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Dynamics of multispecies stocks

ICLARM-CSIRO Workshop on the Theory and Management of Tropical Multispecies Fish Stocks, Cronulla, Australia, 12-23 January 1981

There has been a flurry of symposia and workshops devoted to multispecies fish stocks in the last few years, along with copious papers, ranging from descriptive accounts to highly mathematical approaches, on the dynamics of such stocks.

Almost all of these activities, however, were concerned with temperate waters, especially on the demersal stocks and fisheries of the North Sea, the North-east Atlantic and the North Pacific.

These stocks and fisheries have mainly been (mis)managed under the implicit or explicit assumption that the interactions such as predation or food competition between the various populations could be neglected. Only in the last few years has this assumption been challenged and gradually shown to be untenable.

In the tropics, for demersal fisheries at least, the multispecies nature of the resource could never be 'assumed

away', since there are simply too many species in the catch and the fishery is never selective, ie based on any single species or group of species. Also, in the early 1950s and 1960s, when large-scale demersal fisheries started in South-east Asia (eg in Manila Bay, Philippines and in the Gulf of Thailand), scientists called on to advise the governments on potential yields, etc could not build on previous knowledge of the biology and exploitability of the major species in the catch.

Massive changes in species composition of South-east Asian stocks following exploitation were first documented by Tiews *et al.*¹ These authors wisely abstained from interpreting these changes. Later, Gulland² suggested treating the whole species assemblage as if it were a single species, thus turning attention away from changes in catch composition, while setting the basis for a useful rule of thumb - the stock size should not be

reduced to less than $\frac{1}{2}$ the virgin stock size, or the even better known 'potential yield $\approx \frac{1}{2} M \cdot B_0$ '.

Yet these rules, born out of expediency and still widely used for lack of suitable alternatives, cannot mask the fact that the dynamics of multispecies stocks, especially in the tropics, are at present not understood.

Recently, Pope³ and this writer⁴, working with essentially the same data from the Gulf of Thailand, attempted to derive further 'rules' and generalizations which could be used in tropical multispecies stock management. However, these attempts were severely limited by the scanty database (eg the unavailability of detailed catch data) and by the existence of contradictory concepts in the literature pertaining to the behaviour of these complex systems.

Aims

John Marr, then ICLARM (International Center for Living Aquatic Resources Management) Director General, approached the Australian Government in 1978 to sponsor a Workshop on this subject. In 1980, a grant was awarded to ICLARM by the Australian Development Assistance Bureau (ADAB) to hold, in conjunction with the Commonwealth Scientific and Industrial Research Organization (CSIRO), a 'Workshop on the Theory and Management of Tropical Multispecies Stocks'.

The workshop, which was held on 12-21 January 1981 at the CSIRO Division of Fisheries and Oceanography premises in Cronulla, near Sydney, included participants from six countries (Australia, the UK, Canada, the USA, Papua New Guinea, Philippines). It was convened by Dr G. I. Murphy (CSIRO) and chaired by Professor P. A. Larkin (University of British Columbia, Canada), with the writer acting as technical secretary. The aims of the workshop were:

- to review models that are presently in use, or that have been proposed for multispecies stock assessment in the tropics;
- to define the data requirements of various assessment and management methods;

- to review current research on multispecies stock assessment in tropical waters;
- to identify the major constraints for stock assessment in tropical waters and to formulate a feasible plan of action to overcome these constraints.

Fourteen papers were presented and discussed, after which working groups were formed to discuss special topics in detail. The contributions (all invited) covered the following broad areas: Fisheries Management and Research (J. Gulland, FAO, Rome; J. Marr⁵, formerly ICLARM; A. Simpson, formerly South China Sea Programme); Biology of Single-species Stocks and of Coral Reef Fishes (P. Sale, University of Sydney; J. Munro, University of Papua New Guinea; G. Murphy, CSIRO; D. Pauly, ICLARM); Ecology⁶ (G. Marten, East West Center, Hawaii; J. T. Polovina,⁵ Southwest Fishery Center, Hawaii; R. Jones, Marine Laboratory, Aberdeen; K. Sainsbury, CSIRO); and Modelling of Stocks and Fisheries (G. P. Kirkwood, CSIRO; P. Larkin and W. Gazey, University of British Columbia; J. Majkowski, CSIRO; M. James and K. P. Stark,⁵ James Cook University, Townsville, Australia). These four groups of papers, while not providing instant solutions to any of the investigated problems, have helped focus attention on a number of specific points.

