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ON

LIVING RESOURCES *of* THE SEAS AROUND INDIA

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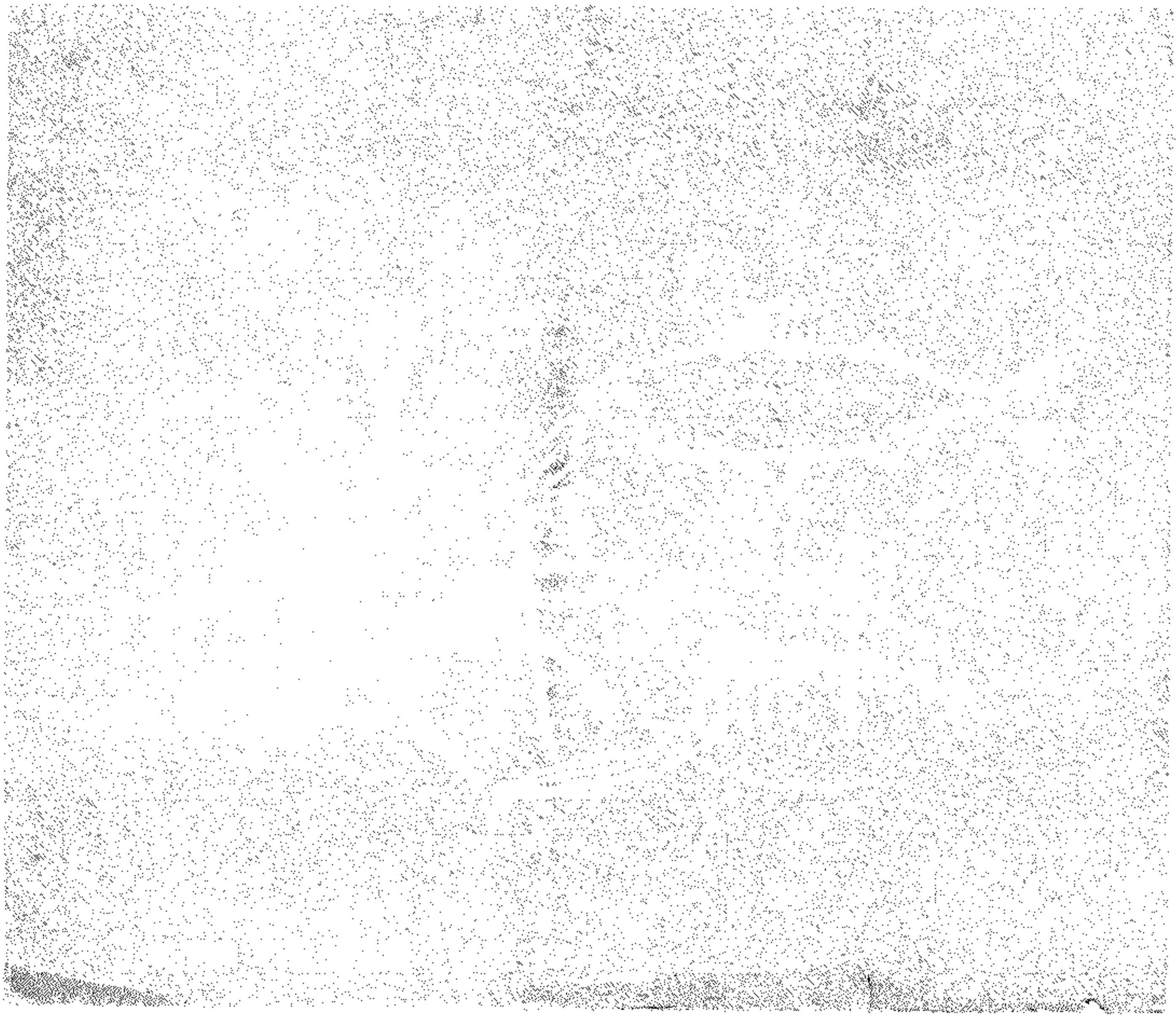

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OPTIMUM SIZES OF FISHING VESSELS FOR EXPLOITATION OF THE NEAR AND DISTANT WATER FISHERIES AROUND THE INDIAN COAST

