5. OBSERVATIONS
5.1. ALL-INDIA PRODUCTION

Annual landings of the mackerel in India from 1950 to 1981 extracted from published accounts (CMFRI 1969, and FRAO 1980 and 1982) are given in Fig. 2. During 1950-'53 the landings were good and in next 3 years poor. Again in 1957-'60, the landings rose. The years 1951, 1958 and 1960 witnessed landings over 100,000 tonnes. From 1961 to 1968 except 1963 with 76,980 tonnes, the landings were comparatively poor. The lowest landing of 16,431 tonnes in 32 years under review, however, occurred in 1956. The landing which was 21,703 tonnes in 1968 increased four-fold to 91,837 tonnes next year. In the following 3 years the landings stood high. In fact, the highest ever recorded landing of 204,575 tonnes occurred then in 1971. In the succeeding years there was a decline in the landings till it reached 37,462 tonnes of 1974. Further it climbed to a peak with 85,233 tonnes in 1978, followed by a fall continuing up to 1981.

The average annual landings of mackerel for 1950-'81 period was 68,895 tonnes. The landings during 1950-'53, 1957-'60 (except 1959), 1963, 1969-'73, and 1978-'79 were higher than the average and during the rest lower (Fig.3).
Fig. 3: Fluctuations of all-India annual mackerel production from average landings during 1950 to 1981.
5.2. STATEWISE LANDINGS

Full complements of statewise landings including that of the Union Territory of Goa is available only from 1965 onwards (Fig.4).

In Gujarat the landings ranged between zero and 35 tonnes except in 1980 when it turned out to be 112 tonnes. Often there was no mackerel landing in the state (Fig.4). On the other hand, the mackerel occurred in Maharashtra in all years (Fig.4). But the landing in 1967 was only 4 tonnes. The peak with 20,683 tonnes occurred in 1969. The landing in next year also remained high. Apart from these, the annual catches here were mostly below 2,500 tonnes. The average for the 17-year period however, works out to be 3,641 tonnes. Goa known to be an important place of mackerel production had an average annual landing of 9,894 tonnes. Though the landings here (Fig.4) varied between 2,446 tonnes of 1980 and 35,258 tonnes of 1971, production between 3,500 and 8,000 tonnes per annum was most common.

In Karnataka (Fig.4), the mackerel landings in the 17-year period ranged between 5,736 and 64,047 tonnes. The landings were low and unsteady during 1965-'69. The lowest landing in the state in fact occurred during this period in 1968. During
Fig. 4: Statewise mackerel landings during 1965-'81.
1970-'73, there was substantial increase in landings. As a result the peak production in the state was witnessed in 1971. Except the low landings in 1974, catches during the rest of the years were about 20,000 tonnes or more. On the whole, the landings here during the 17-year time averaged 25,787 tonnes per annum.

In 1965-'81 period, the landings in Kerala (Fig.4) ranged between 3,600 tonnes of 1968 and 95,164 tonnes of 1971. During 1967-'68 the landings were very low and in 1969-'72 very high. But for these, the annual production were mostly within 10,000 to 20,000 tonnes. The average annual landing for the 17-year period in the state was 24,434 tonnes.

The landings in Tamil Nadu - Pondicherry (Fig.4) in 17 years ranged between 521 tonnes of 1965 and 12,086 tonnes of 1973, the average during the period being 5,254 tonnes. The landings were, however, mostly between 2,000 and 4,000 tonnes only. In Andhra Pradesh (Fig.4), the landings were uniformly low and within the range of 1,040 tonnes of 1977 and 3,255 tonnes of 1981 except 1972 and 1980 with 5,396 and 6,203 tonnes respectively. The landings in Orissa (Fig.4) were generally within a few hundred only. The lowest catch here was 13
tonnes of 1964. In Andaman and Nicobar Islands (Fig. 4) the
mackerel landings ranged between 12 and 183 tonnes, the average
working out to be just 69 tonnes.

