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Surface and Subsurface Fisheries for Young and Immature Yellowfin Tuna (T. albacares) Around Ceylon

By

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Introduction

THE anxiety caused by the production trends and the present status of the Yellowfin tuna stocks in the three Oceans, has directed attention on the feasibility of exploiting the young and immature Yellowfin tunas by surface fisheries and the potential of such surface and subsurface resources as against that of the deep swimming mature tunas which has been intensively exploited up to now.

In the Indian Ocean, there appears to be a concentration of young and immatureYellowfin tuna around the island of Ceylon and about four thousand metric tons of it is caught annually by Ceylon. However, it will be evident that, at present, no fishing effort is directed specifically on this variety. In these waters exploitation for the deep swimming older fish by longline is relatively insignificant and any impact of the surface and subsurface fishery on the deep swimming stocks is not clearly evident. Until about 1967 mechanised boats (3– ton class) directed their effort on bloodfish, mainly through trolling gear and to some extent through pole and line and longline gear. The effort through the last two methods was limited by live and dead bait shortage, manaul hauling and seasonal occurrence of large size tunas within the fishing range of this class of vessels.

Even though drift netting for blood fish was commenced by some mechanised boat fishermen from the " South " (operating in the " East "), N.West"", " N.N.West " and " N.N. East " as far back as 1965, their success was impaired by severe public objection to this method of fishing for the large pelagic fishes, limitation of the operation to the inshore waters and the smallness of the set (10–15 pieces per set). However, in 1967, 11–ton class of vessels were introduced and they took up to drift net fibing in the off-shore range round the island and by 1968, drift net fishing disputes died down and drift net fishing became popular even among the 3– ton class of vessels (Table I). Gradually the size of each set of nets also increased to 30–40 pieces and the with the confidence established by the 11–ton class, the 3– ton class of drift netters ventured into the offshore range. Thus resulting in a sharp increase in the production of surface and subsurface swimming Yellowfin and Skipjack tunas.

Source of Material and Statistical Analyses

For sampling and convenience of analysis, the coastline of Ceylon was divided into ten areas (Fig. 1). The boundaries between area were based on preliminary findings on the catch distribution pattern. Each area has an inshore and offshore range and as defined by the Author (1965) the inshore waters extends up to 15 miles from the beach and the offshore range is between 15 and 100 miles from the beach. The offshore range covered by the vessels, presently, is probably between 15 and 35 miles.

Details of the sampling techniques and statistical methods applied were as already described (Sivasubramanium 1970). The data on the distribution of fishing vessels of the 3– ton class and 11–ton class were obtained from the Statistical Division of the Department of Fisheries and the Ceylon

