Annexure 3

TROLL AND PURSE SEINE FISHERIES IN WEST AND NORTHERN SUMATRA

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1. Introduction

The tuna fisheries in West and North Sumatra are concentrated mainly in Padang and Banda Aceh. The production is only for local consumption, though it is occasionally marketed in Medan and other large cities in Sumatra. From Banda Aceh, tuna and tuna-like fish are transported in trucks and stored in boxes with ice. From Padang, they are transported in refrigerated trucks to other cities such as Medan, Pekan Baru and Bengkulu. Refrigerated trucks are owned by the marketing project of the Directorate General of Fisheries.

During the peak season, when there is a glut of tuna, a part of it is processed in Banda Aceh into ***katsuboshi*** which is locally called ***ikan kayu.*** The katsuboshi is also for local consumption.

The areas covered by this paper are : West Sumatra province, North Sumatra province (west side), and Aceh province (west side). (See Figure 1).

2. Gears used

Unlike in eastern Indonesian waters, where the main gear used for exploiting tuna and skipjack is pole and line, the main gears in western Indonesian waters are troll line, gillnet, seine net and purse seine. There is no pole and line operation in this area. A trial operation was done in West/Sumatra waters in the 1970s. but there was no follow up.

Tuna fisheries in western Indonesian waters are mainly small-scale operations. Troll lines are used mainly in Bali and West Sumatra, gillnets in Muncar and Prigi (East Java) and Pelabuhan Ratu (West Java). Seine nets are used in Pelabuhan Ratu. Purse seines for small pelagic fish in Muncar and Prigi, and purse seines for skipjack in Bande Aceh. Purse seines for pelagic fish have been developed recently in West Sumatra, where there are 15 purse seiners operating now. Trolling boats that are operating in West Sumatra waters have engines varying from 16 to 55 hp and capacities between 4.43 and 28.89 GT. More than 80% of the boats use 33 hp engines About 4 to 5 fishermen work on each boat, using 8 to 12 trolling lines. The fishing ground is mainly in the western part of Mentawai Islands (see Figure 2). Each trip ranges from 4 to 15 days with an average of 8 days, and boats carry 2.5 to 3 tonnes of ice per trip (Marcille ***et al.,*** 1984). During the past year, fishermen have started using smaller boats, locally known as “kapal unyil”, with engines of 8 to 12 hp (most of them 12 hp), and three fishermen, using 8 lines and operating 3 to 7 days per trip with an average of 6 days. The fishing grounds are the same as those of the larger boats.

A small purse seine net fishery has also developed recently in Padang, but mainly for catching small pelagics and small tunas. The Sumatra Fisheries Development Project (SFDP) in Padang has started operating a small purse seiner and a multipurpose boat.

There is no commercial scale fishery in this area. The number of small trolling boats (kapal unyil) operating in this area has increased from 51 in 1984 to 67 in 1985. There was no increase

in the number of larger boats (mostly of 33 hp) which is about 109, used for troll fishing in Padang.

In North Sumatra Province (west coast), the gear mainly used for small pelagics and small tunas are the purse seine, gillnets and encircling gillnets. In 1984, as many as 31, 68 and 853 units respectively of these gear types were registered.

In Banda Aceh, Pidie and Lhok Sumawe, the main gear used for catching small pelagics, skipjack tuna and other small tunas is the purse seine. The boats in Banda Aceh are 19 to 26 GT, with engines of 33 to 105 hp, and operate nets of about 700 to 1,200 m in length and 20 to 40 m in depth, with a crew of 20 to 23. They operate as day boats because the fishing grounds are not far, about 3 to 4 hours steaming from Banda Aceh, Pidie and Lhok Sumawe (see Figure 3). The number of boats registered in Banda Aceh, Pidie and Lhok Sumawe is presented in Table 1. The 7m boats used in Lhok Sumawe have engines ranging from 33 to 37 hp and use purse seine nets of 800 to 1,000 m length and about 55 m depth. They operate with a crew of 15 to 25. The main target species of purse seiners in the three centres is skipjack tuna and small tunas, but they also catch other pelagic fish during the night by using lights (in Banda Aceh), and during the day by using fish aggregating devices, which are locally called "unjam" or "tuasan" (in Lhok Sumawe).

3. Species composition

The tuna species caught in West Sumatra and Banda Aceh differ. In Banda Aceh, the species observed in the catches are:

- Yellowfin (Thunnus *albacares)*
- Skipjack (Katsuwonus pelamis)
- Eastern little tuna (Euthynnus affinis)
- Frigate tuna (Auxis *thazard)*
- Bullet tuna (Auxis *rochei)*

In West Sumatra (Bungus and Pariaman landing centres), the following species are caught, in addition to the above.