5.3 STATEWISE PERCENTAGE OF MACKEREL IN ALL-INDIA PRODUCTION

In all-India annual landing, 80% in 1965 came from
Karnataka and Kerala in equal proportions (Fig. 5) and another
9% came from Goa. But Goa's contribution was 31% in the next
year. More than half (51%) of the all-India catch in 1967 came
from Karnataka alone. Kerala's share in the year and the year
next were only 15 and 16% respectively. In 1969, the percentage
in Karnataka also was as low as 14. The catches in Goa in 1968
and 1969 registered respectively 29 and 26%. Maharashtra (Fig. 5)
too had an unusually good catch of 23% in 1969. The contribu-
tions by the states along east coast during 1969-71 were low.
During 1972-76, the catches in Tamil Nadu–Pondicherry (Fig. 5)
accounted between 10 and 18%. The catches in Kerala from 1969
to 1961 ranged between 25 and 47%. In Karnataka the contribu-
tions during 1970-75 were between 26 and 34% except 1973 when
it was 45%. High concentrations up to 60% occurred here in
later years. The percentage contribution from Goa and Maha-
Fig. 5: Statewise percentage of mackerel in annual all-India total from 1965 to 1981.
rashtra more or less tapered during 1970-'81. Trends in percentage contributions in these 2 states broadly had a parallel run. The fluctuations in Andhra Pradesh and Tamil Nadu - Pondicherry too (Fig.5) were parallel.

In average production in the country during the 17-year period, Karnataka tops with 35.88% to its credit (Fig.6) followed by Kerala with 34.00%. The contribution of Goa in all-India annual mackerel production is 13.77%. States next in order of importance with regard to the percentage landings are Tamil Nadu - Pondicherry, Maharashtra, Andhra Pradesh, West Bengal & Orissa, Andaman & Nicobar Islands, and Gujarat each contributing respectively 7.31, 5.06, 3.40, 0.46, 0.10, and 0.02% (Fig.6).

5.4. COASTWISE PRODUCTION

Production of mackerel along the east and west coast of the country is given in Fig. 7. Along east coast (Fig.7), the catch during 1965-'81 varied between 2,233 tonnes of 1965 to 16,700 tonnes of 1972 and the average for the 16-year period was 8,100 tonnes. In the total for the country this formed only 11.3%. The remaining 88.7% of the mackerel caught in India
Fig. 6: Percentage of mackerel production by states in all-India total, average during 1965-'81.
Fig. 7: Annual landings of mackerel in east coast (dark bars) and west coast (stippled bars) against their respective 17-year average (lines across).
was fished along the east coast. Though the average percentage for 17 years in east coast was 11.3, annually it varied between 2.7% of 1971 and 25.9% of 1980. Along west coast (Fig.7), the average landing was 63,769 tonnes and the range was between 16,123 tonnes of 1968 and 199,120 tonnes of 1971. The landings during 1969-'72 and 1978 were above average, in 1973 and 1979 almost the same. The landings during other years were well below the average. Generally when the annual catch in the country was low, the percentage in west coast too appeared low. The total production at all-India level is nothing but a reflection of the fluctuation in catches along the west coast.

5.5. Mackerel in All-India Marine Fish Catches

Average annual production of marine fish in the country during 1950-'81 was 925,407 tonnes (Fig.8). In this the mackerel formed only 7.45% (Fig.9). However, the mackerel was found to contribute to a percentage as high as 19.65 in 1951 (Fig.10). In 1971, when the mackerel catch was the highest in the country, it formed only 17.61% in the year's marine fish landings. In the last 9 years beginning with 1973, the percentage of mackerel in marine fish catches was
Fig. 8: Mackerel in all-India marine fish catches from 1950 to 1981.
Fig. 8

Landings in 100,000 Tonnes

- MACKEREL
- OTHER FISHES

Legend:
- Landings in 100,000 Tonnes
- MEAN
Fig. 9: Percentage of mackerel in marine fish landings of different states, and the country as a whole, 1965-'81 average.
Fig. 10: Percentage of mackerel in annual marine fish production of India.
low. Earlier for 8 years from 1961 (except 1963) and 3 years beginning with 1954 also, the percentage of mackerel in total marine fish catch was low. The percentage was the lowest at 2.29 in 1956 (Fig.10) when the catch also was incidentally the lowest (Fig.2).

5.6. ANNUAL MACKEREL CATCH IN STATES' MARINE FISH LANDINGS

In Maharashtra (Fig.11) during 1965-'81, the mackerel in marine fish catches varied between 0.003 and 12.3% of 1967 and 1969 respectively. But for another 8.7% of 1970, mackerel in marine fish in the state formed only below 2.5%.

