SEASONAL TRAWLING BANS CAN BE VERY SUCCESSFUL IN HEAVILY OVERFISHED AREAS: THE "CYPRUS EFFECT"

by

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1. Introduction

Total trawling bans have proved to be very effective in rebuilding depleted fisheries in temperate waters, as shown by the remarkable recovery of European stocks during the World Wars. In the tropics the potential effects of such bans have not been documented until recently. A total ban in the tropics was implemented in Indonesia after 1981 and the results are given by Naamin (1984). They are considered both positive and negative as conflicts have decreased, incomes of artisanal fishermen and sizes of shrimp have increased, but total production of shrimp decreased and the reconversion of the trawling industry raised problems which have not yet been entirely solved. A proper assessment of the biological effects of this ban has not been possible to date.

Total trawling bans in littoral areas have been adopted by most countries around the world, generally in order to reduce gear conflicts between artisanal and industrial fishermen. These bans are usually poorly enforced for various reasons and until recently no assessment of their actual effects on the resource has been made. Seager (1981) showed that in the Philippines a ban on trawl fishing, implemented in the coastal area in 1979, resulted in an average increase in biomass of 100% in only one year.

Seasonal trawling bans or closed seasons are also among the most conventional management measures. They are more easily enforceable and, if implemented at the appropriate time of the year, usually produce good results.

The purpose of this paper is to describe a very successful experiment of this type undertaken recently in Cyprus, and the surprisingly good results draw attention to the particular usefulness of such a measure in very heavily overfished areas.

2. The Overfishing Process

Many definitions of overfishing have been given since the theory of fishing started to be elaborated but probably nothing really new has been said since the review of the problem by Beverton and Holt (1957, pages 389-392). Overfishing is usually defined as an excess of fishing effort with reference to particular criteria of a biological or economic nature. For most biologists overfishing occurs when the total catch decreases as effort increases, the underlying concept being the surplus production model. However, as stressed by these two authors, the selectivity of the fishermen will most likely decrease as fishing increases and the average size of the fish decreases leading to gross overfishing when stocks are exploited with a size at first capture which is much too small and with too much effort. The underlying concept here is the eumetric curve.

It is interesting, although not immediately relevant in this paper, to note that this behaviour of the fisherman, usually unnoticed because it develops very slowly, is probably a serious source of bias when very long time series covering very important changes in fishing rate are used in production modelling. In such a case the observed data points describe a trajectory of the fishery across a series of production models corresponding to the continuously but surreptitiously changing age at first capture. For instance, such a situation has existed for decades in the hake fishery off the Moroccan Atlantic coast and is characteristic of all the fisheries on the demersal resources of the Mediterranean shelf. The main consequence of this is that the phenomenon is not easily reversible and a reduction of effort alone will not bring the fishery back to the early situation suggested by following backwards the trajectory observed in its development.

It is, however, necessary to look into the process of overfishing in more practical terms, i.e., in terms more relevant to the physical operations of fishing, in order to reach a better understanding of the unfortunately frequent failure of traditional management.

In the Mediterranean, as well as in most tropical areas, the fish production originates in the littoral areas where fingerlings become benthic before starting to migrate towards deeper water, growing in size and decreasing in numerical abundance. This well-known interaction between growth and mortality results in changes in biomass with depth. This, in turn, results in changes of potential value and profitability of fishing with depth, a pattern well known to the fishermen and exploited by them in the most immediately profitable way.

The important point is that this pattern is affected by fishing. As fishing mortality increases and biomass decreases the maximum weight of the cohorts is attained at a progressively earlier age and shallower depth while the fish caught become progressively smaller. In this situation, the short-term economic optimum of the fishermen tends to move also slowly towards shallower depths and the trawlers will be constrained by economic forces to fish closer and closer inshore towards the nursery area, from which the biological production and the revenues originate. They will, in the process, come in contact with the inshore small-scale fishery generating the sort of very widespread competition and conflicts with which the fishery administrations are, unfortunately, very familiar.

In addition to the concepts of overfishing given earlier in this section, one should therefore remember that in operational terms, overfishing appears also as a situation where the fishermen are economically constrained to catch very small fish very close inshore. This has two important practical consequences. First, it is very unlikely that in such a situation the fishermen will cooperate in the implementing of regulatory measures concerning mesh sizes or closed inshore areas unless the economic "trap" in which they find themselves is broken, for instance, by breaking the mechanism that led to their present situation (build-up of effort due to the non-limited access to fishing) by limiting further entry into the fishery and reducing effort levels. Secondly, because of the fishing strategy imposed, fishing concentrates on months and depth strata where small fish are more abundant while trawl selectivity is reduced to the minimum. As a result the fishing mortality will most probably not be constant with age after some theoretical age at first capture, but instead will peak sharply on very young fish and then decrease with age. Under these circumstances the use of simple assessment models assuming parameters constant with age and with time, for predicting the most likely effects of some foreseen management measure, is likely to yield biassed results.

