001, peak lengths-at-age occurred in the mid-1970s for young ages and progressively later for older ages. From the mid-1980s to the mid 1990s, length at age varied with no trend (younger ages) or declined (older ages). There is some indication of a slight increase in length-at-age among older ages in the late 1990s.

The condition of cod is typically expressed as W/L^3, where W is the gutted weight or liver weight, and L is the length. Cod collected during the April 2001 research vessel survey were generally in better condition than those sampled at the same time of year during 1993-95. Comparison of post-1992 condition with that observed during 1985-1992 is difficult because survey timing has changed. Condition varies seasonally and tends to decline during winter and early spring. Nonetheless, condition of cod in the 1995-2001 surveys appeared to be normal.

Maturation in female cod was re-evaluated in the current assessment and was estimated by cohort rather than by year. Proportion mature at age in female cod sampled during research trawl surveys has increased among younger cod, particularly between the late 1980s and early 1990s. For example, the proportion of 6 year old females that are mature has increased from about 30% in the 1970s and early 1980s to over 80% in the early 1990s. Proportion mature at age for young cod has high during the mid-1990s, but there is some indication that the trend may be reversing in the most recent years.

Discussion (Rapporteur – Peter Shelton)

The problem of the single large set or the couple of large sets in some surveys was raised. The current approach is to make no adjustment to the estimate when large sets occur, but to include the data just like the data from any other set. A number of approaches were suggested such as the “delta method” or “bias corrected geometric mean” approach. There are pros and cons to these approaches and although the issue has been discussed at length both in terms of Atlantic Canada groundfish assessments and assessments elsewhere, it has not been adequately resolved. At present the best approach appeared to be to continue to use the biased estimate from the survey distribution.

There was considerable discussion regarding the appropriate treatment of the maturity data collected on the RV surveys. The traditional “annual ogive” approach was being replaced by the “cohort ogive approach” and there was general agreement that this was appropriate. There was not good agreement, however, on the most appropriate method for filling in the corners of the matrix for incomplete cohorts. This issue is particularly important with respect to assessment of current mature biomass and projections of future mature biomass. There was some discussion as to whether or not the maturity estimates from the survey should be weighted by the stratum catch. It was suggested that there were not enough data on a stratum basis to do this.

Current assessments derive beginning of year and mid-year (average) weights from the commercial catch data, the sampling of which does not include the weighing of individual fish. Instead, fish weights are derived from a length-weight relationship with constant (year-invariant) parameters. The suggestion was made that it may be more appropriate to use the individual fish weights obtained during the sampling of the RV survey catches. It was noted that the survey data tend to be much more variable that the weights derived from the commercial samples. It was generally acknowledged that the approach for obtaining reliable body weights for computing such quantities as spawning stock biomass needs to be evaluated to make sure that the best possible estimates are being derived.

Working Paper 7: Recent trends in bottom temperature and distribution and abundance of cod (Gadus morhua) in NAFO Subdivisions 3Pn and 3Ps from the winter/spring multi-species surveys – Eugene Colbourne and Eugene Murphy

An analysis of near-bottom temperatures in NAFO Division 3P during winter and spring surveys were presented in relation to the spatial distributions and abundance of cod (Gadus morhua) for the years 1983 to 2001. Interannual variations in the near-bottom thermal habitat were examined by calculating the areal extent of the bottom covered with water in 1^{o}C temperature bins. The analysis revealed a significant shift in the thermal habitat in the region with the areal extent of subzero ^{o}C bottom water covering the banks increasing dramatically from the mid-1980s to the mid-1990s. During this time period zero catch rates dominated on St Pierre Bank and in the eastern regions of 3Ps. Beginning in 1996 the area of 0^{o}C water on the banks decreased significantly reaching very low values in 1998 and a complete disappearance in 1999 and 2000. The areal extent of bottom water with temperatures >1^{o}C on the banks was about 50% of the total area during 1998 the first significant amount since 1984 and it increased further to about 70% during 1999 and to 85% during 2000. During 1999 and 2000 larger catches of cod became more wide spread over St. Pierre Bank region as the cold sub-zero ^{o}C water disappeared from the area. There were many zero catches in the eastern areas during 2001 as colder water returned to the region. During all surveys most of the larger catches occurred in the warmer waters (>2-3^{o}C) along the slopes of St. Pierre Bank and areas to the west of St. Pierre Bank. An examination of the cumulative distributions of temperature and catch indicates that cod are associated with the warmer portion of the available temperature range, with a slightly warmer preference based on weight than numbers.

Discussion (Rapporteur - Dale Parmiter-Richards)

It was suggested that, because the RV survey for 3Ps cod is very noisy, the temperature component could perhaps be helpful in resulting the fish density signal from the noise in the survey. This would require some predictable relationship between fish density and temperature.

The comment was made that the pronounced cooling in ocean temperatures seen in the Northern Gulf since 1997 had apparently resulted in fish moving out of the Gulf and into the 3Pn and western 3Ps area earlier and earlier in the year. Data apparently show that

the median latitude of the fish distribution in the Gulf shifted south with cooling temperatures. The suggestion is that the mixing problem between the northern Gulf cod stock and the 3Ps cod stock may be more of an issue during anomalously cold conditions.

It was suggested that, although the stratified survey design should be robust to the movement of fish within the survey area, if fish moved to deeper water under colder conditions on the banks, and if there is a relationship between the trawl wingspread and water depth, then there could be a bias introduced in the survey estimates which would be correlated with temperature changes.

Working Paper 8: GEAC Survey results – John McClintock

To enhance the fisheries research database in NAFO Division 3Ps, the Groundfish Enterprise Allocation Council (GEAC) has funded surveys each fall from 1997 to 2000 directed at cod. The continuing intent is to create a series of annual fall surveys in 3Ps to complement current resource assessment activities carried out by the Department of Fisheries and Oceans (DFO). GEAC funded and performed the surveys with scientific guidance from DFO in the design and execution of a stratified random survey and the associated sampling. The data collected during these surveys have been subsequently analyzed on behalf of GEAC and for the additional intent of providing this information to DFO, for their databases and their assessment work. This is the fourth such GEAC survey in 3Ps following on the previous 1997-1999 surveys (CSAS Research Documents 99/20, 99/34, 2000/024). One trip to perform the 2000 survey was carried out from 4-15 December 2000. These dates correspond well with the late-November and December time periods for the earlier three years. During the trip, set details and length frequencies were logged in the DFO FFS system and otoliths were collected for subsequent aging. Catch statistics, length and age distribution, and stratified analysis estimates of cod abundance and biomass, including age distribution estimates, and interpretation of results are presented. Total abundance estimates for the 2000 survey are 37.7 million and up three fold from 1998 and 1999 and comparable to those for 1997. Total biomass estimates for 2000 are 187 000 t, up almost four-fold from 1998 and 1999 and are almost double those of 1997. The results indicate that the 1997 year class stands out strongly in 2000. The 1989 and 1990 year classes continue to be well-represented as well.

Discussion (Rapporteur - Martin Castongay)

A question was asking relating to how fishing sites are selected. The selection is done through the usual stratified-random survey set selection procedure used by DFO. Large sets sometimes occur that will be quite influential on the results, a consequence of the contagious nature of the fish distribution.

With regard to the benefits of the GEAC survey design, it was pointed out that for a stock that may change distribution because of cold water, it may be a good idea to have a stratified-random survey instead of a fixed-station survey such as that which takes place in the North Sea where fish distributions are less affected by cold water.

It was suggested that a comparison of total mortality rates estimated from GEAC and DFO RV trawl surveys would be useful to examine the reliability of both sets of data.

In a discussion of the stratified-random design, it was noted that because of the constraint that each station should have a minimum of 2 sets, the number of sets is not proportional to the number of strata.

It is pointed out that the GEAC survey data could be used as an abundance index for calibrating SPAs for the first time in this assessment because the survey is in its 4th year.

Working Paper 9: Capital, interest, temperature and delay difference – John Pope

A delay-difference model was proposed in which the size of fish in terms of weight is included in addition to age. Delay-difference models explicitly contain age-structured dynamics including the lag between spawning and recruitment but are less complicated than vector-based age-specific population models.

The proposed model uses Deriso-type delay difference equations:

$$B_{t+1} = 1.05*(B_t - Cw_t) + 0.5*(N_t - Cn_t) + Wt_3 * R_{3,t+1},$$

and, $$N_{t+1} = N_t \exp^{-M} - Cn_t \exp^{-M/2} + R_{3,t+1}.$$

The model takes into account the relationship between the weight of fish in the catch and the weight of fish in the stock. Consideration was also given to the effect of temperature on yield through a stock-recruit relationship.

Discussion (Rapporteuer - Peter Shelton)

The author suggested that it would be better to use 7+ biomass as a proxy for spawner biomass rather than 3+ biomass. It was felt that a slope of greater than 1.0 was unrealistic for the linear fit of weight at age next year over weight at age this year. It was pointed out that the weights used in the model are derived from lengths and the length-weight relationship that is used is time-invariant. It was agreed that the weights at age are an important part of the assessment and that more attention needs to be devoted to including the information in a realistic manner in all models.

It was noted by the author that one of the strength of the delay difference model is that it says “tomorrow looks like today” – we often have to work hard to do better than that in our model projections.

There was some discussion regarding the appropriate water depth for evaluating temperature effects on cod recruitment. The values used are the April anomaly at 20m. It was suggested that it may be more appropriate to use a deeper depth, such as 50m.

Working Paper 10: VARMA ogive modelling – Coby Needle

ICES assessment Working Groups routinely produce medium-term (10-year) stochastic projections of stock dynamics. To date the only randomised elements in such projections are the starting population estimates and annual recruitment. However, proportion mature-at-age and weights-at-age are also known to fluctuate from year to year, and simulations have shown that these can have at least as much of an effect on projections as recruitment has. This Working Paper was presented to the ICES Annual Science Conference in Oslo in September 2001, and suggests one possible means by which maturity and weights-at-age could be effectively characterised in projections. VARMA (vector autoregressive moving-average) time-series modelling is used to generate projected ogives in which the time-series structure and density-dependence of historical ogives are maintained. This has the dual benefits of incorporating an aspect of the biological processes of growth and development, without explicitly involving environmental variates, and of improving the statistical appropriateness of the projections.