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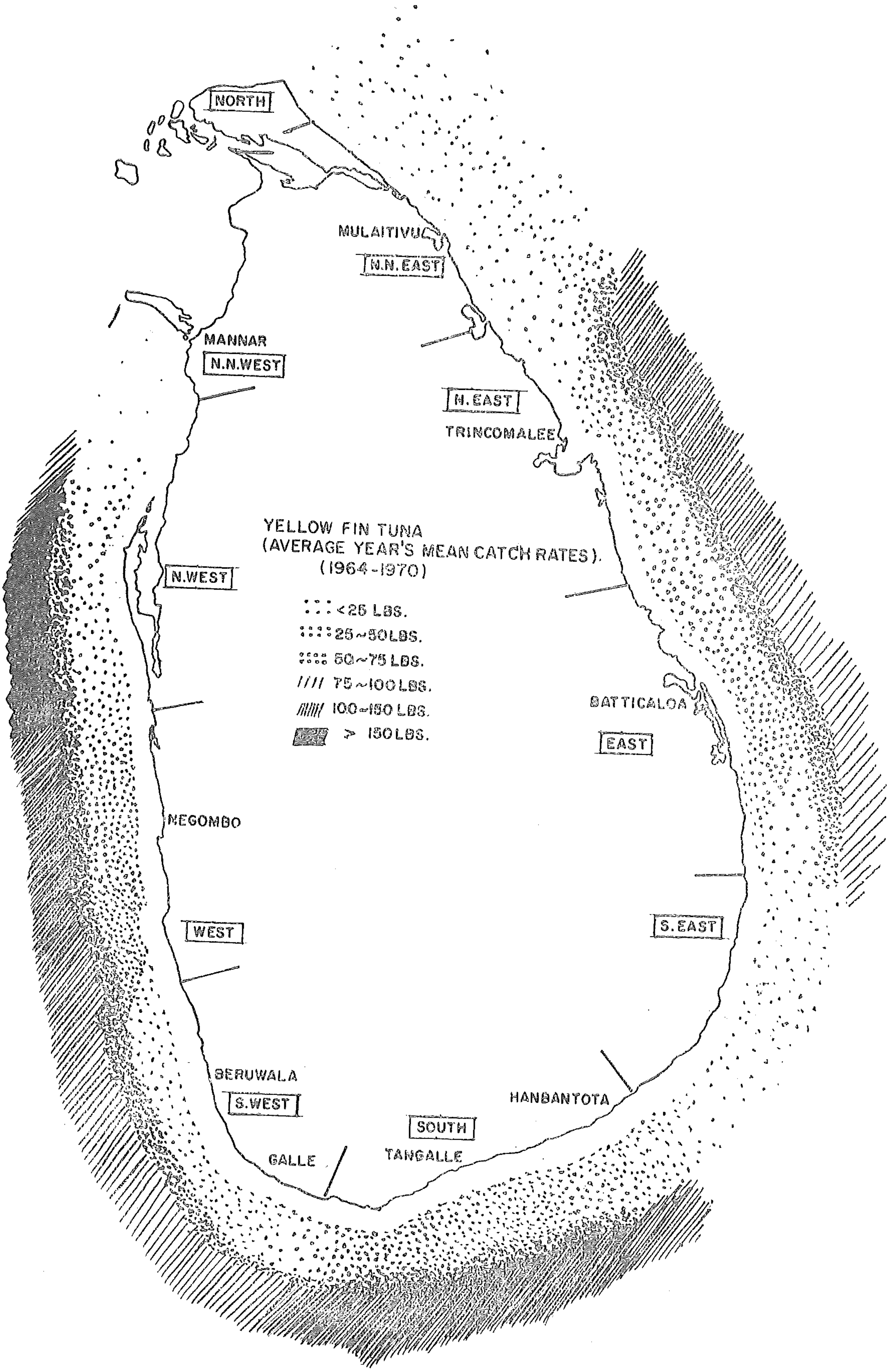

Fig. 1. The densities of distibution of young and immature yellowfin tuna in the different areas of inshore and off-shore ranges.

TABLE I

Percentage distribution of effort directed through various gears used for exploitation of bloodfish in Ceylon waters.

Area	Period	Troll	Driftnet	Longline	Pole & Line	Beach Seine
N. West	1963—67	60,2	20,1	0	0	19,7
	1968—70	15,6	82,4	0	0	2.00
West ..	1963—67	68,4	11,3	20,3	0	0
	68—70	16,2	76,6	8,2	0	0
S. West	63—67	70,3	2,1	6,1	21,5	0
	68—70	35,0	45,9	10	9,1	0
South	63—67	61,5	0,5	8,3	29,7	0
	68—70	24,4	70,6	0,5	4,5	0
East N. East	63—67	40,5	48,0	10,5	6,7	0,3
	68—70	18,0	66,0	6	9,9	0,1
N.N. East	63—67	13,0	83,0	4,0	0	0
	68—70	5,0	95,0	0	0	0
N. N. West	63—67	81,2	0	0	0	16,3
	68—70	11,0	87,0	0	0	1,1

Fisheries Corporation, respectively. The distribution of fishing effort (number of fishing operations) was estimated by utilising the sampling for the fishing effort through different gears used for capturing bloodfish and the data on the distribution of the vessels. In these waters there is a mixed fishery for the bloodfish group and the fishing effort is seldom directed on any one species of this group, except in the case of pole and line fishery where the effort is directed on Skipjack schools. Hence the fishing effort in this instance is not the effective effort on Yellowfin tuna only but the effort on the bloodfish group.

