DISCUSSION OF SESSION 3

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The four presentations by the panel were each followed by a short discussion chaired by David Smith. The session concluded with a broader discussion of the data requirements for population dynamics modelling and fisheries management.

The opening paper by *Niel Klaer*, Bureau of Resource Sciences, addressed the requirements to standardise the time series of fishing effort data for stock assessment. Martine Kinloch suggested that it may be better to dispense with catch and effort information entirely and use fishery independent assessment methods considering all the problems of standardising commercial fishing effort data. Niel Klaer agreed that for some species such as orange roughy, the commercial catch rates would not provide useful information on fish abundance and that in spite of the expense, fishery independent methods were more appropriate. However, for many fisheries it is more cost effective to use a time series of commercial catch and effort data to indicate changes in stock abundance by standardising the effort data for changes in fishing power.

The second paper by *David Smith*, Victorian Fisheries Research Institute, focussed on the need to collect sufficient sample sizes of fish age and length data to undertake stock assessments with age-structured models. Rob Day confirmed the benefits of age-structured models when year class strength was consistent but was concerned that large fluctuations in year class strength may make a big difference in the data requirements and the stock assessment. David Smith agreed that annual variation in year class strength should be considered when doing these sorts of simulations.

Jean Chesson in her paper raised the issue of data quality and referred to the completeness of the data sets, sources of bias, precision and comparability. Phillip Sluczanowski agreed that data quality could have a big effect on stock assessment models and fisheries management. He used the South Australian rock lobster fisheries as an example of a large collection of data which varied from high to low quality due to the accuracy of the catch returns from particular fishermen. He suggested that it would be appropriate to analyse the complete data set and then repeat the analysis using just the high quality data to examine the effect of the data quality on the stock assessment. He asked whether anybody was aware of any attempt to determine the sensitivity of a stock assessment to the quality of the data in the literature.

Norm Hall referred to Carl Walters' comments on the use of heterogeneous data from a variety of sources which all have different levels of precision and accuracy. He considered that by bringing various sources of heterogeneous data into a model, it was possible to allow for low quality data to a certain extent. However, it was stressed that it was essential to review the data quality and the level of bias or accuracy of data sets used for stock assessment.

Phillip Sluczanowski suggested adjusting data sets or selecting the high quality data in retrospect if the stock assessment was particularly sensitive to data quality. A targeted program to maintain and improve data quality is required especially after changes in management.

Russell Reichelt gave an example from the northern bluefin tuna stock assessment which involved many sets of data from different countries. A variety of weightings were applied to each set of data to compensate for the differences in the quality of the data. A high weighting was applied to the high quality data which was used to tune the age structured model. Jean Chesson stated that in many statistical procedures, such as the analysis of variance, adjusting for precision occurred automatically by weighting the data. It was much harder to take into account problems such as bias in the data.

The final paper on the data requirements of multispecies, spatial and ecosystem models was given by *Norm Hall*, Western Australian Fisheries Department. He emphasised the need for long time series of data to provide the contrast at different levels of stock abundance. He also referred to the importance of data on changes in fishing methods and the introduction of new technology that might affect the selectivity of fishing gear and species targeting. He mentioned the need to monitor the discarded part of the catch to provide additional data for multispecies models. He considered that the boundaries of single species models may be too narrow to adequately explain the population dynamics of a stock. It may be possible to construct a better single species model by the addition of biotic or abiotic variables as aggregated environmental parameters.

Campbell Davies asked the speaker whether fleet dynamics could introduce a bias in estimates of biomass from a fishery. Norm Hall replied that fleet dynamics were very important and that significant bias could be introduced in biomass estimates. In particular, fleet dynamics influenced the representativeness of the data in terms of the spatial context. For instance, catch rates may appear to be stable indicating no change in stock abundance when in fact the fishermen were sampling the fish stock in a different way by increasing the size of their vessels and moving to new fishing grounds farther from port or in deeper water. For this reason, fleet dynamics were extremely important because of the biases introduced to stock assessment models which assumed that catch rates were proportional to stock biomass.

David Smith observed that one of the problems in trying to understand how the fleet works was that fishing behaviour can be difficult to model. It was relatively easy to model cost-driven functions compared to modelling the way individual fishermen respond to their own particular needs. Norm Hall agreed that fishing behaviour was a very difficult and complex series of processes which were aggregated in terms of space and time. Modelling was an attempt to represent those abstract processes and although it was almost impossible, he considered that it was important to keep trying the mathematical approach.

Norm Hall further suggested that some management controls, such as reductions in fishing effort, are not completely effective because fishermen work around the constraints by changing their fishing methods. Fishers are the principal predator in most fisheries so it is important to take into account changes in their behaviour. Following implementation of management controls, it is necessary to collect data on both fish and fishers and incorporate both into the stock assessment models.