R. L. ROY CHOUDHURY

Craft Unit, Offshore Fishing Station, Ernakulam

ABSTRACT

Modernisation of fishing operations in the inshore areas around India has progressed appreciably during the last decade and increasing attention is now being given towards the exploitation of the resources in the near and distant waters. Careful planning of larger fishing vessels, which involves considerable investment is an important factor in this development programme. This paper considers the available data on the known and potential resources and outlines a method of analysis by which the suitable vessels for the optimum exploitation of the resources can be determined. The analysis covers the relations between vessel parameters like size range, speed, hold capacity, operational cost, etc., as against catch returns.

INTRODUCTION

FISHING in India is still largely carried out by the traditional non-mechanised vessels in a narrow belt along the 3,000 mile coastline using only the traditional methods and this has imposed limitations on the efforts to increase the production figures. The marine fishing has gained considerable importance during the last ten years due to the rapid growth of the processing industries exporting frozen and canned products, and the rise in the demand for domestic consumption of different varieties of fish. Introduction of small mechanised trawlers and gill netters in the inshore areas during this period were successful in increasing the catches of shrimps and certain varieties of fishes. However, for a sizeable overall increase in production, it is necessary to exploit the possible resources in the areas beyond the inshore limits coupled with more intensive and efficient exploitation of the inshore areas. Oceanographic and exploratory fishing observations support such possibilities and efforts are being made to introduce larger vessels using modern techniques for the effective exploitation of the offshore areas. The economic success of such a programme largely depends on the careful choice of suitable fishing vessels which represents the largest capital investment. The basic problem in this choice, is the selection of size and type of vessels whose returns are most economic in relation to the location and productivity of the ground, type of fishing and related factors. The combination of these factors vary from place to place leading to differences in economic vessel sizes. In a well-established fishery, the choice is easisr since it can be based on a large amount of available experience of a variety of vessels already operating on these grounds. The absence of any such previous experience in the areas around the Indian coast restricts the applicability of this method and requires an analysis of the more basic factors for a proper choice. The cost of production of a ton of fish is proposed as a criterion, for judging the efficiency of a vessel and an analysis is carried out to find out, on the basis of this criterion, the optimum ranges of vessel sizes in relation to particular fishing conditions likely to be met in these areas.

THE PROBLEM

The fishing vessels can be of three major types according to the fishery, *e.g.*, trawler, purse seiner and long liner. The size of a near water purse seiner depends mainly on matching the fish hold capacity to the size of the moderately large fish shoals in the area (Smith, 1960). For distant waters the size will be mainly determined by the range and the weather conditions to be met. Similarly the size of long line vessels are also determined mainly by the range and weather conditions to be met (Kanasashi, 1960). The suitable sizes in these classes of vessels are generally the minimum sizes which meet these specific factors of range and size of catch. They are not included in this study. However, in the case of trawlers, various vessel sizes are possible to meet given requirements of range, catch, etc. Out of these only some sizes ranges show distinct economic advantages, according to combination of factors of productivity of the grounds on the one hand and the earning capacity of the vessels on the other. These economically optimum sizes in this case needs careful consideration and can be determined by computing the economics of a range of sizes of vessels fishing under similar conditions according to the rational approach outlined in this paper.

Certain rational assumptions are necessary to reduce the number of variables for such computational purposes without sacrificing the essential details. It is assumed in this study that the trawlers of different sizes have the technical characteristics as shown in the graphs in Appendix I. These are based on the analysis of the particulars of seventy recently built vessels and the data presented by Benford (1960) and they represent good average trends. The variable factors considered in the estimation of performance are:

(*a*) Cubic number

(*b*) Installed horse power

(*c*) Distance of ground

(*d*) Productivity of ground

(*e*) Catching rate (catch/hour)

(*f*) Fishing depth range

(*g*) Stowage rate and fish hold capacity

(*h*) Capital cost

(*i*) Fuel cost.

