

## Appendix

### LIST OF PARTICIPANTS

#### Second and Third Meetings of the Working Group on Mackerels and Scads in the Malacca Straits

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\* Attended the second meeting of the working group only.

\*\* Attended the third meeting of the working group only.

\*\*\* All observers attended only the third meeting.

## Annexure I

### PRELIMINARY ANALYSIS OF THE MACKEREL (*RASTRELLIGER* AND *DECAPTERUS* SPP.) RESOURCES ON THE WEST COAST OF THAILAND

by Veera Boonragsa

#### 1. Introduction

Prior to 1930, the marine fishery in the west coast of Thailand was basically artisanal. Several types of gears, such as bamboo stake trap, set bag net and some types of small purse seines, were used. Most of the catch consisted of small pelagic fishes caught in the inshore waters of less than 20 metres depth. In 1930, the Chinese purse seine was introduced. Target species were the Indo-Pacific and the Indian mackerel, sardines and round scads. The fishery for these resources developed rapidly after the Second World War, nylon gillnets became widespread and the fishing method of the Chinese purse seine was modified, operating the vessel itself to set the net like a Thai purse seiner, instead of using two rowing boats.

In 1973, luring techniques using drifting or anchored coconut leaves during the day or kerosene lamps at night were introduced to the purse seine fishery, which then became the most important fishery for pelagic fish. From 1982 on, kerosene lamps were replaced by electric lights (generators). The total number of Thai purse seines decreased while the number of luring purse seines increased. The number of Chinese purse seines showed small fluctuations. The fishing effort at present is directed toward all small pelagic species. This development in fishing techniques increased the total pelagic landings, which reached a peak of 65,374 t on the west coast in 1983.

#### 2. Fisheries

The annual production of mackerels fluctuated and in 1973, the catch of Indian and Indo-Pacific mackerels (*Rastrelliger kanagurta* and *R. brachysoma*) showed peak values of 10,329 and 13,005 t respectively. Thereafter, a decreasing trend was observed year by year until the landings dropped to 2,392 and 2,354 t respectively in 1978, and then the production increased again, with only a slight drop in 1982. The production in 1985 was at the level of 6,012 and 22,162 tonnes for *R. kanagurta* and *R. brachysoma* respectively (see Table 1). The annual catches of round scads (*Decapterus* spp.) showed the same trend as those of the *Rastrelliger* species; they oscillated between the peak of 1,535 t in 1975 and the smallest catch of 886 t in 1978. Since 1978, the landings have increased and reached a level of 13,941 t in 1983 (Table 1) and the production in 1985 was around 8,205 tonnes. The fishing grounds are shown in Figure 1.

The rapid development of fishing techniques may lead to full or over-exploitation in the near future. In order to be successful in managing the resources and planning the fishery development, it is necessary to investigate the resources and determine the current status of the fisheries.

#### 3. Species composition and distribution

The sampling survey conducted by the biologists of the Phuket Marine Fisheries Station in 1984 showed that the mackerel resources comprised *R. brachysoma* (about 87.4%), and *R. kanagurta* (about 12.6%), with a negligible amount of *R. faughni*. The scad landings consisted of 58.6% *D. macrosoma* and 41.4% *D. maruadsilrusselli*. Very few *D. macarellus* were recorded along the northern part of the west coast of Thailand. Additionally, the percentage of *R. brachysoma* in the landings is higher than that of *R. kanagurta* in the southern part of this coast, while it is the reverse in the northern part. *Decapterus* spp. are found all along the coast with highest densities occurring in northern and central parts of the Thai waters.

The 1985 sampling survey showed 78.6% *R. brachysoma*, 21.4% *R. kanagurta* and again very few *R. faughni*. for species composition of mackerels, and 73.78% *D. maruadsilrusselli* and 26.22% *D. macrosoma*, for the scads. The average annual percentages of *R. brachysoma*, *R. kanagurta* and *Decapterus* spp. in the total pelagic catch are 30.2, 8.2 and 11.0, respectively.

#### 4. Seasonality

The fishing season for mackerels extends all the year round but it is clearly seen that the peak seasons for *R. brachysoma* are from February to April and from September to November. The *R. kanagurta* production shows a peak in March and April and also around October. The *Decapterus* spp. landings are highest from October to April, in all three areas (Table 2).

## 5. Catch by area

The annual landings of the mackerels and scads, by province, along the west coast of Thailand during 1979 to 1985 are presented in Tables 3, 4 and 5.

The annual landings of *R. brachysoma* are higher in Krabi (Area II), Trang and Satul (Area III) than in Area I. As for Area I, reasonable landings are recorded at Ranong where the fishing grounds are located off the Ranong river mouth, while in the upper part of Phang Nga province much less *R. brachysoma* is landed. In Area I however, landings of *R. kanagurta* are more important. Also, the landings of *Decapterus* spp. appear to be the highest in Area I,

## 6. Annual and monthly variation of catch rate

The catch rates (kg/boat/day) for both *Rastrelliger* species declined considerably after 1979. The *Decapterus* catch rate increased sharply from 1979 to 1983 but then decreased slightly. The 1985 catch rate, however, is still higher than that in 1979. The annual catch rates are presented in Figure 2.

The monthly catch rates for the various species are presented in Figures 3, 4 and 5. Catch rates for both *Decapterus* species fluctuate strongly, but, peaks may be seen in March/May, July/August and November/December. The catch rates for the two *Rastrelliger* species also fluctuate considerably. *R. kanagurta* exhibits main peaks in April, July and May in Areas I, II and III respectively. Peaks in *R. brachysoma* catch rates may be found in May, March and February for the three areas respectively. The peak catch rates are of the order of 200-250 kg/boat/day in the case of *Decapterus* species, 400-600 kg/boat/day for *R. kanagurta* and 1000-1900 kg/boat/day for *R. brachysoma*.

## 7. Size composition

In Area I, the smallest size in the catches of *R. brachysoma* is about 15.5 cm. The entry to the fishery occurs in March and May/June and the dominant sizes range from 19.5 to 21.5 cm. The smallest fish in the catches from area II and Area III are 9.5 and 10.5 cm respectively. The recruitment takes place in January and May in Area II and from December to March in Area III; the dominant size range is 16.5 — 19.5 cm in Areas II and III. Further, the larger fish appear in Area I and the smaller ones in Area II. It seems likely that the stock in Area I is separated from those in Area II and Area III (Figures 6-8).

The smallest size in the catches of *R. kanagurta* appears to be 10.5 cm in Areas I and III and 8.5 cm in Area II, but there are small differences in the season of recruitment. The occurrence of the small fish in Area I, Area II and Area III is in March/April, February/March and March respectively. The major recruitment occurs in Area II. The larger fish occurs in Area I with a dominant size range of 21.5 — 23.5 cm, while the length of this species in the other two areas ranges from 18.5 to 21.5 and 13.5 to 21.5 cm. respectively (Figures 9-11).

The smallest sizes of *D. maruadsilrusselli* and *D. macrosoma* observed in all three areas are 8.5 and 13.5 cm in March and February respectively. The dominant size ranges are 18.5-20.5 cm for *D. maruadsilrusselli* and 19.5 - 21.5 cm for *D. macrosoma* (Figures 12-13). The findings are summarised in Table 6.

