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PENAEID PRAWN RESEARCH IN PAPUA NEW GUINEA

by

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INTRODUCTION

In prawn fisheries, as with most other fisheries, the ideal management control is to have the correct amount of effort to catch the maximum sustainable annual yield. Ideal predictions of annual yields have to be correlated with spawning success, recruitment to nursery zones and emigration to the commercial fishery. For these predictions, protection of spawning stock (or at least that proportion deemed necessary to maintain a maximum yield the following year, as is the case in penaeid prawn fisheries) and juveniles is required. Knowledge of the environmental parameters which affect both larval, juvenile and adolescent recruitment to the nursery zones and commercial fishery is also essential.

In the late 1970's and early 1980's penaeid prawn research was undertaken in PNG to try and determine some of the essential parameters for correct management of the fishey. This research obtained data for management from four main areas

i) the commercial fishery through comprehensive logbooks (trawl by trawl catch return forms)

ii) observer programs

iii) surveys of potential nursery grounds

iv) tagging experiments to determine growth, and juvenile and adolescent migratory patterns.

This paper outlines the methods used and outlines their successes and shortcomings.

MODELS

While it is not the intention of this paper to outline or discuss the relative merits of fish stock assessment models, the two models used mainly in stock assessment for penaeid prawns will be outlined so as to give an idea of what parameters need to be collected if management is to be based on these or similiar models.

The two models mainly used in stock assessment for penaeid prawns are the Schaefer (1954, 1957) surplus yield or production model and the Beverton and Holt (1957) yield per recruit model. Details of these models can be found in most stock assessment manuals: Ricker (1957); Gulland (1976),(1983); Garcia and Le Reste (1981).

The production model (Fig 1) is used for long term predictions and requires a minimum of data, namely catch and effort data. This model provides an estimate of the average expected catch based on the historical pattern of the fishery. The 1986 FAO/Australian workshop on the management of penaeid shrimps/prawns in the Asia-Pacific region mentioned consideration of the following limitations in using the model: an inadequate biological basis, difficulties in standardization of effort, variations in catchability, difficulties in fitting and the biological variability demonstrated in the population.

A simple extension of this model for economic analysis is the conversion of catch to value of catch and inclusion of a cost of catch graph (Fig 1). Where these graphs meet is where no economic return is made (i.e. Income = Expenditure). The greatest difference between these two graphs is the maximum economic yield (MEY).

The yield per recruit model (Fig 2) is used for both short and long term predictions and requires more complex data; namely growth, length frequency and mortalities. The main limitation in this model is its sensitivity to the estimation of the parameters, especially natural mortality which is hard to determine with any degree of accuracy. Figure 2 shows how the graph can change depending on the relative proportions of fishing mortality (F) and natural mortality (M) in the total mortality (Z : Z=F+M).

An example of the relevance of the yield per recruit model is its use in conjunction with closed seasons as a form of management. Pre-season length frequency sampling combined with yield per recruit estimates can be used to provide predictions on the optimum opening time of a season.

For the model estimates to be valid, the area the population covers needs to be known. This requires the identification of nursery localities, migrations from nursery zones to fishing grounds and migrations between fishing grounds.

LOGBOOK

Logbooks form the basis from which records of catch and effort are extracted. In PNG the completion of logbooks is mandatory on the issuing of a license.

Information which PNG collects on effort and catch is recorded as hours trawled and kilograms per grade per trawl respectively. Records are also kept on the type of processing (heads on/off) per grade, date, time and duration of trawl, surface water temperature, depth, area and bycatch. An important component of effort is the fishing capacity of the vessel both in net size and trawling speed and these along with vessel size, fuel capacity, engine size, number of crew etc., are recorded in dossiers kept on all vessels licenced in the Gulf of Papua.

The need for accurate data is shown in the following example of catch per unit effort (CPUE) against effort (E) plots given by Gwyther (1982), and Kolkolo (1983) (Fig 3). The standardized forms presently used were implemented in 1977. Prior to this various catch return forms (logbooks) existed which recorded information in various different ways (i.e. boat days, landed retail catch etc). Although Gwythers' estimates of data prior to 1977 are the best attainable, the shape of his plot is determined by the 1974 to 1976 points. Gwyther concluded from this plot and production and yield per recruit models (also using 1974 to 1976 data) that the present yield (1980 yield) in the Gulf of Papua prawn fishery was approximately its sustainable yield. Kolkolo, using the 1977 and onward points and including the 1980, 1981 and 1982 points, obtained a positively sloping plot suggesting that the stock is underexploited. Unfortunately the 1977 to 1982 points are clumped as effort has remained relatively static and thus interpretation requires a deal of caution. This emphasizes the need for logbooks to be implemented from the start of the fishery so as to obtain CPUE data under varying amounts of efforts (i.e. as the fishery builds up and expands).