There are two points of interest for the RAP: (i) The proposed shift to multiannual TACs forces the generation of medium-term projections. These should initially restrict stochasticity to starting populations and subsequent recruitment, but VARMA modelling suggests one way in which future meetings might seek to improve on this methodology. (ii) Fitting ogives to historical maturity data by cohorts would alleviate some of the problems observed in the currently-used maturity-generation scheme, which produces noisy estimates and biological implausibility's.

Discussion (Rapporteur – Peter Shelton)

It was confirmed that both DFO and FRCC have indicated that longer term projections are needed, particularly in the context of stock rebuilding plans and the precautionary approach, so that the content of the working paper is relevant to the assessment meeting.

The α and β parameters from the maturity ogive fit are regressed against temperature in the working paper. Questions were raised as to whether or not these were the appropriate parameters (compared to a50 and a75 for example), and whether or not the estimates could be biased. In addition to temperature, it was suggested that fish weight should also be explored as an explanatory variable.

There was some discussion regarding the relative merits of using a plus group as the mature group rather than attempting to accurately estimate mature biomass from maturity data. It was suggested that although the maturity data are noisy, there is evidence of a signal which could be extracted by the appropriate cohort maturity model.

The point was made that a drop in maturity at age will inflate spawner biomass but that this may be misleading because of lower egg production and survival from first time or young spawners.

Working Paper 11: Acoustic surveys of Placentia Bay in springtime, 1996 – 2001 – George Rose and Luise Mello

Acoustic surveys have been conducted in spring and early summer (April-July) in Placentia Bay from 1996 to 2001. These surveys span the main spawning season and the April surveys are conducted at the same time as the DFO trawl survey. All surveys used an EK500 38kHz echosounder on the Teleost and Shamook, with the exception of the 1997 and the inner-Bay portion of the 1999 surveys which were undertaken with a BioSonics DT system (38 and 120 kHz) on the Innovation and Mares.

Placentia Bay was "blocked" into 28 blocks for all surveys. Blocks include the full Bay from the Cape St. Mary's rocks to Captain Balls Rocks on the outside to the bottom of the Bay, and cover most waters > 20 m deep for the small boats and > 50 m deep for the Teleost. Small boat results are preferred and used in all instances when possible. Data from each block were bootstrapped (50% sample rate 1000 times) using the routine in SYSTAT. Bootstrapped CI's are not calculated for all years yet but the most recent data (2000 and 2001) are complete. Initial biomass estimates were made by scaling with a TS per kg of –33.0 dB without regard for cod catch length (Rose 2000). Detectabilities were determined experimentally as follows: 1996 (0.35); 1997 (1); 1998 (0.9); 1999 (0.24 for Teleost; 0.6 for Mares in July); 2000 (0.6) and 2001 (0.6).

Areal densities are calculated as: $A = sA * sigma^{-1} * D^{-1}$ following the Simrad type analytical procedures, where A is areal density, sigma is mean backscattering coefficient, and D is detectability.

Directed fishing sets were made using the Campelen trawl on the Teleost and using handlines on the other vessels. All available data were used to assess catch data (from these and other surveys) and were weighted equally (trawl and handline) to attempt to equalize the contributions of these gears which have different selectivities.

Discussion (Rapporteur – Dawn Maddock-Parsons)

Questions were asked regarding detectability. This is in part to do with the acoustically dead zone close to the bottom and it varies depending on the nature of the bottom. The problem in Placentia Bay is that this is a highly variable quantity, more so than in other areas which are surveyed acoustically.

It was noted that acoustic surveys are carried out in both the daytime and the nighttime. The author commented that diurnal migrations can be quite variable and that reverse migrations can occur and that year-to-year variability in migration patterns can be substantial.

It was noted that a fixed target strength is used in the acoustic studies that is independent of fish length. The reason for this is the desire not to introduce a bias from length sampling which is based on trawl and handline catches which may not fully reflect the age composition of fish being analysed acoustically. It was acknowledged

that use of a constant target strength could be misleading when there are changes in length (age) composition of the population.

Survey covers only part of the stock area and the coverage has varied over time. Estimates are sensitive to this. The 2001 data show a significant number of age 5 fish (1996 year class), whereas this year class was not thought to be particularly strong – possibly reflecting fish moving into the survey area rather than recruitment. On the other hand, it was also noted that 1997 year class seems to track through the series and the 1992 year class also tracks. This is consistent with survey observations and sentinel survey data.

It was noted that the FRCC had criticised DFO for not using the information from the acoustic survey in the last assessment. While it is a fact that only a portion of the stock area is covered, this is not unique to the acoustic survey – sentinel survey data also equates to only a partial coverage. Partial coverage may be representative if the whole stock area is thought to do the same thing, which is what the SPA assumes. If you have two areas, one going up, one going down, if you weight them and put them together in the model, they might be more useful indices.

The RAP concluded that there was the potential to derive a valid index for a portion of the stock from the acoustic data, but it was felt that the data and methods used needed to be more fully described and evaluated and that more information was required on how the index was derived before the acoustic data could be considered as a tuning index in the SPA. It was also suggested that the internal consistency of the index should be evaluated (ANOVA etc.) as a means of sorting out the signal from the noise.

The author was hesitant to say that the data describes what goes on in the whole stock area, but was more comfortable saying that it does describe what happens during the spawning season in Placentia Bay - extrapolation to the whole of 3Ps is not appropriate.

Interactions between indices might also be informative. The meeting agreed that the index be used in the stock status report as auxiliary information, but not used in calibration of SPAs at this stage.

Working Paper 12: Seasonal variability in biological condition of Atlantic cod (Gadus morhua):implications for harvesting and industry – Luise Mello and George Rose

This study examined, through simulations, how seasonal changes in cod condition may affect harvesting. It also examined how these trends may affect product quality and economic benefit. The Placentia Bay cod fishery (NAFO Subdivision 3Ps) is used as a case study. Weight and other biological measurements of cod were obtained by sampling during seasonal surveys conducted in Placentia Bay between 1997 and 2000. Industry indices of product yield and quality originated from cod processed by the National Sea Products plant in Arnold's Cove (Placentia Bay) from June 1998 to January 2001. Cod were in poor condition in the spring during spawning as indicated by low average weight at age and condition indices. Following spawning, cod became

engaged in intense feeding activity, resulting in considerable and rapid increase of all biological indices by July. By October or November all indicators increased and reached high annual values by December. The results of the simulations indicated that over a 3-year period (i.e., 1997-1999 fishing seasons) it would be possible to harvest near to one million fewer fish without reducing the overall landed biomass in Placentia Bay if harvesting occurred in the fall and early winter (period of peak condition). The Industry indices showed similar trends, reflecting a close relationship between biological processes such as weight changes or feeding and yield or product quality. Finally, we propose that the use of simple indices describing the biological condition of cod may be useful in assisting the implementation of conservation-based fishing strategies that may (1) reduce the effect of harvesting on stock productivity, and (2) increase the economic benefits of fish products.

Discussion (Rapporteur – Peter Shelton)

Fishermen participating in the assessment agreed that seasonal changes in the quality of fish is very evident. It was also stressed that there are gear differences in fish quality and it was suggested that 100 fish from gillnet are more valuable than if caught by trawl. It was noted that the projections would be more accurate if the fishing season were known in advance and the appropriate fish weight in the catch were used. Fish weight in the catch in assessments is currently derived from sample measurements of length and a standard constant length-weight relationship. Accurate annual length-weight relationships which took into account seasonal variation would be an improvement.

Working Paper 13: Movements and exploitation rates of Atlantic cod in NAFO Subdiv. 3Ps based on tagging experiments – John Brattey

Tagging studies initiated in spring 1997 in Placentia Bay were expanded in subsequent years (1998-2001) to include inner and outer Fortune Bay and two offshore areas (Burgeo/Hermitage Channel and Halibut Channel). In these five years over 42,000 fish have been tagged and 6,500 reported as recaptured. Cod tagged inshore were mostly recaptured inshore, even 4-5 year after release. Returns also indicated that some cod tagged offshore were recaptured in the inshore fixed gear fishery on the south coast during the summer and fall. Among cod tagged in the Burgeo/Hermitage Channel area in April, recaptures came from 3Pn4RS as well as along the inshore of 3Ps; the proportions recaptured in each region varied annually, but in two of three years more recaptures came from 3Pn4RS.

Recaptures also indicated a spring-summer movement of cod from the inner reaches of Placentia Bay toward the mouth of the bay. Several of these cod, as well as others tagged offshore in Halibut Channel, were recaptured in 3L during 1998, 1999, and 2000. The pattern of recaptures suggests a movement of some 3Ps cod across the stock management boundary into 3L during late spring, with a return migration during late fall. Historical and recent tagging of cod offshore in southern 3Ps also revealed some movement of cod between this area and the southern Grand Banks (3NO).

Information from recaptures of cod tagged in various regions of 3Ps since 1997 was used to estimate average annual exploitation rates. Three analyses of the tagging data were conducted. In the first analysis, reported in this working paper, which did not incorporate length selectivity of the fishery, exploitation rates were calculated for cod tagged in specific regions. A portion of the exploitation typically occurred in regions other than where fish were tagged and these estimates could not be converted to exploitable biomass using local catches. During 1999 and 2000, exploitation was high for cod tagged in Placentia Bay (3Psc) and intermediate for cod tagged west of the Burin Peninsula (3Psa/b/d/e).

Discussion (Rapporteur – Peter Shelton)

It was noted that if the tagging data for the northern Gulf cod could be obtained in the same format as that for 3Ps cod then a combined analysis that accounted for fish movements between the two stock areas could be considered. The relative quality of the two data sets was discussed as well as the differences in the reward incentives for tag returns.