## 6. Growth parameters

The growth parameters estimated by means of the ELEFAN programs are presented in Table 7. No clear modal progressions could be observed from the length frequency distributions of mackerels and scads. This might be due to sampling errors or to the migratory behaviour of the species.

The length frequencies, restructured frequencies and the growth curves for the scads and mackerels are presented in Figures 6-13.

## 9. Maximum sustainable yield

The Schaeffer's surplus production model was applied to the available catch and effort data. The following MSY values were obtained for the mackerel and scad species: *R. brachysoma* 20,900 tonnes, *R. kanagurta* 4,800 tonnes and *Decapterus* spp. 7,650 tonnes. The production of *R. brachysoma* appeared to have exceeded its MSY in 1985. *R. kanagurta* catches also exceeded the MSY in 1985. From 1983 to 1985, *Decapterus* spp. catches were higher than the calculated MSY. The production models are presented in Figures 14, 15 and 16 and the catch and effort data in Table 8.

For estimating the MSY, data from the landing place survey were used for the period 1979-1984, and that from the sampling survey for 1985. The catch rates for the period 1979-1985 were from the sampling surveys conducted by the Phuket Marine Fisheries Station. The figures obtained, therefore, differ from the values presented in earlier reports (Anonymous 1985 a + b). In this study the correlation coefficients appeared to be higher than in earlier estimates except for the *Decapterus* spp.

#### 10. References cited

- Anonymous 1985(a) Review of the chub mackerel (*Rastrelliger* spp.) fishery on the west coast of Thailand. BOBP/WP/30. Appendix 1: 17-33
- Anonymous 1985(b) Review of the scad mackerels (*Decapterus* spp.) fishery on the west coast of Thailand BOBP/WP/30. Appendix 2: 34-41.

**Table 1.**  
**Production of *Rastrelliger* and *Decapterus* spp. on the west coast of Thailand, 1972-1985**

Year	(tonnes)		
	<i>R. brachysoma</i>	<i>R. kanagurta</i>	<i>Decapterus</i> spp.
1972	5,702	<b>3,966</b>	1,475
1973	13,005	10,329	811
1974	5,120	6,050	1,416
1975	7,979	5,722	1,535
1976	3,141	5,384	1,074
1977	4,623	2,545	1,450
1978	2,354	2,392	886
1979	8,643	4,045	1,427
1980	13,091	3,081	1,770
1981	15,181	3,169	2,397
1982	9,714	1,890	2,212
1983	11,410	3,959	13,941
1984	16,129	3,580	11,721
1985	22,162	6,012	8,205

**Table 2**  
**Monthly catches of mackerels and scads on the west coast of Thailand in 1985.**

Year	(tonnes)		
	<i>R. brachysoma</i>	<i>R. kanagurta</i>	<i>Decapterus</i> spp.
January	868	231	<b>297</b>
February	3200	232	<b>509</b>
March	2,835	756	1,101
April	4,838	1,537	1,111
May	3,620	1,439	1,509
June	687	35	16
July	676	544	561
August	1,004	7	749
September	1,098	193	62
October	1,139	316	417
November	1,180	439	772
December	1,027	283	1,101
Total	22,172	6,012	8,205

**Table 3**  
Landings of Indo-Pacific mackerel by major fishing ports  
on the west coast of Thailand, 1979-1985

Year	1979		1980		1981		1982		1983		1984		1985	
	tonne	%	tonne	%	tonne	%	tonne	%	tonne	%	tonne	%	tonne	%
Ranong	1593	18.43	1344	10.27	1517	9.99	1717	17.68	1617	14.17	303	1.88	2635	11.89
Takkuapa	55	0.64	-	-	-	-	-	-	-	-	-	-	29	0.13
Tarmuong	-	-	-	-	41	0.27	78	0.95	509	3.16	-	-	1	-
Phuket	630	7.29	1	0.01	50	0.33	-	-	237	2.08	11033	68.40	5051	22.79
Krabr	386	4.47	507	3.87	1682	11.08	1402	14.43	1973	17.29	994	6.16	1469	6.63
Trang	1822	21.08	4597	35.11	3941	25.96	2635	27.13	2675	23.44	3266	20.25	6477	29.23
Satul	4157	48.09	6642	50.74	7950	52.37	3882	39.96	4800	42.07	24	0.15	6500	29.33
<b>Total</b>	<b>8643</b>	<b>100</b>	<b>13091</b>	<b>100</b>	<b>15181</b>	<b>100</b>	<b>9714</b>	<b>100</b>	<b>11410</b>	<b>100</b>	<b>16129</b>	<b>100</b>	<b>22,162</b>	<b>100</b>

Source 1979-1984, The Landing Place Survey, Department of Fisheries, Thailand  
1985, from the sampling survey conducted by Phuket Marine Fisheries Station

**Table 4**  
Landings of Indian mackerel by major fishing ports  
on the west coast of Thailand, 1979-1985

Year	1979		1980		1981		1982		1983		1984		1985	
	tonne	%	tonne	%	tonne	%	tonne	%	tonne	%	tonne	%	tonne	%
Ranong	1159	28.65	443	14.38	350	11.04	39	2.06	169	4.27	298	8.33	610	10.15
Takkuapa	1332	32.93	745	24.18	535	16.88	372	19.68	647	16.34	898	25.08	1820	30.27
Tai muong	237	5.86	166	5.39	1200	37.87	782	41.38	1597	40.34	1177	32.88	858	14.27
Phuket	678	16.76	706	22.91	734	23.16	656	34.71	1394	35.21	1189	33.21	1486	24.72
Krabr	374	9.25	350	11.36	55	1.74	4	0.21	-	-	10	0.28	171	2.84
Trang	186	4.60	260	6.69	295	9.31	37	1.96	152	3.84	8	0.22	567	9.43
Satul	79	1.95	465	15.09	-	-	-	-	-	-	-	-	500	8.32
<b>Total</b>	<b>4045</b>	<b>100</b>	<b>3081</b>	<b>100</b>	<b>3169</b>	<b>100</b>	<b>1890</b>	<b>100</b>	<b>3959</b>	<b>100</b>	<b>3580</b>	<b>100</b>	<b>6012</b>	<b>100</b>

Source 1974-1984, The Landing Place Survey, Department of Fisheries, Thailand  
1985, from the sampling survey conducted by Phuket Marine Fisheries Station

**Table 5**  
Landings of round scad by major fishing ports  
on the west coast of Thailand, 1979-1985

Year	1979		1980		1981		1982		1983		1984		1985	
	tonne	%	tonne	%	tonne	%	tonne	%	tonne	%	tonne	%	tonne	%
Ranong	91	6.38	383	21.64	163	6.08	6	0.27	781	5.60	259	2.21	119	1.45
Takkuapa	401	28.10	173	9.77	710	29.62	886	40.05	1333	9.56	1252	10.68	1708	20.82
Tai muong	302	21.16	369	20.85	526	21.94	388	17.54	2083	14.94	2242	19.13	3004	36.61
Phuket	486	34.06	521	29.43	519	21.65	555	21.65	8908	63.90	7658	65.33	3062	37.32
Krabr	20	1.40	98	5.54	53	2.21	243	10.99	300	2.15	57	0.49	49	0.60
Trang	127	8.90	226	12.77	428	17.77	134	6.06	520	3.73	253	2.16	179	2.18
Satul	-	-	-	-	-	-	-	-	16	0.12	-	-	84	10.00
<b>Total</b>	<b>1427</b>	<b>100</b>	<b>1770</b>	<b>100</b>	<b>2397</b>	<b>100</b>	<b>2212</b>	<b>100</b>	<b>13941</b>	<b>100</b>	<b>11721</b>	<b>100</b>	<b>8205</b>	<b>100</b>