OBSERVERS

Observers on board vessels collect information on length frequency, maturity and sex ratio for all species at differing fishing areas and depths. This includes length frequencies of the grading categories, where commercial grading takes place (i.e. number of tails per pound). This information can be used subsequentially to determine major size frequency changes in the fishery, especially in regions where juveniles are captured.

Length frequency information is required for estimation of total mortality. In the Gulf of Papua the continuous recruitment in to the fishery prevents the use of length converted catch curves to estimate total mortality. However, Gwyther (1982), used Berry's (1970 - cited Gwyther 1982) method where annual length frequencies are converted to age (or relative age from recruitment) and the average catch rate is used to derive a catch curve. This requires knowledge of sex ratio's as most penaeids exhibit differential growth curves for males and females.

NURSERY REGION SURVEYS

The 1985 FAO/Australian workshop highlighted the need for identification of nursery regions: 'The protection of juvenile nursery habitat is essential for the continued well being of the shrimp stocks'.

Major nursery locations were identified in PNG by surveying the coastal regions of the Gulf of Papua. Distribution and measures of abundances were recorded using beach seines, and surveys were undertaken throughout the year to determine seasonality. With technological advances in high level vertical colour photography and satelite imagery, delineation of potential nursery grounds can be rapidly acquired in certain areas, especially for those species which use coastal seagrass beds or nursery habitats. In conjuntion with sampling, collection of abiotic factors such as salinity, substrate type, temperature, turbidity etc. should also be recorded, where possible.

Environmental factors affecting the postlarval and juvenile stage in the prawns life history are often crucial for subsequent recruitment to the fishery. Large fluctuations in catches exhibited by penaeid fisheries are often independant of adult stock and attributed to varying environmental factors such as rainfall, reduced salinities, river discharge and associated factors. The need for accuracy in the collection of environmental data is highlighted by Hughes (1969) who found juvenile Penaeus duorarum to respond to salinity changes as low as 1 to 3 ppt.

An important factor involved in the management of nursery grounds is the potential for their alteration by man, especially those which are adjacent to landmasses. Pollution of nursery grounds will become an issue as the populations of islands increase.

Exploitation of juvenile prawns by subsistence and artisanal fisheries has not been an issue in PNG, however where this happens it is important that catch and effort data be collected.

TAGGING

Once the effect of tagging on prawns has been evaluated, tagging is a valuable tool in stock assessment as it provides values for growth analysis and migrational pathways for population interactions.

Growth studies are normally determined from three basic techniques: ageing of hard parts (i.e. otoliths), model progression from size frequency analysis and tagging. Ageing by hard parts is impossible in prawns which shed their entire exoskeleton on moulting. In the Gulf of Papua, Gwyther (1982) found no clear pattern in monthly length frequencies obtained by observers on the commercial fishery. This is attributed to the continuous form of recruitment and extensive migrations undertaken by prawns. Tagging was therefore the only available method with which to obtain growth estimates.

For stock assessment to be valid it is essential to know the population limits, and the degree of intermixing between fishing grounds. Fox (1974) showed the importance of the rate of mixing between stocks for the validity of overall assessment made on a group of stocks together. Many rivers drain into the Gulf of Papua, each having its own characteristics of tidal penetration, freshwater runoff, fringing vegetation, sediment load and bottom substrate. The importance of each of the major rivers was achieved by routine sampling and an intensive tagging program. Results from this demonstrated that an area 100 to 200 kilometers from the main commercial fishery was the most important nursery region, while other closer rivers contributed only to a lesser extent. Results also showed clear intermixing between the main eastern Gulf of Papua fishery and a smaller fishery in the west, thus emphasing the need for one management plan to control the entire fishery.

The tagging program in PNG concentrated on two phases in the life cycle of the banana prawn (P. merguiensis): juveniles in nursery habitats, and adolescents in coastal regions prior to offshore maturation migrations. Both sections required different strategies of capture: in nursery regions, beach seining in mangrove creeks required a net and dinghy with outboard motor. This was relatively cheap compared to sampling adolescents which required a small trawler. Although the latter method produced ten times more recoveries than nursery releases, the recapture rate for nursery releases could be increased if a minimum size at tagging is observed. In the Gulf of Papua tag returns of P. merguiensis of carapace length <17mm (mmCL) were less than 1% although 59%of tagged prawns were <17mmCL. Although prawns of 11mmCL were shown to behave normally in aquaria experiments, prawns of <17mmCL appear unsuitable for tagging (Frusher 1986). Obviously the type of information being sort dictates the location of tagging. Is it essential to know which nursery creek the prawn came from or are you only looking for movement from adolescent to adult migrations?