It was noted that in some areas harvest rate is low which may lead to inaccurate estimates of biomass. This was thought to be a particular problem for fish tagged in the offshore.

It was reported to the meeting that tag mortality estimates from experiments carried out in the Gulf appeared to be a lot lower than those carried out in 3Ps and 2J3KL. Average for 3Ps/2J3KL is 13% compared to less than 5% in the northern Gulf.

Working Paper 14: Tagging model – Noel Cadigan and John Brattey

A model for analysis of the post-moratorium cod tagging data that accounts for migration between regions, tagging mortality, tag loss and reporting rates, as well as growth and length selectivity of the commercial fishery was presented. The model estimates weekly exploitation rates by region and cod length class. Exploitation rates are converted to exploitable population biomass using reported catches. Sampling of the length frequencies of commercial landings in each region, in conjunction with a length-weight relationship, were used to convert catch numbers to biomass. This model gave estimates of exploitable biomass for Placentia Bay (3Psc) and areas west of the Burin Peninsula (3Ps/a/b/d combined) of 70,000 t, which was similar to the estimate obtained from the simple tagging model. The estimate of exploitable biomass for the offshore was several hundred thousand metric tons.

Discussion (Rapporteur – Brian Healey)

Possible reasons for the high estimates in the offshore were discussed. These include the restricted distribution of tagging coverage and restricted distribution of fishing activity in the offshore, more uncertainty in the estimates of reporting rate from the offshore, and lower survival of fish caught for tagging offshore in deep water. These factors need to be explored further.

The results from sensitivity runs were presented with an imposed 80% post-mortality tagging on fish in the offshore. This resulted in much lower biomass estimates and offshore 3Ps no longer acted as a "refuge" where the biomass built up. There was also increased movement into 3NO.

The authors expressed some concern regarding the large CI's estimated for some return regions. In one case, the 95% CI's for a smoother through the residuals do not cover zero.

Working Paper 15: Some Alternative Assessments of 3Ps cod – Coby Needle

Three methods commonly used in ICES stock assessments are applied here to the 3PS cod dataset: the Kalman filter method or TSA (Gudmundsson 1994), Extended Survivor's Analysis or XSA (Darby and Flatman 1994), and Integrated Catch-at-age Analysis or ICA (Patterson and Melvin 1996). Brief methodological summaries and model results only are given for XSA and ICA, while a more detailed description is also included for the Kalman filter method as this may be less well-known to those in attendance at the Fall RAP. The method has been used for several years in ICES assessments of groundfish in the North Sea (Sub-Area IV) and the West of Scotland (Division VIa). A modification to accommodate the cessation of directed fishing effort during the 1994–1996 moratorium is presented here, along with results of the associated assessment. In theory TSA should be a good method for the assessment of 3Ps cod, but parameter estimates are pathological. Further work will be needed to rectify these difficulties; it may be the case that the method will not be appropriate until several more years of post-moratorium data are available. On the other hand, both XSA and ICA yield believable stock summaries with reasonable internal diagnostics, despite a priori belief that they would not be appropriate. Further investigation of these two models for the purposes of this RAP would be opportune.

References:

Darby, C.D. and Flatman, S. 1994. Lowestoft VPA Suite Version 3:1 User Guide. MAFF: Lowestoft.

Patterson, K.R., Melvin, G.D. 1996. Integrated catch at age analysis. Version 1.2. Scottish Fisheries Research Report, no. 58

Gudmundsson, G. 1994. Time series analysis of catch-at-age observations. Appl. Statist. 43: 117–126.

Discussion (Rapporteur – Peter Shelton)

The meeting decided that it would be useful to carry forward further analyses of the stock using XSA to provide comparative results to those obtained from ADAPT and QLSPA. Although the residual pattern from analyses using ICA did not look too bad, it was decided that it would require more time than was available to obtain usable results.

A problem common to all the SPA approaches was raised. Catch is not equally distributed across all stock components – much of it comes from the inshore area and may not reflect the whole stock. The idea of carrying out separate analyses on inshore and offshore components was raised. It was pointed out that this had been attempted previously but that it had been found that it raised a number of problems, one of which is related to the seasonal movement of fish from the offshore to the inshore. The similar problems associated with splitting the survey in terms of east and west components was also discussed. In this case only the survey data has been disaggregated.

There was some agreement that SPAs on separate components of the stock may be useful as a "stone turning over process" to shed light on things such as the estimate from tagging experiments in the offshore which indicate a very large biomass.

Working Paper 16: Considerations from Fisheries Management - Larry Yetman

Information was provided on the fishing gear allowed in the 2001/2002 fishing season. If licensed to fish gillnets, and vessel class was A257, the following conditions applied:

i) A minimum 5 1/2-inch (140mm) mesh size to a maximum of 6 1/2 inch (165 mm) mesh size was permitted for gillnets. ii) The maximum number of gillnets that could be used was 20 nets of 50 fathoms each in 3Ps (a)(b) and (c); and 40 nets of 50 fathoms each in 3Ps (d)(e)(f)(g) and (h). iii) In 3Ps (d)(e)(f)(g) and (h) gillnets had to be removed from the water and returned to port at the end of each fishing trip. iv) Gillnets could not be left unattended in the water for more than 48 hours. v) Gillnets could only be fished during the defined season for gillnets set out for specific areas of 3Ps. vi) When the directed cod gillnet season was closed, cod by-catch was required to not exceed 10% daily of the weight of the directed species retained on board or 200 pounds (round weight) whichever is greater. For hook and line gear, the maximum number of hooks permitted was 4,000.

The area of Burgeo Bank encompassed by 3Psd was closed to fishing for the period November to April 2000/2001. The whole offshore area, 3Psdefgh, was closed to cod fishing from March through June 2001 (spawning closure). The directed cod fishery using gillnets in Placentia Bay in the Inner Island Area, Woody Sound and Bar Haven Islands areas was closed to non resident fishers (Rose closure). Only a 10% bycatch of cod in groundfish fisheries was permitted when spawning closures were in effect.

The directed cod fishery using gillnets in Placentia Bay (inside a line from Grandy's Point to Bald Point) was closed July 21 to reopen October 15, 2001. The directed cod fishery using gillnets in Fortune Bay (inside a line from Pt. Crewe to Pass Island) was closed Aug 31, to reopen October 15. The directed cod fishery using gillnets in Hermitage Bay (inside a line from Pass Island to the Western tip of Long Island) was closed, Sept 13 to reopen October 15.

Discussion (Rapporteur – Rick Stead)

A question was asked regarding how much of the catch was handline, because there is a perception that much fish caught with gillnet may be reported as caught with handline because of the restrictions placed on gillnet catch. There is no way to know how much misreporting of this kind is going on. It was stessed that the type of gear used in the fishery doesn't matter to science, however, the bookkeeping around the landings by gear and the projections that are carried out does.

It was noted that the French portion of the TAC is15.6%. Of this, 70% must be caught by Canadian large vessels and landed in St. Pierre. The remainder is caught by the SPM small boat fishery.

A question was raised with respect to the location of most of the fishing activity by 3Pn fishermen who hold overlap licenses. It was determined that most of these fishermen fish on Burgeo and St. Pierre Banks. It was noted that 3Pn fishermen with overlap licenses are allowed to catch more than that which is permitted for 3Ps fishermen in terms of their IQ. There was a 50 t allocation of Gulf cod made available to 3Ps of which 27 t was landed in Nova Scotia.

With regard to how much of TAC would remain for Jan-Mar 2002, it was determined that a considerable portion of the offshore TAC still remained to be caught. For the inshore, further fishing would take place in the Nov-Dec 2001 period and only longlines would be allowed after Dec. 15.

Working Paper 17: Catch in mixing area by vessel class and homeport – John Brattey

An analysis was presented of the reported landings by month for different length class fishing boats fishing in3Psn, 3Psa and 3Psd and an analysis of catch by month by area of homeport origin (4WX, 3Ps, 3Pn4R and 2J3KL) over the period 1998 to 2001. Fishing in 3Pn in Jan-Mar is carried out by vessels >65 ft originating from 2J3KL. From May to September it is predominantly by boats <35 ft from 3Pn4R. Highest landings occur in the August to November period. Fishing in 3Psd takes place predominantly from May to November with no clear peak. Area of origin of vessels is mainly 3Ps but includes vessels from 3Pn4R and 2J3KL. Fishing in 3Psa takes place mainly from May to November with no clear peak, mainly by 3Ps and 3Pn4R vessels. It should be noted that these patterns are in large part of consequence of existing management regulations over the time period and not altogether to do with the seasonal movements and availability of fish.

Discussion (Rapporteur – Peter Shelton)

It was noted that the presence of Gulf fishing vessels in the purported mixing area between northern Gulf cod and 3Ps cod implies that management measures would affect fishermen from both regions.

Working Paper 18: Analysis of less than 35 ft commercial logbooks – Don Stansbury and Eugene Murphy

An analysis of the data collected in science logbooks by the < 35 ft sector over the period 1997 to 2000 was presented. A generalised linear model similar to that applied to sentinel data was adopted, except that age composition data were not directly available for the logbook data so that the age effect was dropped. In addition, catch rates from logbooks were expressed in terms of weight, whereas sentinel catch rates were expressed in terms of numbers of fish. In a similar approach to that adopted for the sentinel survey data, the response distribution was specified as Poisson and the logarithmic link function was used.
Catch per unit effort (CPUE) data were standardised to remove area and seasonal effects. The model adequately fitted data from gillnets and line-trawls and two standardized annual catch rate indices were produced. The observed trends in the indices are influenced by annual changes in the management plans as well as the density of fish. Catch rates are also influenced by annual variability in the extent and timing of inshore and long-shore migration patterns. Consequently, inshore commercial catch rate data must be interpreted with caution.

Discussion (Rapporteur – Peter Shelton)

It was noted that one would expect equal slopes in the catch rate data across years, (response of catch to more effort), but different intercepts indicating year effects in the data which are interpreted as more or less fish in the stock.

