REPORT ON POPULATION DYNAMICS COURSE 4-22/2/74

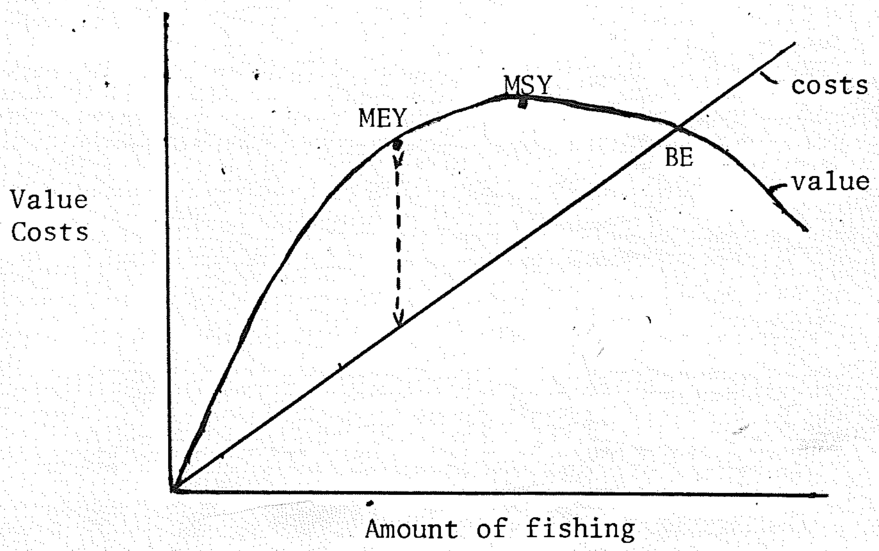
This course, convened by CSIRO on behalf of the Fisheries Education Committee, and conducted by Dr J.A. Gulland, FAO, consisted of an introductory course on fish management for the first three days, an advanced technical course for the period up to the final day, and a summary of the achievements of the course and follow up work required on the final day.

INTRODUCTORY COURSE

This course was given by Dr Gulland to explain to the fisheries managers the role of population dynamics in assisting in the forming of management decisions. Dr Gulland emphasized the reason for managing fisheries, listed some of the possible objectives, and briefly indicated the output of a population dynamics study.

1. Why manage fisheries

Dr Gulland pointed out that it basically comes down to the yield and cost curves given below



The point of intersection of these curves, BE, represents the break-even point where costs equal value. It is at this point that an unmanaged slowly developing fishery will tend to stabilize. However, at the point marked MEY for maximum economic yield, almost the same total catch could have been obtained at much less cost, leaving a larger profit. However, many fisheries have developed at a very rapid rate and have overshot point BE with consequent reduced catch and increased cost. Because it is not very easy to get capital, ships and men out of a fishery once they have entered it, the fishery may well stabilize at a situation where it is not the total cost which is equal to the catch, but just the running costs, and the fishery is overcapitalized. Dr Gulland emphasized that bad management can cost money.

2. What is the objective of management

Having determined the shape of the yield curve and the present position on it of the fishery, the fisheries manager has to decide where he would like the fishery to be. This can be done in terms of one of a number of possible objectives.

a) Maximum economic yield : MEY

Since this position is not one at which the fishery would stabilize naturally, it is one which can only be maintained by management measures which limit the fishing effort. Having reached the point of maximum economic yield, a decision must be taken as to how the difference between costs and yield should be disposed. It can be left with the fisherman as high profits, it may go to the government in the form of a high licence fee, or it can be passed on to the consumer if the retail price can be controlled.

b) Maximum sustainable yield : MSY

This objective maximises production and in some cases requires limitation of effort. In some fisheries the shape of the yield curve drops for high amounts of fishing as in the diagram and limitation of effort is required to maintain the MSY point. In other fisheries (e.g. prawn fisheries) the shape of the yield curve is level for high fishing effort and hence the point MSY will be achieved without any limitation.

