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*Edited by*

Dr. P. P. PILLAI

Shri A. A. JAYAPRAKASH

Dr. N. GOPALAKRISHNA PILLAI

**Central Marine Fisheries Research Institute**

COCHIN - 682 014

Cover Layout : Shri A. A. Jayaprakash

# ASSESSMENT OF OCEANIC TUNA AND ALLIED FISH RESOURCES OF THE INDIAN EXCLUSIVE ECONOMIC ZONE BASED ON EXPLORATORY SURVEYS

D. Sudarsan, T.E.Sivaprakasam,
V.S.. Somvanshi and M.E. John
Fishery Survey of India, Bombay

## INTRODUCTION

High Sea and distant water fishing by large vessels both for demersal and oceanic fish resources is still in its infancy in India. Just as the country took to mechanisation and modern fishing methods very late, in the early fifties, while many developed and developing countries were facing problems of over-fishing, high sea fisheries also has made a late beginning, only in the last few years, when most of the high sea fish stocks including tuna and tuna like fishes are under severe fishing pressure. These stocks which were practically in a virgin state in the early fifties, were heavily exploited by Japan, Korea, and Taiwan and as a result the tuna stocks in the Indian Ocean steadily came down. However, with the declaration of the 200 n.miles exclusive zone, by most of the maritime nations, the foreign fishing fleet had to be withdrawn and as a result the tuna stocks have started showing signs of revival. Recently, the Phillipines and Australia have started large scale exploitation of tuna stocks in their own territories. France, Spain and Italy have become major tuna fishing nations especially along the east and north African cost. However, India remained to be a silent spectator of all these developments. Early efforts made in India during the years 1961-63 (Meena Prayas) and 1968-71 (Pratap) when some of the smaller vessels were converted into long liners for exploratory tuna fishing, have not been successful though it created an awareness of the tuna resources in Indian waters (Eapen, 1964, Joseph, 1972, FAO, 1967, and 1976). It was only with arrival of Japanese aided tuna survey vessel Matsya Sugandhi and training vessel Prashikshani and conversion of Norwegian aided vessel Matsya Harini that the availability of rich tuna resources within the Indian EEZ, almost in virgin state, has been proved beyond doubt. Although the data pertaining to tuna fishing by foreign fishing vessels were available, and detailed compilation of the information of tuna

resources have been made the Indian Fishing Industries were yet to be convinced, as no fishing data by any Indian vessels were available until recently in order to enable them to venture into tuna fishing projects. Results of tuna long lining by Matsya Sugandhi, Matsya Harini and Prashikshani had a major impact on the fishing Industry and as a result a large number of companies have gone for chartering of tuna long line vessels and acquiring their own tuna long line vessels.

The present paper overview the results of survey on marine resources of the Indian EEZ including tuna and allied fish species, their distribution, catch rates, seasonality, assessment of stocks etc. supplemented by the chartered vessels' data. The paper also presents the trends in the tuna fishing and future survey programme of the Fishery Survey of India.

**Results of Exploratory Tuna Long Line Surveys**

With the arrival of the Japanese aided survey vessel Matsya Sugandhi and training vessel Prashikshani during 1980 and also with the arrival of the Japanese Expert, Capt. E. Haruta, valuable data have been obtained on the tuna and allied fish resources of the Indian EEZ and also adjacent northern Indian Ocean. The results of these surveys have already been presented in several publications by the Fishery Survey of India, including Bulletins, Occasional Papers and Atlases (Sivaprakasam and Patil, 1987, Sivaprakasam and Sudarsan, 1988; John et al. 1988; Sudarsan et al., 1988a, b). In view of voluminous nature of the data, only the results of Matsya Sugandhi and Matsya Harini which have followed norms of random sampling with vast coverage of areas and seasons in systematic manner were analysed and results presented.

The vessels have covered a very large area of the Indian EEZ (Table-1). The South west coast has been very extensively surveyed followed by the South east cost. (Fig. 1). The Andaman & Nicobar waters and the equatorial waters have also been considerably sampled while North west coast and North east have only been marginally touched and the data are the inadequate. It will be of interest to know that the two sophisticated tuna long line survey vessels, Yellowfin and Blue Marlin acquired very recently under Japanese aid will be in a position to survey these areas and are expected to yield very interesting results if the data of chartered vessels presented later are any indication.

The average hooking rate in respect of all fish and yellowfin tuna is furnished in Table-2. It is observed that the southwest coast presents the most rosy picture with a very good average hooking rate of 0·6% to 3.76% for tuna, and the yellowfin forms almost entire catch. (Figs. 2&3)

Based on the exploratory survey and comparison of the MSY, hooking rate and area available in similar tropical areas, we have worked the annual potential for various zones while it must be admitted that the data are not adequate except for south west and south east coast. It is seen that the potential of deep sea swimming tuna and tuna like fishes are about 48,000 tonnes of which Yellowfin tuna forms about 27,000 tonnes. The major fishing grounds for Yellowfin tunas are along south west coast of India. It is hoped that based on further observations, the north west coast is likely to become one of the richest grounds for yellowfin tuna for which Fishery Survey of India is going to deploy a new tuna long line survey vessel Blue Marlin.

Table 2 presents the zone-wise catch rates, species composition by number and weight and the seasonal variation of tuna mostly comprising yellowfin tuna. It is observed that in respect of these parameters the south west coast is most productive and promising zone. It will be seen that hooking rate of tunas are the highest (3.76%) along south west coast followed by the equatorial waters and lower east coast. As already stated, data are inadequate for north west and north east coasts. All the zones except south west and lower east coast, require detailed surveys.

The composition of long line catches is mostly comprised of tunas in all the zones. In the south west coast it formed 72.37% while it was 66.1% in the equatorial waters. It was 33.7% in the lower east coast and 40% in the Andaman seas. While bill fishes are more in the lower east coast, sharks are more along the lower east coast and Adaman seas.