A pattern in residuals with respect to effort was noted. It was suggested that there may be a problem may be with low levels of gillnet effort in some areas and this needs to be looked at.

The question of the usefulness of commercial catch rates as an index for ground fish was brought up. Because fish aggregate, commercial catch rates are known to be biased indicators of stock size in many cases when stock size is low. It was agreed that this might be less of a problem with respect to gillnets and linetrawls than it was in the case of bottom trawls, but might still be a problem.

The analysis suggested that different year effects may be associated with different areas. Significant interactions terms such as this can make interpretation of the results difficult., and needs to be examined further. One possibility suggested is that different area effects may represent different stock components. Alternatively, the way the fishery is prosecuted in different areas is very different and this may generate year-area interactions. There was general agreement that the year-area effects for gillnets and linetrawls needed to be thoroughly evaluated for the next assessment.

Working Paper 19: Simple ANOVA evaluation of SPA inputs – Don Stansbury

Analysis of variance (ANOVA) was used to examine age, year and year-class effects in these data using the multiplicative model approach of Shepherd and Nicholson (1991).

Much of the variance in the logarithm of catch-at-age data can be explained by a simple multiplicative model with 3 factors representing ages, years and year classes. In this approach, the catch at age or tuning index at age value is considered to be a product of an age effect (a combination of selectivity or catchability and cumulative total mortality) and a year class effect (to account for the varying strengths of year-classes). This model is applied by fitting age, year-class and year factors to the logarithmic transformation of the catch or tuning index at age data. Fitting was carried out using PROC GLM in SAS. We first fitted each effect by itself to determine how much of the variation could be explained by each effect alone. We then examined Type I SS for age, year class and year, which is the improvement in the error SS when each effect is added sequentially to the model. Lastly, we examined the Type III SS, which is the improvement in the error SS when the effect is added to the model after all other effects have already been taken into account. The results were presented to the RAP for discussion and for consideration for inclusion in the Research Document.

The ANOVAs examining each effect by itself showed that in all cases the age effect explains most of the variation (60-83%). This is in keeping with the anticipated effects of selectivity and cumulative mortality. In all cases, with the exception of the catch data, year class was next in terms of the amount of variation explained. However the amount of variation explained by year class was not significant at the level in the case of sentinel line-trawl data. A strong year class effect in the indices is desirable because it indicates that year classes are being tracked, despite measurement error and variation in mortality and catchability or selectivity at age. In the case of the commercial catch data, the year-class effect was not significant and explained less of the variation than the year effect. The strong year effect in the catch data is mostly a consequence of the strong signal imposed on the data by the changes in TAC that have taken place. Significant year effects in the tuning indices are not desirable and can arise through changes in survey catchability from year to year or a trend over time. Significant year effects were apparent in the Templeman RV survey data (not split), the eastern portion of the survey data and the GEAC survey data. The root mean square error (root MSE) provides a measure of the residual variance unexplained by the model. Values ranged from about 0.8 to 2.2.

An examination of Type I SS (Table 19) showed that age, year class and year effects together generally explain between 86% and 99% of the amount of variation in the data. The year class effect in the acoustic data was not significant after the age effect in the data has been accounted for. In all other data year class effects were significant. An examination of the Type III SS (Table 20) also shows that year class was not significant for the acoustic survey index when it enters last into the model. Year class effects were smaller than the year effects for the RV survey indices when year class enters last into the model. The largest root MSE occurred in the acoustic data, indicating considerable residual unexplained variability once age, year class and year effects had been removed. Values were also high for the eastern portion of the RV survey, the Cameron survey and the GEAC survey. Large values suggests a lot of noise in these tuning indices (e.g. age*year interaction, age*year class interaction or year*year class interaction).

Reference:

Shepherd, J. G. and M. D. Nicholson. 1991. Multiplicative modelling of catch-at-age data, and its application to catch forecasts. J. Cons. int. Explor. Mer, 47:284-294.

Discussion (Rapporteur – Peter Shelton)

It was agreed that ANOVA provided a very useful tool for looking at individual tuning indices before they entered the SPA. The intention is to conduct them routinely in future cod stock assessments.

It was noted that that the GEAC and Burgeo tuning indices were border-line with respect to a significant yearclass effect and that the acoustic index had did not have a significant yearclass effect. It was suggested that the use of a smoother might assist in looking at patterns in the residuals.

It was pointed out that the simple ANOVA approach would not account for the changing mortality pattern that occurred with respect to the moratorium. The method is sensitive to cumulative mortality.

Working Paper 20: A Simple Matrix Bases Analysis of Multiple Area Tagging Data – John Pope and John Brattey

A simple model for the analysis of tagging data was described. This model accounts for both harvest within stock components and migration between components. An exact matrix solution is provided for the simple case where all components are tagged in a year and extensions of this are constructed to handle the singular matrix situations where not all data are available for all years. This model is applied to inshore components of the Newfoundland Northern (NAFO subdivisions 2J3KL) cod stock and to inshore and offshore components of the 3Ps cod stock. Assessment of this stock is complicated by post moratorium fisheries being conducted only on inshore sub populations. These are not fully covered in the groundfish survey which provide the main link to the pre-moratorium population estimates. Hence, assessments of abundance of these sub-populations must rest heavily on the results of tagging experiments. Results indicate that the biomass of components of the Northern cod have remained at about 40Kt for the past three years and that harvests rates have typically been of the order of 10% on the major 3L North component and rather higher on the 3K component during this period.

Discussion (Rapporteur – Peter Shelton)

The approach was supported by the meeting as providing a model of intermediate complexity that, while capturing the main elements of the problem, was nevertheless reasonably tractable. It was noted that on an earlier version presented in the previous assessment meeting had been solved iteratively rather than through matrix manipulations. It was suggested that the iterative approach may be more appealing.

If results were broadly similar to those obtained from more complex models dealing with selectivity, growth etc., then this begged the question the question of the appropriate level of model complexity for answering questions related to exploitation rate and biomass.

Working Paper 21: Canadian research survey data conversions for redfish in SA2 + Div. 3K based on comparative fishing trials between an Engel 145 Otter trawl and Campelen 1800 shrimp trawl – Don Power and Dave Orr

In 1995, Newfoundland Region replaced the research vessel, standard survey gear and fishing protocol that been utilized on groundfish surveys in Divs. 2J3K from 1977 to 1994. Comparative fishing trials were conducted in 1995 between the new vessel and gear (CCGS Teleost with Campelen 1800 shrimp trawl) the previous vessel and gear (MV Gadus Atlantica with Engel 145 Otter trawl). The data collected were analysed by length groups to provide a means to convert the older data time series into Campelen equivalents. The conversions did not distort any trends in the historic series for Div. 2J3K redfish but suggest that the rate of decline in the survey index since the 1970's was even greater. This is a reflection of the increased catchability of the Campelen for all size groups, particularly for those less than 30 cm.

Discussion (Rapporteur – Peter Shelton)

There was a general discussion of how the comparative fishing experiment was carried out and how the data were analysed. In the case of redfish, it was suggested that it might have been better to leave fish 10cm and less out of the analysis because there was not much data from which to estimate a conversion factor. This was not considered to be a major problem because not many small fish are captured in the survey.

Working Paper 22: The status of redfish in SA2 + 3K – Don Power

Information on the status of the stock was provided based on bycatch data and DFO bottom trawl survey data. The bottom trawl surveys continue to indicate the resource is at a very low level with poor recruitment for the past 25 years. Stock structure is poorly understood, particularly the relationship between redfish in SA2+Div. 3K and those of the Irminger Sea pelagic stock. This stock remains at a very low level. Recruitment has been very poor since the year classes of the early 1970s. Most of the abundance in the 2000 survey is composed of fish less than 25cm (10 inches). There are no indications that the status of the stock will change in a positive way in the foreseeable future.

Discussion (Rapporteur – Peter Shelton)

Concern was expressed regarding the variable and incomplete survey coverage for the northern part of the stock area (2GH). It was pointed out that historically redfish in the northern part of the stock area had been considered to be a separate stock and that there were indications that some of these fish originated from Greenland.

In the absence of age composition data, the length frequency data were evaluated for modal progressions. It appeared that any signal in the length frequency data since 1995 was very weak relative to the sampling variation.

A question was posed as to whether or not the shrimp fishery could prevent good recruitment in redfish. It was note that observer coverage on shrimp vessels was about 10% and that not all the shrimp vessels have separators.

It was asked why there was no analytical assessment for this stock. It was pointed out that there is catch-at-age data for the period 1973-88 and that an illustrative SPA has been attempted in the past. However, it was considered that the survey was very spikey and did not provide a good tuning index. The suggestion was made that it might be possible to carry out length-based assessment to get a feel for what the abundance might have been.

Working Paper 23: 2GH Cod, 3LNO Haddock, 3Ps Haddock – Eugene Murphy

No new information was provided on 2GH cod. There has been no directed fishing permitted on cod in the 2GH area since 1996 and there has been no reported catch since 1991. The stock collapsed to exceedingly low levels in the 1980s. There has been no recovery. Bycatch in the shrimp and turbot fisheries that are taking place in the stock area could delay or prevent recovery. Predation by harpseals may also be a factor.

The haddock fishery in 3LNO from the late 1940s to early 1960s was supported by a few strong year-classes. If the warm period continues and survival is good there is the potential for increases in the haddock biomass in this area. Since 1998 the biomass of small haddock, thought to be the 1998 year-class, has increased and the distribution has expanded. The actual strength of the 1998 year-class is not known. However, with the increase in the yellowtail flounder TAC from 6000 t in 1999 to 13,000 t in 2001, an increase in the haddock bycatch may be expected if this year class is strong.

A significant haddock fishery existed in subdivision 3Ps in the mid to late 1950s. That fishery was supported almost entirely by the abundant 1949 year-class. There has been no significant recruitment since the mid 1950s. It is not known whether haddock in 3Ps constitute a separate stock or whether haddock in the entire 3LNOP area undergo range expansion when a year-class survival is enhanced by suitable environmental conditions.