c) Maximise number of fishermen

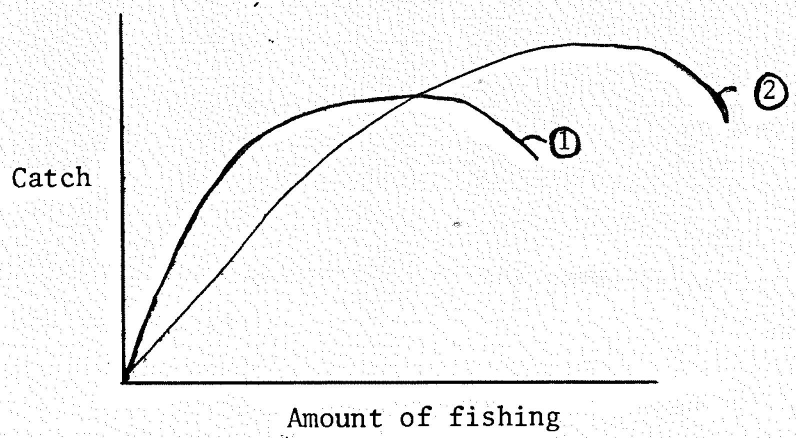
The cost line given above is the line fishermen themselves determine as that where it is no longer worthwhile coming into the fishery or where they may pull out. An alternative to limiting entry in order to maintain a given position on the yield curve is to legislate for inefficiency and hence alter the cost curve so that the BE point then coincides with the desired position. This may be done by limiting a trawl net size, limiting the number of pots, introducing a closed season, limiting the size of the boats, or some other similar measure. This results in increasing the cost of catching the stock and stabilizes the fishery at a point where there is no economic return, but it also increases the physical returns and keeps a large number of fishermen employed.

In sport fisheries the objective may be to maximise the number of people who are getting some entertainment from the fishery. With this objective no management is necessary, provided there appears to be no danger of collapse of the fishery.

d) Minimise disturbance to the fishery

This objective can be achieved by introducing (or not introducing) a management measure which will minimise the disturbance to the participants. This will also maximise the happiness of the fisheries manager.

Dr Gulland indicated that the yield curve will look somewhat different depending on the size of the first captures of the fish. If the size of first capture is low then curve 1 may apply and if the size were a little higher curve 2 may apply. Since there is



little change in the cost of fishing and few economic or social objections, this type of management is fairly easy to introduce (via mesh size limits, escape gap limits, etc.).

3. <u>How much should be spent on populations dynamics research</u>

Dr Gulland indicated that the percentage of biological research in fisheries is always higher than the corresponding research elsewhere. In general this is warranted since the fishery is a long-term resource so there is a responsibility to the future, and also since it is a common property resource the individual fisherman or enterprise cannot do the kind of research required.

However, when dealing with decisions such as refining the precision of various estimates, the expected benefits should be first considered. If on the basis of a certain amount of research a range of yield curves are determined, then the best advice to the manager is to set the size limit at some point but suggest that it could be a little higher in which case 5% of the catch is lost or a little lower in which 2% of the catch is lost. If the cost of further research is $2,000 and 2% of the catch is $200,000 then it is a fairly reasonable investment. If it is small catch and a big research programme then it is not a good investment.

An important distinction should be made between research programmes breaking new ground adding to further understanding, and research on monitoring which is simply a process of keeping track, by an established technique of something that you know you need to keep track of if you want to know what is happening in the fishery. Monitoring probably is something that you can do a fairly reasonable cost benefit analysis because it is a standard programme and one should be able to indicate the likely sort of benefit to come out of it. Research that is breaking new ground, by definition, is difficult to do a cost benefit analysis since the outcome is unknown.

Dr Gulland stressed the value of monitoring programmes as there is a great need in fisheries as a whole to have a series of years' data. He also indicated that it is not necessary to carry out basic research on all stocks. Prawn stocks were cited as an example where studies on a compact small stock may be done cheaply and the results applied elsewhere. In fact there is a very considerable value in grouping species for general parameter estimates. Thus a set of so-called "international" values for mortalities or stock/recruitment relationships etc., may be set up. Dr Gulland very strongly indicated that it is much better to apply this type of analysis rather than the biologist throw up his arms and not give any advice to his manager.

4. <u>What to do about fluctuations</u>

Fluctuations cause difficulty whatever the objective or how well one manages. However it may cause less worries the lower down the curve the fishery is, since the less heavy one fishes, the longer the fish stay in the fishery and the more things tend to average out. On the other hand if the vessels are multi-purpose and can go from one fishery to another it may not matter if there is overshoot. There may be trouble though, if the fishery requires vessels and shore factories which are unsuitable for other purposes or if there are no other suitable fisheries.