JUDGING THE PERFORMANCE

The cost of production per ton of catch (Rs./ton), *i.e.*, minimum landed cost (MLC) is defined by the total yearly costs of operation divided by the total yearly production. The costs are composed of the fuel costs, salaries, overheads, cost of ice (where carried) and 16% of the capital cost representing depreciation, insurance, interest on capital, maintenance and port dues. The MLC thus derived is used to judge the economic performance of the vessel sizes. The assumptions in the analysis of operations are given in Appendix II. The details of the derivation of various coefficients used in the computations are the subject-matter of another investigation (Roy Choudhury, unpublished) and are not included here.

The cubic number is chosen to represent the size of the vessel. [A curve of length cubic number is given in Appendix I (Fig. 6) from where the length can be determined.] The major steps in the computation are as follows:

1. An arbitrary range of sizes represented by cubic number are chosen and the installed power, displacement, length, fish hold capacity, number of crew, capital costs for each size are determined from the curves in Appendix I. (Fig. 6).

2. The speed is determined from curves in reference 3, which are derived on the basis of Doust minimum line (Doust, 1963) and data presented by Ridgely Nevitt (1967). The time for the journey to and from the ground can thus be calculated.

3. The installed power is taken as the "under way" power and the trawling b.h.p. is found by multiplying this power by a factor (Appendix I) (Fig. 7).

4. The appropriate aux. power "under way" and "on ground" obtained from available data are added.

5. The catch rate factor is determined from the figure (Appendix I) and the actual catch/day is found by multiplying productivity of the ground (*i.e.*, corresponding to catch rate factor of unity) by this factor.

6. The time on ground is found by considering the fish hold capacity, the catch/day and the stowage rate. The port time is taken as 3 days per voyage for Cases I and II and 2 days for Case III (Ref. Appendix II).

7. Total number of trips/year is determined by dividing 330 operational days in a year by the voyage duration.

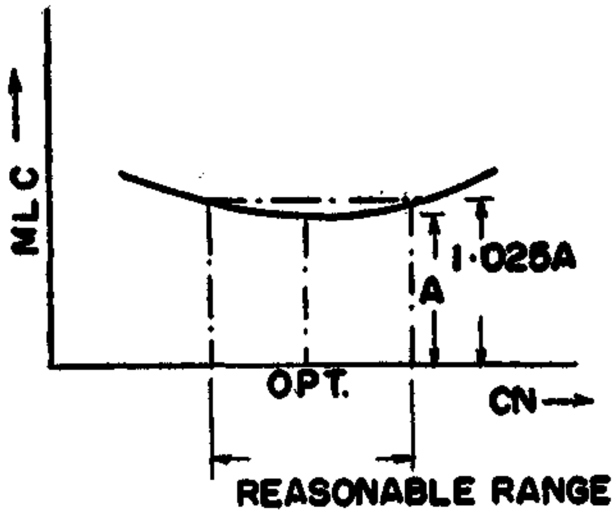

FIG. 1. Determination of optimum reasonable size (CN).

8. Ice, where carried, is 110% of the fish catch/trip.

9. The minimum landed cost (MLC) is plotted against the cubic number and the minimum value indicates the optimum vessel (Fig. 1). The intersection of the curve with a line 2·5% above the optimum gives the limits of reasonable range of sizes. This reasonable range, chosen arbitrarily, is defined as the range having MLC within 2·5% of the optimum MLC (Benford, 1967).

RESULTS AND DISCUSSION

Case I

Figure 3 summarises the results of optimum size analysis for Case I, *i.e.*, vessels fishing around 280 m depth. The standard vessel has particulars obtained from Fig. 6 and operates at a distance 1,200 nautical miles from base. The items affecting performance are varied only one at a time from the standard condition. The nature of variation from standard, its effect on the optimum size of vessel, the reasonable size range for each condition and the MLC corresponding to the optimum size in each case are shown in Table I. The following observations are made:

1. It is seen that the optimum size is most sensitive to productivity of ground (Conditions 6 and 7). Variations in the other items have little effect on the optimum size.

