DISCUSSION OF SESSION 4

Recorded by M. J. Moran

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The chairperson Nick Caputi invited a short discussion after each panel presentation, followed by a more general discussion at the end of all the presentations. These are reported here in sequence.

Terry Walker asked *Jeremy Prince* what sort of control is there in getting the fishers to survey abalone abundance on the reefs, and whether the abundance estimate is affected by how far they can see or how fast they can swim. Jeremy Prince replied that the divers are given a bar of fixed length and as they swim they count animals under the bar and record the numbers they see. It is necessary to give the divers some training. Some of the divers would not do the surveys themselves but would employ a biologist.

George Jackson asked *Lindsay Joll* what is the age from recruitment at which the scallops in Shark Bay are fished. Lindsay Joll replied that they are fished at around one year old. They settle one year and are fished the next.

John Glaister invited Lindsay Joll to comment on the suggestion that the way to manage saucer scallops is to have sanctuaries, given that the variability in scallop recruitment is so great. Lindsay Joll stated that one of the problems with this variability is that it makes finding a stock-recruitment relationship very difficult, but the appropriate form of management depends on the level of fishing pressure. In Queensland, where the level of fishing pressure is so high, stock-recruitment relationships may be relevant and sanctuaries may have some value because they provide a reservoir of breeding stock. In Western Australia, with a smaller number of boats licensed to fish scallops, the fishery is managed on a different basis, limiting the timing of the fishing season so that a sufficient spawning stock is left in the spawning season.

Phillip Sluczanowski asked if Lindsay Joll thought that the huge recruitment in Shark Bay scallops could have been prevented by bad management? If so, it would make a change to not have to debate whether the fishery has collapsed because of environmental effects, but instead to be able to claim a good result because of good management. Lindsay Joll agreed that the aim is to manage the fishery to preserve some level of spawning stock. There is no detectable stock-recruitment relationship in the data, but one can assume there is one point, i.e. no stock-no recruitment and that after that there is some sort of relationship. Farther from that point the relationship becomes fuzzy and hard to find. After the arbitrarily chosen level of spawning stock has been preserved, good or bad recruitments appear to be determined by the environment of the larvae.

Iain Suthers had two questions: 1. What is the mechanism by which the Leeuwin Current influences the survival of the larvae? and 2. There is a Northern Hemisphere bias in looking for a stock-recruitment relationship. Why assume there is a stock-recruitment relationship when there is clearly none detectable in the

data? Lindsay Joll thought that the mechanism is a sheer flushing the larvae out of the Bay by the current but it could be more subtle than that.

He reiterated that there is one reliable point, i.e. no stock-no recruitment. Beyond that, it is thought to be mainly environmental effects. The management of Shark Bay scallops to preserve a level of spawning stock also results in good yield per recruit management of the fishery so it is appropriate even if parental stock has no detectable effect on recruitment.

Campbell Davies asked *Geoff Gordon* if his model of the NSW prawn fishery assumed that prawn movement is constant between the zones, if so, was this justified and could the model have different rates of movements between zones? Geoff Gordon stated that a different movement rate could be used for each zone but, to simplify the parameterisation and fitting of the model, it was assumed that the rates of movement are the same. It was also assumed that the parameters were constant over time and that is not necessary in the model either, so the framework is quite flexible. He said that there is really a hidden parameter in the model for the dispersion in that there is an arbitrary allocation of the number of zones and the width of each zone. The optimal width of a zone had not been determined but so far zone width had been based on the catch-effort data-gathering zones.

Tony Smith asked *Norm Hall* if the stock-recruitment relationship in the western rock lobster model was for the whole fishery even though the model has a number of zones, or if it was a local relationship. Norm Hall replied that the relationship is for the whole fishery. Work done by CSIRO had shown that the larvae move to an average distance of 300 km offshore, and can be found up to 1000 km off-shore. It is assumed that they are well mixed in this oceanic period for around 9 months before returning to the coast as puerulus (the final larval stage).

John Glaister wished to know how the figure of 25% of the virgin egg production was chosen as a target for minimum spawning stock. Norm Hall said that this is a rule of thumb from the literature, proposed by Cooke and Beddington, and previously by Gulland, that it is inadvisable to allow more than a 10% risk of the spawning stock falling to below 20% of the virgin stock, otherwise the fishery is likely to experience a recruitment problem. Another reason for selecting the 25% level is that the stock was at that level in the late 1970s and early 1980s and produced adequate recruitment.

Norm Hall added that if the fishery is managed to target the 25% level, the catch would be similar to that at the present level of exploitation. There are also advantages in reducing the variability in the catch which comes with high levels of effort, for marketing reasons. Thus there are a number of reasons rather than a single reason for managers to target this level of breeding stock.

Neil Loneragan asked how much effort goes into measuring the rock lobster egg production each year. Norm Hall explained that the egg production is calculated in the model from fecundity schedules based on work by Chris Chubb on the incidence of repetitive spawning within a season and the relationship between a female's length and the number of eggs carried in each brood, for the different parts of the coast.

Norm Hall added that the fecundity schedules were combined in the model with estimates of female lobster abundance derived from commercial catch rates. This has caused concern because catch-rates are biased by changes in fishing technology. To overcome this Chris Chubb is commencing a programme of annual fishery-independent surveys throughout the fishery. This takes a large research team about a month each year.

The chairman then invited comments on invertebrate fisheries modelling in general or on specific issues.