There may be some value in a research programme monitoring recruitment if there are real alternative fisheries for the fishermen. If more than one year class can be monitored before entry to the fishery, and the first year class is poor but the second year class is normal, then this can be useful to stop panic decisions.

5. Developing and established fisheries

What does the manager do while waiting for the scientist to come up with the yield curve and the present position on it. In an existing fishery the manager must have some idea of what is happening unless the scientist has been extremely unsuccessful in collecting relevant data. In a new fishery, by definition, the data required such as changes in age composition as a result of fishing are absent. The need then is to look at a whole range of data so as to get some sort of feeling as to where the fishery is. The great fear is of overshooting and the extent of this fear depends partly on the animal being dealt with. If the yield curve drops sharply at high fishing effort then considerable care needs to be exercised. If the yield curve does not drop sharply then overshoot is not so important. The same is somewhat true of the fishery. If this involves building up quite a lot of vessels and shore facilities which are not suitable for anything else then overshoot results in a lot of capital which one cannot do anything with. In this case there is a need to go rather more slowly on a step-like approach. The biologist should be able to give some idea on how far to go, knowing the nature of the animal, extent of its distribution, and the distribution and abundance of similar kinds of animals.

A common problem in management aimed at holding the fishery at a given level is the subtle way in which efficiency improves. This gets back to the original curve that if there is a difference between value and costs of the fishery it will be used up by somehow circumventing the regulations such as by putting in larger boats or more boats or more powerful engines.

ADVANCED COURSE

A discussion of the available techniques required for the drawing of the yield curve was made in this section. In previous courses given by Dr Gulland, text book examples were worked. In this course, however, data from Australian, N.Z., and P.N.G., fisheries were also used. This contributed greatly to the course. The main fisheries examined were prawn, southern rock lobster, western rock lobster, southern bluefin tuna, scallop, shark, schnapper, abalone, and freshwater fishes. Data from some other fisheries were also examined but not in as much detail.

FINAL DAY SUMMARY

In introducing this session Dr Gulland indicated that the course went further than simply a training course and was really a working seminar on a number of real fishery problems. These were:

1. Prawns

A yield curve was drawn for the eastern king prawn fishery and the present position of the fishery estimated. The fishery is probably near the break-even position but the trend in fishing effort would probably be to increase by an efficiency increase and by an increase in numbers of vessels which are also suitable for the other fisheries. This has largely been checked by the introduction of the Moreton Bay permit system which limits entry and which limits the size of replacement vessels in that part of the fishery.

The banana prawn fishery in the gulf was analysed using Dr Gulland's method of extrapolating from other known prawn fisheries. Since the fishing season only lasts for three months compared to seven to eight months in the king prawn fishery, the fishing mortality rate is probably much higher than the natural mortality rate. Hence the fishery is well past maximum economic yield and almost the same catch could be taken by much less fishing effort. This is not necessarily undesirable as most of the fleet is very mobile and can shift to other fisheries. However the progressive build-up of large vessels and shore plant which are not suitable for anything else will lead to economic overshoot and this may have already occurred. Further data on the extent of the fishing grounds are required.

2. Rock Lobster

The historical catch and effort data on both southern and western rock lobster was analysed and a high exploitation rate was calculated thus indicating that any expansion of fishing effort is undesirable. A similar analysis based on mean length gave a very similar result. Calculations on optimum size of first capture indicate that an increase of up to 20% may be possible in the western rock lobster fishery if the minimum size was substantially increased. The present minimum size on southern rock lobster is at the optimum.

3. Southern Bluefin Tuna

The interaction of the various fisheries on this stock was discussed. There was a discrepancy between the analysis of the catch and effort records in the longline fishery and tag recapture data in the Australian fishery. This discrepancy can probably be explained if tagged fish suffer an additional mortality.

4. Abalone

The yield calculations on abalone were not possible as the fisheries have had constant fishing effort due to licence limitation. However, Tasmania has size distribution data which, when analysed in the future, may shed some order of magnitude on the limits of fishing and natural mortalities. Victoria have carried out some detailed experimental work which should also give some estimates of these quantities. Growth estimates have been made.