Source 1979-1984, The Landing Place Survey, Department of Fisheries, Thailand  
1985, from the sampling survey conducted by Phuket Marine Fisheries Station

**Table 6**  
**Smallest observed lengths, recruitment periods, dominant size ranges and peak seasons of the fishery for mackerels and scads on the west coast of Thailand**

	Smallest observed (cm.)	Seasons for small size	Dominant size range (cm.)	Peak season of the fishery
<i>R. brachysoma</i>				
Area I	15.5	March, May, June	19.5 — 21.5	May
Area II	9.5	Jan., May	16.5 — 19.5	March — Very high CPUE
Area III	10.5	Feb., March, Dec.	17.5 — 19.5	Feb. — Very high CPUE
<i>R. kanagurta</i>				
Area I	10.5	March, April	21.5 — 23.5	April — Very high CPUE
Area II	8.5	Feb.-Mar., Sep.-Nov.	18.5 — 21.5	May/July — Low CPUE
Area III	10.5	March	19.5 — 21.5	May — moderate CPUE
<i>D. maruadsilrusselli</i>				
All three areas	8.5	March	18.5 — 20.5	March
<i>D. macrosoma</i>				
All three areas	13.5	Feb., April	19.5 — 21.5	August

**Table 7**  
**Growth parameters, mortality and exploitation rates of mackerels and scads on the west coast of Thailand, obtained from the ELEFAN analysis (K annual, lengths in cm)**

	K	$L_{\infty}$	$L_C$	Observed Z	E	
<i>R. brachysoma</i>						
Area I	1.6	28.	19.7	2.6	15.76	0.84
Area II	1.25	25.1	17.6	2.4	6.88	0.68
Area III	1.33	25.4	17.8	2.3	8.68	0.74
<i>R. kanagurta</i>						
Area I	1.75	28.6	22.7	2.7	8.53	0.69
Area II	1.9	27.5	19.7	2.5	5.32	0.48
Area III	1.5	27.6	20.0	2.5	2.49	0.004
<i>D. maruadsilrusselli</i>						
All three areas	1.01	27.2	19.6	2.5	6.57	0.72
<i>D. macrosoma</i>						
All three areas	0.89	24.2	18.8	2.3	5.97	0.57

**Table 8**

**Catch, effort and catch per unit of effort data (purse seine as standard gear)  
of Indo-Pacific mackerel, Indian mackerel and round scad on the west coast of Thailand**

## a: Indo-Pacific mackerel

Year	1979	1980	1981	1982	1983	1984	1985
Total catch (tons)	8,643	13,091	15,181	9,714	11,410	16,129	22,162
Total effort (days)	9,891	15,278	18,789	10,877	13,005	26,457	39,368
CPUE (kg/day)	873.82	856.85	807.97	893.08	577.35	609.63	562.94

## B: Indian mackerel

Year	1979	1980	1981	1982	1983	1984	1985
Total catch (tons)	4,045	3,081	3,169	1,890	3,959	3,580	6,012
Total effort (days)	6,631	12,243	15,238	15,214	28,887	19,585	40,354
CPUE (kg/day)	610.01	251.65	207.97	124.23	137.05	182.79	148.98

## C: Round scad

Year	1979	1980	1981	1982	1983	1984	1985
Total catch (tons)	1,427	1,770	2,397	2,212	13,941	11,271	8,025
Total effort (days)	21,667	49,915	19,790	13,377	25,503	23,984	40,353
CPUE (kg /day)	65.86	35.46	121.12	165.36	546.64	488.70	203.33

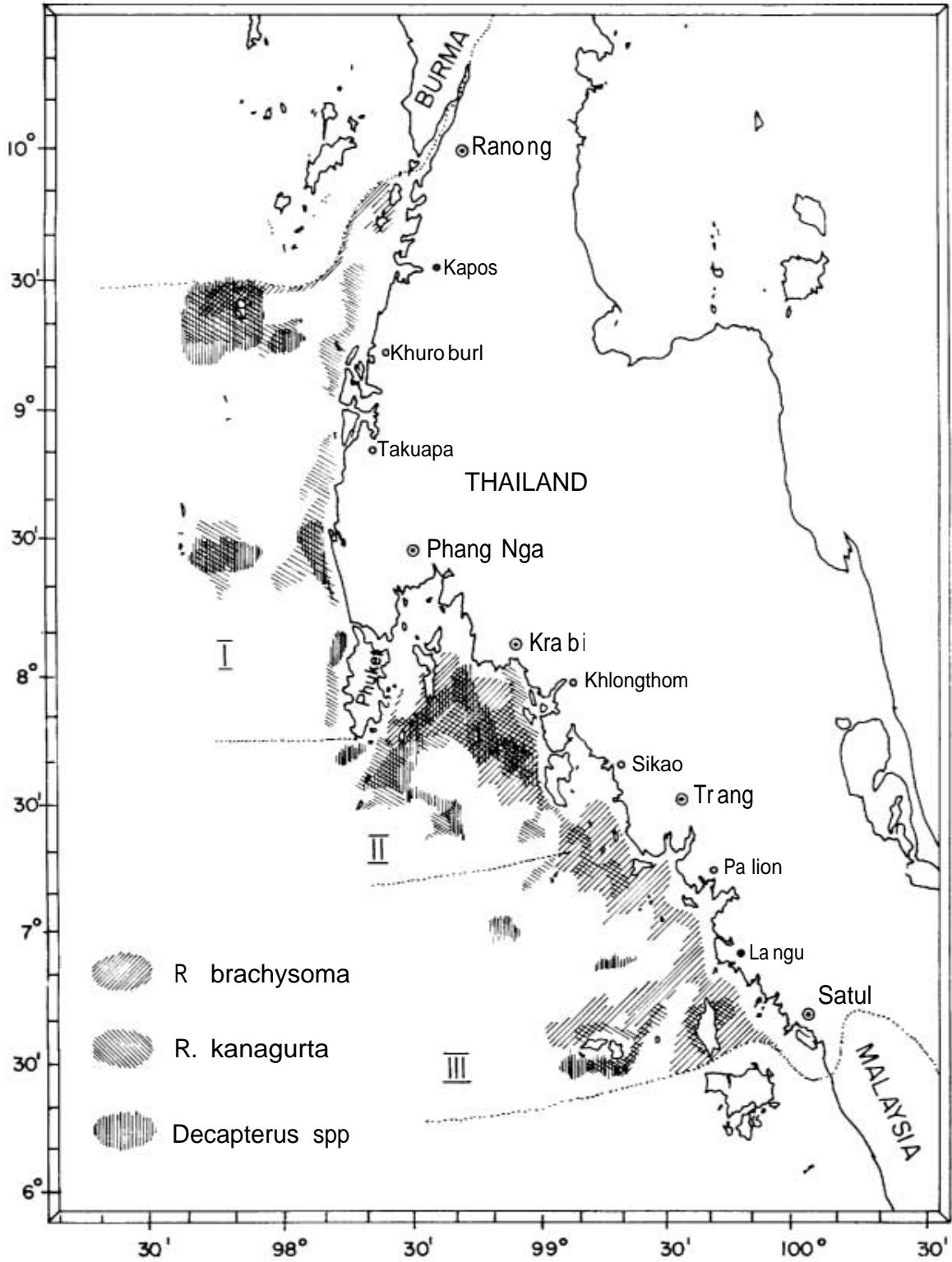
Source: 1979-1984 Total catch from the Landing Place Survey, Department of Fisheries, Thailand.