- Bigeye (Thunnus obesus)
- Longtail tuna (Thunnus tonggol)
- Dogtooth tuna *(Gymnosarda unicolor)*
- Double-lined tuna *(Grammatorcynus bilineatus)*

Juvenile bigeye tuna, usually 20 to 70 cm long, are caught during March, April and May. Only a few longtail, dogtooth and double-lined tuna are caught and they do not appear in the records. Although many tuna species are caught, they are reported in the statistics under three groups, i.e. :

Tuna group.	Yellowfin, bigeye and other large tunas caught by tuna longline and handline around deep sea fish aggregating devices.
Cakalang group:	Skipjack.
Tongkol group:	Small tunas, such as eastern little tuna, frigate tuna and bullet tuna, dogtooth, double-lined mackerel and bonitos *(Sarda orientalis).*

4. Production

The production of tuna in West Sumatra, North Sumatra (west coast) and Aceh (north coast) provinces is presented in Table 2. From 1976 to 1984, the production of tuna in the three provinces increased by about 11.3%, 8.6% and 5.1% respectively.

The monthly catch rates of the troll fishery in Padang (West Sumatra) in 1985 are presented in Table 3. The catch rates of larger boats appear to be higher than those of smaller boats during the entire period except in July 1985. The distribution of catch rates in West Sumatra in April 1986 is presented in Figure 2.

Monthly catch rates of the purse seine fishery in Banda Aceh are presented in Table 4. These catch rates fluctuated and revealed no trend.

5. Research activities

Fisheries research lags far behind agricultural research; the manpower, money and materials needed to probe the marine waters of Indonesia are lacking. Research into tuna fisheries was started towards the end of 1979 at some designated sampling sites that are mainly in the eastern Indonesian waters. Sampling activities in Banda Aceh were started in 1984 as a collaborative effort of the Fishing Technique Development Center, the Directorate General of Fisheries and the Bay of Bengal Programme (BOBP). In Padang, the Research Institute for Marine Fisheries (RIMF), the Sumatra Fisheries Development Project (SFDP), and the Directorate General of Fisheries commenced a collaborative programme in 1986. The sampling programme in Padang aims at collecting data on :

— catch by species by boat

— number of days per trip

-fishing grounds

— number of fishing boats landing.

Another important sampling site chosen in Sumatra is at Lampulo (Eanda Aceh). At any sampling site, the catch and effort data are collected and enumerated every day. The data collected includes :

— catch by species for each boat

— GT/hp of the boat

number of hooks or pieces of net used

— number of days per trip

— number of fishermen per boat

-fishing grounds.

For biological data, only length and weight are collected for each species. Because of budget limitations, no other biological data are collected at present, The length frequency distributions for yellowfin, skipjack, eastern little tuna and frigate tuna caught by troll lines in West Sumatra are presented in Table 5, 6, 7 and 8. The length frequency distributions for frigate tuna and skipjack caught by purse seine in Eanda Aceh are Presented in Table 9. Length-weight relationships for several tuna species are presented in Table 10.

Other biological data, such as gonad maturity, fecundity, food habits and morphometric measurements are collected incidentally by the staff of RIMF during their field visits. The preliminary result obtained by RIMF is that the size at first maturity of skipjack can be estimated at 417 mm FL for male and 428 mm FL for female (Merta, 1983). It was observed also that the food of skipjack caught in West Sumatra waters consisted mainly of fish, cephalopods and crustaceans (Merta, 1983).

Length frequency data for skipjack were analyzed using the ELEFAN program (post-Sicily version) provided by BOBP. The best combination of L_∞ and k obtained is 860 mm and 0.62 respectively. The growth, selection curves and recruitment pattern are presented in Figures 5, 6 and 7.

From the length distributions of frigate tuna in the purse seine catches, a reasonable result was obtained (Figure 4). The best values obtained for k and L_∞ are 0.85 and 620 mm respectively. From this combination, the values of M, F and E obtained are 1.31, 3.20 and 0.71 respectively. The length-converted catch curve, the selection curve of frigate tuna and their annual recruitment patterns are presented in Figures 8,9 and 10.

6. Discussion

As stated by Marcille et *al.* (1984), it is likely that the number of purse seiners operating in Banda Aceh has reached the maximum level, and any further increase in the number of boats, because of the restricted fishing grounds, may not increase the catch per boat. This is also supported by the high exploitation rate obtained from the ELEFAN analysis, as mentioned above. In order to increase the catch, two suggestions have been made :

1. Increase the size and power of the boats in order to find new fishing grounds.
2. Use deep sea fish aggregating devices which have successfully been introduced in Tomini Bay (North Sulawesi) and recently in Sorong.