The example of the success of the recently implemented management measures in Cyprus is given in this paper in order to illustrate the spectacular effects that slight changes in fishing strategy, aimed at the protection of juveniles, can have on total production of very heavily overfished stocks. A more detailed description is given in Garcia and Demetropolous (1984).

3. The Development of Overfishing in Cyprus

Overfishing has developed in Cyprus slowly, but steadily, over the last three decades despite the fact that the number of trawlers has been limited since 1952. The trawl fleet, limited to 10 boats, was allowed to increase to 12 boats in 1961 and then decreased progressively to 8 units. The main development occurred in the inshore fishery for which no effort limit was considered. This fishery, which exploits essentially the same species as the trawl fishery (plus some specific reef species) has grown very rapidly. It provided 40% of the total catch in 1961 and 74% in 1983. It must also be noted that the fishing intensity in the southern part of the island increased sharply after the disturbances in 1974, because of the refugees. By 1982, the overfishing was apparent through the very small sizes of the fish in the landings, the massive killings of new recruits by the trawl fishery in October-November, during the main recruitment period, and through the endless conflicts between inshore and offshore fisheries in the coastal fishing grounds. The trawl fishery was barely profitable despite the high prices in the market.

4. The Management Measures

A closed season has been in force for many years from June to September. As is often the case in similar situations, the administration tends to put a seasonal ban on fishing during the period when the catch rates are so low that fishing is in any case unprofitable. Some biological justification for this can usually be found because the period when the newly recruited cohorts are close to extinction and fishing is no longer profitable corresponds to the spawning season, and the protection of spawners becomes the argument justifying the closure. As fishing effort continues to grow and the "economic fishing season" becomes shorter and shorter, the closed season tends to be extended backwards. This sort of closed season is not a positive measure as it is an effect of the overfishing and cannot solve the problem.

As the problem was raised again, the Fisheries Department refused to follow the trawlers' request to close fishing in May and instead proposed to close fishing during the recruitment period in October. This was finally implemented with the full support of the inshore fishermen, from October 1982 onwards and the results are shown in the following section.

5. The Results

Preliminary analysis of length frequency distributions collected before the introduction of this new measure showed that age at full recruitment was around six months. The practical effect of the measure was therefore to delay fishing by one month. Some simple yield per recruit calculations showed (a posteriori) that only very minor results could be expected under the usual assumptions of knife-edge recruitment and constant age-specific mortality.

The effective results, however, were far greater than expected and are briefly summarized here (for more details the reader is referred to Garcia and Demetropolous, 1984. An analysis of the available time series of catch and effort (expressed on a per unit area, in order to be able to combine data referring to two different overall fishing areas available to fishing before and after the disturbances) in a production model, showed very clearly that the 1983 and 1984 data points were totally outlying (Fig 2). The much higher abundance now available for effort levels similar to the ones applied in the past indicate that:

(a) the new management has raised the productivity (catch rates increased by about 80%);
(b) the old production model, rather well-behaved until 1982, is now totally inappropriate (the new catch rates do not fit anymore with the cpue/effort relationship established for 1967-1982).

In order to develop a model corresponding to the new situation, a Composite Production Model was elaborated (see Caddy and Garcia, 1982, and Garcia, 1984 for details). This model, following an idea of Munro (1977) uses space-structured catch and effort data instead of a time series and is particularly convenient here. Data corresponding to heavily fished and lightly fished zones, with and without trawling, before and after the extension of the closed season, were used (see Figs. 3 and 4). These figures show clearly that:

(a) before, as well as after, the new management regime the catch rates were higher (+25% to +30%) in the untrawled areas, exploited only by the inshore fishery with a higher age at first capture and using traditional set gears;

(b) that the new management regime has greatly increased the catch rates obtained at a given level of effort (from 40% at low fishing intensity to 70% at high fishing intensity).

The usual production models by zone have then been elaborated from the cpue/effort relationships given in Figs. 3 and 4 and taking into account the areas of the various fishing zones (only the ones corresponding to the new situation are given in Fig 5). The new management measure appears to have increased the maximum sustainable yield by about 100% in all areas, from 2.9 to 5.8 mt/sq. mile in heavily trawled areas and from 3.8 to 7.5 mt/sq. mile in untrawled or rarely trawled ones.

Economic effects were also significant both in the catching and marketing sectors: significant increases of incomes, capital "stuffing" in the form of acquisition of new electronic equipment, creation of an important economic rent, multiplication of marketing outlets. An undesirable consequence was the increase of pressure to enter the fishery, a problem which the Fisheries Department has now to deal with, if the dissipation of the benefits generated is to be avoided.