1985 Total catch from the sampling survey conducted by Phuket Marine Fisheries Station.

1979-1985 CPUE from the sampling survey conducted by Phuket Marine Fisheries Station.

Figure 1.

Fishing areas on the west coast of Thailand.





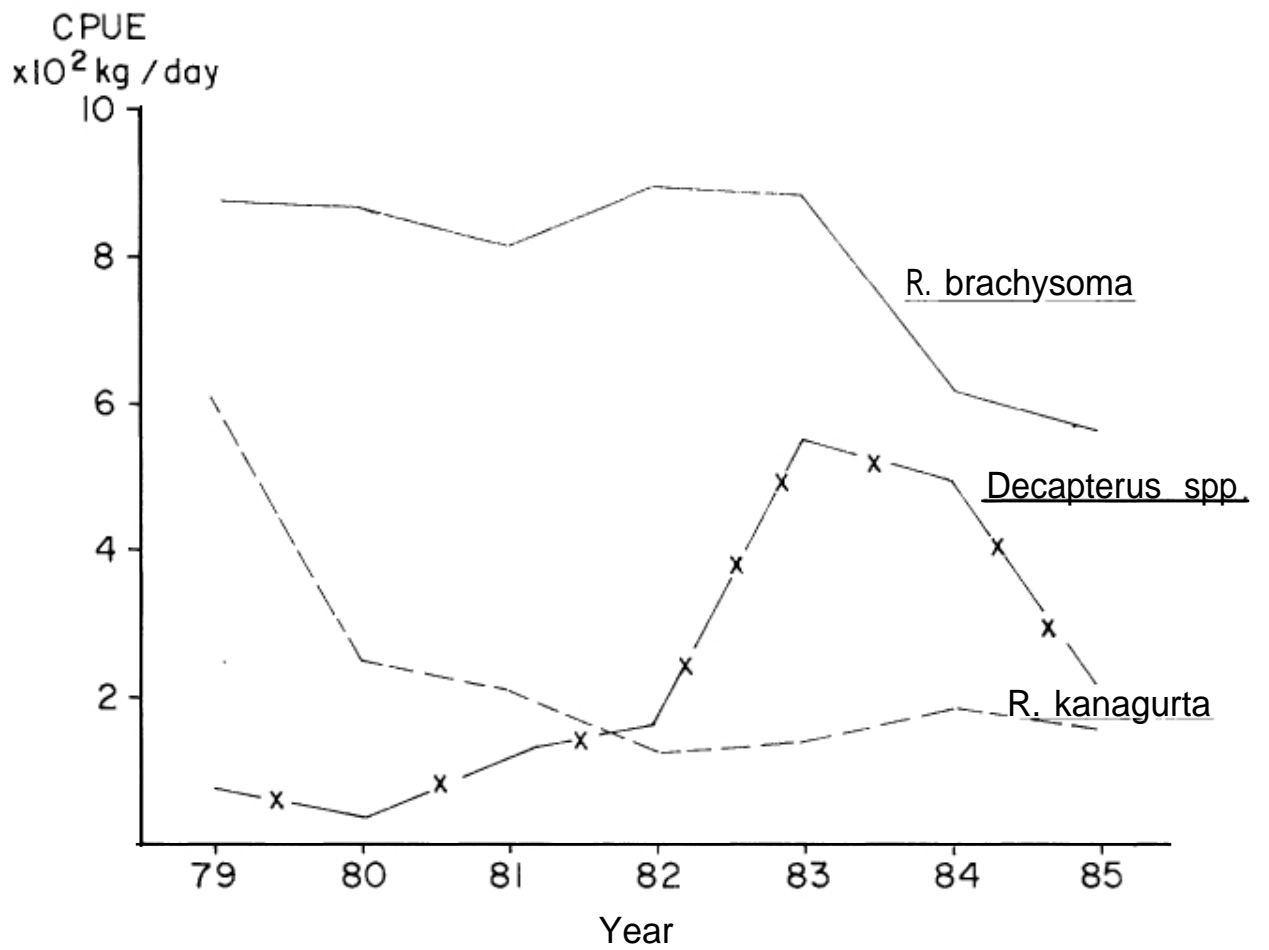


Figure2. Annual mean catch rates for *R. brachysoma*, *A. kanagurta* and *Decapтерus spp.* in the purse seine fishery on the west coast of Thailand.

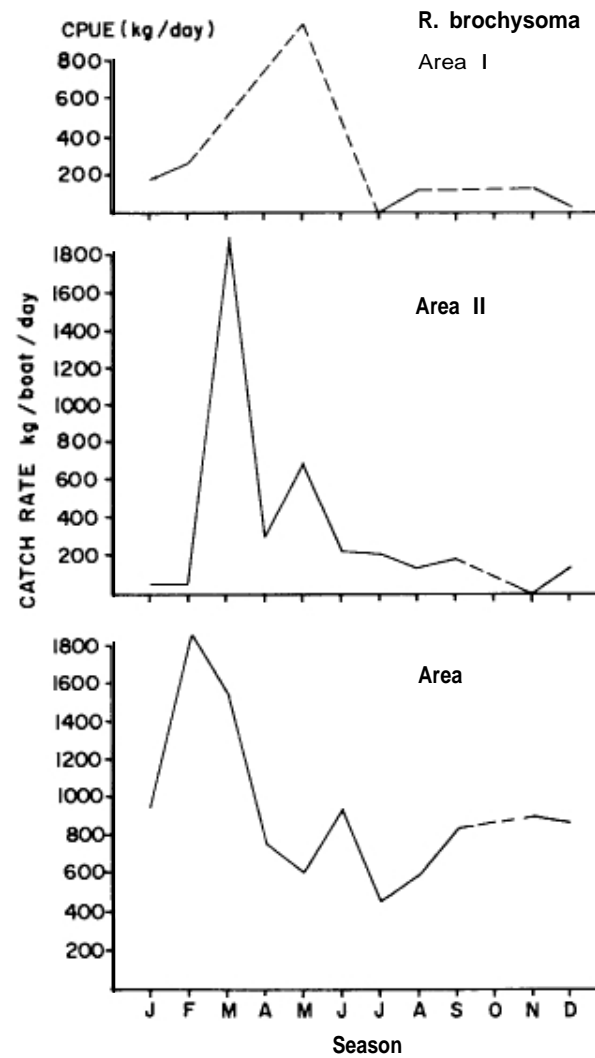


Figure 3. Monthly catch rate for *R. brochysoma* in the purse seine fishery in the three areas on the west coast of Thailand.