By weight, which is very important for marketing purpose, tunas form 76% of the catches along south west coast. The pattern of composition by weight is however more or less similar to that by number.

The seasonality of tunas especially the yellowfin tuna which forms 98-99% among the tunas, present a very interesting picture. While it is generally believed

that the tunas move towards the north during the second half of the year it was observed in the present study that the season extends for 9 months in a year from September to May, with peak season during January to March along south west coast. The hooking rate ranged from 2.5 to 9.6% in this zone. The lower east coast also presents equally interesting picture though the hooking rate and the season are a little limited. The season extends from November to April with the hooking rate ranging from 0.9 to 1.3% with peak period in March. The data for other regions are inadequate and covers only a part of the EEZ.

The species-wise percentage composition within the tunas and bill fishes are given below:

| Species | W.Coast | E. Coast | Andaman Sea | Equatorial Sea | Total |
|---|---|---|---|---|---|
| Tuna | | | | | |
| Yellowfin | 97.7 | 93.6 | 95.7 | 93.5 | 97.2 |
| Big eye | 0.5 | - | 1.5 | 3.9 | 0.6 |
| Skipjack | 1.6 | 6.2 | 2.7 | 2.4 | 2.3 |
| Bill fish | | | | | |
| Marlin | 33.5 | 48.3 | 30.2 | 62.9 | 40.4 |
| Sailfish | 58.6 | 47.5 | 38.1 | 31.5 | 52.7 |
| Sword fish | 7.7 | 4.2 | 31.7 | 5.6 | 6.9 |

It is interesting to see that yellowfin forms the bulk of the tuna catches to the extent of 97% on the whole. The Big eye is available in substantial quantity mainly in equatorial waters as can be seen from the above Table. The skipjack forms only a small percentage ranging from 2 to 6. Among the bill fishes the sail fish forms the bulk followed by marlin while sword fish forms only a smaller percentage.

**The tuna long line charter operations**

The chartering of foreign fishing vessels with the objective of transfer of technology leading to joint ventures, has also increased knowledge of tuna and allied fish resources of the Indian EEZ. Table-3 the results are classified

according to the area of operation namely west coast only, east coast only and and west coasts. The analysis is based on the declared catch and effort data. It is seen that the total hooking rate is quite high and comparable to our own survey results i.e. 5%. The hooking rate of yellowfin tuna was 1.8 while that of skipjack was 2.7 along the west coast and it was 0.8 and 3.7 respectively along the east coast. This is however not in agreement with our survey results as skipjack formed only a very smaller percentage. The catch per unit of effort with reference to different time parameters are also presented in Table 4. It is observed that the catch per fishing day was highest, i.e. 2.23 tonnes per fishing day along the west coast while it was 1.6 along the east coast. The catch per month was also highest along the west coast. On the whole the catch per voyage of 2-3 months was about 100 tonnes.

Big eye tuna, a prime species for sashimi market, is available mainly in the equatorial waters, is obvious from Table 4 which presents the result of operation of a chartered vessel for one voyage. It will be seen that the Big eye is available in better proportion between 3° to 9° north.

The results of some of the chartered vessels operating during September '88 to March '89 have revealed some very interesting results of far reaching effect. (Fig. 4). While the chartered vessels were earlier concentrating along south west coast, they have now moved towards north west coast during October - December with very high hooking rates ranging up to 4.8%. After this, the vessels moved to east coast and Andaman waters during January to March also obtaining high hooking rates of yellowfin tuna. These observations amply attest our earlier finding that Yellowfin tuna migrates northwards along both east and west coasts after the south west monsoon and go as far north as the continental limits and then they make a return sojourn.

**Biological studies on yellowfin tuna**

During the course of tuna long line surveys biological studies were also undertaken with a view to assess the yellowfin stocks. The growth and mortality parameters obtained from these studies are detailed below.

Size composition

Analysis of length frequency data collected during the surveys revealed that the yellowfins are recruited to the subsurface longline fishery in Indian waters

while attaining about 75-80 cm fork length (John and Reddy, 1989). The first modal group was observed with a mean length of about 84 cm. The fishery is largely supported by age 3 and age 4 classes, the mean length of modal groups being in the rate of 120-140 cm. In 1984 frequency showed greater abundance of 75-90 cm size group compared to the samples in later period. The age 5+ yellowfins were rarely found in catches.

The largest species recorded was of 164 cm which will be of age 8 group according to the age scale estimated by Yesaki (1983) and about 7 year old based on Romanou and Korotkova (1988).

Growth parameters

The growth parameters of the yellowfin stock in Indian waters were estimated by different methods and the values obtained are in the range of 170-182 cm and K yr-1 0.25 - 0.31 (John and Reddy, 1989). Details are furnished in Table 5.

Table 5. Estimates of $L_{\infty}$ and K of yellowfin tuna in Indian waters.

| Method | $L_{\infty}$ (cm) | $K^{Yr-1}$ |
|---|---|---|
| Gulland & Holt method | 182 | 0.25 |
| Ford Walford method | 179 | 0.27 |
| Von Bertalanffy plot | - | 0.31 |
| ELEFAN I | 170 | 0.30 |

Silas et al (1985) have worked out the parameters of $L_{\infty}$ = 145 cm and K = 0.32 based on pole and line and gill net catches, where the $L_{\infty}$ value appears to be a underestimate due to absence of larger specimens in the samples. Estimates of $L_{\infty}$ by other authors from different parts of Indian Ocean are in the range of 173-212 cm.

Natural mortality

The natural mortality coefficient of the stock was estimated by John and Reddy (1989) following Pauly's empirical formula using the growth parameter

values and mean environmental temperature and found the coefficient (M) in the range of 0.41 to 0.48.