Mackerel landings in marine fish stood at percentages between 10.0 of 1950 and 88.2 of 1972 in Goa (Fig.11). In Karnataka (Fig.11) the mackerel contributed to between 6.5 and 61.7% in marine fish catches. In Kerala (Fig.11), though the catch of mackerel in quantity more or less equalled to that of Karnataka, in marine fish catches of the state it varied only between 1.0 and 21.4%.

The percentage of mackerel in marine fish produce of Tamil Nadu - Pondicherry, and Andhra Pradesh was below 7.0 only (Fig.12). Along West Bengal & Orissa coast (Fig.12) it
Fig. 11: Percentage of mackerel in annual marine fish production of Maharashtra, Goa, Karnataka and Kerala.
Fig. 11

PERCENTAGE

GOD

PERCENTAGE

MAHARASHTRA

PERCENTAGE

KERALA

PERCENTAGE

KARNATAKA

YEARS

YEARS

YEARS

YEARS
Fig. 12: Percentage of mackerel in annual marine fish production of Tamil Nadu - Pondicherry, Andhra, Orissa & West Bengal, and Andaman & Nicobar Islands.
formed a maximum of only 5.6%. In Andaman & Nicobar Islands (Fig. 12), the percentage of mackerel in marine fish catches ranged between 3.5 and 11.7 respectively of 1968 and 1973.

In spite of high catches, mackerel during the 17-year period as a whole in Kerala formed only 6.9% (Fig. 9) in its marine fish landings. In Karnataka (Fig. 9) it averaged 26.5% and in Goa (Fig. 9) 39.5%. In the marine fishery of Andaman & Nicobar Islands (Fig. 9), the catch of mackerel became 7.2%. In other maritime states of the mainland (Fig. 9), the percentage of mackerel in marine fish catches was just less than 3.0. As already stated, no fishery for mackerel exists in Lakshadweep Islands.

5.7. SPATIAL AND SEASONAL DISTRIBUTION

Identification of areas and periods of abundance of a resource is necessary for its economic and judicial exploitation. Data for 1976-'80 available at the Fishery Resources Assessment Division of the Central Marine Fisheries Research Institute was utilized here and the following observations made. But for 2 small attempts made by Noble (1979 and 1982 a), no information on identification of areas and times of this
5.7.1. DISTRIBUTION OF FISHERY IN SPACE

Statewise treatment of annual landings as shown in Fig. 6 gives an overall picture where mackerel fishery abounds. The findings below, however, locate areas in each state where the fishery is prominent.

Along West Bengal & Orissa coast, the mackerel is available mostly in Ganjam district of Orissa (Fig. 13: 2-3). Areas of good mackerel catches in Andhra Pradesh are the coasts of Kakinada (Fig. 14: 4) and Guntur district (Fig. 14: 7). The best mackerel production in Tamil Nadu — Pondicherry occurs along the South Arcot-Tanjavur area (Fig. 15: 7). Next to it, coasts of Karaikkal (Fig. 15: 8) and Pattukkottai (Fig. 15: 9) have some fishery. Other places in the state where similar fishery occurs are along the west coast of Kanyakumari district (Fig. 15: 17) and Pondicherry (Fig. 15: 5). Madras coast (Fig. 15: 2) also has a fishery in a smaller measure.

In Kerala, the coast from Ponnani to Kasargod (Fig. 16: 7-9) has the highest yield. Production from Ernakulam and
Fig. 13: Spatial distribution of mackerel in Orissa and Goa during 1976-'80.
Fig. 13
Fig. 14: Spatial distribution of mackerel in Andhra during 1976-'80.
Fig. 15: Spatial distribution of mackerel in Tamil Nadu - Pondicherry during 1976-'80.
Fig. 15

[Bar chart showing landings in 100 tonnes for different zones (1 to 16) in years 1975, 1977, 1978, 1979, 1980, and mean.]

TAM, NADU & PONOCHEERRY
Fig. 16: Spatial distribution of mackerel in Kerala during 1976-'80.
contiguous areas of Alleppey and Trichur districts (Fig. 16: 4-5) is also good. Some catches that occur off Vizhinjam in Trivandrum district (Fig. 16: 1) is significant as the fishery that exists to its immediate south and north are comparatively poor.