As the fisheries statistics available for the 3– ton class of vessels shows production of the whole bloodfish group, the annual production of Yellowfin tuna was estimated by two methods. (1) Multiplying the catch per unit effort for each class of vessels and type of fishing gear, obtained by sampling, by the estimated effort for each of the above stratum and (2) Applying the percentage composition of the Yellowfin tuna for each year, on the bloodfish procuction for the corresponding years. The estimation by both methods were close to each other for the years 1965 to 1970 and hence the values estimated for the preceding years were rejected. In the case of the 11–ton class of vessels, the effort and Yellowfin catch statistics have been maintained accurately by the Ceylon Fisheries Corporation.

The catch per operation or per fishing trip not exceeding twenty four hours has been taken as the catch rate for each class of vessel operating a particular gear and these values have been taken to be directly proportional to the densities of distribution. In order to evaluate production trends and apparent abundance in relation to the fishing effort applied, the effort by the 3– ton and 11–ton class of vessels were standardised at the level of the 11–ton class, by estimating efficiency factors. The efficiency factors are ratios of yearly catch per fishing day or fishing trip of the 3– ton class operating a popular gear to that of the 11–ton class (Table 2).

TABLE 2

Yearly mean catch rates of Yellowfin tuna and efficiency factors for the different classes

Year	Mean catch			Efficiency Factors	
	11-ton Drift net	3-ton Drift net	3-ton Troll	3-ton Drift net	3-ton Troll
1965	—	—	16,7	—	—
1966	—	—	18,6	—	—
1967	98,4	41,8	16,7	0,42	0,17
1968	102,8	56,8	16,4	0,54	0,16
1969	144,6	51,8	24,5	0,36	0,17
1970	140,9	52,1	25,3	0,36	0,18

Mixed Fishery

There is a mixed fishery for four varieties of the bloodfish group in the waters around Ceylon, and the degree of mixing in relation to size groups had been discussed elsewhere by the author (1968, 1970).

Analysis of percentage composition of the catches by the two main classes of fishing boats, gears and by area are given in Table 3.

TABLE 3

Percentage composition of bloodfish catches according to classes

Area	Yellowfin			Skipjack			Mackerel Tuna			Frigate Mackerel		
	11 Ton Drift net	3 Ton Drift net	3 Ton Drift	11 Ton Drift net	3 Ton Drift net	3 Ton Troll	11 Ton Drift net	3 Ton Drift net	3 Ton Troll	11 Ton Drift net	3 Ton Drift net	3 Ton Troll
N. N. West	26·3	—	—	47·2	—	—	26·3	—	—	0	—	—
N. West	64·0	36·8	—	31·4	62·1	—	3·3	0·8	—	1·1	0·2	—
West	23·6	19·5	28·1	65·9	62·7	12·7	8·2	15·4	47·9	2·1	2·2	11·1
S. West	21·7	32·4	7·0	61·2	34·8	21·8	5·2	19·1	44·6	11·7	13·6	26·4
South	24·7	23·0	18·9	54·1	51·3	19·3	3·2	4·8	16·5	17·8	20·7	45·1
East	30·3	22·2	4·6	51·0	61·9	55·2	15·5	11·2	18·2	3·1	4·6	21·8
N. East	32·5	30·1	15′4	34′0	40′5	47·6	13·5	17·0	21·8	19·8	12·4	15·2

In the areas of the inshore waters the difference in the percentage contribution by Yellowfin to bloodfish production are the same as given earlier by the Author (1967) (Table 3). In the areas of the offshore waters the pattern roughly fits that of the inshore with few noteworthy features. In the North West the percentage of Yellowfin in the bloodfish catches is very high (64%) and in fact it is only in this area, Yellowfin is ahead of Skipjack in production and this value is smallest in the offshore waters of the " South West ".

The proportion of the different bloodfish varieties in the catches varies not only with the distance from the shore but also according to the depth or swimming layers. Table 4 shows the percentage composition by different gears which are effective at different swimming layers.

