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Bigger Net Mesh Size Will Mean Bigger Catches in the Ivory Coast Trawl Fishery

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The trawl fishery on the continental shelf of the Ivory Coast has been well documented. Catch-and-effort data by zone and depth have been recorded since 1966. The major species are (i) croakers (Sciaenidae), which are found in shallower waters (10-50 m), and which are mainly caught during October to June and (ii) sea breams (Sparidae) which live at greater depths (50-120 m) and are captured from July to September.

Seven major species were sampled in catches from 1975 to 1980–88,000 fish in 1,370 samples. A statistical study showed that their proportions in the samples represented well their proportions in the catch. Yield-per-recruit analyses were performed to identify the mesh size and levels of fishing effort most appropriate for this fishery, and some results from these analyses are presented below.

Yield Per Recruit

Basically, the weight of fish taken from a stock each year depends on the interactions of several factors—recruitment, natural mortality, growth rate, age at first capture and fishing effort.

To simplify calculations of expected yields, the assumptions commonly made for yield-per-recruit analysis were also made here. Under these assumptions, in an equilibrium situation, the annual production of a stock is equivalent to the production of one group of recruits for the duration of its life and directly proportional to recruitment level. A certain constancy of recruitment has been shown by demersal species in the tropical Atlantic and may be applicable in other tropical areas.

For each species we derived several yield-per-recruit curves, in which the lifespan of a cohort (i.e., single group of recruits) is divided into intervals within which the growth and mortality parameters are considered constant. Total production for the cohort is derived by summing that of each interval. The effects of changing fishing mortality by changing fishing effort and of changing age at first capture by changing net mesh size were then studied.

The possibility of adapting such analytic models to multispecific use is very interesting. To do this, it is necessary to sum up the results for each species as a function of net mesh size and fishing mortality. Such multispecific models are limited by the range of mesh sizes used and assume that the fishing effort is the same for all species. This was true for the Ivory Coast demersal fishery, the proportion of effort applied in each season being fairly constant from year to year.

Growth, Mortality, Selection Reproduction

Growth data were obtained from studies of fish on the Ivory Coast or similar areas. Differences between areas and sex-specific differences were expected not to bias the findings significantly because mortality rates, especially fishing mortality, are much more important. Of the two components of mortality, natural (M) and fishing (F), the former is very difficult to estimate. An average value of M over the exploitation period was used. This value was calculated using Pauly's empirical equation, which links natural mortality to the growth parameters K and L_∞ and to mean water temperature. To compensate for what appeared to be underestimates of natural mortality, values of this parameter double those obtained from Pauly's equation were also used in the analyses.

Fishing mortality was estimated using Pope's cohort analysis. The different runs of the method suggested that fishing mortality was much higher—for the fully recruited age groups—than natural mortality; therefore, this method could be confidently applied. The results were similar between years, validating the assumption of a more or less stable age distribution. The different natural mortality values had little impact on the final results.

The data on selectivity considered here, consisting essentially of "selection factors"—proportionality factors linking mesh size with mean size at first capture—were used to assess the impact of a change of mesh size from the presently used 40 mm to 53 and 77 mm.

While the total number of eggs produced annually by the females of given species and size could not be estimated, the relationship between size and number of mature ova was estimated for a number of species. These relationships, along with knowledge of size-specific sex ratios allow the assessment of the impact of a reduction, through increasing fishing mortality and the resulting reduction of mean fish sizes, of egg production by the various species and of the multispecies stock as a whole. Thus, one can identify a stock size sufficient for maintaining a "normal" egg production (it is often assumed that reduction of egg production below 10% of the value in the virgin stock will result in recruitment overfishing).

Results

The results of the analyses show that at the present levels of fishing mortality an increase of age/size at first capture would bring about a large increase in yield per recruit for all species considered, particularly for the cassava croaker *(Pseudotolithus senegalensis)*, the most important species. This increase, which may continue beyond the maximum mesh size considered here (77 mm) is independent of natural mortality within the range considered.

Relative fecundities, presently 9-20% of their values in the virgin stock, would also increase if mesh size were increased, and thus protect the stock against a possible recruitment failure.

Yield-per-recruit analyses performed simultaneously for all major species in the stock show that yield could be increased by an increase of mesh size (possibly well beyond 77 mm), a decrease of fishing effort, or both. Depending on the mesh size, yield could be increased from 15 to 40% if fishing effort was reduced by 20 to 50%. Similar results were obtained when the value of natural mortality was doubled, although the potential yield increases would be slightly smaller. The results obtained using data for different years were similar, suggesting that the results obtained are reliable.