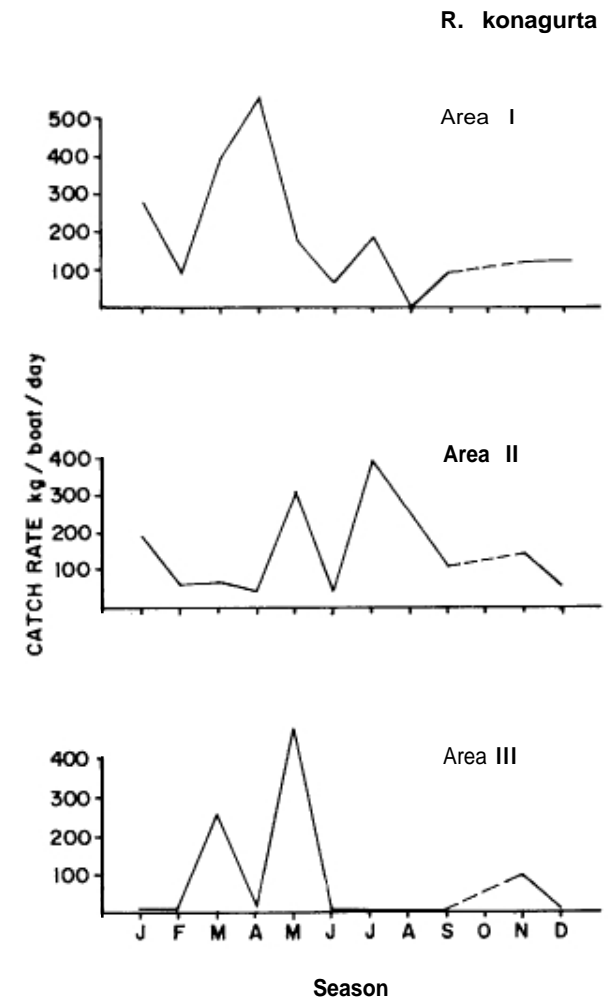


Figure 4. Monthly catch rates for *R. kanagurta* in the purse seine fishery in the three areas on the west coast of Thailand (1985).

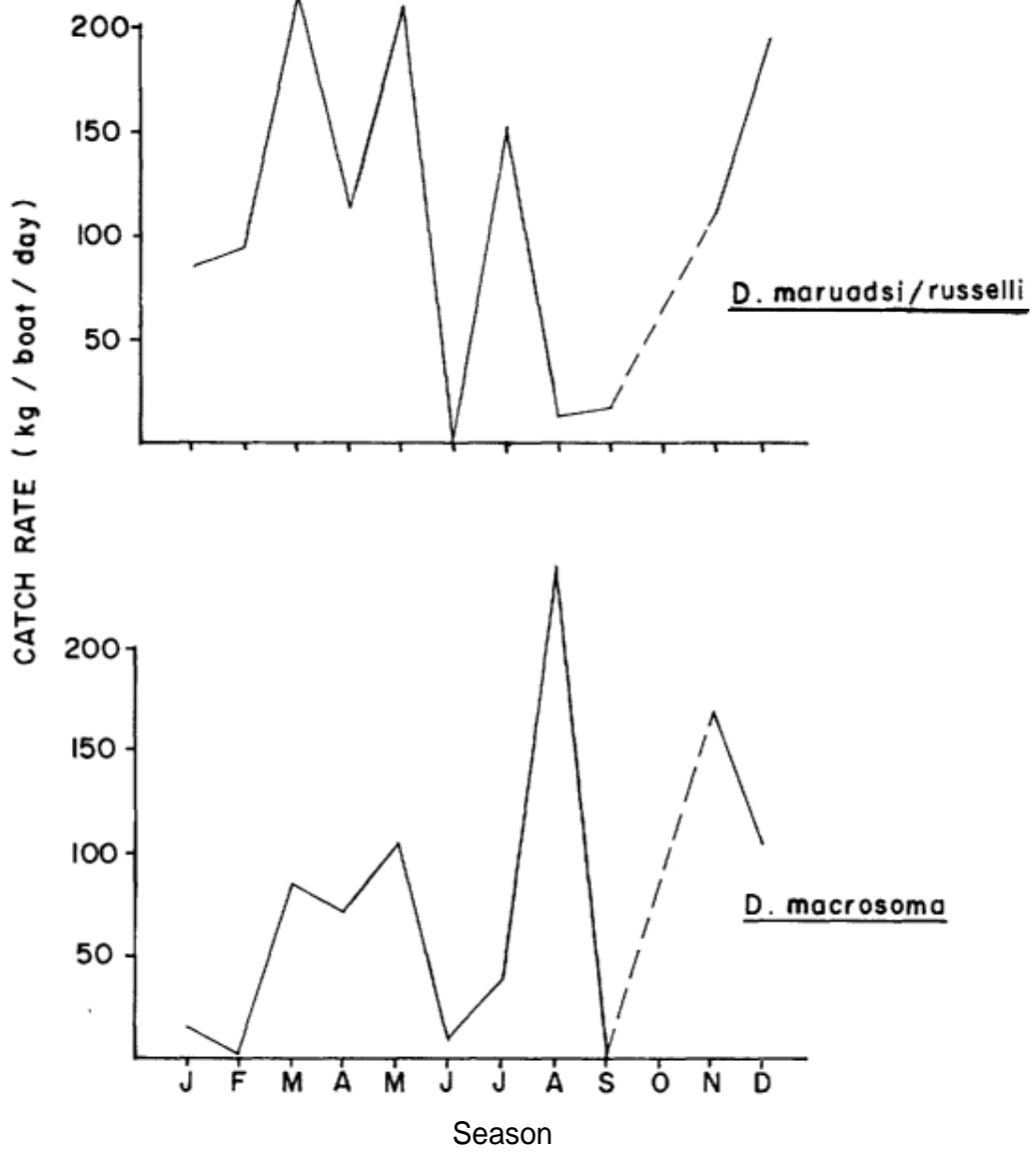


Figure 5. Catch rates for *D. maruadsi/russelli* and *D. macrosoma* in the purse seine fishery along the west coast of Thailand (1985).