Peter Millington remarked that it was nice to be able to discuss fisheries in which models were not limited by minimal data and were not

so overfished that while the data were good there was no longer a fishery. He thought that most of the fisheries discussed in this session dealt with a different set of management problems. In some abalone fisheries, the models were being used by the fishers themselves to maximise their benefit. For instance in Western Australia a group of abalone fishers were discussing a concept of setting aside a portion of their fishing zone and intensively managing it to maximise their long-term yield. Similarly in the Shark Bay Scallop Fishery, there are no more arguments about the total catch, but about the share of the catch between the two sections of the fleet. In such cases the models are no longer confounded by management measures for fisheries in crisis but by management for economic benefits confounding data sets.

Chairman Nick Caputi agreed that economics is playing an increasing part in fisheries. For instance in the prawn fishery, peeling machines had led to demand for smaller prawns but the market changed; in the last few years the prices of smaller grades of prawns have fallen and there has subsequently been a movement towards fishing larger prawns. Industry have asked fishery managers not to open the fishery until April to give the prawns time to grow. He invited comments on the impact of economics on fisheries assessment and management.

Vicki Wadley suggested that researchers, managers and fishers were united by their ability to respond to market-driven forces. For example the greater demand for red than white rock lobsters could be incorporated into a model to estimate the effects of proposed management measures on fishers' incomes. Discussion in a previous session had highlighted the importance of market forces in stock-fleet dynamics. In the NW slope fishery, boats go out and fish for particular grades and species in response to requests by telex from overseas buyers. There is an opportunity for the three groups to decide together whether they want fisheries management to respond to market forces or to follow a different direction.

Jeremy Prince thought that as a group, fisheries scientists tend to neglect the impact of economics which has always been present; fishers have always fished for dollars. It was a dinosaur mentality to believe that fishers are always going to destroy the stock. Economics dictated that they should do that when there was a surplus of virgin biomasses to exploit. It paid the fishers to capitalize on relatively unproductive virgin breeding stocks and re-invest in overexploiting another virgin stock.

He said that the world now is a different place, interest rates are a lot lower. At low stock levels an abalone stock would probably, give a compounding return of 30%, much greater than investment interest rates. There are few virgin biomasses left to fish down. The orange roughy may be one of the last great virgin biomasses we will see fished down. We should recognize that the economic equation is changing in favour of the science of rehabilitation. The abalone divers mentioned earlier by Peter Millington are an example. If they can get resource security over their area, they plan on borrowing money from the bank so that they can refrain from fishing for several more years, believing this will result in a recovery to a higher future sustainable yield. Those who do not recognise that the world situation has changed are not moving with the times; it is not so easy these days to build an empire on overexploiting virgin biomasses.

John Glaister pointed out that the uncertainties with fish populations were nothing compared to the uncertainties of predicting the economic situation. In the prawn fisheries mentioned earlier, demand can change again. At present in some fisheries they are saying that the larger prawn is not always the better prawn. As well as prices, other driving factors are fuel crises, interest rates, the state of the domestic economy. He argued that it is not possible to predict these things and build them into a fishery model.

Iain Suthers questioned the attention paid to the spawning stock in fishery models. He argued that if a variable has an r^2 of 0.1 or 0.2 we

should discard it. Although he conceded that we should be concerned if parental biomass reached very low levels, at other times he said we should concentrate on environmental variables instead of maintaining an obsession with stock-recruitment relationships that comes from the 1950s literature.

Peter Doherty responded that he would not disregard stock-recruitment relationships. Sissenwine and others have said that a three-dimensional relationship exists with an environmental axis at right angles to the stock and recruitment axes. This is because a stock-recruitment relationship is not a single equation, it is different in a favourable year from an unfavourable year. For most species, information is currently lacking on which combination of environmental factors that third dimension should be.

Iain Suthers countered that other factors might be better predictors of recruitment, e.g. use temperature and sea level as two axes rather than parental biomass.

Peter Doherty explained that the point is that in looking at a multi-dimensional relationship collapsed into two dimensions, the signal due to stock size is not detectable. Sissenwine and others have argued that the signal is there perfectly well, it is just that the other dimensionality hasn't been teased out.

Norm Hall added that for most fisheries there will be no visible information on a stock-recruitment relationship until the stock has declined so far that recruitment is starting to decline as well. Consequently in fisheries that do not have such a low stock, it is necessary to monitor the breeding stock and use a rule of thumb such that the stock is not allowed to decline below an arbitrary limit.

Norm Hall also pointed out that most stock-recruitment problems occur not simply because the spawning stock has been reduced by fishing, but because there is a run of years in which the environment is not right for strong recruitment. A couple of weak year-classes then push the fishery over the edge.

He added that when the stock is large, recruitment is dominated by environmental variables. Identifying the pertinent variables and incorporating them in attempts to find a stock-recruitment relationship can help to identify real effects of stock decline.

Rob Day agreed that it is a paradigm that there must be a stock-recruitment relationship somewhere. In the past there was a strong debate between density dependence and independence in terrestrial ecology. He said that stocks may not respond in terms of density dependent mortality or fecundity; but they may respond by migration and dispersal. These effects may appear to be density dependent effects on mortality etc and biologists should explore the possible ways that populations may behave.

Terry Walker concluded the discussion for this session by saying he had an open mind on stock and recruitment. For long lived, low fecundity species like sharks, it is vital to think in terms of stock-recruitment relationships. However he is sympathetic to Iain Suthers' view for other species, especially scallops. The scallops in Port Phillip Bay have been known to vary in abundance one hundred fold within a few years.