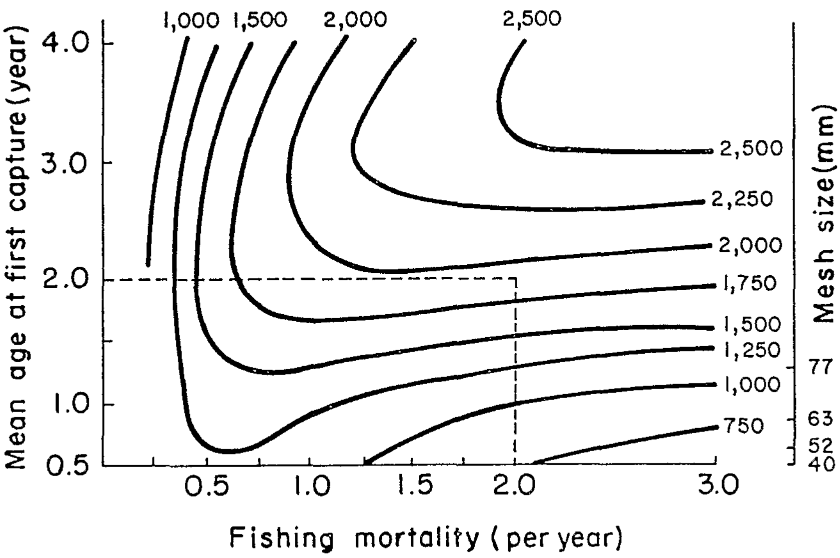

Fig. 1. Yield (in tonnes) for *Pseudotolithus senegalensis* as a function of fishing mortality and mean age at first capture and M = 0.15. For example, if fish become catchable at age 2 years and fishing mortality is estimated at 2.0, the expected yield is between 1,750 and 2,000 t.

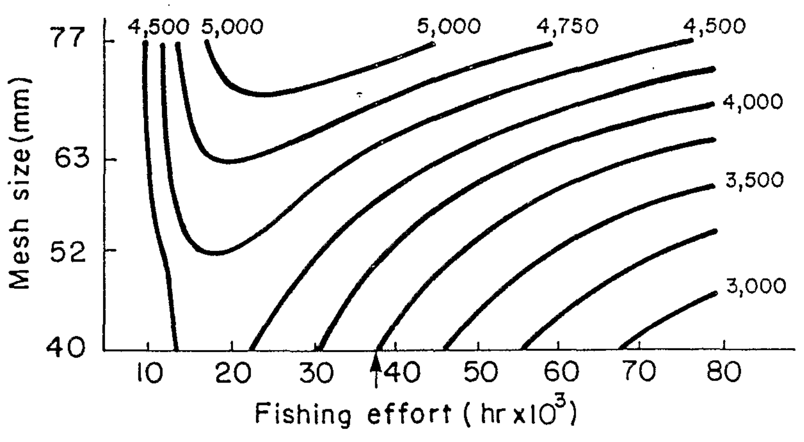

Fig. 2. Yield (in tonnes) as related to mesh size and fishing effort on the seven major trawl species of the Ivory Coast. The arrow shows the present effort level.

Implications for Management

With respect to the resource itself, it is obvious that an increase of mesh size from 40 mm to 77 mm or more would be beneficial, since this would result in an overall increase in yield per recruit of about 36% and a doubling of egg production.

However, in the short term, a rapid increase of mesh size would result in a decrease of catch per effort for the brief period needed for the fish to grow from the previous to the new mean size at first capture. Short-term loss could be as high as about 40% and the transition from smaller to larger meshes would, therefore, have to be gradual.

A transition from 40 to 63 mm would entail short-term losses of only 8%, for a period of less than two months, after which equilibrium yield increases of 18% would be reached, with even higher economic gains, due to the larger size of the fish caught.

Yields could be increased even more, about 26%, if effort were simultaneously reduced by half, but the difference between 18 and 26% may be too small to justify the loss of jobs which a large reduction of effort would imply.

The moderate mesh size increase suggested above, which would result in higher sustained catches, and increased profits for the owners of the trawlers should be relatively easy to implement, and its results could pave the way for an acceptance of future mesh increases, to be proposed later, following a close monitoring of the fishery. ●

Further Reading

Pauly, D. 1980. On the interrelationships between natural mortality, growth parameters and mean environmental temperature in 175 fish stocks. J. Cons. CIEM 39(3): 175-192.

Pope, J.G. 1972. An investigation of accuracy of virtual population analysis using cohort analysis. Res. Bull. Int. Comm. Northwest Atl. Fish. 9: 65-74.