TABLE 7

Percentage composition of bloodfish catches according to gears effective in different swimming layers

Gear or Effective Swimming layers	Bigeye Tuna	Yellowfin Tuna	Skip-Jack	M. Tuna	F. Mackeral
Surface					
Troll ..	0	12·6	27·3	31·2	28·9
Pole & Line ..	0	2·5	87·6	4·4	5·4
Subsurface					
11 T Drift net ..	0	22·8	54·2	7·0	15·7
3½ T Drift net ..		28·2	57·7	7·7	6·3
Deep Swimming					
Longline	28·1	71·2	0·7	0	0

Size Composition

Yellowfin tuna in commercial catches range from 20–145 cm. As in the case of Mackerel tuna (Sivasubramanium 1970) there are difference by area. The heavy entry of young Yellowfin of age group 0 is in the areas "South west " and " East " and that in the " South West " is the highest forming nearly 35% of the total catch from the area. Immature Yellowfin of age group I contribute 60 to 95% of the production depending on the areas (Fig. 2). The age groups II, III, IV and V are

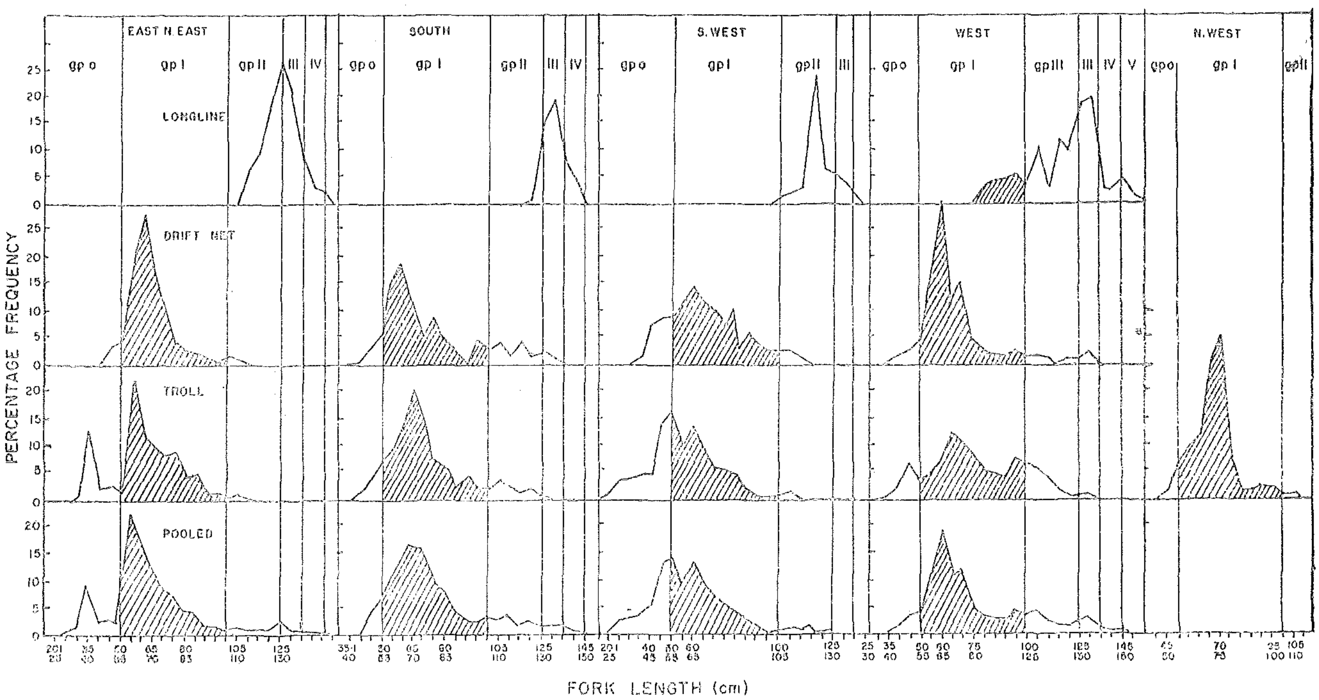

Fig. 2—Length frequency distribution by areas and by gear, for 1969/70

relatively less partly because effort through tuna longline is relatively very small. Eventhough group I dominates in areas, there are difference in the modal length groups. In the inshore waters, the modal length group shifts from 50–55 cm in the South West to 55–60 cm. in the South and East and 65–70 cm in the West. In the offshore areas the modal lengths are the same in all areas except in the "N-West " where it is at 70–75 cm.