The fishery in and around Mangalore coast (Fig. 17: 1) in Karnataka state is high. Along Malpe-Coondapur section (Fig. 17: 3) and off Karwar area (Fig. 17: 5) the catches appear good. In Goa, the catches are more around Panaji (Fig. 13: 2). Maharashtra coast lying next to Goa up to Dandi in Ratnagiri district has the maximum landings (Fig. 18: 1). Landings off Bombay (Fig. 18: 7) are less than half of Ratnagiri area. In Gujarat what little mackerel caught, comes from Bhavanagar-Porbunder area.

Almost the entire catch in Andaman & Nicobar Islands occurs along the coast of Andaman Islands (Fig. 19: 1-3), especially the Middle Andamans.

5.7.2. DISTRIBUTION OF FISHERY IN TIME

The mackerel besides being highly fluctuating in landings from year to year is seasonal in its occurrence. Information
Fig. 17: Spatial distribution of mackerel in Karnataka during 1976-’80.
Fig. 18: Spatial distribution of mackerel in Maharashtra during 1976-'80.
Fig. 19: Spatial distribution of mackerel in Andaman & Nicobar Islands during 1976-'80.
on it is, nevertheless lacking. Being one of the important pre-requisites in fisheries management, the study made on seasonal distribution of mackerel is presented below:

Maximum mackerel landings in Orissa (Fig.20) occur in February and March. It coincides with the catches in Ganjam district where the fishery as already stated in the state is concentrated (Fig. 21: Or. 3). During May-August, no fishery for mackerel exists in the state.

Catches in Andhra Pradesh (Fig.20) too are the maximum in February and March. Low percentages occur during June - September. In Kakinada (Fig. 21: Anp. - 4) the season is good in March. In Guntur (Fig. 21: Anp. - 7), on the other hand, season abounds in October. A secondary peak in the season in the state falls in October (Fig.20).

Along Tamil Nadu - Pondicherry also (Fig.20), as in Andhra Pradesh, the season is bimodal. It is more important during March-May than the one in December. The catches during the former period are high in South Arcot-Thanjavur and Karaikal (Fig. 21: TnP. - 7 & 8). Immediately to its south in Pattukkottai (Fig. 21: TnP. - 9) the fishery is good in the latter period. The fishery in Tamil Nadu - Pondicherry on the
Fig. 20: Average statewise monthly percentage landings of mackerel during the 5-year period of 1976-'80 as a unit of time.
Fig. 20

Bar charts showing percentage distribution over time for various regions:

- Orissa
- Kerala
- Maharashtra
- Andhra
- Karnataka
- Gujarat
- Tamil Nadu
- Pondicherry
- Goa
- Andaman & Nicobar Is.
Fig. 21: Distribution of mackerel in space and time along Indian coasts. Percentage on average for the 5-year period during 1976-'80.
whole seems to be more in March-May in areas from north up to and including Karaikkal and December-January from Pattukkottai and to its south.

There are 2 seasonal peaks in the fishery in Kerala (Fig. 20). The peak in September is more important than the one that occurs in May. June-August is conspicuously slack time. Catches in the southern areas (Fig. 21: Ker. - 1-3) are more during March-May and in the northern sector (Fig. 21: Ker. - 7-9) during September-October. In Karnataka (Fig. 20) the fishery is good during September-November with peak in October. At other times it is thin if not absent. The season in Goa (Fig. 20) extends from September to March with peak in October.

In Maharashtra (Fig. 20), the landings peak in November. Next best catches occur in January and an off-season spreads through June-August. What little mackerel fished in Gujarat (Fig. 20) occurs in the first part of the year with peak in March.

The season in Andaman & Nicobar Islands (Fig. 20) is a protracted one with catches almost equally spread out in all 12 months of the year.

The fishery along the east coast (Fig. 22) peaks in March
in a season spread out during December-May. In the west coast (Fig. 22), high catches occur during September-November with peak in October. Bulk of the landings in the country coming from west coast, the all-India picture (Fig. 22) is not different from that of the west coast. In March the fishery here is a little better than the preceding and succeeding months tempting to show a secondary peak.