It is important also to know that the measure seems to have broken, at least temporarily, the fatal trend leading the trawlers into inshore waters. Because an economically usable biomass exists now in deeper waters the fishing activities have also moved offshore for the first time and without constraint. As a matter of fact the fishermen have even recently agreed between themselves to comply with the regulation on this matter.

6. Discussion

The example given in this paper clearly illustrates a few important points related to the problem of managing very heavily overfished stocks:

(a) in stocks heavily overfished both in terms of excessive effort and a much-too-small size at first capture ("cacometric overfishing, according to Beverton and Holt, 1957), a seasonal ban on trawling during the peak recruitment period can have spectacularly positive effects in both biological and economic terms ("Cyprus effect");

(b) these effects are more spectacular and more easily obtainable than through mesh size regulations, which in very overfished fisheries are not readily adhered to by fishermen for the reasons mentioned in Section 2;

(c) the problem of low profitability of fishing due to excessive fishing effort cannot be solved by mesh size regulations alone. An appropriate seasonal ban at the right time of the year can greatly improve the economic situation temporarily, but a stable solution will only be found by limiting fishing effort to the appropriate level;

(d) the usefulness of a minimum knowledge of biological information (on sizes caught by type of fishing and by season, on species composition of landings, importance and seasonality of discards), of space distribution of fishing effort and of potential effects of management measures;

(e) the extreme usefulness of an intimate knowledge of the way the fishery and the fishermen operate. This knowledge has allowed the Fisheries Department to act efficiently despite the very limited data and manpower available for