5. Scallop

Scallops are a good example of a variable recruitment stock. Available yield models are not as applicable to these stocks as in some other fisheries. Thus it is difficult to quantitatively answer the question of whether it is best to fish hard while the good year classes are available or to fish at a lower level over a longer period of time. If the fleet is mobile and other fisheries exist in the poor recruitment years then no management is required. If, however, this case is not applicable, then it is better to limit the fishing effort in order to lengthen the season.

6. Sharks

Sharks being a long lived species with a low number of pups, there is the probability that recruitment will be reduced if the adult stock is over-exploited. Some calculations were made determining the maximum size for a given mercury level content on school shark. Further calculations were to be made after the completion of the course.

7. Freshwater Fish

This is essentially an amateur fishery in which the costs exceed the value of the catch. The major factors affecting the freshwater stocks are habitat despoilment through pollution, water extraction etc., and exploitation by the angler, the former being a greater threat. Because of the large fluctuation in availability of fish it appears there is no danger of overfishing stocks. Hence if maximising enjoyment to the amateurs is the management objective no management procedures are required.

8. Schnapper

Catch and effort data from the fishery in Hauraki Gulf, N.Z. were considered and calculations on growth and mortality will be made after the course. This fishery is substantially more heavily fished than that in Victoria and a comparison of these fisheries will be valuable in estimating mortalities.

The final session considered future developments. The possibility and desirability of further courses was discussed. Various points were made.

This course was extremely valuable in discussing a vast range of problems though not in much detail on any particular fishery. It was valuable in bringing people together and allowing different groups to consider and criticise their work.

However, it was clear that a full course such as this need not be frequently carried out nor in any case are most people able to afford three weeks each year. It was felt though some continuation was necessary possibly on an annual basis and for a shorter duration of one week.

A point made by Dr Gulland was the desirability of bringing biologists, economists and managers together so that each can appreciate the way in which various calculations and decisions are made.

It was felt that a possible way of combining most of these features would be to have a workshop on a particular group of fisheries (e.g. prawn fisheries, pelagic fisheries). This should be about one week's duration on an ad hoc basis as the need arises for developing a management strategy. There should be considerable preparation of data and prior calculations and all three groups (biologists, economists, managers) should be represented. However, in order that the education aspects of the course are fully utilised as well as the development of a management strategy, other people not directly concerned with the fishery should also attend.

Finally, since CSIRO have an extensive computer network it was felt that CSIRO may set up a library of the more commonly used computer programs in population dynamics so that these can be used directly by various research establishments.

Tasmania

Dr T. Dix (Trevor)

J.H..Bradbury (John)

South Australia

S.A. Shepherd (Scoresby)

Western Australia

N.G. Hall (Norm)

G.R. Morgan (Gary)

N. Campbell (Norm)

P.N.G.

A.D. Lewis (Tony)

B.R. Smith (Barney)

New Zealand

R.F. Coombs (Roger)

Dr R.D. Elder (David)

Dr R.L. Allen (Robin)

CSIRO

Dr W. Dall (Bill)

G.P. Kirkwood (Geoff)

Dr P.C. Young (Peter)

I. Somers (Ian)

W.S. Hearn (Bill)

Senior fisheries managers present at introductory or summary sessions

Mr A.Bollen	-	Department of Agriculture
Mr N. Crozier	-	N.S.W.
Mr A.J. Harrison	-	Tasmania
Mr G.G.T. Harrison	-	Queensland
Dr D. Hancock	-	W.A.
Dr K. Kenth	-	Victoria
Mr S.A. Shepherd	-	S.A.

POPULATION DYNAMICS COURSE

Course Organizers

Dr J.A. Gulland (John)	-	FAO
Dr K. Radway Allen (Kay)	-	CSIRO
Dr C. Lucas (Chris)	-	CSIRO

Queensland

M.A. Potter (Mike)

R. Mayer (Bob)

Victoria

M.J. Sanders (Michael)

K. Beinssen (Konrad)

T.I. Walker (Terry)

I. Brown (Ian)

New South Wales

K.D. Shearer (Karl)

A.J. Collins (Alan)

R.D. Tilzey (Richard)

Miss M.I. Leedow (Margaret)