Tony Smith asked whether there was a role for models to assess the data requirements before setting up a sampling program, given the huge range of types of data that could be collected. Norm Hall, replied that there certainly was an important role for models in the evaluation of the data requirements. In any modelling process, you are trying to bring together an

understanding of how the fishery or ecosystem actually works and interacts. At the beginning, the model is constructed in a very broad framework to try and understand what the processes might be. Tony Koslow had illustrated this sort of approach to ecosystem modelling using tropho-dynamics to try and understand which were the likely pathways and which factors were likely to be important. Norm Hall argued that after modelling at the single species level, it is then necessary to take a broader approach based on biological knowledge of the interactions with other species and the environment.

More general discussion of Session 3 was opened by Jeremy Prince with a comment on the need to start the modelling process at the beginning of a stock assessment program. He considered that for many fisheries a large amount of research had been done and a lot of data gathered, but the essential elements were often missing which made it impossible to make an assessment of the fish stock. Modelling can help determine which types of data are the essential elements.

Derek Staples raised the important issue of the cost of collecting data and the funding of fisheries monitoring programs. The need for long time series of fisheries data was recognised by managers who levy the fishing industry in order to pay for commercial logbook data. However, the requirement for long term programs to maintain data integrity or to provide additional data on fleet dynamics or the age length composition of the fish landings was not recognised by fisheries managers. These important data requirements for stock assessment were usually designated as research projects and consequently only received short term funding. He asked why logbook monitoring was routinely funded as part of annual management costs whereas there was no long term funding for other types of information essential for providing stock assessments and fisheries management advice.

Geoff Rohan noted the question but did not offer to comment. Instead he asked another question about the essential information required by fisheries managers for making decisions and for determining risk levels. In contrast to the many types of data that were necessary or useful for the development of a stock assessment model, he regarded information on abundance, spawning biomass, and recruitment as key elements from a management perspective. He asked whether it was necessary to have the whole range of species parameters in a stock assessment or whether it was possible to reduce the parameters to a few biological indicators. He suggested that by examining key indicators, it may be possible to short circuit the data collection process and provide cost-effective management advice in a shorter period of time. He was concerned that a lot of research was being conducted that was interesting but not useful for management. He concluded by asking what data were required for monitoring fisheries and what further research was required to provide a basis for developing a system of indicators for the status of a fishery.

David Smith argued that there were certain "non-negotiable" data requirements for fisheries stock assessments. A long term commitment to funding these data collection programs was essential to maintain the time series of data required for stock assessments. One of the biggest problems in fisheries research was the withdrawal of funding for long term monitoring programs in favour of short term studies. The essential non-negotiable data requirements include : quality catch and effort data, and age at length data across the whole distribution of the stock.

Phillip Sluczanowski supported the direction of research that the CSIRO modelling team was taking to provide the answers to fisheries managers' questions. Fish stock models could be developed to search for indicators of stock status. It was possible to simulate a fishery in a model and test it to determine whether a variable such as average length was a good indicator for the whole complex system or whether more data were required to adequately assess the fishery

status. In a model, it was possible to simulate how data could be used to develop critical fishery parameters and to show how these lead on to provide the management advice. Using models, it was possible to go back to the data and determine how sensitive the management advice was to the data and evaluate the quality of the data. It was a complex issue and it was hoped that Tony Smith's modelling group in CSIRO was tackling the task. It was certainly worth emphasising the profile and value of this work because it was the basis of the cost benefit analysis of all fisheries research.

Tony Smith agreed with some of Phillip Sluczanowski's comments and explained that the CSIRO's approach was to start from the objectives of the management and work backwards. It was intended to determine the type and extent of the monitoring programs that were required to both effectively achieve those objectives and to collect the required data inputs for the stock assessment models so as to provide the required management advice. He thought that it was necessary to negotiate the "non-negotiables" by working backwards from a management plan through a series of assessment methods and by looking at the data needed for those assessments. David Smith agreed and said that he was not suggesting that, say, age length data were required for every species each year, but emphasised the problem of having to negotiate in order to collect basic fisheries data on major species.

Norm Hall considered that it would be necessary to tailor the stock assessment model to the available data and the value of the fishery. When there was no information, the first assessment would probably be based on the 1/2 M B_0 model. In that scenario, just one piece of data was required - B_0 if the assumed value of 0.2 was used for natural mortality (M). After this approach and as the fishery developed, commercial catch and effort data could be used in biomass dynamic models. These simple models may be extended as more data were collected to the next stage and delay difference models could be constructed. A new level of complexity was reached in the age or length structured models which required a greater amount of data. The final stage was the multi-species and ecosystem models which have huge data requirements. In the end, there was a point where there would be insufficient resources to collect all the data for a particular level of modelling. So there was a trade off between the level of model that could be applied and the data that could be obtained. It was a lot easier to start with the data that were available and then build up the complexity of the model as more data were obtained.

Managers were going to ask the questions and fisheries scientists will be required to provide the advice. There was no way to avoid it, so it is necessary to attempt to model the stock at the level determined by the available data. In this situation, it made more sense to start the modelling at the beginning using the best understanding of how such a fishery actually worked. There were many examples of fisheries models from around the world and new models are not developed for each fishery. So, it is possible to bring in information from around the world and gain from past experience. This information could then be used to determine what sort of data was needed. It would be quite wrong to collect data for twenty years and then try to incorporate them in a model only to find that it was useless.