It may be seen from Figure 2 that the fishing grounds for the troll fishery off Padang are very far, west of Mentawai Islands and sometimes furhter north, and can be reached in about 12 hours of steaming. The distant fishing grounds make the trip very long, even longer during the lean season, and consequently reduce the quality of the catch. Since the fuel price is high, the costs of fishing in this area are also very high -about Rp. 500,000 (US$ 450) per trip (see Table 11). This problem may be solved in the near future, because SFDP in Padang is planning to build cold storage and other facilities on Siberut Island. Another way to improve the troll line fishery in West Sumatra, as suggested by Marcille *et a/* (1984) is to use deep sea fish aggregating devices, adapting Hawaiian, Samoan or Fijian designs, which are strong enough to stand the bad weather.

However, the fishermen in West Sumatra have their own solution to the problem, i.e. using the smaller boats. Fifty-one new smaller boats (8 to 12 hp) have been given licences by the West Sumatra Provincial Fisheries Office. By using these smaller boats, fishermen can decrease operating costs to about a fourth of those of the larger vessels. They operate on the same fishing grounds, with shorter trips and the catch rates not very different.

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8. References

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Table 1

Number of purse seiners registered in Aceh Besar, Pidie and North Aceh, 1977-1984

Regency	1977	1978	1979	1980	1981	1982	1983
Aceh Besar	72	64	64	64	93	100	94
Pidie	12	8	12	12	11	14	28
North Aceh	10	41	72	83	96	98	—

Source: Marcille et *al* (1984) ; Aceh Provincial Fisheries Office.

Table 2

Catch statistics of tuna species in West Sumatra, North Sumatra (west coast) and Aceh (west coast) provinces, 1976-1984

(tonne)

Area	1976	1977	1978	1979	1980	1981	1982	1983	1984
West Sumatra									
Tuna	1,001	911	1,303	1,763	1,598	973	1,196	1,055	1,278
Skipjack	2,394	1,434	2,245	126	2,994	3,166	2,379	3,426	3,601
Tuna-like species	–	913	786	1,481	2,745	3,680	1,713	2,872	3,130
Subtotal	3,395	3,258	4,334	3,370	7,337	7,819	5,288	7,353	8,009
North Sumatra									
Tuna	234	551	626	728	720	746	571	349	566
Skipjack	209	427	350	432	438	644	1,028	587	498
Tuna-like species	870	5,423	1,153	1,453	1,194	3,209	1,894	1,703	1,476
Subtotal	1,313	6,401	2,129	2,613	2,352	4,599	3,493	2,639	2,540
Aceh									
Tuna		694	696	538	513	657	614	319	299
Skipjack	1,986	422	531	2,161	1,892	1,183	1,930	1,826	2,336
Tuna-like species	5,088	1,698	3,167	2,239	2,168	3,680	2,627	2,486	4,369
Subtotal	7,074	2,814	4,394	4,938	4,573	5,520	5,171	4,631	7,004
Total	11,782	12,473	10,857	10,921	14,262	17,938	13,952	14,623	17,553

Source: Directorate General of Fisheries, 1976-1984; Fisheries Statistics of Indonesia 1976-1984.

Table 3

Monthly catch rates of small and large trolling craft in West Sumatra

Month		No. Trips	No. of days at sea	Catch rates (kg/day at sea) YFT	SKJ	KAW	FRI	BUL	Total
1985									
May	- A	201	2,003 (10)	22.9	107.0	0.4	4.3	–	134.6
June	- A	117	1,371 (8)	6.8	174.0	–	6.1	–	186.9
July	- A	200	2178 (11)	1.3	89.8	–	2.6	–	93.8
	-B	11	57 (5)	-	157.8			–	157.8
August	- A	201	838 (4)	37.2	311.9	9.5	17.0	1.0	376.7
	-B	19	80 (4)	4.6	153.0	26.3	37.7	3.8	225.4
September	-A	206	1,062 (5)	5.0	210.3	0.2	0.3	–	215.8
	-B	8	37 (5)	31.4	133.0		0.3	–	164.7
October	-A	195	2,388 (12)	19.5	69.1	12.9	7.5	–	88.7
	-B	25	291 (12)	15.8	53.2			–	69.1
November	-A	201	2,470 (12)	19.4	63.2	27.3	12.5	–	122.4
	- B	36	405 (11)	18.0	41.9	0.4	0.04	–	60.3
December	- A	174	2,015 (12)	23.5	75.9	0.1	0.1		99.5
	- B	25	246 (10)	12.9	61.3	–	–	–	74.2
1986									
January	- A	160	1,902 (12)	23.5	59.8	—		––	83.3
	- B	13	164 (13)	13.4	33.7	5.0	4.1	–	56.1
February	- A	128	1,622 (13)	16.2	60.9	0.03	0.02	--	77.1
	-B	18	195 (11)	14.2	40.2	4.4	3.4	–	62.7
March	-A	128	1,587 (12)	17.7	49.2	1.7	2.1	–	70.6
	- B	44	278 (6)	9.3	26.5	17.2	16.9		69.8
April	- A	112	1,309 (12)	26.2	65.6	0.7	0.05	–	92.6
	- B	14	134 (10)	9.4	42.1	15.3	8.7	–	75.5
	-A	2,023 (169)	20,745 (1 ,729)	(18.3)	(111.4)	(4.4)	(4.4)	(0.1)	(133.5)
	- B	213	1,887	(10.8)	(61.9)	(5.7)	(5.9)	(0.3)	(84.6)

