Management of Multispecies Stocks: A Review of the Theory

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The multitude of species contributing to the catch of the demersal fisheries of Southeast Asia, combined with an acute lack of knowledge on the biology of these species and the scarcity of good statistical data on the fisheries themselves, have traditionally made resource assessments in tropical waters one of the most difficult problems encountered by fishery biologists. The development of large-scale fisheries in the last two decades, however, has forced scientists to develop a simplified model which could be used when both biological and statistical data by species are nonexistent. This model which may be called here the "Total Biomass Schaefer Model" is based on the idea that the entire exploited stock grows and maintains itself and reacts to fishing more or less like a single species would. Therefore, the usual plot of catch-per-effect against effort can be used to obtain estimates of total maximum sustainable yield and optimum level of effort.

This model has been quite widely applied in the region, and is indeed the most sophisticated tool in use for monitoring the development of the region's demersal fisheries. This model and even more simplified versions of it have also been used for estimates of the productivity of the whole region, and on the basis of these estimates the conclusion has been drawn that on a per-area basis, the region's fisheries may be at least as productive as certain North Atlantic fishing grounds.

When reviewing the theoretical basis of this model, I found, however, that most of the assumptions made for its derivation, and which are met by single species stocks, do not apply to multiple species stocks. Thus, for example, one of the (implicit) assumptions made when applying this model to a single species stock is that the stock prior to its exploitation by man is virtually unexploited by predators. This assumption, which holds true for most tuna, halibuts, cods, sharks and/or marine mammals—indeed to all "top carnivores"—certainly doesn't apply to the stocks of small and very small fish which contribute so greatly to the demersal fisheries of the region. Indeed, it is the stocks of small fishes which maintain the various exploited populations of predatory fishes such as snappers, sea basses, and sharks. The pooling of all these different groups into one entity thus doesn't take into account the "natural" exploitation of the small fishes by their numerous predators.

The demersal fisheries of the region, because of the small meshes utilized, tend to remove both the large and the small fishes, and the data available from the Gulf of Thailand show that contrary to expectations, it is the stocks of small fishes which diminish fastest as fishing increases. The result is that the food base on which the production of a larger fish relies simply disappears, with the predators declining thereafter.

These stock interactions are quite simplified from the real state of affairs, but the main point is obvious: a model based on total fish biomass will have the tendency to overestimate the maximum sustainable yield and consequently to suggest a level of "optimum" effort that will be too high. The overestimation may be substantial, and therefore the demersal fishing grounds of the region may be, on a *sustained basis*, much less productive than was previously assumed. These findings will be presented in detail in an ICLARM Report, together with the supporting evidence, most of which stems from the relatively well-documented Gulf of Thailand trawl fishery.

Among the various conclusions derived from these findings, I emphasize the need to locate and collate the body of extant data on the demersal stocks of the region, both in terms of the biological data on the species contributing to these stocks and in terms of statistical data pertaining to the various fisheries.

It seems, on the other hand, that a thorough standardization and compilation of the information available on the stocks of the region, and especially on their response to the fishery (rate of decrease, changes in species composition) could very well help to verify (or disprove) the interpretations outlined here, and if they appear correct, could help in efforts to review present yield estimates and projections, as well as to help formulate a generalized theory of species interactions in tropical stocks.

My previous work, which focused on fish growth, showed that contrary to widely held opinion, the age determination of tropical fishes is a problem that is quite easy to solve. This also applies to the estimation of mortality rates and age (size) at first maturity, all of these parameters being closely related to the growth parameters of the fish population in question.[2]

It appears, therefore, that contrary to previous practice, it will be possible to make yield-per-recruit assessments for most species of tropical fishes, that is, to apply to tropical fishes one of the most sophisticated tools devised for the study of fish population dynamics. But, again, this will not be sufficient. What is needed is a completely new approach to the assessment of potential yields from multispecies stocks, especially tailored for use in the tropics. The ICLARM report mentioned above will, I hope, make this need obvious, and may also represent a first step toward this new approach.

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2. Papers presenting these findings are currently in preparation. One, to be given at the upcoming meeting of the International Council for Exploration of the Seas, is entitled, "A discussion of the potential use in population dynamics of the interrelationship between natural mortality, growth parameters, and mean environmental temperature in 122 fish stocks." A preliminary compilation of growth parameters is available from the author (see Pauly in listing of New Publications elsewhere in the newsletter).