Discussion (Rapporteur - Peter Shelton).

DFO bottom trawl surveys in 2GH have been sporadic of late and are not directed specifically for cod but, rather for turbot and shrimp. There was a question with regard to how the hydrography might have influenced the distribution and productivity of the stock. A study of cod distribution relative to temperature and depth may be useful.

Questions were posed with regard to the degree the changes in cod abundance in 2GH could be related to range expansions of the 2J3KL cod stock and whether or not there were parallels with what has been observed off the west coast of Greenland.

With regard to 3LNO haddock, it was noted that peak catches occurred in the early 1960s and that haddock was preferred over cod at this time. It was noted that the increase in haddock in the recent period was all within the Campelen survey series. The haddock survey data collected with the Engel trawl have not been converted to Campelen equivalent units – there would be little information the comparative fishing experiments on which to base such a conversion. It was suggest that graphs of haddock survey data should emphasize that the two series are not directly comparable.

With regard to 3Ps Haddock, a question was asked as to whether the decrease with respect to 1998 had been a result of decrease in abundance or change in distribution with respect to temperature. It was suggested that this was something that could be examined further with the available data.

It was noted that the 1998 year-class which was relatively strong in 3Ps, was also observed in significant numbers in Divisions 3LNO in the late summer early autumn pelagic juvenile survey and in both the fall 1998 and the spring 1999 3LNO multi-species groundfish surveys. A suggestion was made to examine the combined spring distribution of haddock in 3Ps and 3LNO.

Computations for 3Ps cod

Initial diagnostic analyses were carried out to examine quality and coherency of the catch at age and tuning indices prior to running any SPAs using ANOVA and SPAs tuned with single indices. This was followed by a number of sensitivity runs using ADAPT, QLSPA and XSA to examine the effect of alternative models and formulations. For comparison purposes, the identical model/formulation used for providing scientific advice in the 2000 assessment was also applied to the data.

It was considered that, while the actual size of the stock over time was uncertain, the consistency in the trends among methods would imply that inferences regarding risk may be relatively robust. Consequently, 5 model/formulation runs were selected on the basis of providing plausible representations of the stock consistent with the available data and acceptable fits under commonly applied statistical criteria for evaluating SPA output in stock assessments. These models were applied to the catch data from 1977 onwards and included the RV index (split and non-split), Cameron index, Sentinel line-trawl index and the GEAC index.

Some preliminary precautionary biological reference points were suggested for 3Ps cod in past assessments. These included both fishing mortality reference points and spawner biomass reference points. Although the concept of a precautionary approach is well established within DFO, this has not led to the development of recognized target and limit reference points for use in decision making. It is generally acknowledged that the development of targets would require broad debate. However, in the case of limits,

some argue that the basis should almost entirely be scientific, while others argue for a social, economic and political considerations to factor into determining limits as well as targets. In the absence of operational precautionary approach in groundfish, this assessment chose three preliminary reference points for 3Ps cod which may be of use in current decision making regarding TACs and other management actions: i) population decline, a stock-rebuilding reference; ii) F =$F_{0.1}$, a limit reference point (only a small probability of exceeding it should be tolerated under a precautionary approach, e.g. a 10% probability); iii) F = 0.5* $F_{0.1}$, a target reference point (fishing mortality to be aimed for – i.e. a 50% probability).

APPENDIX I

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APPENDIX II

WORKING PAPERS AND RAPPORTEURS

1. Review of 3Ps cod – John Brattey and Peter Shelton (Rapp: Peter Shelton)

2. Oceanogrpahic conditions in NAFO Subdivisions 3Pn and 3Ps during 2001 with comparisons to the previous year and the long-term (1971-2000) average – Eugene Colbourne (Rapp: Dale Parmiter-Richards)

3. Sentinel surveys 1995-2001: Catch per unit effort in NAFO Subdivision 3Ps – Dawn Maddock Parsons and Rick Stead.(Rapp: RickStead)

4. Sentinel set selection – Don Stansbury (Rapp: Rick Stead)

5. Commercial catch for 2000/2001 – Eugene Murphy (Rapp: Morgan)

6. RV Survey data for 2001 – John Brattey, Eugene Murphy and George Lilly(Rapp: Peter Shelton)

7. Recent trends in bottom temperature and distribution and abundance of cod (Gadus morhua) in NAFO Subdivisions 3Pn and 3Ps from the winter/spring multi-species surveys – Eugene Colbourne and Eugene Murphy (Rapp: Dale Parmiter-Richards)

8. GEAC Survey results – John McClintock (Rapp: Castongay)

9. Capital, interest and temperature – John Pope (Rapp: Peter Shelton)

10. VARMA ogive modelling – Coby Needle (Rapp: Peter Shelton)

11. Acoustic surveys of Placentia Bay in springtime, 1996 – 2001 – George Rose and Luise Mello (Rapp: Dawn Maddock Parsons).

12. Seasonal variability in biological condition of Atlantic cod (Gadus morhua):implications for harvesting and industry – Luise Mello and George Rose (Rapp: Shelton)

13. Movements and exploitation rates of Atlantic cod in NAFO Subdiv. 3Ps based on tagging experiments – John Brattey (Rapp: Peter Shelton)

14. Tagging model – Noel Cadigan and John Brattey (Rapp: Brian Healey)

15. Some Alternative Assessments of 3Ps cod – Coby Needle

16. Considerations from Fisheries Management - Larry Yetman (Rapp. Rick Stead)

17. Catch in mixing area by vessel class and homeport – John Brattey

18. Analysis of less than 35 ft commercial logbooks – Don Stansbury and Eugene Murphy

19. Simple Anova evaluation of SPA inputs – Don Stansbury

20. A Simple Matrix Bases Analysis of Multiple Area Tagging Data – John Pope and John Brattey

21. Canadian research survey data conversions for redfish in SA2 + Div. 3K based on comparitive fishing trials between an Engel 145 Otter trawl and Campelen 1800 shrimp trawl – Don Power and Dave Orr (Rapp: Peter Shelton)

22. The status of redfish in SA2 + 3K (Rapp: Shelton)

23. 2GH Cod, 3LNO Haddock, 3Ps Haddock – Euegene Murphy (Rapp: Peter Shelton).

APPENDIX III

REVIEW BY INDEPENDENT EXTERNAL REVIEWER

Coby Needle, FRS Marine Laboratory, Aberdeen

Summary

This document contains a series of impressions, congratulatory remarks, occasional criticisms, and suggestions for future improvements of the fall RAP groundfish assessment meeting. There is no real structure to my comments, although I have tried to keep notes on similar themes together. Unless specifically noted, my remarks relate to the 3PS cod assessment.

Comments on specific presentations

Overview of the last assessment (Working Paper 1)

I found this summary of the last assessment extremely useful in getting acquainted with the peculiarities of the stock, as I'm sure did many of the non-regular attendees. The following points might be worth raising.

The major aspect missing from the dataset and which is present in several ICES groundfish datasets is the estimation of discards, especially given that quotas appear to be restrictive. Discard programmes are expensive to implement and tend to give noisy estimates, but are invaluable nevertheless. In stocks such as North Sea haddock it has been shown that a compressed age-structure leads to an increase in the number of first-time spawners, and a subsequent decrease in quality and survivability of eggs. Is there any evidence if age-structure compression in 3Ps cod, and if so, are there studies showing the suitability or otherwise of first-time spawners? If this is a feature of this stock, it may be worth accounting for in the assessment. The change of gear in 1996 in the DFO RV survey is problematic, and should be evident in catchability residual patterns from an XSA analysis – however, although there is a substantial positive year effect in 1996, it is not maintained as would be expected after a gear change.

CPUE indices have become increasingly unpopular in ICES assessments, since it is clear that modern vessels are able to locate and catch fish aggregations from a dwindling population. Such indices from commercial fleets are no longer used in the RAP assessments, but data from the Sentinel fisheries are. This raises the question of whether the Sentinel CPUE data are equally problematic. While Sentinel fishermen do not target aggregations in the way that commercial fishermen do, the initial placement of sites was done in such a way as to maximise the likelihood of catching reasonable numbers of fish. Given this, is it appropriate to use the Sentinel series as an unbiased and fair representation of abundance?

Oceanographic review (Working Paper 2)

It is very important that this kind of information be presented to the meeting. This is particularly true for 3Ps cod, which is so clearly adversely affected by cold-water influxes. I was rather concerned by the emphasis on the NAO as an indicator for all things marine, but thankfully the presentation stopped short of correlating this index with recruitment or abundance. This is done far too often, and any significant fits invariably collapse just when you decide they might be valuable. I agree that a cool period, if one is clearly in progress, should be taken into account when thinking about one- or two-year forecasts for this stock, but I would caution against doing so when the downturn in temperature is relatively small and only of one year's duration.

Sentinel surveys (Working Papers 3 and 4)

I would have liked to have seen some more explanation of how set-selection criteria were determined. Although some information was forthcoming during the discussion session following the presentation. There was reference made to a planning-group meeting, but I presume many of those at the RAP were not involved in this earlier meeting. This would also have been consistent with the impressive level of detail in presentations of other surveys. Without knowing the findings of the planning meeting, many of the selection criteria seemed arbitrary to me. One example was the restriction of soak time to 18 to 24 hours, and I agreed with the conclusion of the meeting that a coarser measure of an appropriate soak time (say, 1 "day" howsoever defined) should be used instead. However, I would still advocate that it would be better to model explicitly the behaviour of these gears.

Catch and survey data (Working Papers 5 and 6*)*

These were excellent and very thorough summaries of the collection and collation of catch-at-age data from the commercial fishery, and represent a level of detail that we unfortunately never see at ICES working groups. I was very interested in the information on the likely effect of a restriction in the amount of gillnetting, as my experience with any gear other than an otter trawl is limited. This was followed by a good and wide-ranging discussion, again of the type which we are seldom able to pursue at ICES.