A: >20 GT boats
B: <20 GT boats (locally called "kapal unyil")
Figures in brackets are average trip durations

Table 4

Monthly catch rates of tuna in the purse seine fishery in Banda Aceh (1985)

Month	No. of operating days	Catch rates (kg/day)					
		YFT	SKJ	LTT?	FRI	Others	Total
January	445	1.0	103.8	131.7	13.0	3.1	252.6
February	384		108.6	88.1	96.2	14.3	307.2
March	297	0.3	45.8	28.5	33.7	97.1	205.4
April	269	—	8.8	3.7	124.9	114.8	252.2
May	136	—	7.9	6.5	421.7	58.2	494.3
June	51	—	86.4	—	43.6	29.4	159.4
July	193	—	51.7	—	114.3	26.3	192.3
August	—	—	—	—	—	—	—
September	297	—	79.5	—	158.3	122.3	360.1
October	408	—	96.0	—	257.8	188.4	542.2
November	374	—	101.3	—	121.5	337.6	560.4
December	330	—	79.1	—	147.6	246.8	473.5
Average	289	0.1	69.9	23.5	139.3	111.7	344.5

Keterangan : YFT : Yellowfin tuna
SKJ : Skipjack
LTT? : Long tail tuna (not sure yet)
FRI : Frigate tuna

Source: Fishing Technique Development Center (FTDC), Semarang.

Table 5

Length frequency distributions of yellowfin tuna caught by troll line in West Sumatra (1985/l 986)

Mid-length (cm)	1985								1986			
	5	6	7	8	9	10	11	12	1	2	3	4
22	2			1								
26	6			1								
30	20	1	1	1	3	7	4			8		7
34	33	14	6	4	6	10	10	4	8	7	2	12
38	39	9	7	6	2	5	14	13	24	19	13	20
42	19	8	–	7	63	199	131	154	107	16	22	24
46	31	2	2	12	94	330	678	787	664	364	244	204
50	58	14	–	55	35	158	178	207	140	609	700	483
54	101	8	8	60	31	123	78	60	42	50	97	132
58	52	9	9	90	10	115	76	29	18	40	4	21
62	37	2	2	65	6	17	55	14	6	3	1	3
66	9	2	1	32		3	8	2	1	4		–
70	9	—	1	4								3
72	8	–	1	3								1
78	5	–		2								
82	2	–		–								
86	5	–		–								
90	3	1		2								
94	1			1								
	440	70	38	346	250	967	1,232	1,270	1,010	1,120	1,083	910

Table 6

Length frequency distributions of skipjack caught by troll line in West Sumatra (1985/86)

Mid-length (cm)	1985									1986		
	5	6	7	8	9	10	11	12	1	2	3	4
18	3	1										
22	10	7	12	5								
26	19	36	50	9								
30	67	89	164	36	8	4	1	11	17	22		4
34	93	91	216	43	3	1	2	3	–	3		18
38	99	98	178	141	21	34	3	6	3	29	3	15
42	104	118	154	160	324	386	434	439	358	142	63	50
46	152	145	148	158	307	522	593	700	636	516	524	447
50	180	129	145	139	237	352	350	232	177	365	508	434
54	130	116	58	142	42	62	44	47	28	67	69	111
58	115	126	66	128	8	4	3	2	1	4	3	11
62	34	40	21	34						2		1
66	18	4	4	27								1
70	7											
74	3											
78	3											
82	1											
86	–											
90	2											
	1,040	1,000	1,216	1,022	950	1,365	1,430	1,440	1,220	1,150	-1,170	1,092

Table 7

Length frequency distributions of eastern little tuna caught by troll line in West Sumatra (1985/86)

Midlength (cm)	1985								1986			
	5	6	7	8	9	10	11	12	1	2	3	4
23	1	4										
25	1	10		13								
27	1	10		19								
29	1	14		25			1					
31	1	7	18		8		—					
33	1	8	10		3	1	3				8	3
35	–	12	15		18	8	21	3		6	47	23
37	1	11	43		2	5	8	3	2	6	14	6
39	–	2	32		2	3	5	1	1	3	35	3
41	1	2	30		–	–	5	–	1	3	3	2
43	–	27		3		8	3	–	1	1	2	1
45	–	32		2		7	6	3	1	10	–	1
47	1	2		–		2	5		1	4	1	1
49	1		2			1	2		3	3		1
51							–					1
53							1					2
55												2
57												1
59												1
	10	80	266	40	35	60	10	10	36	110	48	