It is conjectured that young Yellowfin of age group 0 move into the waters around Ceylon, appearing mainly in the surface fishery. The immature age group I may also appear in the surface catches but it seem to be concentrated in the subsurface layer and continue to support the drift net fishery until the end of age group II when it shifts to the deep swimming layer (50–150 m.) and become available only to the longline fishery (Fig 3.) The length frequency distribution of the Yellwfin in the surface and subsurface waters over the last seven years(Fig. 4) indicate a shift in the modal length group between 65–70 acm and 70–75 cm during the period 1964 to 1967 and a slightly lower modal lengths 55–60 cm and 60–65 cm ranges in the years following it. That of the longline catches range between 120–130 cm. though no clear cut changes were noticed over the years. Considering the fact that 6″ stretched mesh is the maximum perimeter of the Drift nets used on blood-fish in Ceylon waters, the extension of the net twines and the contraction of the fish body during enmeshing and that the circumferance just behind the operculum would be the minimum girth for efficient enmeshing, it is estimated that the efficiency of the drift nets in use would decline for the Yellowfin tunas above 60 cm

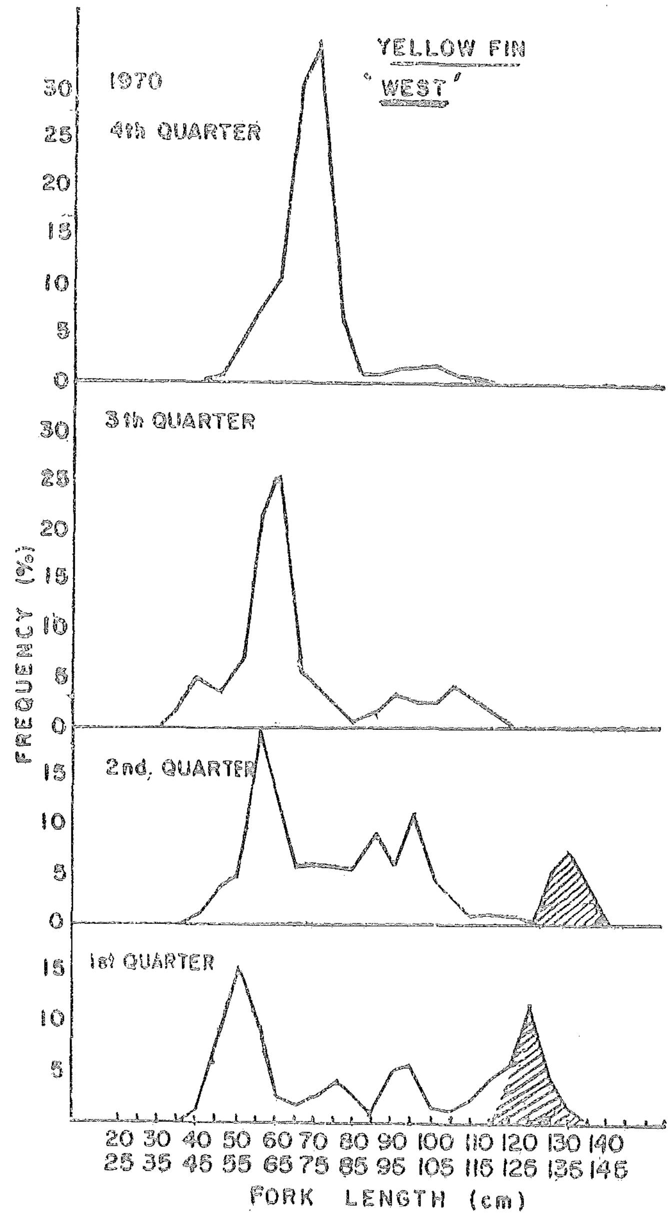

Fig. 4—Length frequncy distribution of yellowfin catches of the west coast, for the four quarters of 1970.