The time-series of maturity-at-age looked to be extremely noisy, and thus far has been estimated on an annual basis. Suggestions were made to model maturity by cohorts and use other smoothing techniques, and this was investigated by a sub-group.

Influence of temperature on cod distribution (Working Papers 7)

This presentation clearly demonstrated that colder temperatures lead to reduced catches. However, I would be happier with this relationship if there were some firm, testable hypotheses about the causative mechanisms involved. Is it just temperature inhibiting life processes, or could it also be the fact that colder water is usually accompanied by increased advection which might disrupt juvenile feeding?

GEAC survey (Working Paper 8)

Good, detailed exposition of area covered, gear characteristics, and results. Because each stratum has at least two hauls, the number of hauls is not necessarily proportional to stratum area, and the survey is not a true randomly-stratified design – whether this is a problem is hard to ascertain.

Capital, interest and temperature (Working Paper 9)

I liked the analogy used here, comparing a fish population to a savings account, and I can see how this would appeal to canny Scottish fishermen in particular. I have doubts, though, about fitting different stock-recruit curves to different temperature "regimes": these fits did not convince me and the choice of partitioning criteria will always be arbitrary.

VARMA ogive modelling (Working Paper 10)

Only a subset of a larger analysis was presented here, as this is very much ongoing work and not all of it is necessarily relevant to this meeting. Having said that, the proposed change to multiannual TACs and the consequent need for longer-term projections meant that there was more interest than anticipated in the ICES medium-term projection methodology. The idea of modelling maturities as cohort-based ogives has been investigated previously by several members of the RAP, and it was decided to use this to generate new maturity estimates.

Acoustic surveys (Working Paper 11)

As my expertise in acoustic surveys is limited, I feel poorly qualified to give constructive criticism on this presentation. However, the opinion of the meeting seemed to be that there were aspects of the analysis and methodology used which were missing from the paper, the inclusion of which would have been beneficial. Certainly, the limited areal extent of the survey seems to preclude its use as a tuning series for the whole 3Ps area, and it should perhaps be viewed as supplementary information.

Variability in condition and implications for management (Working Paper 12)

This is potentially valuable information, and similar datasets are being analysed in ICES to attempt to generate alternatives to SSB as an indicator of reproductive potential. However, I found this presentation to be a little unbalanced: there was a lot of detail about the data series and collation methods, and correspondingly little about the use of these data in subsequent management – which is what the RAP should be interested in. The presentation of biological information to an assessment meeting should be focussed on those aspects of the data which can best serve to improve management, there being a danger that interesting science can lead attention away from the purpose of the meeting.

First tagging model (Working Paper 13)

The tagging studies undertaken by DFO are highly impressive and are to be thoroughly commended. The tagging of cod is made possible by the regional familiarity with capture methods such as gillnetting and hand-lining: in comparison: tagging of ICES fish is extremely difficult because of high post-trawl mortality. The first analysis method presented, far from being "trivial", served as an invaluable first look at the data and yielded a great deal of information about distribution, movement and exploitation of 3PS cod. It was a good study, well-explained, and I found it very useful. The only suggestion would be for graphical summaries of the percentage returned to different areas. I was rather surprised that little use has been made so far of the tag-derived estimates of exploitation, but that may be a task for the future. Finally, I would have thought it beneficial to estimate different post-tag mortality rates for different capture methods, depths, seasons, etc., rather than using a standard figure for all experiments.

Second tagging model (and general discussion on tagging) (Working Paper 14)

The tagging model presented here looks to be an excellent analysis, and seems to derive a great deal of extra information from an already-impressive dataset. But it is hard to be sure, because the presentation skipped over a lot of detail and it was difficult to know exactly what the model structure was. I can appreciate that a full discussion of this work would be unwieldy, but highlighting the salient points would have been helpful. I'm not saying that the model was perfunctory – just the explanation of it.

I am not personally aware of any tagging work currently being undertaken by ICES member states. The FRS sandeel tagging program during the 1980s (I think) characterises the problems we had – every sandeel tagged and thrown overboard could be seen to disappear down the throat of one of the attendant gannets, so post-tagging mortality was 100% and model interpretation became very easy. The programme was shelved very quickly, and the thousands of left-over tags were used to make a sandeel statue which was on display in Aberdeen for several years – or so I am told.

Alternative assessment methods (Working Paper 15)

Three methods commonly used in ICES stock assessments were applied to a preliminary version of the 3PS cod dataset: the Kalman filter method (TSA), Extended Survivor's Analysis (XSA), and Integrated Catch-at-age Analysis (ICA). Brief methodological summaries and model results only were given for XSA and ICA, while a more detailed description is also included for the Kalman filter method as this was less well-known to those in attendance at the Fall RAP. A modification to accommodate the cessation of directed fishing effort during the 1994–1996 moratorium was presented, along with results of the associated assessment. In theory TSA should be a good method for the assessment of 3Ps cod, but parameter estimates were pathological. Further work will be needed to rectify these difficulties: it may be the case that the method will not be appropriate until several more years of post-moratorium data are

available. On the other hand, both XSA and ICA yielded believable stock summaries with reasonable internal diagnostics, despite *a priori* belief that they would not be appropriate. It was decided by the meeting that the XSA method would be carried forward to a full historical assessment.

CPUE from log books (Working Paper 18)

This was a detailed and comprehensive treatment of CPUE data from submitted log books. While such information is increasingly discredited in the ICES area where trawlers are able to fish down shrinking aggregations, the extensive use of gillnets and lines in 3PS means that CPUE indices may be less likely to be problematic. I would still question their use as tuning indices in SPAs, if only for the fact that the commercial fishery is already represented in catch-at-age data and to use a CPUE index would effectively include the same data twice. In addition, diagnostics show that area interactions may be present.

Tuning series ANOVAs, single-series XSA runs, and exploratory data analysis

Three analyses were carried out with the intention of examining the variability of the catch and survey data, and the consistency of the latter in terms of reflecting catch-at-age trends. Such data mining is beneficial and should be continued. Possibly the best approach for future meetings would be factor analysis, in which the different sources of information are rated according to how well the explain the underlying factor they are all purporting to measure (in this case, abundance).

Producing ANOVA tables of each survey series and the catch data is highly commendable: it enables us to look at the data unencumbered by the strictures of sequential population analysis, and informs decisions about which age and year ranges to use for each series. Single-series XSA analyses perform a similar function, but are hindered by the assumption that the catch data are the ideal against which everything else is compared. While I normally despise bubble plots in all their incarnations, I found the ones presented during the final exploratory data analysis to be useful in highlighting the degree to which different series track year-class strength.

The strongest overall conclusion from the analyses was that the splitting of the Canadian RV series into Burgeo and non-Burgeo components reduced the fit of catch-at-age models to the data. It was also suggested that large year effects in the GEAC survey reduced its suitability, and that the younger and oldest ages on the acoustic survey series were problematic.

Predicting year-class strength from survey data

This analysis demonstrated a method of deriving estimates of year-class size directly from survey series, and seemed like a useful approach. The only problem I have with it is the notion of inverse-variance weighting of tuning series. This is an option in the ICA assessment package and has been investigated on numerous occasions by ICES Working Groups. In every instance it has been found that has much weight as possible

is assigned to the survey with the least variance, whether or not that survey concurs with the catch data or is in any other way a valid representation of stock dynamics. It may not be important, and indeed it was shown in this presentation that the results are not affected by changes in the upper limit on weights: rather, it just seems to me to be taking empiricism a bit far. I would prefer to see survey weightings determined manually by an expert who has a good feel for how representative each one is likely to be.

Other stocks

I was surprised at the cursory nature of the assessments of stock other than 3PS cod. While data and commercial interest are not at the same level, there are still populations to be managed and there are opportunities for assessments to be carried out. In ICES meetings, with less personnel and more management parameters to be estimated, there would be an imperative to assess such stocks with all the tools and information at our disposal.

SA2-3K Redfish (Working Papers 21 and 22)

Although I am not an expert in the methodology of comparative fishing trials, the number and type of trials carried out seem appropriate, and are certainly more than the number we were able to undertake in testing the new *Scotia*. The historical review of the redfish fishery was useful and enlightening for those of us with no experience of this stock, which has undergone one of the most spectacular population crashes/emigrations I have ever seen. It might be an idea to look into the use of catch-at-age analyses for redfish, given that it is difficult to age and very long-lived.

2GH cod (Working Paper 23)

Cod in 2GH would appear to have undergone an almost complete collapse since the early 1980s. However, a reasonable cod fishery in this area only ever lasted for five years in the late 1960s, and it is possible that this stock has undergone a range shift that has taken it out of the 2GH area. This hypothesis cannot be evaluated without further information on the prevailing environmental conditions, and a request was made for additional exposition from the DFO oceanographer. Unfortunately this was not forthcoming during the meeting, but is something that should be looked into in the future.

I have no specific comments on the data summaries for 3LNO and 3PS haddock.

General considerations

Medium-term projections

FRCC has called for medium-term projections (5 years, in this case) to inform perceptions of the likely results of multiannual TACs. This is something that is routinely done in ICES assessments, where we use 10-year projections over a range of fishing-

mortality multipliers to estimate F_{pa} (a reference point below which, under the precautionary approach, we would like exploitation to be). Current opinion in ICES is that environmental information should not be incorporated explicitly in these projections, as the environment is not predictable nor are causative links with recruitment well understood. The linkages appear to be far more clear in the case of 3Ps cod (cold is bad, warm is good), but temperature forecasts are just as impossible. Therefore I would advise using projections that incorporate characterisations of the time-series structure of the results of environmental change, namely maturity and growth: to do anything more complicated would be to pretend we know more than we do.

Medium-term projections are driven by the assumed stock-recruitment curve. The dependent variable in such a model is generally SSB. However, much recent work has shown that this is a poor proxy at best for reproductive potential, and can actually be dangerously misleading. 3Ps cod would seem to me to be a good example of a stock for which a suitable index of potential egg production could be generated, given that information such as maternal liver condition indices are available. Analyses have begun in this area in Aberdeen for North Sea cod, but we are hampered by the fact that we have little fecundity data for that area and have to rely on Arctic studies.