Table 8

Length frequency distributions of frigate tuna caught by troll line in West Sumatra (1985/86)

Midlength (cm)	1985								1986		
	5	6	7	8	9	10	11	12	1	2	3	4
21			4									
23			5	2								
25			11	12								
27			9	23								
29			1	30			1					
31			4	26	9	5	2					
33			1	14	5	1	4			3	25	13
35			–	34	14	18	3	6		11	22	17
37			1	23	1	3	15	–		7	–	
39			—	23	1	2	6	–		3	15	
41			–	34	2	1	2	–		2	1	
43			1	22	–	—	1	–		2	4	
45			1	15	1	—	2	–		3	–	
47			5	5	—	—	–	1		7	3	
49			5	5		—	1	1		2		
51			–		1							
53			1		1							
			49	268	35	30	37	8		40	70	30

Table 9

Length frequency distributions of skipjack and frigate tuna from Banda Aceh

Mid-length (cm)	*Katsuwonus pelamis*															*Auxis thazard*												
	1984								1985							1984					1985							
	5	6	7	8	9	10	11	12	1	2	3	4	5	6	7	6	7	8	9	10	11	12	1	2	3	4	5	6	7
300											1					8					1		1		1				
320									3		7	6				14					12		2	6	14	5	1	3	2
340									0		1	0				4	1				3		3	2	1	0	0	0	0
360									3		13	4				4	1				17	2	13	6	12	10	3	1	3
380	1		2					10	6		9	5				11	2	1			12	8	19	9	15	5	3	4	2
400	2	2	5			1	6	4	15	2	15	6		2		30	18	4	2	5	45	13	28	20	18		5	7	12
420	2	3	2			0	0	2	5	7	13	4		3	1	18	1	1	0	1	28	13	14	12	8		2	0	4
440	5	30	3	7		0	6	32	10	8	5	5	1	5	1	17	1	17	0	6	5	34	18	5	0		0	0	2
460	7	19	18	8		3	22	6	11	25	17	12	2	5	4	24	26	19	3	10	8	16	30	12	8		1	4	8
480	11	47	27	7		7	37	16	35	21	15	10	9	2	8	15	32	17	2	6	18	13	33	17	11		1	2	10
500	15	64	52	72	55	56	47	80	40	29	16	8	5	4	9	13	48	90	92	66	27	77	46	23	9		3	3	4
520	6	16	32	45	18	20	42	9	27	16	6	5	2	4	4	18	30	39	32	13	18	5	21	10	2		0	0	0
540	1	3	2	2	1		7	10	6	1	2	1	1		1	1	6	3			1	3	4	3	3			1	0
560	0	0	1					17	1							0		3			0	4	1	0					0
580		1						8	0							0		2			0	5	0	0					0
600		2							2							5					11		3	2					1
	50	187	144	141	74	87	167	194	164	109	120	66	20	25	28	182	166	196	131	107	206	193	236	127	102	20	19	25	48

Source: Fishing Technique Development Center, D.G.F.

Table 10

Length-weight relationships of several tuna species from Padang, June and July 1985

	n	a	b	s^2	r	L_1-L_n (cm)
June						
Yellowfin	70	0.663×10^{-1}	2.705237	0.020	0.9785	26-90
Skipjack	980	0.226×10^{-1}	2.981127	0.067	0.9357	24-67
Eastern	80	0.364×10^{-1}	2.789002	0.053	0.8848	21-41
Frigate	-	-	-	-	-	-
July						
Yellowfin	38	0.672×10^{-2}	3.258277	0.049	0.9639	29-75
Skipjack	1252	0.847×10^{-2}	3.238389	0.031	0.9712	21-67
Eastern		-	-	-		-
Frigate	743	0.194×10^{-2}	3.59688	0.033	0.9859	21-53

Yellowfin : ***Thunnus albacares***
Skipjack : ***Katsuwonus pelamis***
Eastern : ***Euthynnus affinis***
Frigate : ***Auxis thazard***

Table 11

The development of tuna export and fuel price, 1976-1984

	1976	1977	1978	1979	1980	1981	1982	1983	1984
Total volume (tons)	62'1	1,898	9,426	9,797	11 ,1 39	14,013	18,788	20,311	14,702
Total value (US $'000)	33	19	6,193	8,003	12,900	15,416	19,863	14,776	10,674
Tuna (US $/ton)		—	—	1,124	1,424	1,533.3	1,293.3	1,259	1,253
Skipjack (US $/ton)	—	—	—	871	1,190	1,210	980	500	550
Fuel (Rp./litre)	—	—	—	35	52.5	52.5	85	145	220

Source: Tambunan (1985) ; Directorate General of Fisheries (1984)