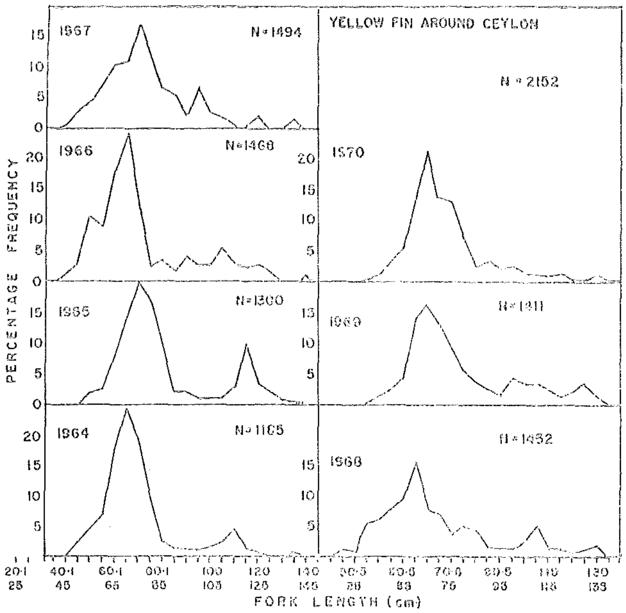

Fig. 4.—Annual variations in the length frequency distribution of yellowfin around Ceylon.

in fork length. Further, in almost all cases the set of drift nets for bloodfish group is made up of a range of mesh size (4″—6″) and it is also observed that the average mesh size in a set was close to 5″ at the begining (1967/68) and close to 6″ at present (1969/70). Therefore the large scale adoption of drift nets towards the latter half of 1967 and the gradual shift since then,in the average mesh size have to be given due consideration in determining the causes of the yearly shift within the group I length mode.

The trolling line is less selective as far as the Yellowfin at or near the surface are concerned. Whereas the Drift nets are highly selective but the mesh size of the nets used on the mixed resources of bloodfish have shown to be selective of relatively larger sizes of the smaller members like F. Mackeral (1968) and Mackeral Tuna (1970) and relatively smaller sizes of the larger fish like the Yellowfin compared to those of the trolling line catches.

In practically all cases it will be observed that the Yellowfin is enmeshed by the pre-opercular part of the body, quite often by the snout. It is expected that a considerable quantity of enmeshed Yellowfin would drop off the net unless entangled.

It is therefore, suggested that an increase in mesh size beyond the present 6″ level would improve the efficiency of this gear for Yellowfin tuna but not for the smaller members of the bloodfish group.

Density of Distribution

Considering the average year's (1964–1970) fishing condition on the basis of the two classes of vessels using gear exploiting the surface and subsurface Yellowfin in the different areas of the inshore and offshore ranges, a density of distribution pattern is projected (Fig. 1). It is conjectured that concentration of these near surface Yellowfin occurs at temperature fronts around the island and very probably, the 28° C isothermal line plays a vital role in determining the boundary of such Yellowfin concentration. Generally such a concentration belt would in the offshore waters as the density of distribution is higher in the offshore range than in the inshore (Fig. 1). However, due to various oceano graphic changes chiefly due to monsoonal effects, the position of concentration may be disrupted or shifted beyond the present fishery range or into some area of the inshore waters, resulting in the seasonal changes in their availability in the different areas of the inshore and adjacent offshore ranges.

It is clearly evident from the densities of distribution that areas on the Western side of Ceylon (Arabian Sea) are richer in Yellowfin tuna than the corresponding areas on the Eastern side (Bay of Bengal). On the Western side the " N. West " area has continually (1967–1970) shown the highest density of distribution (annual mean catch rates and average year's catch rates in figures 5). It