Survey design and treatment

ICES surveys are not random stratified designs, but revisit the same haul tracks each and every year (largely because these are known to be safe for trawl gears). Thus my experience with the type of survey design implemented in the 3Ps area is limited. However, I would still contend that the retention of a haul index two orders of magnitude or more above the norm should be considered very carefully. Perhaps this is done already, but the use of a geometric rather than arithmetic mean in this situation would appear to me to be called for.

The survey-derived biological data presented are impressive in scope, but what are obvious by their absence are analyses of predator-prey relationships, food availability, plankton distribution, and so on. Environmental linkages appear to be strong for cod, and causative mechanisms cannot be fully understood without a better understanding of the prevailing ecological system. Natural mortality estimates in ICES Working Groups are crude, but are at least informed by MSVPA estimates. Stomach-sampling programmes should be initiated to enable this to be done.

Catch-at-age analyses

Results from three competing models were produced and evaluated, the methods being QLSPA, ADAPT and XSA.

The quality of catch-at-age data prior to 1977 is thought to be poor, and the RAP took (I believe) the correct decision in removing the suspect years from historical estimation. They were reinstated in order that the full stock-recruitment relationship could be ascertained prior to running medium-term projections, and again this is correct. Similarly, the creation of the remaining 2001 catch data using the quota-uptake pattern

from the previous year is reasonable: the consequences in terms of forecasts of using some mean of recent years could be investigated. The effect of using a plus-group in the QLSPA analysis should be investigated further.

The retrospective behaviour of the QLSPA method needs to be fully demonstrated. All other catch-at-age methods tend to overestimate SSB and underestimate mean *F* in the terminal year, for nearly all stocks in my experience, and this pattern was indeed replicated in the comparison between last year's QLSPA run and this year's equivalent with the same settings. Although a retrospective QLSPA would not be comparable to the full assessment version, since most of the tuning series are very short, it would still be a useful methodological exercise to examine fully if the usual bias pattern holds. If not, there are implications for the use of QLSPA in other areas, as retrospective bias is one of the main current problems with ICES assessments.

The QLSPA assessment is sensitive to changes in inputs, such as the major downshifting of SSB that occurred last year when the Burgeo area was split off from the rest of the research vessel survey series. It is also evident that QLSPA dramatically revises the entire time-series each year. This is an undesirable feature because it would make reference points derived from stock-recruit models fluctuate considerably from year to year. High sensitivity to inputs is not restricted to QLSPA, but rather is apparent whenever there are conflicting signals from different sources of information (North Sea whiting, for example). Ideally some form of statistical smoother should be able to rectify this problem, although that has not proved possible so far for 3Ps cod; and it may prove more appropriate to view the assessment as indicating relative trends in stock size rather than absolute population levels. It should be noted that perturbation analyses suggested that output metrics are fairly sensitive to a limited subset of survey data, and more so to catchability assumptions: sensitivity to assumed natural mortality values was not discussed in the meeting.

In any case I find it rather difficult to evaluate this model fit, as I have little prior experience with the method. I would like to see it applied to a stock with which I am more familiar, such as North Sea cod, and I would recommend that a disseminable version of QLSPA be created and supported. This would probably have to be the responsibility of a staff member employed specifically for that purpose, thus freeing up the current expert for other work. It would also be beneficial for a greater number of DFO scientists to have a working knowledge of QLSPA, and this could be achieved by the responsible individual running a series of short courses. The application of the method to a wider variety of different stocks would also improve its methodological development.

I liked the local influence analysis that was presented: this appears to be a good way to avoid multiple assessment runs in testing for sensitivity, although it cannot be used (in its current implementation) to determine whether tuning indices should be retained or not (as it looks at the influence of individual data points). Apparently it is also possible to examine the influence of natural mortality, but this was not presented to the meeting. I would anticipate that sensitivity to assumed values of *M* would be extremely large. Such influence analysis would be invaluable for ICES assessment groups, but I am not sure whether a numerical model such as XSA would be amenable to this approach.

During discussion on the ADAPT runs presented, it became apparent that while there are statistical diagnostics produced by ADAPT, there is some argument over exactly they should be used and interpreted. The same could be said of XSA: ICES Working Groups often show some confusion over the correct interpretation of XSA outputs, and a flavour of this was seen during the RAP meeting. In contrast, QLSPA diagnostics were passed as being good or bad by the method's creator, and the meeting was not given the opportunity to be confused. This is not necessarily a good thing, as it detracts from the intended purpose of the meeting to present a consensus of the views of participants.

All three assessment methods presented (QLSPA, ADAPT, and XSA) pointed to a significant downwards trend in log catchability residuals for the Sentinel gillnet series. The consensus of the meeting seemed to be that this is likely to be due to a distribution shift: control Sentinel sites are fixed, and catchabilty will fall if cod aggregations move away because of environmental change. This suggests that the Sentinel series might be problematic, although changing it might lead to a situation where Sentinel CPUE no longer tracks abundance decline. As an interim solution the Sentinel gillnet series was removed from tuning, and this would probably have been done in an ICES WG as well.

I appreciated the willingness of the meeting to study closely the methodology and output of the XSA method. An ICES Working Group would seldom spend so much time on the details of the method, and I learned quite a few things about XSA of which I was not previously aware.

Short-term forecasts

Very little time was devoted during the meeting to short-term forecasts, given that these are actually the most important estimates that have to be produced. This is a function of the imbalance between data presentation and analysis. It must be said, however, that short-term forecasts based on such an extremely uncertain assessment are always likely to be compromised. For this reason, forecasts should be probabilistic, and limited to statements about (say) the probability of SSB declining.

Mixing

The lengthy discussion on the Gulf-Burgeo mixing problem was not edifying. It seems to me that there is some evidence from tagging and from anecdotal information that Gulf fish may be being caught in the 3PS area, but this evidence is not strong enough to form a properly scientific conclusion and cannot be until Gulf and 3PS tagging programs are homogenised. And that is all that needs to be said in a scientific assessment meeting. Instead, we got proclamations from behind entrenched defensive positions, with neither side willing to concede an inch. And what amazed me was that the protaganists were all fishery scientists: the industry, with a couple of exceptions, did not get involved.

I believe the question to be addressed here is political rather than scientific one. Arguments over straddling stocks are inevitable when assessment is a regional process, and when the regions concerned are relatively small. If Scottish and English waters, for example, were to be controlled by the respective Parliaments, this bickering would go on all the time with us too. But it doesn't, and that is the great advantage (which just about outweighs the many disadvantages) of the ICES assessment system. Defensive attitudes do not make for good science. Compartmentalisation of a potentially-homogeneous population seems to make both assessment and management much more difficult, and serves only to reduce the success and credibility of both. A naçve recommendation would be to manage the Newfoundland coastal area as one stock unit, as it seems that there is little reason for the line at the top of the 3PS area. Stock units are more flexible in ICES and can be merged quite readily: examples of where this has happened recently are saithe and anglerfish, which are now assessed and managed as shelf-wide stocks. Clearly there are political and cultural barriers to this for 3PS cod, and advocating such a change is not really within the purview of the RAP, but it is a shame to see a high-quality scientific meeting debased with this stuff.

In last year's assessment the decision was taken to split the Canadian RV series into Burgeo and non-Burgeo components. I was not present at that meeting, but it does not seem to me that the split is completely justifiable on the basis of the current data. This would not be such an issue were it not for that fact that the assessment is highly sensitive to the configuration of the survey series. Therefore, I would have thought that evidence in support of mixing would have to be conclusive before such a change was implemented. If it was, then fair enough, but otherwise the split seems risky. Given that the split *was* made last year, and in the absence of conclusive evidence to recombine the series, it could be argued (on the grounds of consistency) that the split should be maintained. Neither splitting nor combining the indices is very satisfactory, and it seems to me that DFO scientists are placed in a very difficult position by the peculiarities of Canadian fisheries management.

Management issues

One area in which there is a potential for improvement, but which is perhaps not in the purview of the RAP meeting, is the use of management by TAC. This is not a good way to limit fishing mortality should skippers attempt to maximise income by highgrading and other dubious practices, and their utility is further limited by assessment uncertainty. In a mixed fishery like the North Sea quotas are even more inappropriate. In the ICES area we are constantly assuring fishermen that we realise the inadequacies of management by TAC, but that we are constricted by European bureaucracy in how much we can change the system. That level of supra-governmental control is absent in Canada, and it occurs to me that approaches along the lines of flexible harvest control laws might be easier to implement here. On the other hand, it could be argued that one advantage of the European system is that quota allocation is so heavily constrained by the Hague Preference that international arguments over stock mixing and other issues tend to be limited in both scope and volume.

It remains the case that TAC-based management grounded on a single point estimate of abundance is risky – whichever one of several equally-plausible competing assessments is selected, the forecast is likely to be wrong unless by extreme coincidence you manage to nail the correct population estimate. Furthermore, all three assessment methods used showed sensitivity to input configurations. The degree of variation seen (~150% increase or decrease in SSB depending on method) argues very strongly for a more probabilistic approach to fisheries management in this area, in which the likelihood distribution of the consequences of any management action is estimated. I would find it difficult to justify any particular choice of quota, given that conclusions from different but equally-plausible assessment methods are so conflicting. However, this again is something that is probably beyond the remit of the RAP.

The proposed shift to a five-year cycle of assessments, with multiannual TACs covering the interim period, was not discussed at length in the RAP. Medium-term projections are particularly useful when multiannual TACs are being contemplated, which is the incentive for the development of a suitable projection methodology. But this rather begs the question of whether a five-year assessment cycle is sensible. I would argue strongly that it is not. As a cost-saving exercise such an approach would be feasible for a reasonably stable stock such as North Sea plaice, but certainly not for 3PS cod where the fishery fluctuates from year-to-year and the assessment is highly uncertain. In the face of such uncertainty the sensible course to take is invest more in science, rather than less. An interim position which could be adopted, although I would hesitate to recommend it for this stock, would be the method used by the ICES *Nephrops* Working Group, who have an assessment meeting every second year interspersed by a methodological Study Group. But to move to a five-yearly assessment would be self-defeating, would lead to overly-conservative advice, and would certainly cost more than it saved.