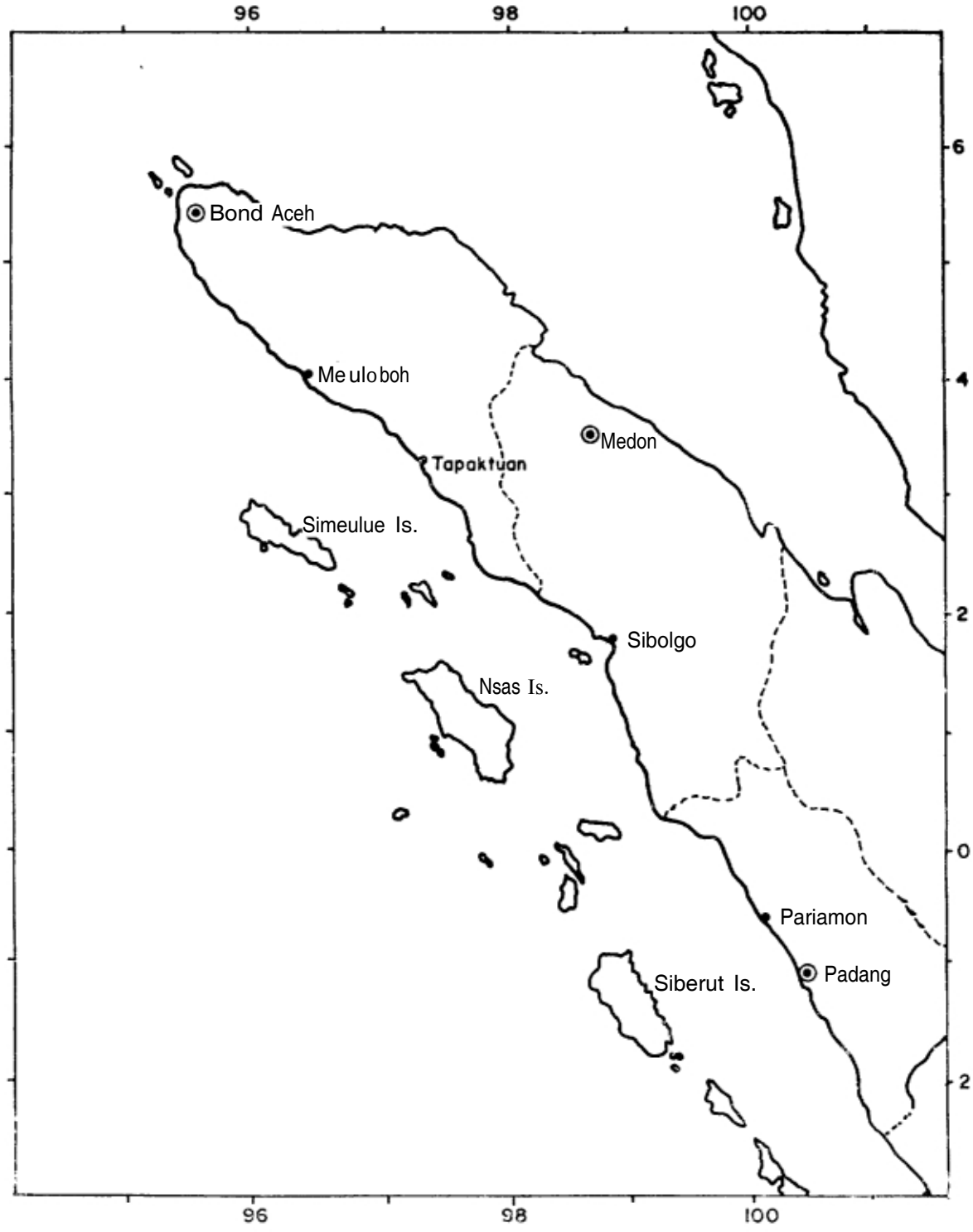

Fig. 1 Map of western and northern Sumatra waters.