## DISCUSSION

The Indian waters are traditionally known to be rich, besides other resources in tuna and tuna like fishes. The Japanese, Korean and Taiwanese vessels have been fishing in our waters since early fifties. Inspite of the legal permission given for fishing under the charter policy, a large number of tuna vessels are reported to be illegally fishing in our Indian waters. The apprehension of six tuna long liners of 53.5 m length off Porbandar during October '88 by the Coast Guard is ample indication of the bounty of tunas that is available in our EEZ. The catch rates are comparatively high in our Indian waters as can be seen from Table 5 and this also implies that the tuna resources are practically unexploited at present. The catch rates also compare very favourably with the commercial data of 1978 pertaining to Japanese, Korean and Taiwanese vessels presented in Table 6.

As already stated elsewhere, the tuna resources of Indian waters are highly promising. In the context of the shrimp resources reaching the optimum level, the fishing companies are diversifying for deep sea lobster, squid and finfish resources. Among these, tunas have the best scope in view of the high price and ready export market. However, we have adequate data only for south west and lower east coasts. The north west coast and upper east coast and Andaman and Nicobar waters are yet to be surveyed. It is with this view that the Fishery Survey of India has acquired two sophisticated tuna long line survey vessels Yellow fin and Blue Marlin (36.5 m OAL, 700 PS and 310 GRT). These vessels have modern navigational and fish finding equipments including satellite navigator, FAX etc. and it should be possible to use the SST maps obtained from satellites through FAX for better understanding of the distribution of the tunas. It may also be stated here that purse seining survey by Matsya Varshini have shown the availability of little tuna shoals all along the south west coast. Long tail tuna, which is abundant in the upper Arabian sea including Iran, UAE and Pakistan, is yet another coastal species for future survey and development of exploitation.

The global and regional picture of the estimated potential and production of tuna and tuna like fishes (FAO, 1987) present some very interesting facts

and the scope for augmenting tuna production. The world production of tuna and tuna like fishes steadily increased from 26.35 lakh tonnes in 1980 to 31.54 lakh tones in 1985. In eastern Indian ocean the production has fluctuated with a peak of 1.3 lakh tonnes in 1983 which has steadily declined to 1.08 lakh tonnes in 1986. However, in the western Indian ocean the catches have steadily increased from 1.63 lakh tonnes to 4.61 lakh tonnes in 1986. In India, the catches included mostly small coastal tunas and tuna like fish including seer fishes, the oceanic species being the skipjack and young yellowfin tunas from the Lakshadweep islands where the traditional pole and line fishery exists. The tuna production alone stands at 30,000 tonnes at present. Large tuna catch has been practically nil. The neighbouring countries of Pakistan, Sri Lanka, Maldives and Malaysia are however exploiting the stocks of large oceanic tunas like yellowfin.

Table 7 and 8 present the global production of tuna and tuna like fishes in the years 1982 to 1985/87 and species-wise estimated potential, production, the state of exploitation and the major fishing countries of the Indian ocean. It will be seen that among the various species, the yellowfin, the big eye, the skipjack and the billfish are relevant to our EEZ. Though most of the stocks are exploited moderate to heavy, there seems to be ample scope for further developing fishery for these species. The stock of yellowfin is estimated to be 1 lakh to 1.5 lakh tonnes in the Indian ocean whereas the estimate made in the present study show that about 27,000 tonnes are available in the Indian EEZ and the production is around 60000 tonnes at present mainly by chartered vessels and there is ample scope for further expansion. Skipjack also offers excellent scope with current production being 1.25 lakh tonnes against a potential of 2.0 to 4.0 lakh tonnes. Big eye is yet another choice species which is currently exploited at 39000 tonnes against the potential of 30-60,000 tonnes. It is hoped that the proposed survey of the northwest coast, east coast and Andaman and Nicobar waters by the newly acquired tuna survey vessels of FSI, yellowfin and blue marlin will open new avenue for further development of tuna fishery in India especially for the deep swimming oceanic tunas. The fishery survey of India also proposes to acquire a tuna purse seiner under Italian aid for the survey of the surface dwelling oceanic tunas including the skipjack and young yellowfin tunas.

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TABLE 1. Summary of Results of Tuna Longline Surveys in Indian E.E.Z.

| | | South West Coast | South East Coast | North West Coast | North East Coast | Andaman & Nicobar Seas | N. Equatorial Sea |
|---|---|---|---|---|---|---|---|
| 1. | Area (lakh $Km^2$) | 4.94 | 1.30 | 3.66 | 4.31 | 5.97 | - |
| 2. | Survey Vessels: deployed | M. Sugandhi | M. Harini & M. Sugandhi | M.Sugandhi | M.Harini & M.Sugandhi | M.Sugandhi | M.Sugandhi |
| | proposed | - | - | Blue Marlin | Yellowfin | Yellowfin | - |
| 3. | Survey effort** (lakh hooks) | 4.56 | 3.11 | 0.18* | 0.07* | 0.52 | 0.43 |
| 4. | Average H.R.and range*** | | | Effort inadequate | | | |
| | a) All Fish | 5.20 | 2.76 | | | 1.57 | 1.63 |
| | | 0.7 - 27.34 (Jan. 86) | 0.4 - 7.4 (Feb. 87) | | | | |
| | b) Tunas | 3.76 | 0.93 | | | 0.63 | 1.08 |
| | | 0.1 - 24.98 (Jan. 86) | 0 - 4.12 (Dec. 86) | | | | |
| | c) Bill fishes | 0.27 | 0.40 | | | 0.12 | 0.21 |
| | | 0 - 1.15 (Apr. 86) | 0 - 1.29 (Oct. 86) | | | | |
| | d) Pelagic sharks | 1.11 | 1.33 | | | 0.70 | 0.33 |
| | | 0.2 - 3.77 (May 86) | 0 - 0.46 (Feb. 87) | | | | |
| | e) Others | 0.06 | 0.10 | | | 0.12 | 0.01 |
| | | 0 - 0.33 (May 86) | 0 - 0.46 (Sept. 86) | | | | |



