RESTRICTED

INTERNATIONAL COMMISSION FOR THE NORTHWEST ATLANTIC FISHERIES

Serial No. 2908
(D.c.9)

ICNAF Res.Doc. 73/6

ANNUAL MEETING - JUNE 1973

Memorandum on the mixed fishery problem in Subarea 5 and Statistical Area 6[1]

by

D.J. Garrod
Fisheries Laboratory, Lowestoft, England

The general concepts of the Schaeffer model provide a convenient framework for discussion of the mixed fishery problem. It is accepted that for individual resources progressive increase in fishing mortality will generate a dome-shaped yield curve with a maximum in the region of one half to one third the virgin stock size. In a mixed fishery exploited by a single, but heterogeneous, fleet, the yield curve of individual resources may remain dome-shaped, but their addition towards an aggregate yield curve will depend on the relative catchability of the separate resources.

The effective catchability of a resource (i.e. the coefficient q when $F = qf$.) is, at its simplest, the product of its biological availability and the degree to which a fleet concentrates on that species. In a mixed fishery this combination will differ between species: some illustrative variants are shown in Figure 1.

EXAMPLE A. Here the biological availability of resources x and y are the same and the fleet does not concentrate more on one than the other (this is equivalent to fishing at random with respect to catch composition). Then $q(x) = q(y)$. Both resources will be exploited at an equal rate giving their individual MSY at the same level of fishing effort. This situation is equivalent to a fishery which is mixed but where individual resources are captured in isolation, (the fisheries are separate in time or space), and total effort divides roughly in proportion to the size of the separate resources.

EXAMPLE B. Biological availability is different for resources XYZ, perhaps because of differential availability to the gear, or they occupy different

[1] Presented to Special Commission Meeting, FAO, Rome, January 1973 as Sp.Mtg.Res.Doc. 73/6.

geographical areas with the same centre. But their distribution is such that the fleet cannot concentrate more on one than another. Then, in principle resources X and Y could be fished to a low level (extinction of the fishery?) whilst resource Z is still fully exploited. The aggregate yield curve of the complex would be skewed.

EXAMPLE C. In reality both the bioligical availability and the ability of fleets to concentrate will vary. In C(i) a relatively small stock X attracts fishing and the exploitation develops to the level shown, and includes a 'by-catch' fishery on a less valuable resource Y. At the point of exploitation indicated the data available would support the yield projection shown by the dotted curve. However, if fishing continues to increase as in C(ii) then the relative importance of Y may become predominant, reduced catches of X actually reducing the fleets interest in it. Then the effective exploitation of X will be reduced, shifting the peak catch to the right, and exploitation of Y will increase, shifting its peak yield to the left. The total situation projected from C(i) has been modified by the fleet fishing pattern. The generality is that if the fleet operates without restraint the peak of the aggregate yield curve will be less than the sum of the MSY of each resource, and, in the example given, even though concentration upon X becomes less, its potential yield could be lost altogether.

The fishery in SA 5 and 6 is a more complex example of Type C., containing perhaps ten important resource components that influence the distribution of fishing activity. On the theoretical grounds outlined it appears that stabilization of the catch or effort at a particular level will fossilize the present particular Type C situation. This may be desirable, but it may involve some sacrifice of potential yield that might be overcome by constraints on fishing that will transform it from Type C to Type A.

The initial step facing the Committee is to define the present situation and to compare it with a distribution defined by the desired level of fishing mortality per resource component. An approach to this problem is set out in Table 1, the species and coefficients being entirely hypothetical as an example.

Across the top of the table are estimates of the numbers of days fishing directed at individual species which, being 'standardized' days, provide, with their catch, a 'standardized' c.p.u.e. per species. All effort should be allocated to a fishery if possible, though it would be possible to insert a

TABLE 1 Estimated days fished (ooo) on each main species

	25 COD	25 HADDOCK	10 REDFISH	25 R.HAKE	25 S.HAKE	10 Y'TAIL	30 HERRING	Σ	% f as by-catch	Long term MSY f
COD	25 / 1.0	7.5 / .30	5.5 / .55	0 / 0	0 / 0	9.5 / .95	0 / 0	47.5	47.4	
HADDOCK	17.5 / .7	25 / 1.0	1 / .10	5 / .20	5 / .20	9.5 / .95	0 / 0	63.0	60.3	
REDFISH	11.25 / .45	5 / .20	10 / 1.0	3.75 / .15	3.75 / .15	45 / .45	0 / 0	38.25	73.9	
R. HAKE	0 / 0	5 / .20	0.5 / .05	25 / 1.0	12.5 / .50	0.5 / .05	0 / 0	43.5	42.6	
S. HAKE	0 / 0	5 / .20	0.5 / .05	12.5 / .50	25 / 1.0	0.5 / .05	0 / 0	43.5	42.6	
Y'TAIL	17.5 / .70	15 / .60	4.5 / .05	1.25 / .05	1.25 / .05	10 / 1.0	0 / 0	49.5	79.8	
HERRING	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	0 / 0	30 / 1.0	30.0	0	