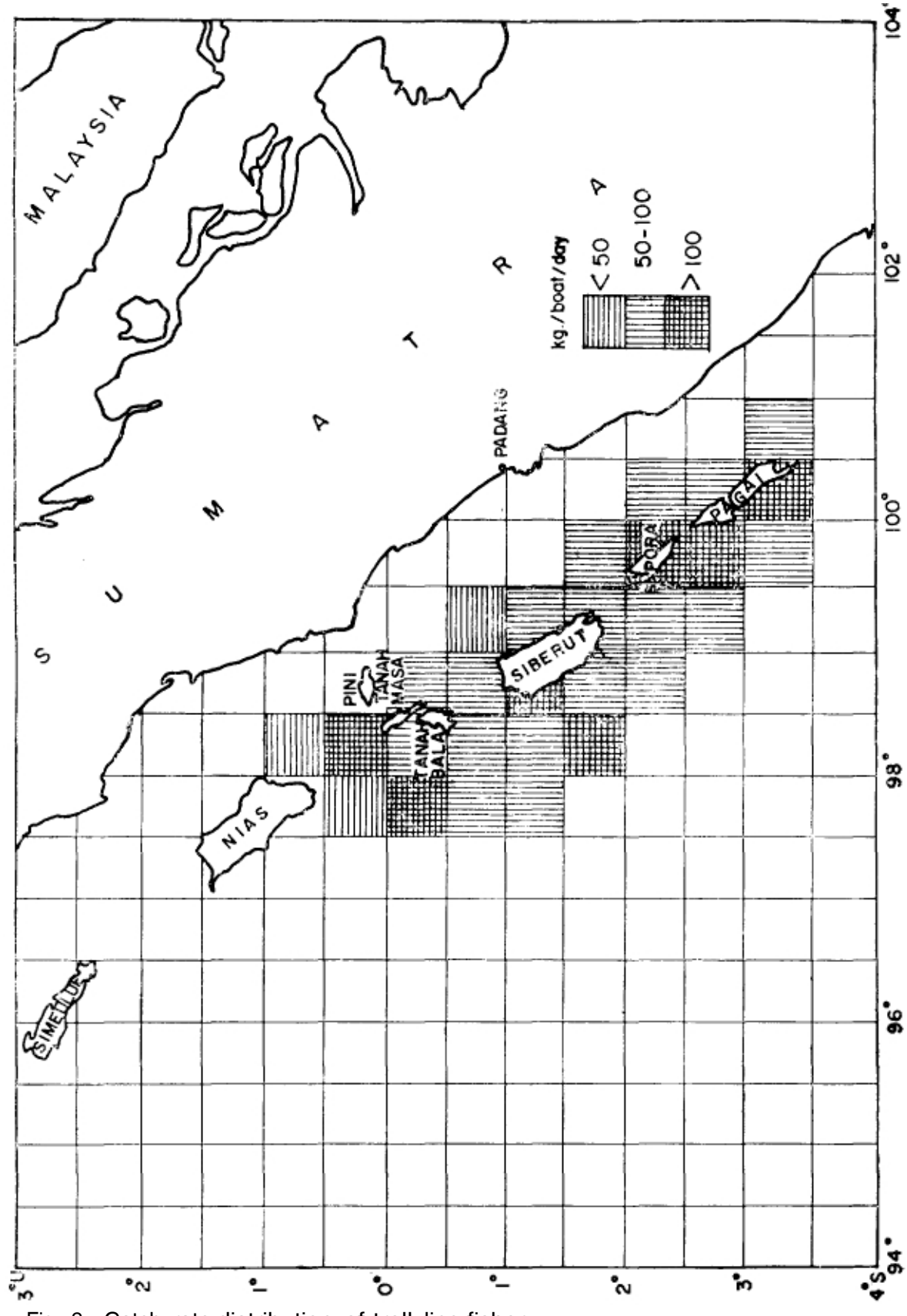

Fig. 2 Catch rate distribution of troll line fishery for tuna in the West Sumatra area (April 1986).