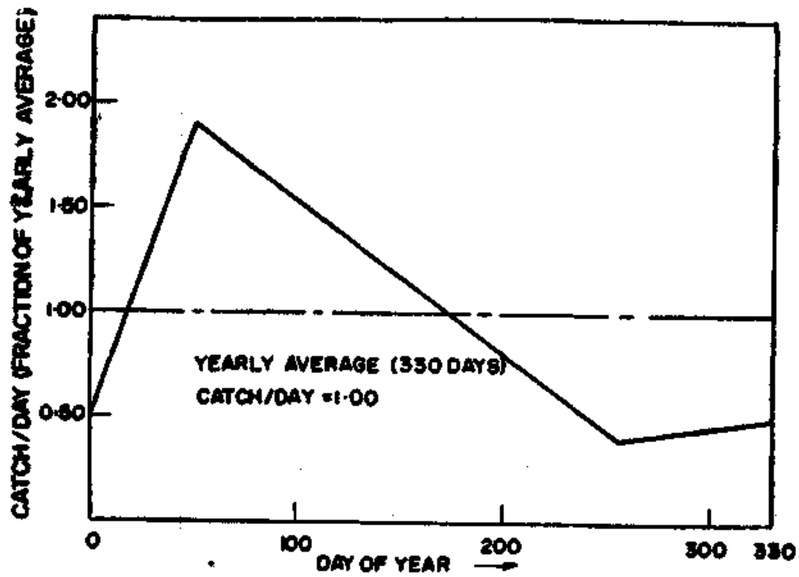

FIG. 2. Assumed variation of catch/day as a fraction of yearly average.

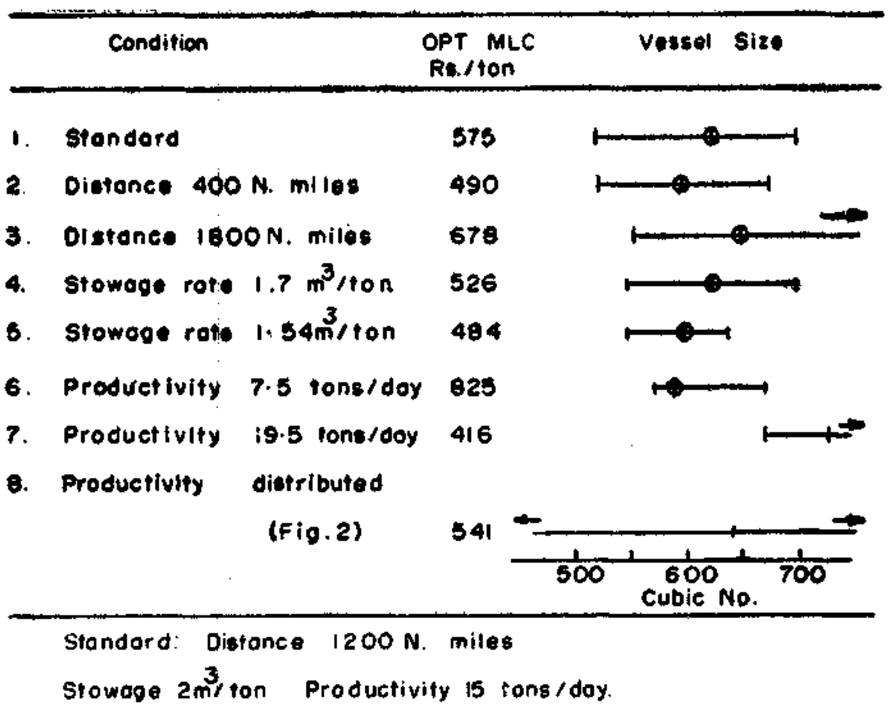

FIG. 3. Sensitivity of optimum size of vessel and the reasonable size range to the variations in the parameters affecting economic efficiency (Case I).

The width of the band of reasonable sizes, however, show certain interesting features. For longer distance (Condition 3) the reasonable range extends far beyond the optimum size. While for low productivity (Condition 6) the range extends far below the optimum size. The arbitrarily chosen variations in productivity during the season (Condition 8, the distribution of productivity being shown in Fig. 2) increases the width of the reasonable size range evenly distributed on both sides of the optimum.