Cont 2

| | South West Coast | South East Coast | North West Coast | North East Coast | Andaman & Nicobar Seas | N. Equatorial Sea |
|---|---|---|---|---|---|---|
| Estimated potential of Deepswimming tuna & tuna like fish ('000t) **** | | | | | | |
| a) Tunas | 17.1 | 0.9 | 6.3 | 1.8 | 1.3 | 27.4 |
| b) Bill fishes | 1.4 | 0.4 | 0.5 | 0.8 | 0.7 | 3.8 |
| c) Pelagic sharks | 6.3 | 1.5 | 2.3 | 3.0 | 2.6 | 15.8 |
| d) Others | 0.3 | 0.2 | 0.1 | 0.4 | 0.3 | 1.2 |
| Total | 25.1 | 3.0 | 9.2 | 6.0 | 4.9 | 48.2 |

* Operated in lat 15° only. As sampling is inadequate in terms of effort, area coverage and seasoal coverage, the results are not separately worked out.

** Also include fishing effort by M.V.Prashikshini.

*** Range indicates minimum and maximum monthly hooking rates.

**** Resources of South West Coast estimated based on the survey. The other figures are projected estimates.

TABLE 2. Results of tuna longline survey, hooking rate, species composition and seasonality

| | South West Coast | Lower East Coast | Andaman Sea | Equatorial sea | Average |
|---|---|---|---|---|---|
| **I. HOOKING RATE** | | | | | |
| 1. Tunas | 3.76 | 0.93 | 0.63 | 1.04 | 2.44 |
| 2. Bill fishes | 0.27 | 0.40 | 0.12 | 0.21 | 0.30 |
| 3 Sharks | 1.11 | 1.33 | 0.70 | 0.33 | 1.13 |
| 4. Others | 0.06 | 0.10 | 0.12 | 0.01 | 0.07 |
| Total | 5.20 | 2.76 | 1.57 | 1.63 | 3.94 |
| **II. SPECIES COMPOSITION (%)** | | | | | |
| 1. By number | | | | | |
| a. Tunas | 72.37 | 33.66 | 40.00 | 66.10 | 61.80 |
| b. Bill fishes | 5.13 | 14.54 | 7.68 | 12.68 | 7.69 |
| c. Sharks | 21.36 | 48.27 | 44.27 | 20.09 | 28.58 |
| d. Others | 1.14 | 3.55 | 8.05 | 1.14 | 1.93 |
| 2. By Weight | | | | | |
| a. Tunas | 76.03 | 33.67 | 47.63 | 63.53 | 65.08 |
| b. Bill fishes | 7.46 | 26.34 | 12.19 | 22.43 | 12.38 |
| c. Sharks | 16.29 | 39.24 | 38.36 | 13.84 | 22.16 |
| d. Others | 0.22 | 0.75 | 1.81 | 0.20 | 0.38 |
| **III. SEASONALITY OF YELLOWFIN TUNA** | | | | | |
| January | 7.81* | 1,90** | Seasonal coverage limited. | | |
| February | 9.79 | 1.34 | | | |
| March | 8.06 | 2.36 | | | |
| April | 5.63 | 1.29 | | | |
| May | 1.98 | 0.56 | | | |
| June | 0.21 | 0.37 | | | |
| July | 0.30 | 0.35 | | | |
| August | 0.55 | 0.14 | | | |
| September | 2.55 | 0.17 | | | |
| October | 4.54 | 0.18 | | | |
| November | 5.10 | 0.86 | | | |
| December | 5.53 | 1.86 | | | |

* 1985-86 to 1987-88
** 1986-87 to 1988-89

TABLE 3. Results of tuna longline operations by F.V. Asian 28 during 2.6.88 - 8.8.88

| Area | No. of hooks | Total hooking rate(%) | Hooking rate (%) | | | |
|---|---|---|---|---|---|---|
| | | | Big-eye | Yellow-fin | Bill fishes | Sharks |
| 3 - 67 | 3951 | 0.68 | 0.25 | 0.05 | 0.07 | 0.30 |
| 5 - 66 | 7724 | 1.55 | 0.66 | 0.37 | 0.05 | 0.06 |
| 5 - 67 | 3807 | 1.05 | 0.50 | 0.34 | 0.10 | 0.10 |
| 7 - 70 | 1812 | 0.77 | 0.33 | 0.05 | - | 0.39 |
| 8 - 71 | 17212 | 2.33 | 0.73 | 0.10 | 0.02 | 1.47 |
| 8 - 72 | 7620 | 1.92 | 0.51 | 0.10 | 0.04 | 1.26 |
| 8 - 75 | 1812 | 0.99 | 0.27 | 0.05 | 0.05 | 0.61 |
| 9 - 70 | 7000 | 3.23 | 0.20 | 0.06 | 0.08 | 2.88 |
| 9 - 71 | 1715 | 1.98 | 0.06 | 0.12 | 0.06 | 1.75 |
| 11 - 74 | 1799 | 0.72 | - | 0.05 | 0.33 | 0.33 |
| 11 - 80 | 1750 | 0.17 | - | 0.11 | - | 0.06 |
| 12 - 72 | 4100 | 0.71 | - | 0.34 | - | 0.36 |
| 12 - 81 | 1750 | 0.51 | - | 0.34 | 0.06 | 0.17 |
| 15 - 80 | 1750 | 1.26 | - | 0.97 | - | 0.28 |
| Total | 63802 | 1.68 | 0.42 | 0.18 | 0.05 | 1.02 |

TABLE 4. Results of Chartered Longliners Operation in Indian EEZ.