CONCLUSIONS

While PNG is far from having the ideal management control of their penaeid prawn fishery, experiences on stock assessment in PNG of the Gulf of Papua prawn fishery are considered of value because they indicate methods which can practicably be used small scale prawn fisheries. In particular the following four areas should be considered in monitoring of a penaeid prawn fishery:

i) Logbooks which cover the entire fishery

ii) Observer programs (at least over two years) to collect data on species distribution, length frequency, sex ratio, depth, area and grading categories.

iii) Nursery habitat identification and monitoring of representative sites to determine environmental factors affecting recruitment and emigration.

iv) A tagging program to generate data on growth and migrations which would demonstrate movement from nursery sites to fishing grounds and between fishing grounds

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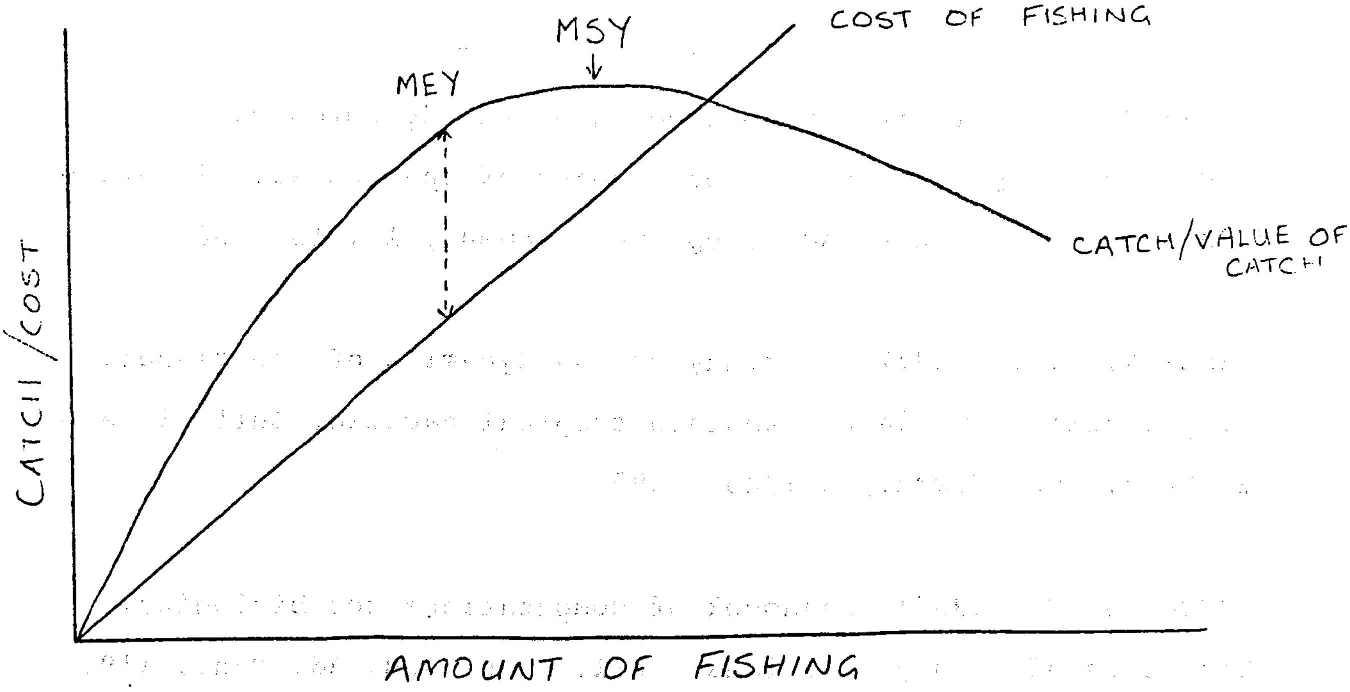
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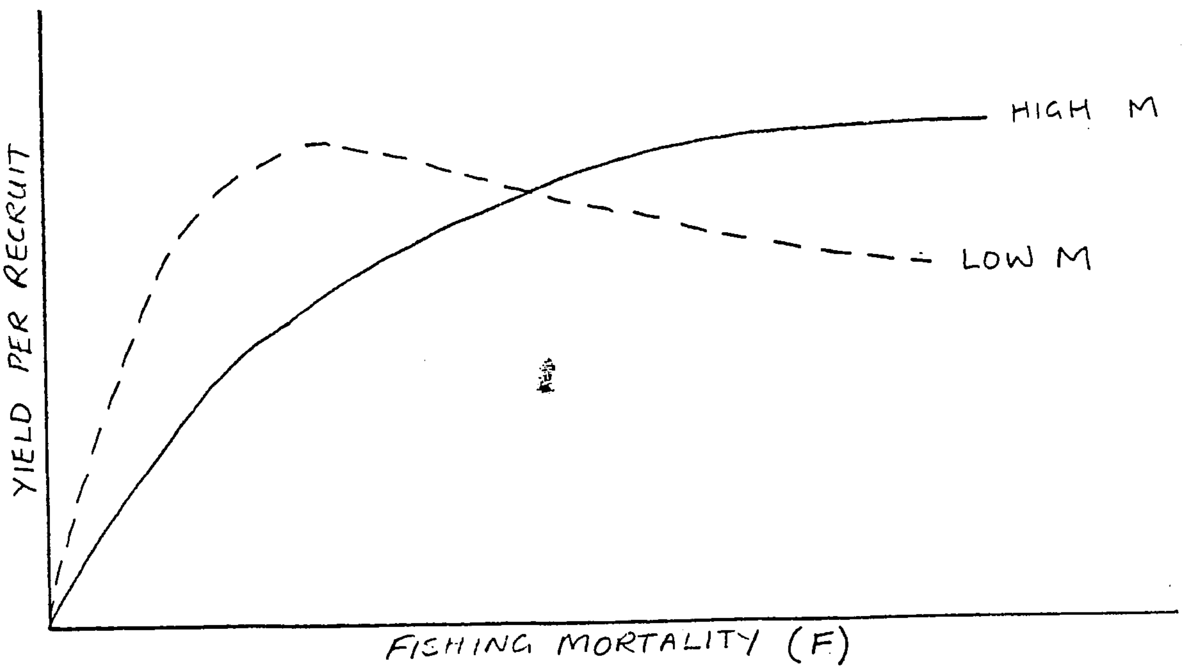
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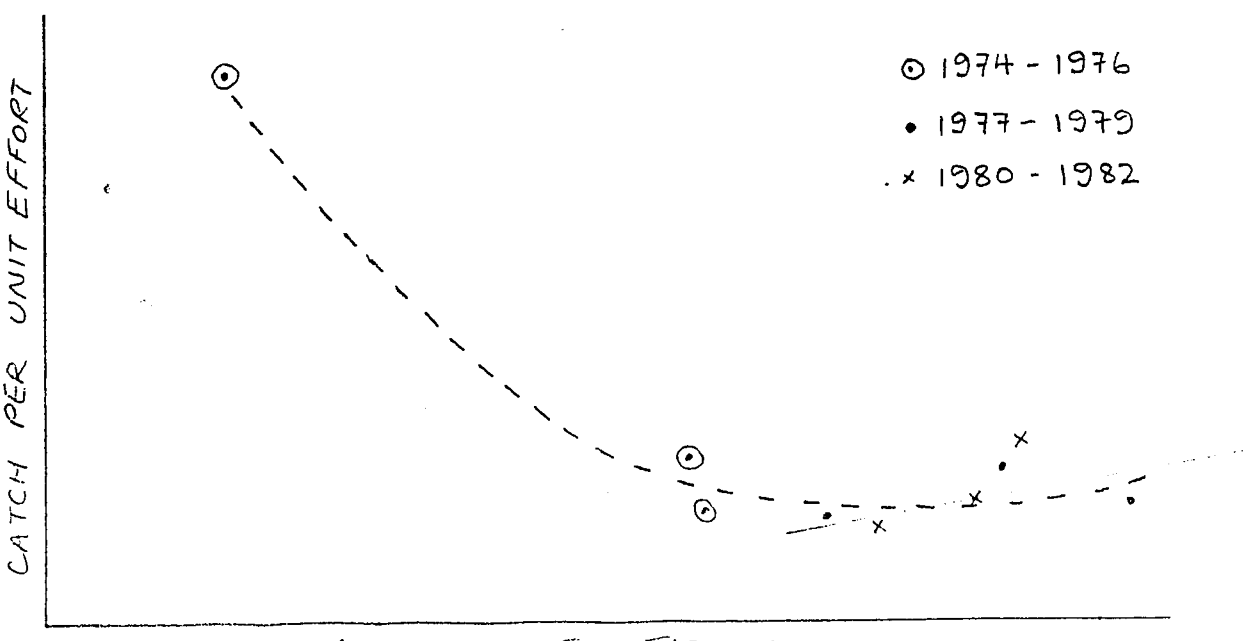
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