2. The examination of Fig. 3 shows that vessels in the size range having cubic numbers (CN) between 600 and 650 (*i.e.*, lengths b.p. 42 m to 44 m) are reasonable to meet the requirements of the conditions for fishing in Case I, *i.e.*, 280 m depth except when the productivity is exceptionally low or the distances are beyond 1,800 nautical miles or below 800 nautical miles.

3. Though most of the factors do not appreciably change the size of the optimum vessel, they do affect the performance and MLC of the whole range appreciably. A vessel makes profit only when the MLC exceeds the market price of the catch. If the average market price is taken as Rs. 600/ton of catch (including all varieties caught), it is clear that operations beyond 1,200 miles or productivity below the chosen standard value will not show any profit.

Case II

The results are summarised in Fig. 4. The following observations are made.

1. The optimum size is very sensitive to the distance and the productivity of ground. (Conditions 2, 3, 4).

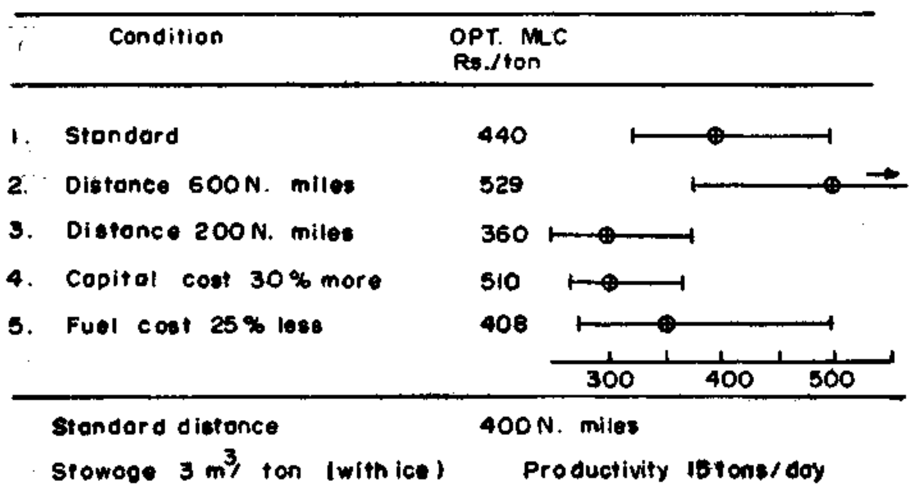

FIG. 4. Sensitivity of optimum size of vessel and the reasonable size range to the variations in the parameters affecting economic efficiency (Case II).

2. The increase in capital cost or decrease in fuel cost (Conditions 5, 6) do not have much influence on the optimum size.

3. Examination of the Table shows that vessels in the size range of cubic numbers 300 to 350 (length b.p. 29 to 31 m) are most suitable for operation in Case II, *i.e.*, 180 m depth provided the grounds are between 200 to 400 nautical miles away.

Case III

The results are summarised in Fig. 5. The following observations are made:

1. Productivity of ground and capital cost influences the optimum size more than the distance of ground. This is rather different from the previous two cases.

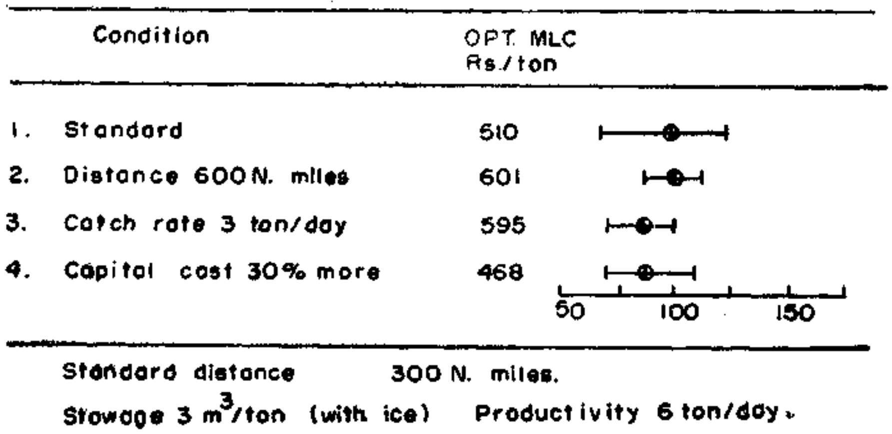

FIG. 5. Sensitivity of optimum size of vessel and the reasonable size range to the variations in the parameters affecting economic efficiency (Case III).