July '85 to Jan. '89.

| | | West Coast Only | | East Coast and West Coast | | East Coast Only | |
|---|---|---|---|---|---|---|---|
| 1. | No. of vessels | 7 | | 8 | | 10 | |
| 2. | No. of voyages | 11 | | 11 | | 20 | |
| 3. | No. of Months | 20.75 | | 33.00 | | 36.75 | |
| 4. | Days at Sea | 634 | | 1003 | | 1119 | |
| 5. | Fishing days/sets | 457 | | 703 | | 910 | |
| 6. | Effort (lakh hooks)* | 11.43 | | 17.58 | | 22.75 | |
| 7. | Declared Catch (tonnes) | 1018.5 | | 1086.8 | | 1427.2 | |
| 8. | Catch/unit effort (tonnes) | | | | | | |
| | a. Per Voyage | 92.59 | | 98.81 | | 71.36 | |
| | b. Per month | 49.08 | | 32.93 | | 38.84 | |
| | c. Per day at sea | 1.61 | | 1.08 | | 1.28 | |
| | d. Per fishing day | 2.23 | | 1.55 | | 1.57 | |
| 9. | Hooking rate, by wt. (kg) and by No. | By wt. | By No. | By Wt. | By No. | By Wt. | By No. |
| | a. Yellowfin tuna | 57.46 | 1.78 | 37.97 | 1.18 | 26.800 | 0.83 |
| | b. Skipjack | 12.77 | 2.72 | 3.75 | 0.80 | 17.23 | 3.67 |
| | c. Bigeye tuna | 3.45 | 0.07 | 5.42 | 0.11 | 0.01 | - |
| | d. Billfishes | 5.01 | 0.08 | 6.23 | 0.11 | 16.46 | 0.36 |
| | e. Sharks | 6.70 | 0.29 | 6.03 | 0.26 | 1.09 | 0.05 |
| | f. Others | 3.76 | 0.38 | 2.45 | 0.25 | 1.14 | 0.11 |
| | Total | 89.15 | 5.32 | 61.85 | 2.71 | 62.73 | 5.02 |

* Calculated on the basis of average 2500 hooks per set.

TABLE 5. Comparison of yellowfin tuna hooking rate from Indian seas and adjoining areas recorded in commercial fishing, experimental fishing and exploratory survey

| Fishing type and area | Range of annual hooking rate (%) | Average hooking rate (%) |
|---|---|---|
| Commercial fishing[1] | | |
| Bay of bengal[2] | 0.27 to 0.83 | 0.39 |
| W. of Sri Lanka | 0.24 to 1.42 | 0.81 |
| Experimental fishing (1982-83)[3] | 0.43 to 1.10[4] | 0.70 |
| Lat. 1° - 8° N, Long. 77° - 83° E | | |
| Exploratory survey (1983-88) | 0.74 to 4.94 | 2.62 |
| Lat. 0° - 16° N, Long. 68° - 85° E | | |

1. By Japan 1976-80; Korea 1976-79 and Taiwan 1976-82
2. In BOBP project area covering Burma, Thailand, Malaysia and Indonesia
3. By Sri Lanka, during July-August 1982 and April-May, 1983
4. Catch rate by weight converted to number taking average weight of yellowfin tuna as 31.8 Kg (Sulochanan et al., 1986).

TABLE 6. Yellowfin tuna hooking rates in grids of 5° lat. x 5° long. obtained by commercial longliners in 1978 and 1982, and by survey vessels during 1983-88.

| Latitude | Data source | | 65°-70°E | 70°-75°E | 75°-80°E | 80°-85°E | 85°-90°E | 90°-95°E |
|---|---|---|---|---|---|---|---|---|
| 0°-5°N | Commercial | 1978 | - | 1.04 | 1.66 | - | 0.35 | 0.44 |
| | | 1982 | - | 0.07 | 0.19 | - | 0.19 | 0.24 |
| | Survey | 1983-88 | 1.01 | - | 0.46 | 0.83 | | - |
| 5°-10°N | Commercial | 1978 | - | - | 1.11 | 0.42 | 0.61 | 0.36 |
| | | 1982 | - | - | - | - | 0.28 | 0.12 |
| | Survey | 1983-88 | 0.51 | 0.33 | 0.41 | - | 0.76 | 0.47 |
| 10°-15°N | Commercial | 1978 | - | - | - | 0.33 | 0.34 | - |
| | | 1982 | - | - | - | - | 0.68 | 0.64 |
| | Survey | 1983-88 | 2.16 | 5.34 | 0.04 | 0.94 | 0.96 | 0.68 |
| 15°-20°N | Commercial | 1978 | - | - | - | 0.68 | 0.19 | 0.76 |
| | | 1982 | - | - | - | - | 0.66 | - |
| | Survey | 1983-88 | - | 8.12 | - | 0.65 | - | - |

Commercial data : 1978 - Japan, Korea, Taiwan; 1982 - Taiwan.

TABLE 7. Oceanic tunas and bill fishes, small tunas and seer fishes of the world.

| Ocean | Species | Main fishing countries (1984) | Estimated potential (000 t) | Catches (000 t) | | | | State of exploitation |
|---|---|---|---|---|---|---|---|---|
| | | | | 1982 | 1983 | 1984 | 1985 | |
| World | Tuna & tuna-like fishes | - | - | 2753 | 2937 | 3132 | 3154 | - |
| | S. Bluefin | Japan, Australia | 35-40 | 43 | 43 | 40 | 29 | Heavy |
| | Albacore | Taiwan, Korean, Rep. Japan | 15-20 (Longline stocks only) | 21 | 17 | 16 | 16 | Moderate |
| | Yellowfin | Korean Rep.,Maldives, Sri Lanka, France | 100-150 | 48 | 58 | 97 | 98 | Probably heavy in the west |
| | Big eye | Korean Rep., Taiwan, Japan | 30-60? | 42 | 33 | 40 | 39 | Moderate to heavy |
| | Skipjack | Maldives, Sri Lanka, Indonesia | 200-400 | 51 | 61 | 104 | 120 | Moderate |
| | Bill fishes | Korean Rep., Japan, Taiwan | 10? | 11 | 6 | 6 | 12 | Moderate |
| | Total for Oceanic tunas & Billfishes | | | 216 | 218 | 303 | 314 | - |
| | Total for small tunas & seer fishes | | 200-300? | 153 | 163 | 160 | 181 | Probably Moderate |

TABLE 8. Tuna and allied fish production World, Indian Ocean (East), Indian Ocean (West), India, Pakistan, Sri Lanka, Maldives and Malaysia.