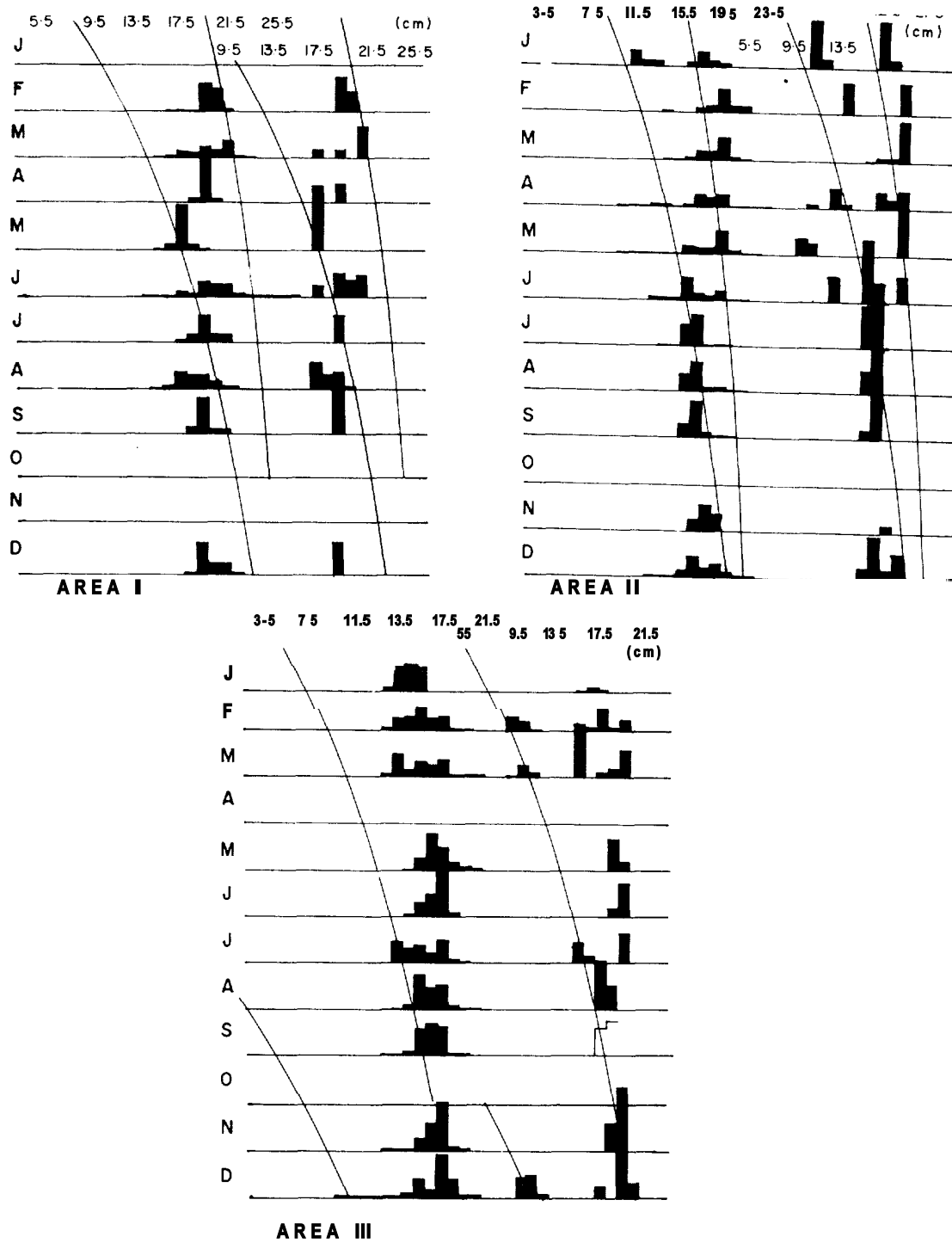


Figure 6-8 Length frequencies, restructured frequencies and growth curves for *R. brachysoma* in Areas I, II and III on the west coast of Thailand (1985).

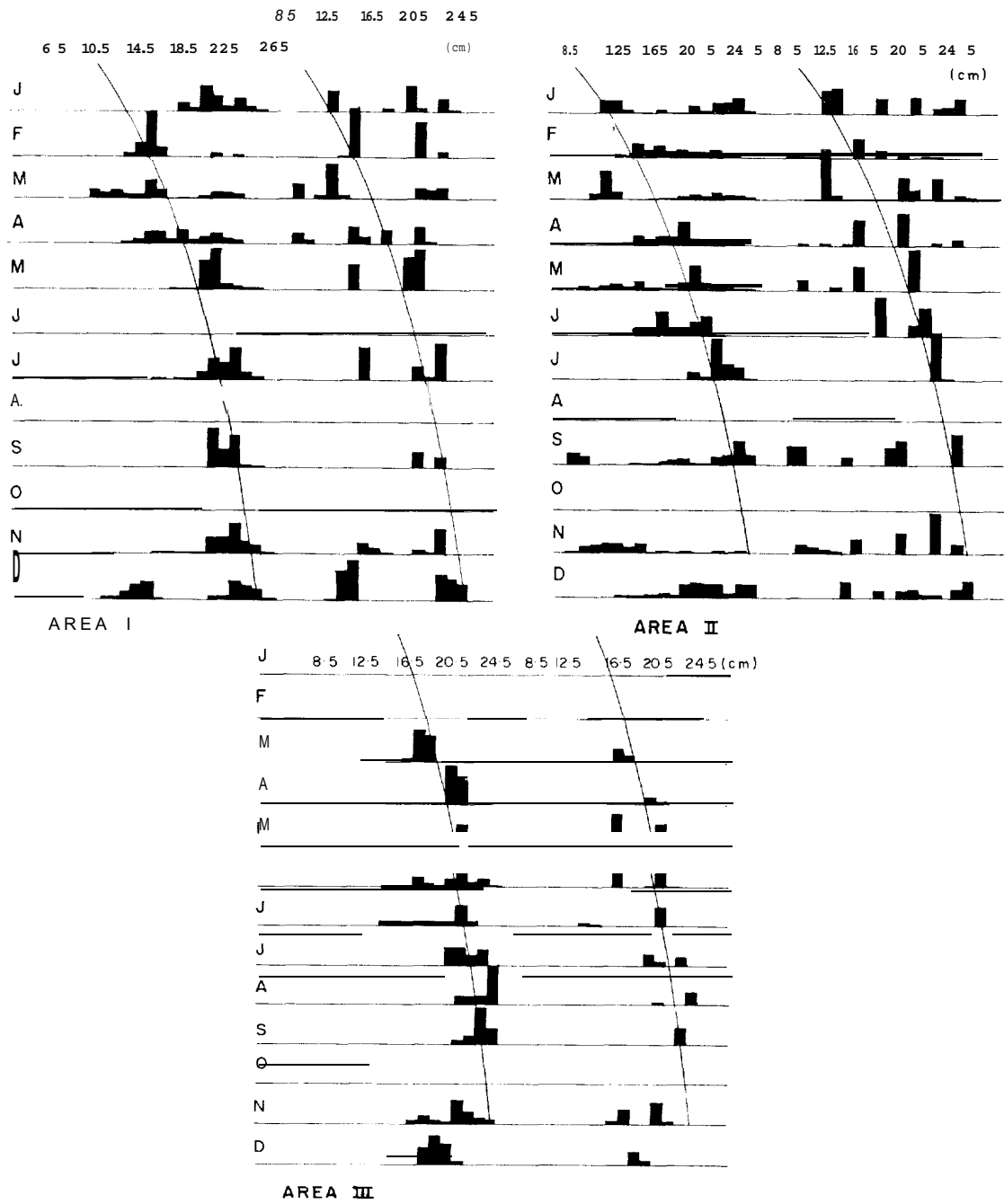


Figure 9-1 | *length frequencies, restructured frequencies and growth curves of f. kanagurta in Areas I, II and III on the west coast of Thailand (1985)*

Figure 12. Length frequencies, restructured frequencies and growth curves for *D. russelli* (maruads) in all the three areas on the west coast of Thailand (1985)