Norm Hall went on to stress that there was a great opportunity to gain by collecting some of the information early in a developing fishery so that there was contrast in the data. In these cases, there was huge value in doing surveys right at the beginning of the fishery and getting some of the biological information when the stock biomass was at its greatest. Once again, it was a trade off between the cost of collecting the data and the potential value of that resource. The costs and benefits of collecting data at any stage is ultimately a judgement.

Peter Doherty agreed with the list of non-negotiable data requirements proposed by David Smith, but considered that the list was too limited compared to the data requirements for multi

species or ecosystem models described in Norm Hall's paper. He emphasised that fish were poikilotherms that were influenced by a cascade of heat from their fluid environment. Fish respond to changes in heat directly through migration and recruitment. Therefore some form of monitoring of the physical environment must be done in conjunction with the collection of the biological data. In his opinion, a much longer list of non-negotiable data requirements was needed to understand the population dynamics of fish stocks over decades of time. This required a long term investment in data gathering on a much greater scale.

Chris Francis stressed the point that the most important data requirement for population dynamics modelling and stock assessment were not one or two years of data but a time series of data. He emphasised that the value of the data goes up exponentially with the length of the time series. He was very sympathetic with David Smith's point on the need to negotiate to collect the same sort of data year after year. He considered that fisheries science was headed for disaster if scientists had to negotiate every year, because eventually the time series would be broken and the value of the earlier data for stock assessment would be significantly reduced. He also told the Society that the New Zealand Government held the view that the fisheries resources exploited by the commercial fishermen belonged to the people of New Zealand. In order to protect those resources, the Government engaged in certain management activities. It was the intention of the New Zealand Government to make sure that all of MAF's activities that were directed towards managing fisheries came from payments from the fishing industry.

Richard Tilzey recognised a new era when AFMA's policy was to liaise more closely with industry in the re-structured management advisory committees and research liaison sub-committees. There was no doubt that industry now had a much greater role in setting priorities for research. However, he was particularly concerned that, as a result the data collection system was targeted first when there was a shortage of funds and that this threatened the value of the time series of data for stock assessment purposes. David Smith believed that it was important for the fishing industry to participate in setting research priorities to a certain extent so that the industry were part of the assessment and had some ownership of it. Otherwise, the industry would not accept the result of the stock assessment.

Jeremy Prince confirmed that the fishermen involved in the gemfish fishery were prepared to accept the outcome of his stock assessment because of their participation in the current project. He considered that some scientists under-estimated the value of long time series of data to the fishing industry and the capacity of fishermen to consistently collect technical and useful data in their personal logbooks. Frequently scientists forgot that most fishermen were compulsive data gatherers who made records in their own personal logbooks which could be of a higher quality than Government logbooks. Ownership of the data was important. Fishermen should understand the stock assessment process, and want to be part of the process and to own the process. If fishermen were forced to provide data, it would be inaccurate and of little use for stock assessment purposes. But if more time resources were spent in educating and informing fishermen about the uses of their data, then the data quality and the stock assessment process would improve and the fishing industry would support the outcome. At the moment, there was far too much adverse dialogue going on within industry and between the industry and Governments.

Chris Chubb considered that it was essential for the fishing industry to understand stock assessment programs to gain support for the fishery management plan. As fishermen become increasingly more educated in fish population dynamics, it was necessary to provide basic data to substantiate the stock assessment and management strategy. Data collection must be cost effective and models should be used

from the beginning to determine the data requirements. Unless there were sound data collected as part of the management plan, which the fishing industry understood, it would be impossible to convince the fishermen that there was a problem with the fish stocks and the management plan would not be accepted.

Frank Prokop provided a perspective from the recreational fisheries management point of view. He regretted the lack of focus on recreational fisheries and attributed it to the emphasis on Commonwealth fisheries of which recreational fishing was only a minor component. It was recognised that a number of stock assessment models incorporated physical parameters such as water temperatures, ocean currents and other intricate details but generally ignored a substantial recreational component of the total catch, euphemistically termed "data leakage". These leakages of sometimes massive proportions were often ignored as somebody else's problem and could lead to some difficult problems in incorporating stock assessments into management plans. He suggested that scientists and managers worked closely to fill the gaps provided by the recreational fishing component in the data sets and incorporated the amateur catch into the stock assessments. He also raised the issues of biodiversity, the value the community placed on the integrity of fish stocks and the future prospects for the stocks irrespective of the level of exploitation. He suggested that this was an additional factor which should be incorporated into models.

Duncan Leadbitter was interested in the comments on communication and the need to make fishermen understand stock assessment programs. He considered that there was a huge potential to make progress in the way in which fishermen and scientists communicate. Fishermen and scientists operated in different worlds and spoke different languages. Only certain individuals with a certain empathy between the two worlds communicated well. It was noted that the Great Barrier Reef Marine Park Authority had recently employed a communication specialist to overcome this problem. He suggested that it was necessary to specifically train people to bridge the very wide gap between the fishing industry and the scientists to improve communication.