('000 tonnes)

| | 1980 | 1981 | 1982 | 1983 | 1984 | 1985 | 1986 | 1987 |
|---|---|---|---|---|---|---|---|---|
| World Production | 2635 | 2650 | 2790 | 2940 | 3111 | 3154 | | |
| Indian Ocean (East) | 113 | 89 | 111 | 131 | 128 | 125 | 108 | 751 |
| (West) | 163 | 196 | 244 | 251 | 304 | 370 | 461 | |
| India | | | | | | | | |
| a. Coastal species | | | 47 | 46 | 45 | 44 | 62 | 55 |
| b. Oceanic species | | | 9 | 7 | 6 | 6 | 7 | 7 |
| Total | | | 56 | 53 | 51 | 50 | 69 | 62 |
| Neighbouring countries | | | | | | | | |
| Pakistan | | | 19 | 13 | 11 | 16 | 19 | 23 |
| Sri Lanka | | | 37 | 36 | 29 | 29 | 28 | 30 |
| Maldives | | | 20 | 25 | 29 | 29 | 34 | 52 |
| Malaysia | | | 33 | 35 | 32 | 32 | 30 | 46 |

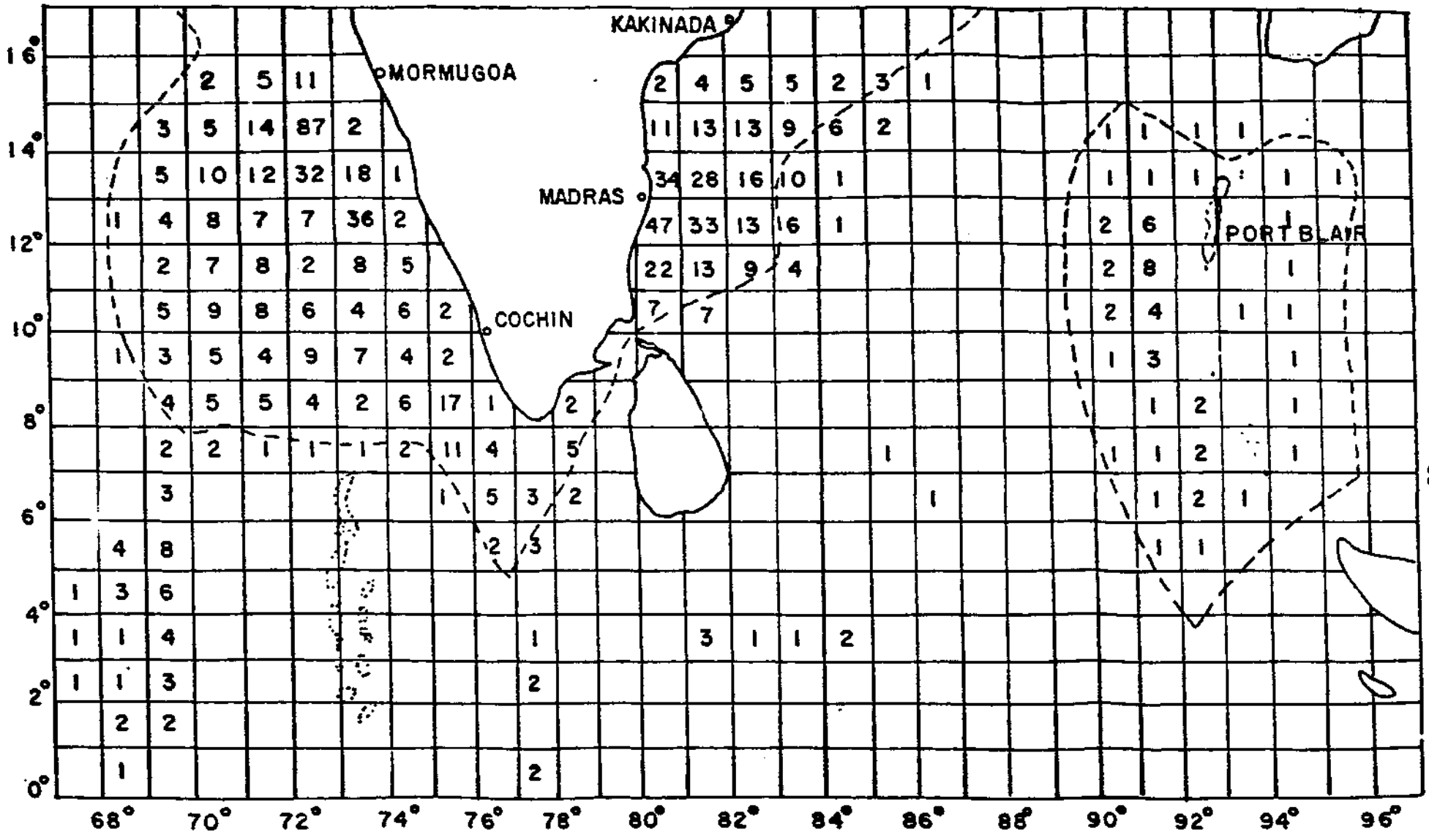
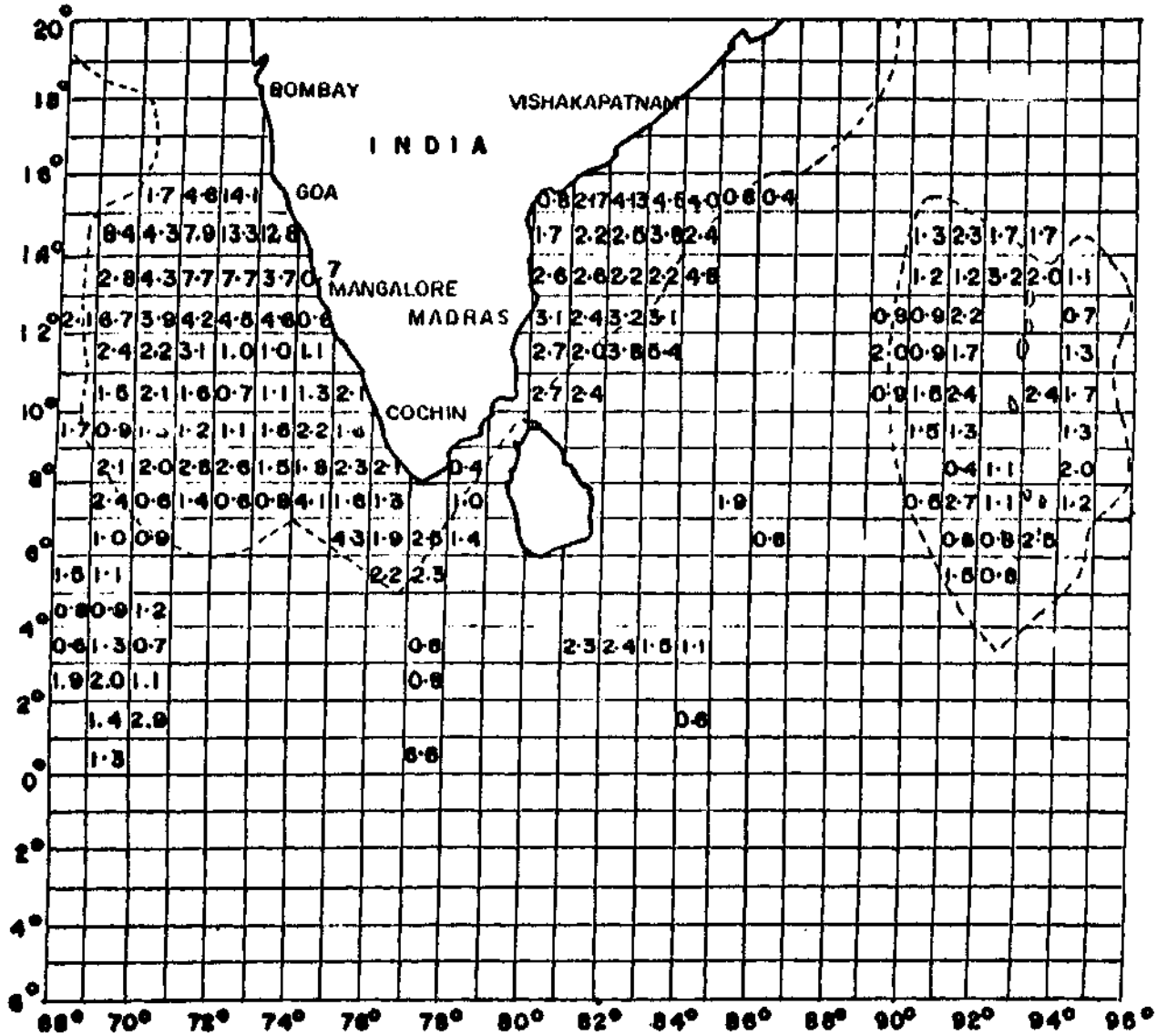