TABLE 2

	Long term obj.		Exploited Short term stock status			Potential yield 1974				For harvest of surplus	
	Stock	MSY	1.1/73	1.1/74	Surplus	F=0.3	0.5	0.7	0.9	F	f
COD											
HADDOCK											
REDFISH											
R.HAKE											
S.HAKE											
Y'TAIL											
HERRING											

miscellaneous column, provided its constituent species were covered by standardized c.p.u.e. data in another column. Each of these main fisheries will take a by-catch which contributes to the exploitation of other resources. This effect on by-catch resources A, B, C, etc., has to be defined in terms of the effective effort in the main fishery for A or B or C, etc. It can be done approximately using the usual relationships that $F = qf$ and thence $YW = qf\,\bar{P}w$ and $YW/f = q\,\bar{P}w$. The catch per standard unit of fishing effort in the main fishery is an estimate of the catch per unit fishing mortality and so the total fishing effort on the main species A will be

$$f(A) \quad + \quad f(B) \left(\frac{\text{c.p.u.e. of by-catch A in fishery B.}}{\text{c.p.u.e. of main sp. A in fishery A.}} \right)$$

In Table 1 the bottom left of each box is a hypothetical ratio of c.p.u.e. in each column to the c.p.u.e. in the main fishery for that species in the row. These factors are applied to the fishing effort in each fishery to give the top right figure in each box, and these are cross-totalled to give a total effective fishing effort per species. The overall total effort will always be greater than the total recorded effort because effort is double counted according to the number of species it acts upon. The allocation of effective fishing mortality to the main fishery, or as a by-catch will be immediately evident even though its level may not be properly known.

This distribution of fishing effort between species can be compared with any other distribution that may be an objective of management. For example, if the $F = qf$ relation can be established from age composition analyses allied to estimates of a standard effort, then some objective levels of effort per specie can be established, for example, from yield per recruit considerations.

Table 2 sets out other population characteristics which in conjunction with Table 1 can be used to frame advice to R and S on the questions before the Committee.

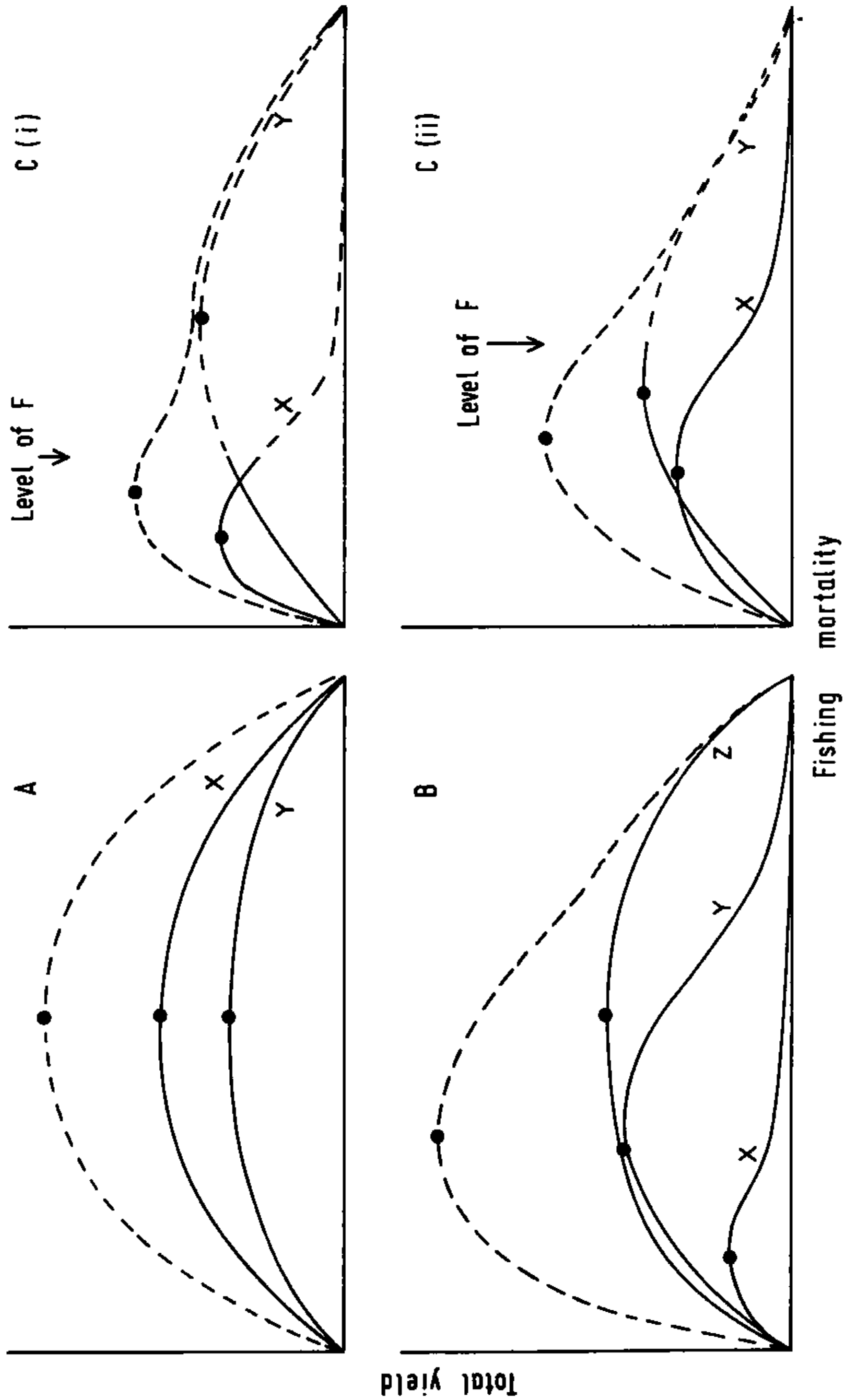
A
B
C (i)
C (ii)
Level of F
Level of F
X
Y
Z
Total yield
Fishing mortality

Fig. 1