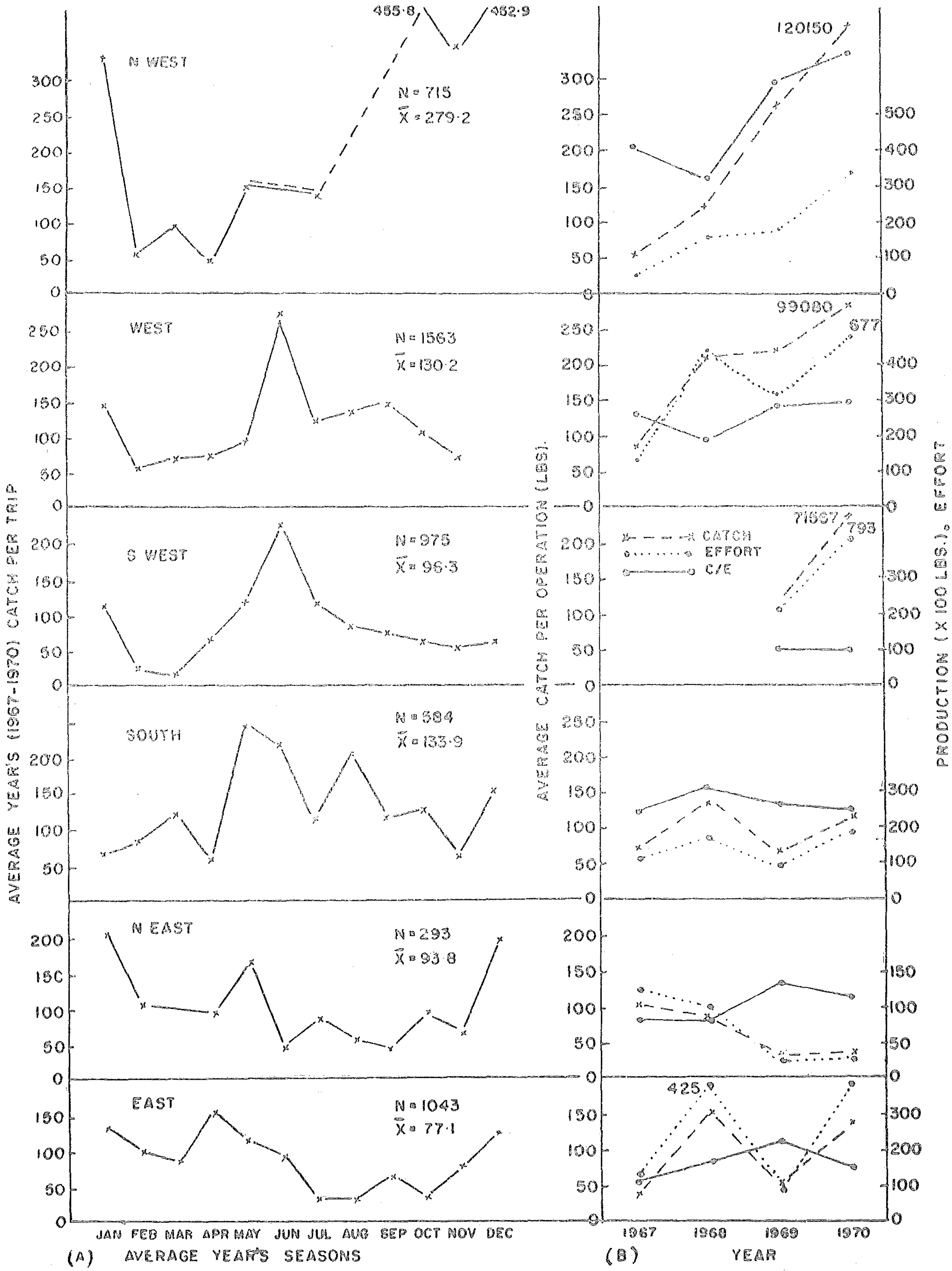

Fig. 5. (A) Seasonal change in the 11-ton drift-net catch rates of yellowfin according to area for the average year (1965-1970).

(B) Annual variation in total catch, effort and catch per unit effort of the 11-Ton class for yellowfins.

gradually declines to the " S. West " and increases again the the " South " . In the inshore waters of the " S. East " fishing has been very sporadic and the results have been poor for Yellowfin tuna. But it is observed that oriental bonito (Sarda orientalis) and dog tooth tuna (Gymnosarda sp.) are frequently met with among the basses in this area. There is no fishery in the offshore range of this area too. The density pattern shows a slight increase from the " East " to " N. East " and then declines again in the " N.N.East " . In the " North " the density of distribution is almost zero and in the " N.N.West " too it is negligibly low. The inshore waters of the S.East"" and " N.N.East " and the inshore as well as the offshore waters of the " North " and " N.N.West " are very shallow.