Fig. 1. DISTRIBUTION OF SAMPLING EFFORT IN TUNA SURVEY OCT 83–FEB. 1989

Fig. 2. AVERAGE HOOKING RATE OF ALL FISH BASED ON SURVEYS OCT. 83 — FEB. 1989



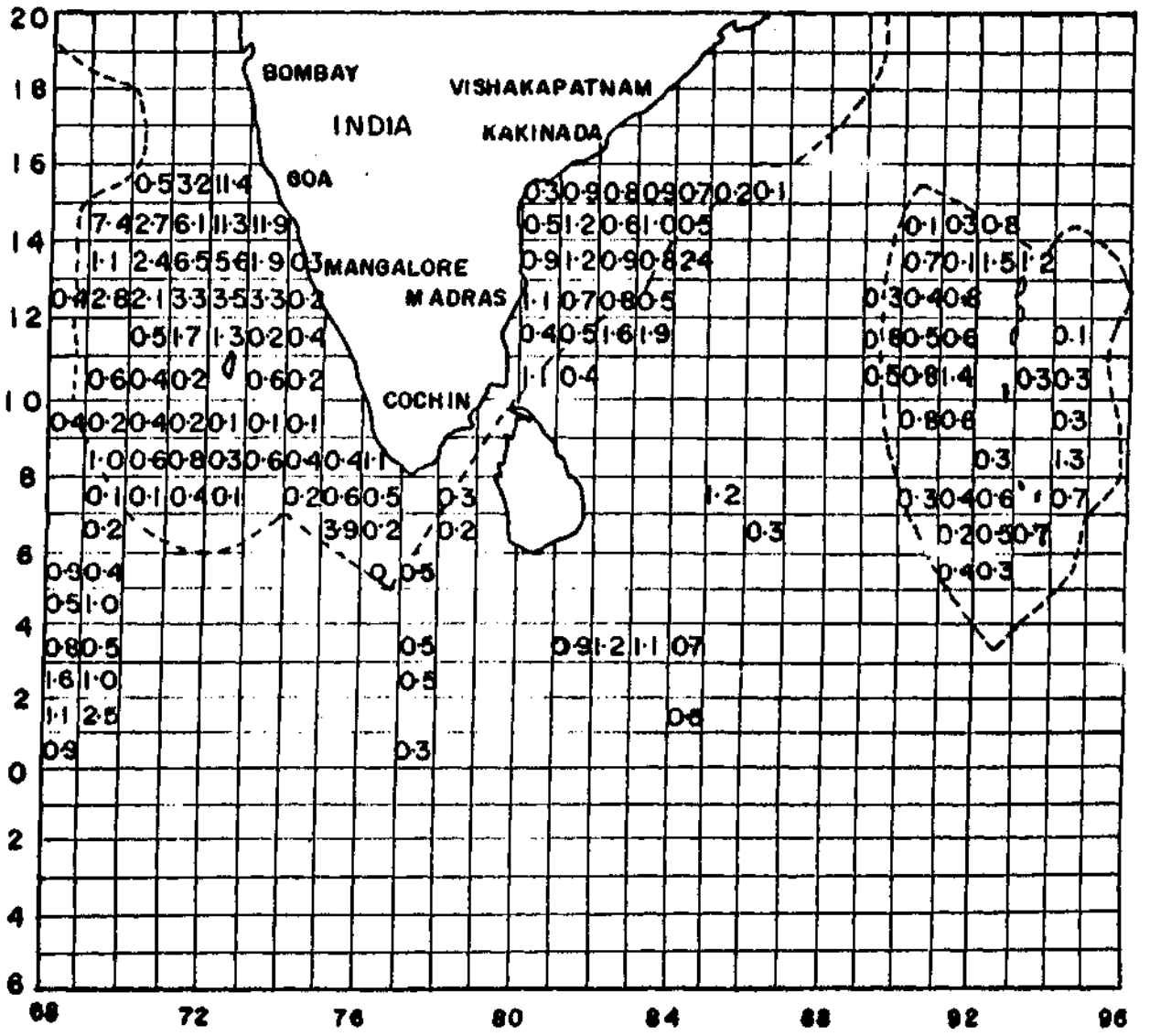



Fig. 3 . HOOKING RATE OF YELLOFIN TUNA OBTAINED IN SURVEYS OCT. 83— FEB. 1989

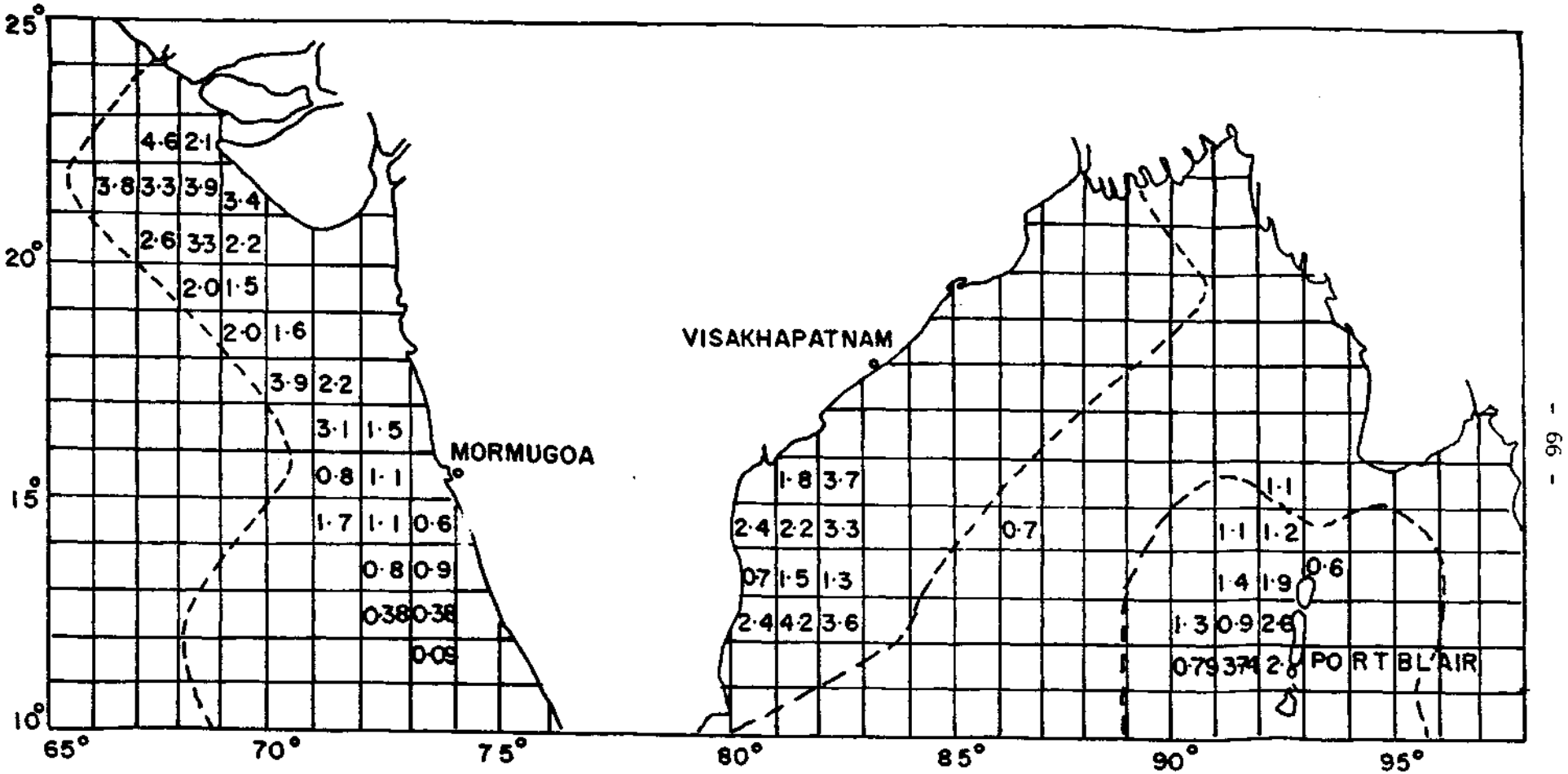



Fig.4· HOOKING RATE OF YELLOWFIN TUNA OBTANED BY SOME OF THE CHARTERED VESSELS OPERATED IN INDIAN EEZ DURING SEPT. 1988 TO MARCH 1989