Concerning management and research, it was felt that although our understanding of the dynamics of multispecies stocks may be deficient in biological terms, it is often sufficient to provide reasonable management advice (eg on the need for effort reduction or redirection). Management advice, generally directed at hard-pressed governments, should also be given to regional banks and similar bodies capable of channelling money into infrastructure development (eg road construction) when these could result in preventing distortions in the relationships between the fishery sector and the overall economy. There is a definite need to strengthen the ability of South-east Asian countries to conduct management-oriented fisheries research and to publish the results of

such research. Generally, decline in total catch with increasing effort is not apparent from multispecies stocks (although tremendous changes in species composition can and do occur) as long as habitat degradation can be prevented. This suggests that total and sudden collapse, such as has occurred in several single-species fisheries (eg the Peruvian anchovy) may not occur in multispecies stocks, which would allow for strategies aimed at employing a relatively large number of persons in the fisheries.

Scanty data

With regard to single species stocks and coral reef fish, the papers and discussions suggested that special topics deserving attention in single-species studies, particularly in reefs, are growth studies (which should concentrate on daily otolith rings) and stock-recruitment relationships, the latter being a highly controversial topic among reef ecologists. A review of the scanty data available on the stock-recruitment relationships of tropical non-reef fish suggested the existence of Ricker-type relationships in several stocks, as well as a strong dependence of recruitment on abiotic factors in at least one stock. These findings are surprising in that strong biotic interactions have generally been expected in tropical stocks. Further studies on this are urgently needed.

The papers on modelling ranged from 'simple' models, such as Pope's⁷ extension of the parabolic surplus-yield model, to more complex simulation models, one of which, presented by P. A. Larkin and W. Gazey, was devised especially to be run at the Workshop to simulate the Gulf of Thailand demersal stocks and trawl fishery. Questions of models' usefulness and sensitivity to input parameters were discussed. No particular consensus was achieved, but some participants felt that models can and should be built of tropical communities and fisheries, without necessarily waiting for more and more reliable data to become available. Such models could be particularly useful to identify the major gaps in our understanding of how the systems work. It was also suggested

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that, possibly, simulation models could be used in South-east Asia and other areas as a training tool to help fishery managers obtain a 'feel' for the possible impact of their various policies.

The papers concerning general ecological principles as applied to tropical multispecies stocks were invited in the expectation that general ecological principles could help identify and interpret patterns which fishery biologists have hitherto failed to notice. However, the papers and ensuing discussion on this topic suggested that ecological *theory*, as it presently stands, has generated too many untestable hypotheses and uses too many unquantifiable parameters to be of great use to fishery biologists. Many of the concepts used in theoretical ecology lack applicability to real life situations; also, too many of these concepts and parameters contradict each other. On the other hand, the *empirical* data at hand allow for the derivation of a number of useful rules, some of them quantifiable, which allow, for instance, preliminary estimates of yield per surface area for different systems, given the structure of the food-web, the water depth and/or the primary productivity. Correlational studies, such as those above, may yield, in the long run, an understanding of systems behaviour leading to theoretical advances, and may be the most useful approaches to rationalizing tropical fishery management.

Although some emphasis was given to South-east Asia, the contributions and discussions effectively covered a variety of tropical systems, from the Great Lakes of Africa to Caribbean reefs. Similarly, the methods and approaches reviewed ranged from the simplest methods (eg for assessing mortality rates from fish length data) to building and validation of complex computer-based models.

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The papers and discussions of the working groups will be published, along with the Chairman's summary of the workshop, in ICLARM's Conference Proceedings series, as a volume edited by Dr G. I. Murphy and Daniel Pauly.

¹K. Tiews, P. Sucondhamam and A. Isarankura, *On the changes in the abundance of demersal fish stocks in the Gulf of Thailand from 1963/1964 as a consequence of the trawl fisheries development*, Contr. Mar. Fish. Lab., Bangkok, 1967, in Thai and English.

²J. Gulland, *The fish resources of the oceans*, FAO/Fishing News (Books), Surrey, UK, 1971.

³J. G. Pope, *Stock assessment in multi-species fisheries, with special reference to*

the trawl in the Gulf of Thailand, SCS/DEV/79/19, South China Sea Fisheries Development Programme, Manila, 1979.

⁴D. Pauly, *Theory and management of tropical multispecies stocks: a review with emphasis on the Southeast Asian demersal fisheries*, ICLARM Studies and Reviews 1, International Center for Living Aquatic Resources Management, Manila, 1979.

⁵Not present at the workshop.

⁶Ecological theory, food chain studies, yield per area studies, etc.