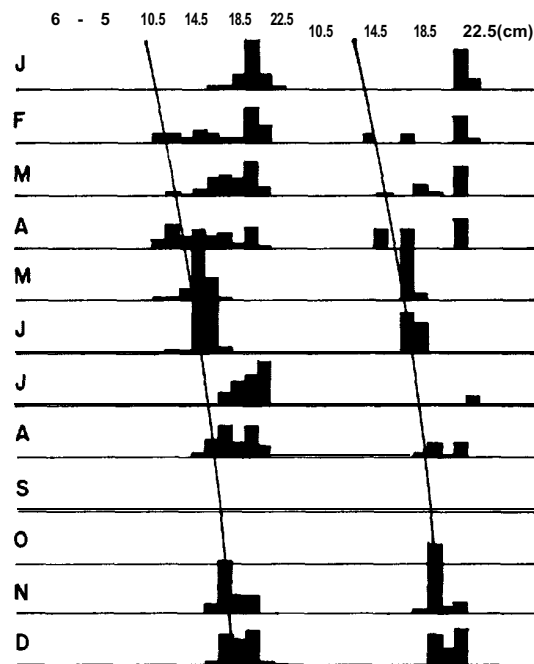
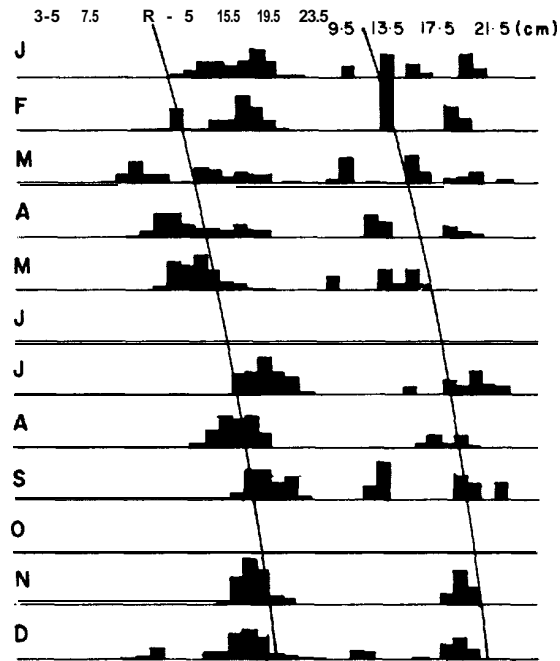


Figure 13. Length frequencies, restructured frequencies and growth curves for *D. marcosoma* in all three areas on the west coast of Thailand (1985).

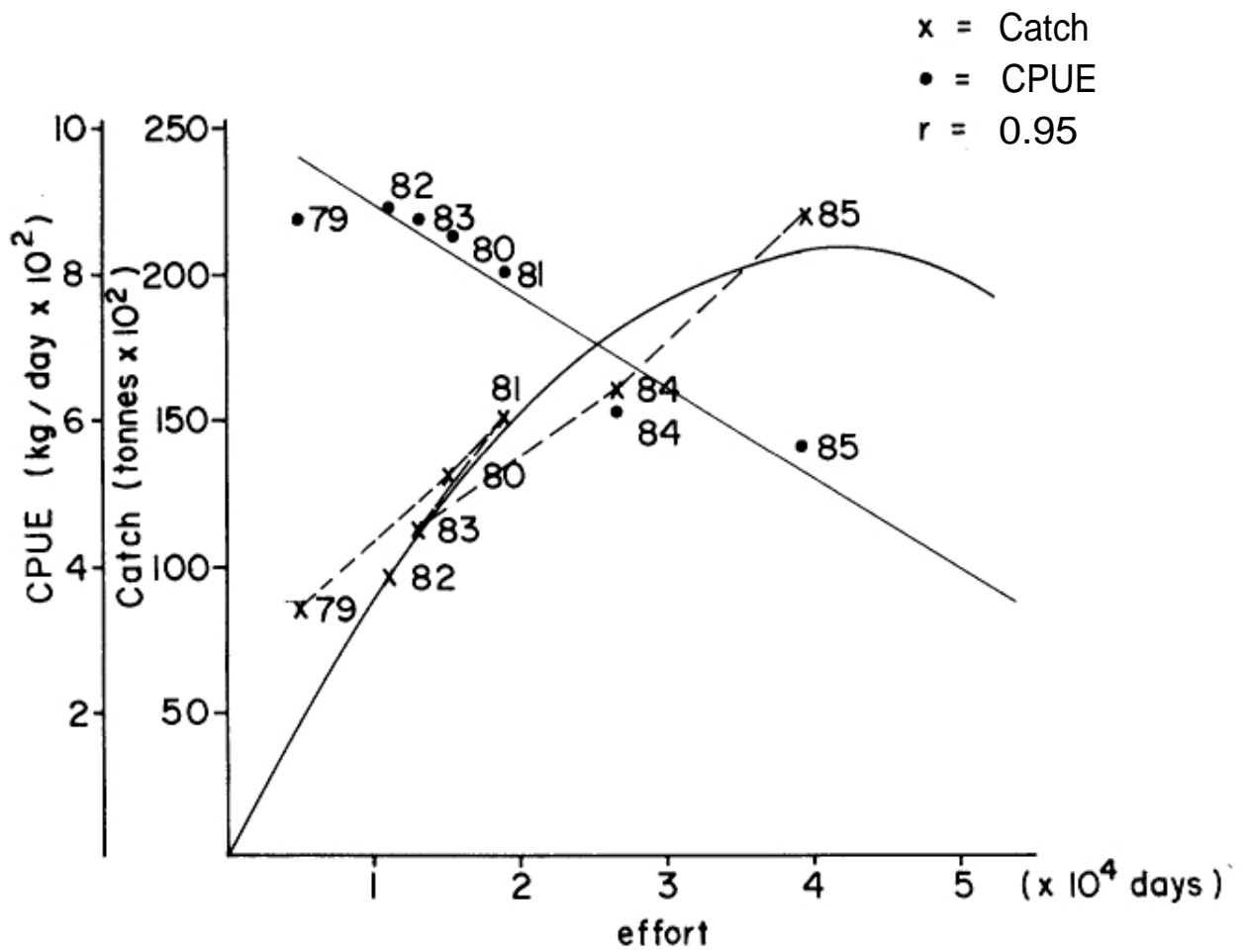


Figure 14.

Catch and catch per unit of effort related to total standardized effort for Indo-Pacific mackerel on the west coast of Thailand, 1979-1985.