Seasonal Changes in the Occurrences

In the inshore waters trolling line fishery for Yellowfin tuna yields noticable catch during the tail end of the south west monsoon and also during the North east monsoon. The catches are predominantly young Yellowfin making their first entry to the fishery, particularly in the South West and East coast areas. Except for these, the inshore surface and subsurface yellowfin tuna fishery is sporadic. The pattern of seasonal changes in the drift net catches by the 11-ton and $3\frac{1}{2}$-ton classes are similar though at different levels (Fig. 5 A). In the " South ", " S. West " and " West " areas the peak season appears to be during the South West monsoon as in the cases of the tuna like forms (Sivasubramanium 1968). Another small peak is observed in these areas during the North East monsoon too. Though the three areas show somewhat similar mean catch rates during the peak season, the " S. West " shows relatively low catch rate during the other months and thus gives it a relatively poor annual mean catch rate. The South West monsoonal weather is very severe in the "N.West " and hence fishing during this season is irregular. During the North East monsoon, the catch rates are the best for this area. In the East, the catches are good during the North East monsoon and the intermonsoon period following it, but relatively poor during the South West monsoon. Theoritically there appears to be a shift in the peak season, from the East to the South, South West, West and North West. It is perhaps a little premature to comment on migrating pattern of the species particularly because of the uncertainity of the parent stock.

Abundance

Suitable statistics are not available for evaluation of the trends and present status of the abundance of the Yellowfin stock around Ceylon. However, an attempt was made to estimate the total effort and the catch, as described in an earlier section. The results obtained appears to indicate an improvement in the apparent abundance until 1969. The 1970 level appears to be almost the same as that at 1969 (Fig. 6). On the other hand from the trends as shown by the performance of the

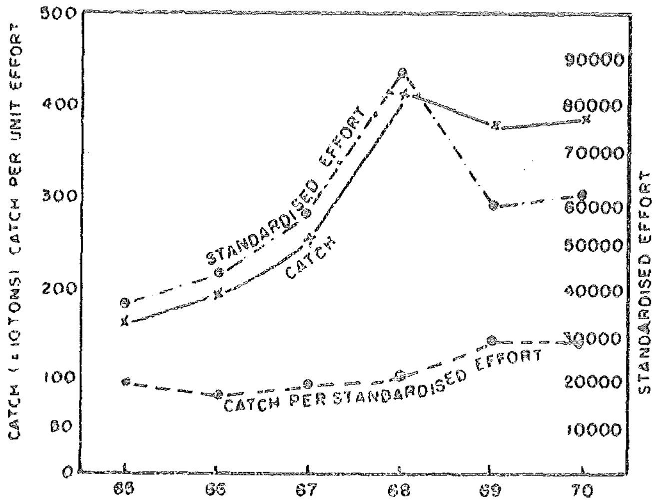

Fig. 6—Annual variation in the estimated yellowfin catch, standardised effort and catch per unit effort.

11–ton class of vessels for which accurate date were available; differences are noticed by area (Fig 5 B). A definite upward trend is seen in the case of the " N. West " and also in the case of the " West " but in other areas the trend indicates a declining status. The mean value for all areas pooled (Table 3) also indicates a leveling off tendency. There has been considerable irregularity in the size of the different sets used by the 11–ton class and there has been increasing report of loss of nets at sea and a decline in the replacements of lost nets. In the case of the 3– ton vessels, there is probably serious error in the estimation of the fishing effort because there is an increase in rate of boats going out of operation due to deterioration in the condition of the boats. The actual fishing effort in the recent past may be much less than the estimated value. Hence the leveling off in the apparent abundance of young and immature Yellowfin tuna in the surface and subsurface layers of the waters around Ceylon over a period of one year has to be viewed with caution. The exploitation of the deep swimming Yellowfin tuna in Ceylon waters by longlining is not very significant but will be taken up for consideration when dealing with the tuna lingline fishery in the Oceanic range around Ceylon.

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