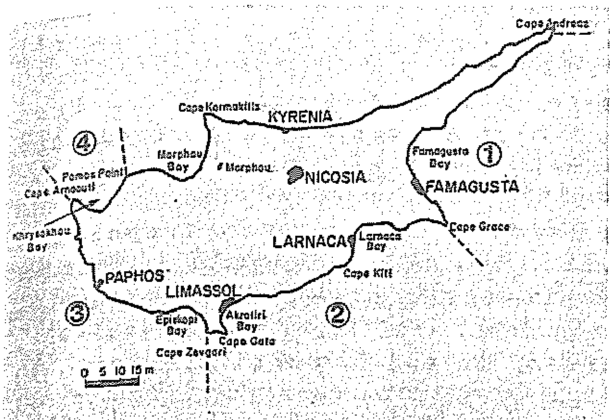

Fig. 1

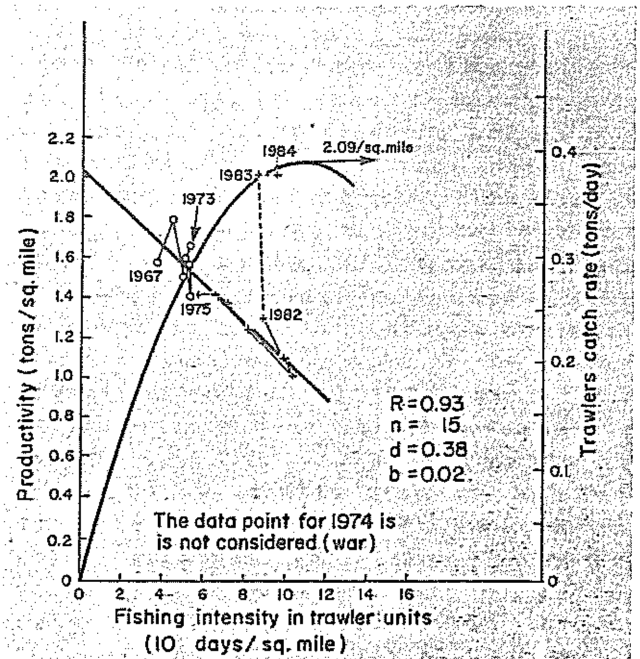

Fig. 2

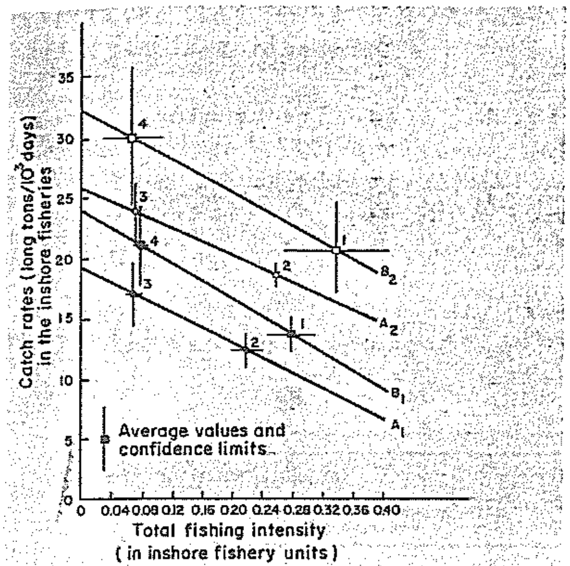

Fig. 3

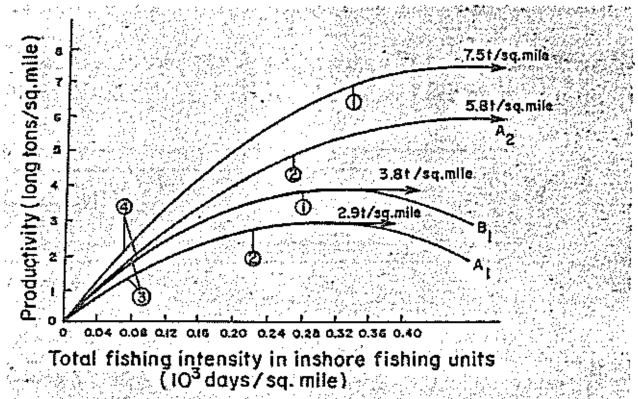

Fig. 4

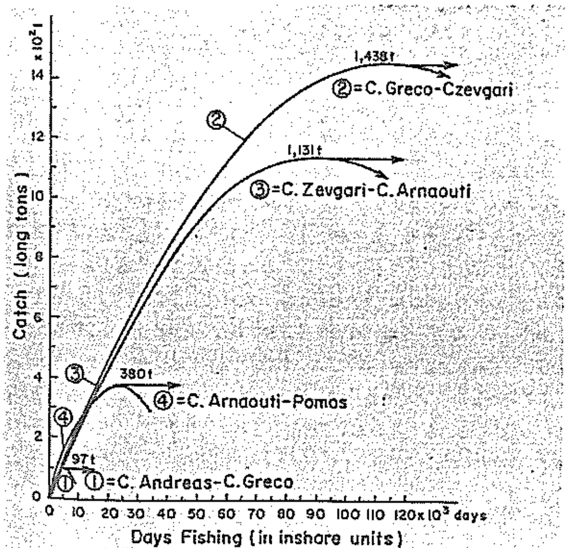

Fig. 5

Fig. 1. Map of Cyprus showing the four fishing zones considered in the analysis. Fig. 2. Relationship between fishing intensity (in trawlers' units), catch rates and catch per unit area ("Productivity"). The points for 1983 and 1984 are not used for fitting and show the change in productivity resulting from the new management measures. Fig. 3. Relationship between catch rates and fishing intensity in areas heavily trawled and lightly trawled, before the extension of the closed season (A_1 and B_1, average 1977-1981) and after (A_2 and B_2, average 1983-1984). Fig. 4. Evolution of the productivity (catch per square mile) with fishing intensity before the extension of the closed season (A_1 and B_1) and after (A_2 and B_2). Fig. 5. Production models for the various fishing areas as derived from Fig. 10. The present position of the fishery on the curve is indicated by a number referring to the areas given in the map.

preliminary analysis.

It remains to be seen whether the results could be applied to other tropical or sub-tropical areas of the world. The probability is, of course, very high that the same biological results will be obtained when starting from similar situations, opening opportunities for trying elsewhere. However, because of the immediate and long-term economic effects observed in Cyprus it is advisable to try on a small scale, through pilot projects, before generalizing such management to the whole coastline. One can wonder what the economic effects would be (on the market, for instance) of such measures if equally successfully implemented in the whole of the Italian coastal resources, one of the most overfished in the Mediterranean, but one still producing many hundred thousand tons of fish.

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A NEW METHOD FOR ESTIMATING GROWTH AND MORTALITY PARAMETERS FROM LENGTH-FREQUENCY DATA

by

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A new, simple method has been found to estimate the asymptotic length (L_∞) and the ratio of the coefficients of mortality and growth (Z/K) using only length-frequency data from a fish catch. Theoretical details of the method are given in a paper by J.A. Wetherall, J.J. Polovina, and S. Ralston, to appear in the forthcoming ICLARM proceedings of the 1985 Sicily conference on length-based stock assessment (See Fishbyte 3(1), March 1985). A practical user's guide to the new procedure, with computational algorithms and Turbo Pascal code, will be available soon from the author. In this report only a brief description of the method is given. (see also Pauly, this issue).

The sampled fish population is assumed to be stable, with constant annual recruitment, von Bertalanffy growth, and continuous mortality occurring at a uniform, instantaneous rate. A random sample of n fish are measured, m of these longer than a particular knife-edge selection length. The measurements are retained for analysis, and data on fish shorter than the selection length are neglected. In practice the assumptions on recruitment, growth, mortality and size