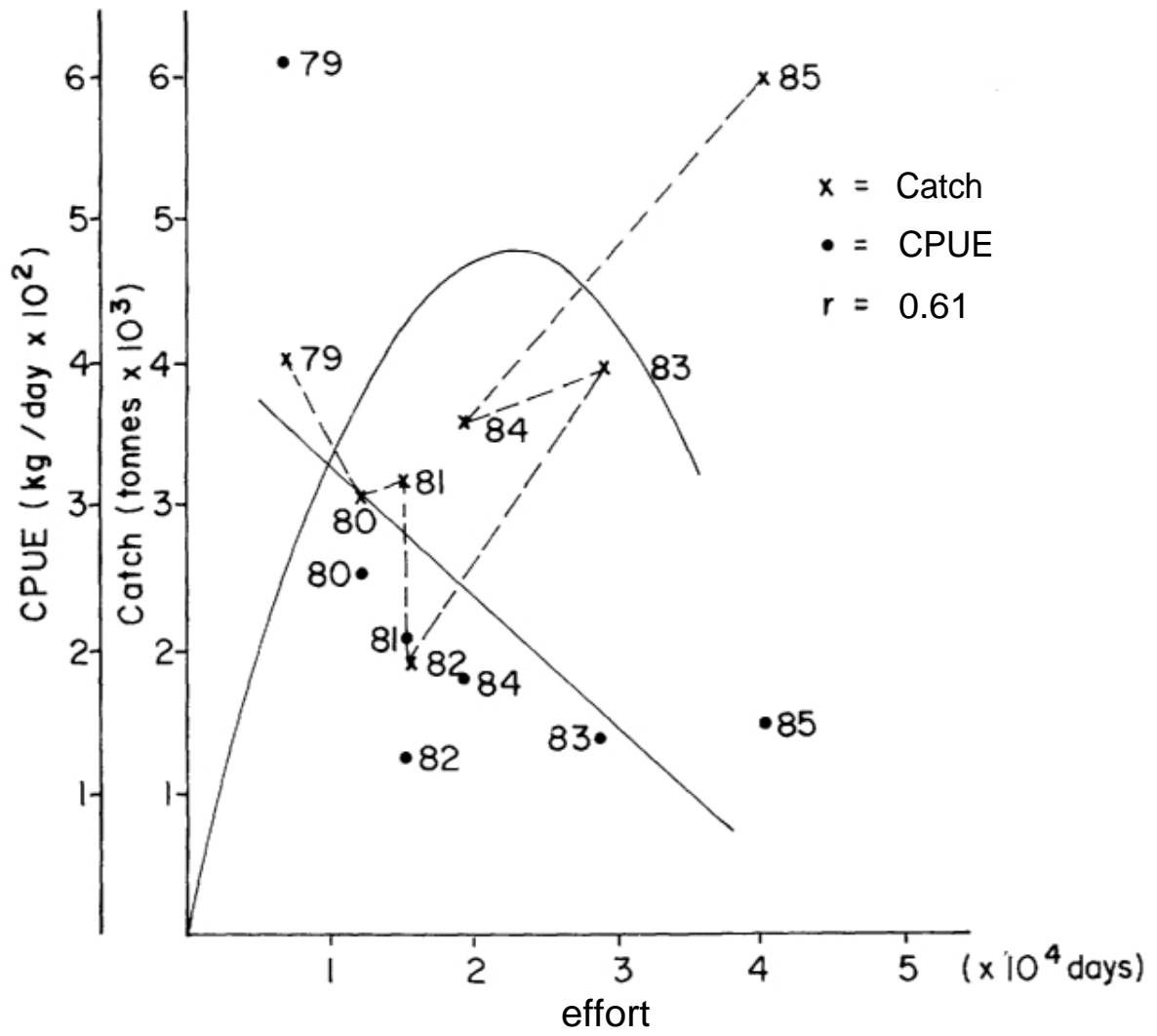


Figure 15. Catch and catch per unit of effort related to total standardized effort for Indian mackerel on the west coast of Thailand, 1979-1985.



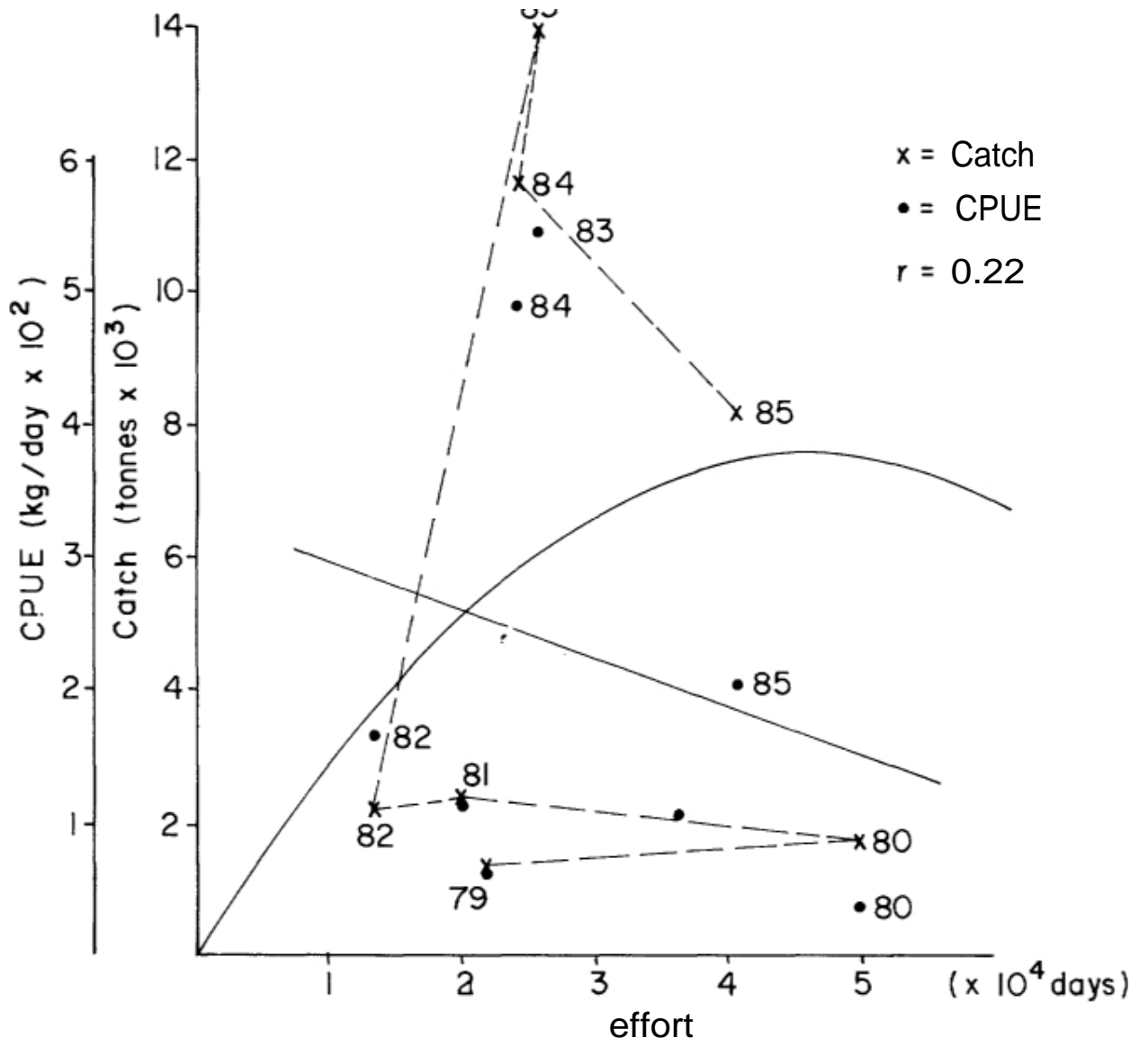


Figure 16. Catch and catch per unit of effort related to total standardized effort for round scads on the west coast of Thailand, 1979-1985.