5.8. THE FISHERY AND BIOLOGY OF MACKEREL BASED ON THE COMMERCIAL CATCHES AT COCHIN

Data on the commercial fishery at Cochin (Menassery) as mentioned in Material and Methods were monitored during 1965-'80 and some information on these are already published by Noble (1974 a, 1979, and 1980) and Noble and Narayanan Kutty (1978).

The indigenous units, Thangu vala and Ayila vala were the gear used for fishing here. The Ayila vala is a selective gear which catches fish by gilling. The Thangu vala is a boat seine (Noble 1974 a), and it being a non-selective gear, the fish caught by it were utilized for this investigation.

From length measurements, monthly size distribution of the mackerel at Cochin were made and given in Fig. 23.
Fig. 22: Seasonal distribution of mackerel on east coast, west coast, and India as a whole - monthly average percentages during the 5-year period of 1976-'80.
Fig. 22

ALL-INDIA

WEST COAST

EAST COAST

JAN  FEB  MAR  APR  MAY  JUN  JUL  AUG  SEP  OCT  NOV  DEC
Fig. 23: Length distribution of mackerel landed at Cochin (Manassery) by *Thangu vela* from July 1965 to June 1980.
The fishery year (hereinafter referred to as season) for 1965-'66 commenced with the entry of juveniles in the catches in June 1965 and continued uninterruptedly up to January 1966. Later some old fish of this season appeared in the fishery in June and July 1966. Meanwhile juveniles of 1966-'67 season had already appeared in April 1966. Fishes belonging to consecutive seasons thus coexisting with, were sorted out and appropriated to their respective ones as delineated in Fig. 23. In the computation of catch, effort, cpue, length and age composition, the seasons were separated accordingly carefully avoiding overlaps and duplication.

5.8.1. CATCH, EFFORT, AND CPUE

The estimated monthly mackerel landings in weight and in numbers of fish are given respectively in Fig. 24 and 25. These landings not only fluctuate from month to month but also show variation from season to season. The effort estimated and given in Fig. 26, however, does not move up and down much like it. But concurrent to the very low landing in 1979-'80, the effort also reduced. Fishing at Manassery at this stage dwindled as fishing by purse seiners based at Fisheries
Fig. 24: Mackerel landings in weight at Cochin (Manassery) from July 1965 to June 1980.
Fig. 25: Mackerel landings in number at Cochin (Manasser) by *Thangu vala* from July 1965 to June 1980.
Fig. 26: Effort of boat seine *Thangu yala* used for fishing at Cochin (Manassery) from July 1965 to June 1980.
Harbour gained momentum.

The catch of mackerel per unit effort of Thangu vala in weight and numbers (Fig.27) are also estimated for population studies and stock estimates. Like total landing, the cpue also exhibits large-scale fluctuations.

5.8.2. SIZE DISTRIBUTION

Monthly size range is given in Fig. 28. Generally juveniles beginning with 90 mm in length are caught at Manassery. In July 1972 and 1975, fishes as small as 75 mm and 65 mm respectively were caught. Juveniles of 65-95 mm sizes occurred in huge quantities in July 1975. Maximum sizes caught by Thangu vala were only 255 mm. But in February 1976, the size caught went up to 270 mm - the longest caught by Thangu vala during the entire period of this study. In June 1977 and March 1980, sizes of 265 mm were encountered. Broadly speaking maximum sizes that occurred in the last few seasons were high. On the other hand, the maximum size in the first few years was only 235 mm (Fig.28). In between, the maximum sizes in catches were increasing.

Modal sizes from month to month in catches during the
Fig. 27: Catch of mackerel per unit of effort of *Thengu vala* at Cochin in weight (continuous line) and in numbers (broken line) from July 1965 to June 1980.
Fig. 28: Monthly size range and mode of mackerel landed at Cochin (Manassery) by Thangavela from July 1965 to June 1980.
entire period of study are given in Fig. 28. There is always
good progression of modes in the early part of a season, and
especially when juveniles are recruited it is very good.
Among older fish, at times as for instance during November -
March 1977-'78, the modes seem to remain static. The monthly
average sizes are also hence computed and given in Fig. 29
for use in the estimation of growth.
Fig. 29: Observed monthly average length of mackerel landed at Cochin (Manassery) by Thangu vala from July 1965 to June 1980.
Fig. 29