2. The range of sizes with cubic numbers 90 to 100 seem to be most suitable for operation in Case III, *i.e.*, depth of 80 meters and distance of ground below 600 nautical miles.

The above three cases were chosen with some bearing on the potential trawl fishing grounds around the Indian coast. The standard condition of Case III corresponds to the grounds being exploited along the north-west coast, certain areas along south-west coast and the northern parts of the east coast in depth ranges 55 to 130 meters. As indicated above vessels around b.p. 18 m (CN 90 to 100) are best suited for these regions.

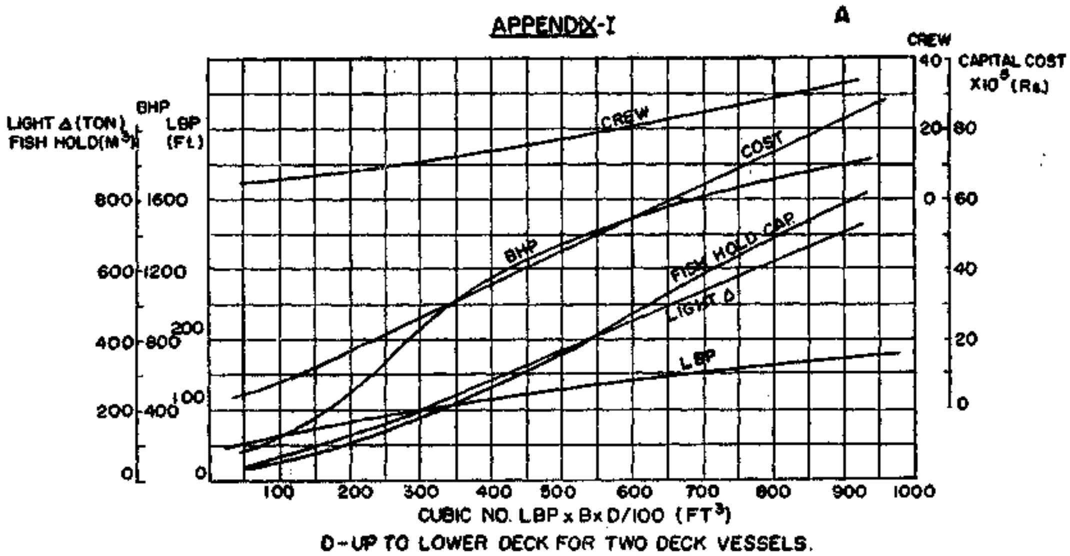

FIG. 6. Relationship of trawler parameters to cubic number.

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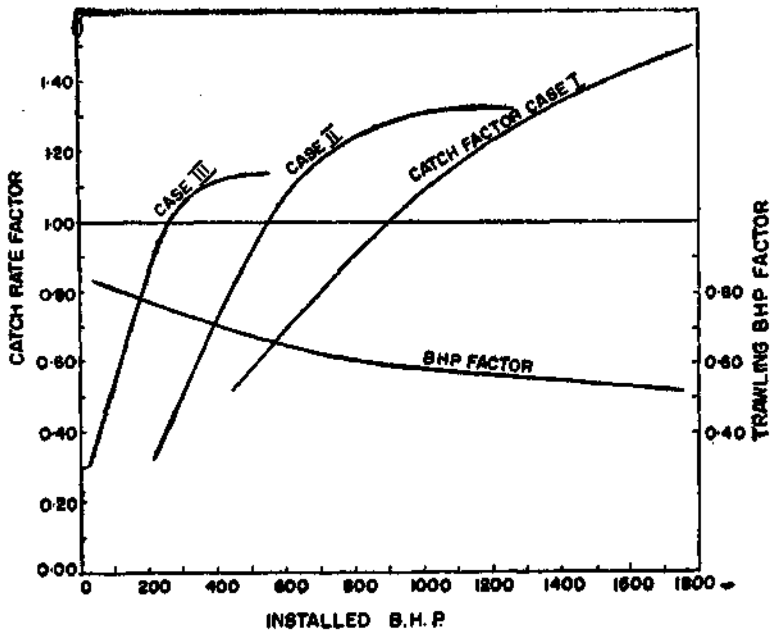

FIG. 7. Variation of power utilisation factors in trawling with installed B.H.P. and variation of catching rates with installed B.H.P. for 3 different depth ranges (Cases I, II, III).