Meeting structure and process

3Ps cod poses extremely difficult assessment problems for DFO scientists, more so than for almost any stock assessed in the ICES framework. SPAs are compromised by a variety of factors, including the fishing moratorium, large environmental influences, selectivity changes, straddling stocks, changes in survey design, year effects in surveys, relatively low fishing mortality, and little information about natural mortality (which may be large in comparison). The assessment scientists involved are to be praised for their willingness to adopt a range of innovative and successful methodologies to alleviate these difficulties, such as the use of Sentinel and logbook schemes, genetic studies, tagging, good survey design where possible (although time-series are short), and condition indices. In addition, it is not easy to concentrate fully on an assessment meeting held in your own institute – people tend to be able to devote more of their time to assessment work when they are away from home. Having said that, DFO scientists were diligent in working late into the night to ensure analyses were completed on time.

The numbers in attendance at the meeting were rather less than I had anticipated, although many more than would be present at an equivalent ICES meeting. Having a

fluctuating roll means that interested parties are at liberty to attend only those parts of the meeting of relevance to them, which is a benefit.

I was impressed with the way that scientists made a point of involving industry representatives in discussion, for example in the formulation of the correct criteria to use when selecting appropriate Sentinal survey data points. The representatives in attendance raised pertinent points and could follow detailed scientific arguments closely. It would be hoped that the involvement of industry would lead to a more complete viewpoint than is the case in Europe. In the ICES domain we are very much aware of the value of industry experience of the fishery, but we are struggling to find a good way of incorporating this knowledge. The fact that the 3Ps fishery is prosecuted by only Canada and France, and that it is now almost a single-species fishery, makes this much easier. The North Sea, on the other hand, is an extremely diverse multi-species, multi-nation fishery with many competing interests, and it is hard to see how industry representation at ICES meetings on the Canadian model would do anything other than degenerate into dissension and argument. It also occurs to me that industry input occurs at two levels at least (RAP and FRCC), which offers a large window of opportunity to ensure that vested interests are protected.

Striving for transparency is a laudable aim, one that we Europeans would do well to attempt to emulate. In particular, pressures of time and a lack of manpower mean that we are never able to present assessment input data collation methodology in the way that was done during the first week of the RAP. This leads to great problems. North Sea groundfish data collation was until recently done by a colleague of mine at Aberdeen, but when he left for a post in Charlottenlund we had great difficulty working through the data in time for this year's assessment round simply because he had never told us exactly how he did it. Therefore the quality of our assessments is compromised from the beginning. The RAP approach is thus highly commendable.

It seems to me that the principal benefits of the RAP approach lie in the incorporation of information and opinions from a wide range of interested parties, not just scientists as at ICES; and the detailed presentation of input data. The fact that only a small subset of the participants can run the actual assessment is a drawback when it comes to detailed discussion of model formulations. I would also be concerned at the lack of time devoted to actual analysis, as opposed to discussion. Again, however, this is offset by the reduced requirements of management. Data presentation is a strength of the process, data analysis a weakness. When providing advice under the ICES umbrella, we are required to produce short-term and medium-term forecasts, yield-per-recruit analyses, sensitivity estimates, reference points, and other diverse items for a large number of stocks. In such meetings it is often as much as one can do to turn the various handles successfully, without error and in the time allocated, and there is little space for discussion or methodological development. A colleague of mine used to assess four northern shelf stocks on his own every year, so it is not surprising that a) mistakes are made, and b) methodology tends to become fossilised. So, neither way is perfect and both could be improved. Incidentally, ICES meetings finish historical assessments by the end of the first week, and spend much of the second week looking at forecasts and projections – that is how long it takes to do it properly. Possible options to enable a better balance between presentation and analysis might include three-week meetings,

more comprehensive exploratory runs before the meeting, or a wider working knowledge of the QLSPA code, thus enabling multiple assessments runs to be performed simultaneously.

The form in which advice is given also seems better in the RAP than in ICES Working Groups. The latter have to produce both a Working Group report, which contains all analyses and conclusions and which often runs to three substantial volumes, and an ACFM summary sheet which is done at the last minute and which occupies a scant page or two at most. Consequently around 3 days of the 12-day meeting is taken up with writing and reviewing text in plenary session, restricting the time available for methodological innovation. The Stock Summary Report produced by the RAP represents a good halfway house between the two ICES extremes, containing as it does enough analysis to explain what was done, but at a level that management can appreciate.

Industry involvement does not seem to remove completely the difficulty of convincing fishermen that fisheries science is hard. Many seem to believe that the resources available to scientists mean that questions *must* be answered, and quickly. But the very nature of fisheries means that some questions are impossible to answer (or at least extremely difficult). We can't see fish, they move around, their numbers fluctuate naturally, and the available data (catches and survey series) are themselves uncertain for a variety of reasons.

I am pleased to say that the chairmanship of the meeting was exemplary throughout. Discussions were kept on track and of reasonable duration, contentious issues were dealt with sensitively by effective mediation between competing views, and the conclusions of each session were summarised succinctly at the end. The group was also impressive, with a part being played by everyone in attendance. In the past it has not been unusual for countries to send three or four more delegates than required to ICES Working Groups out of sheer political expediency.

Finally, I found the meeting facilities to be extremely congenial. The welcome and generosity shown by my hosts was beyond the call of duty, and I would like to express my gratitude for the opportunity to visit sunny St. John's and participate in the Canadian assessment process.

APENDIX IV

REMIT

Meeting of the Newfoundland Regional Advisory Process on Groundfish

Conference Room, The Fluvarium, Nagles Place
St. John's, Newfoundland
15 - 19 October

E.B. Dunne Boardroom, Northwest Atlantic Fisheries Center,
St John's, Newfoundland
22 - 26 October 2001

Stock Assessments

Chair: Peter Shelton, Section Head, Gadoids, Aquatic Resources Division, DFO, Newfoundland Region.

Full assessments of the stock status of the following resources will be reviewed:

- 3Ps cod
- 2 GH cod
- 3LNO haddock
- 3Ps haddock
- 2 + 3K redfish

Stock Status Reports and associated research documents will be produced for these assessments.

Oceanographic Overview: An overview of ocean climate conditions during 2001, in comparison to the historical record, will be presented.

Discussion of joint science-fisheries management issues related to the mixing of Gulf cod into 3Ps.

Steps taken to date will be reviewed and various approaches will be considered in terms of biological impacts on the Northern Gulf and 3Ps cod stocks in terms of stock assessments and the evaluation of management options.

Invited Participants:

All Staff - Science, Oceans and Environment Branch, DFO, Newfoundland Region
Director, Fisheries Management
Director, Policy and Economics
Andrews, Ray - St. John's, NF
Bowles, Wayne - Burgeo, NF

Briand, Daniel - Saint Pierre, France
Brown, Percy - Little Harbour East, NF
Butler, Ross - FPI, Operations Dept.
Caines, Gordon - Rencountre, NF
Campana, Steve - DFO, Martimes Region
Carr, Steve - Dept. of Biology, Memorial University of Newfoundland
Collier, Frank -
Daley, Gary - Capt. Sea Gem, St. Joseph, NF
Decker, Dave - FFAW, Corner Brook, NF
Dooley, Tom - Provincial Fisheries and Aquaculture, NF
Etchegary, Gus - Newfoundland & Labrador Fisheries Advisory Committee, Paradise NF
Felt, Larry - Dept. of Psychology, Memorial University of Newfoundland
Foley, Marin - Fish Harvester, Placentia Bay
Green, John - Dept. of Biology, Memorial University of Newfoundland
Grant, Scott - LGL, St. John's, NF
Haedrick, Dick - Dept. of Biology, Memorial University of Newfoundland
Hutchings, Jeff - Dept. of Biology, Dalhousie University, NS
Jarvis, Harvey - Fairhaven, NF
Kerrivan, Jerome - Jersyside, NF
Mahe, Jean-Claude - IFREMER Station de Lorient France
McClintock, John - AGRA, St. John's, NF
McGrath, Kevin - St. Brides, Placentia Bay
McGrath, Lorraine - Fish Harvester's Resource Centres, St. John's
Methven, David - Ocean Science Centre, Memorial University of Newfoundland
Miller, Ted - Dept. of Biology, Memorial University of Newfoundland
Needle, Coby - External Reviewer, UK
Neis, Barbara - Dept. of Sociology, Memorial University of Newfoundland
O'Connor, Mike - National Sea Products Ltd., NS
Pope, John - Fisheries Scientist and member of the FRCC, UK
Rose, George - Marine Institute, Memorial University of Newfoundland
Russell, Janet - Memorial University of Newfoundland
Sandeman, E. J. - Retired DFO Director/ Scientist, St. John's, NF
Schneider, David - Ocean Science Centre, Memorial University of Newfoundland
Snelgrove, Paul - Marine Institute, Memorial University
Spingle, Jason - FFAW, Corner Brook
Strang, Patrick - Lawn, NF
Taggart, Chris - Dept. of Oceanography, Dalhousie University
Vermette, Michel G. - FRCC, Ottawa
Woodman, Fred - FRCC, Ottawa
Winters, George - Focus Technologies Inc., St. John's, NF
Wroblewski, Joe - Ocean Science Centre, Memorial University of Newfoundland
Alain Frechet, - Institute Maurice Lamontagne, DFO, Laurentian Region
Martin Castongay, - Institute Maurice Lamontagne, DFO, Laurentian Region
Marcel Boudreau, - Institute Maurice Lamontagne, DFO, Laurentian Region
Larry Yetman - Fisheries Management, DFO, Newfoundland Region
Gary Brocklehust - Fisheries Management, DFO, Newfoundland Region