The standard condition of Case II corresponds to the grounds being exploited by a few of the larger vessels off the southern tip of India, and specially the grounds along the northern parts of east coast and 30 to 31 m L b.p. vessels are suitable for these areas fishing in 130 to 180 meters.

The standard condition in Case 1 corresponds to the potential areas of exploratory fishing. Range of 1,200 miles from a base port covers the areas in 370 meter depth contour along the coast. Vessels 40 to 42 m L b.p. are suitable for these areas.

CONCLUSIONS

The optimum size of vessels depend more on the two factors, *e.g.*, the distance and the productivity of grounds. The maximum power that can be utilised for a particular depth of trawling restricts the upper limit of size reasonable vessel. For the existing and potential trawling grounds in India, vessel sizes 18 m, 30 m and 40 m., length (between perpendiculars) appear most suitable. The production costs per ton of catch are likely to be between Rs. 400 and 600 and this is within reasonable limits in relation to market value.

The investigations show the restrictions on the utilistion of power according to depth of ground and the importance of reliable information on the relations between catch/hour and installed power for computing the economic returns. To gain such information, exploratory fishing programmes should include accurate measurements of speed, power and other records of the vessel performance simultaneously with fishing operations. This will enable determination of the factors connecting the productivity of the ground with the productivity of vessel in a more definite manner.

Acknowledgements

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APPENDIX II

Analysis of Vessel Operation

Three main cases are considered:

I. Vessels trawling in depth around 380 m. Whole catch is frozen and stored. Standard stowage 2 m^3/ton of catch. Basic distance of ground 1,200 miles and standard productivity 15 tons/day.

II. Vessels trawling in depth around 180 m. Whole catch is stored in ice 1 : 1 ratio. Standard stowage 3 m^3/ton of catch and productivity 15 tons/day.

III. Vessels trawling in depth around 80 m. Whole catch is stored in ice 1 : 1 ratio. Standard stowage 3 m^3/ton of catch and productivity 6 tons/day.

The main assumptions are:

(1) The vessel travels a fixed distance (the given distance of ground) either way to and from the ground. The full installed B.H.P. is used in propulsion and the service speed is constant throughout.

(2) During the time spent on ground, the vessel uses only the reduced "trawling B.H.P." output. The occasional higher power used in hauling the net, searching for fish, etc., are more or less balanced by the much reduced power output during the idle periods on the ground.

(3) The basic auxiliary power representing the lighting, general service is constant during the whole voyage. Only in Case I additional auxilliary power is used for freezing while the vessel is in ground and this is constant over the time spent on ground.

(4) The vessel returns only after the hold is full. Whole catch is stowed in the same manner. No part of catch is thrown away.

(5) For each day spent on ground, on an average eleven hours are used in actual trawling. The rest represents time spent in hauling and shooting gear, repairs, change of ground, crew rest and bad weather in ground.

(6) The productivity of the ground (at the given figures) is constant throughout the season. In Case I, one condition of seasonal variation of productivity is studied.

(7) The vessel is operational for 330 days in a year. The rest of the time is used on annual repair and maintenance.

(8) For each depth range the utilisation of power in trawling increases rapidly upto a certain power and then drops off. The catch/installed B.H.P. increases rapidly upto this critical B.H.P. for the particular depth, after which, the figure rapidly levels off. The catch rate factor for this somewhat critical power is taken as 1·00 and the catch rates for other powers are derived from this with the help of a catch rate factor shown in Appendix I. The ratio of trawling B.H.P. to the installed B.H.P. decreases with increasing power and this follows the relationships given in Appendix I.

(9) The standard productivity of the ground is taken as 15 tons/day corresponding to the catch rate factor of 1·00. However in Case III, the standard productivity is 6 tons.