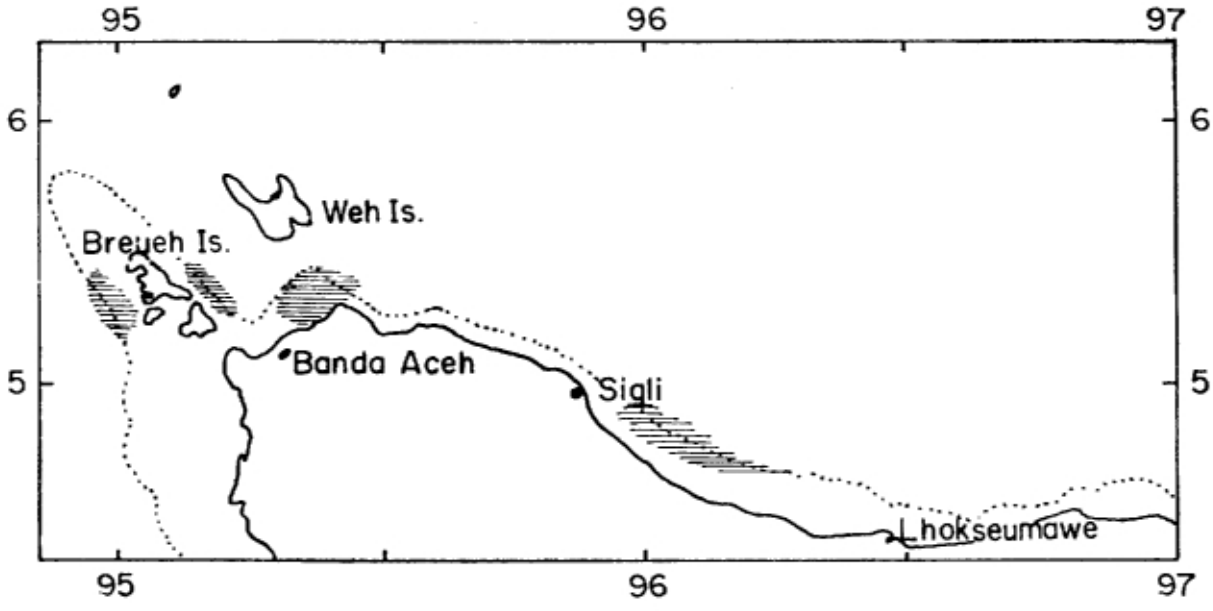

Fig. 3 Major fishing grounds for the artisanal purse seine fishery in the north of Sumatra (Marcitle et al., 1984).

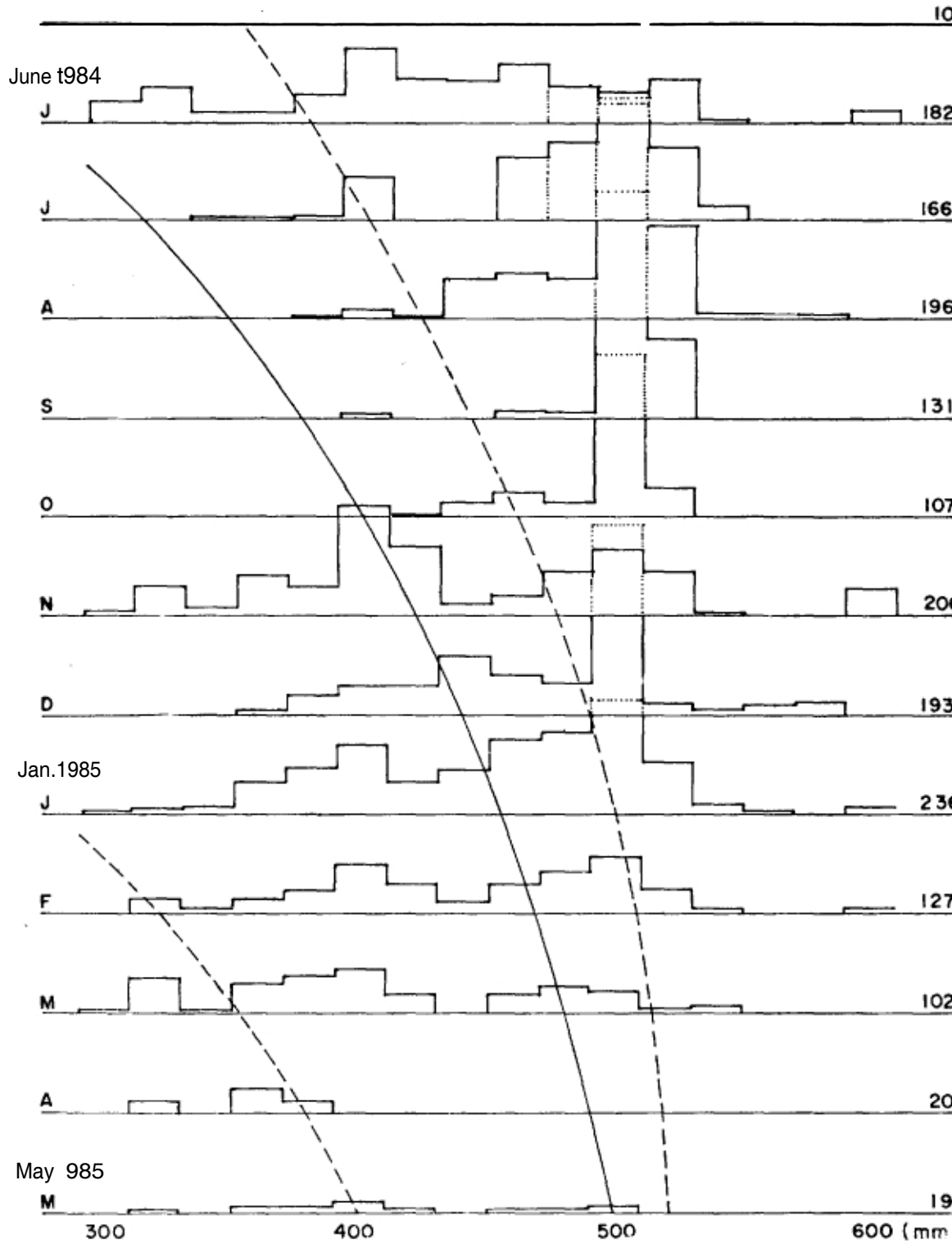

Fig. 4 Monthly length frequency distribution of *A. thazard,* caught by purse seine in Banda Aceh (1984—1985).

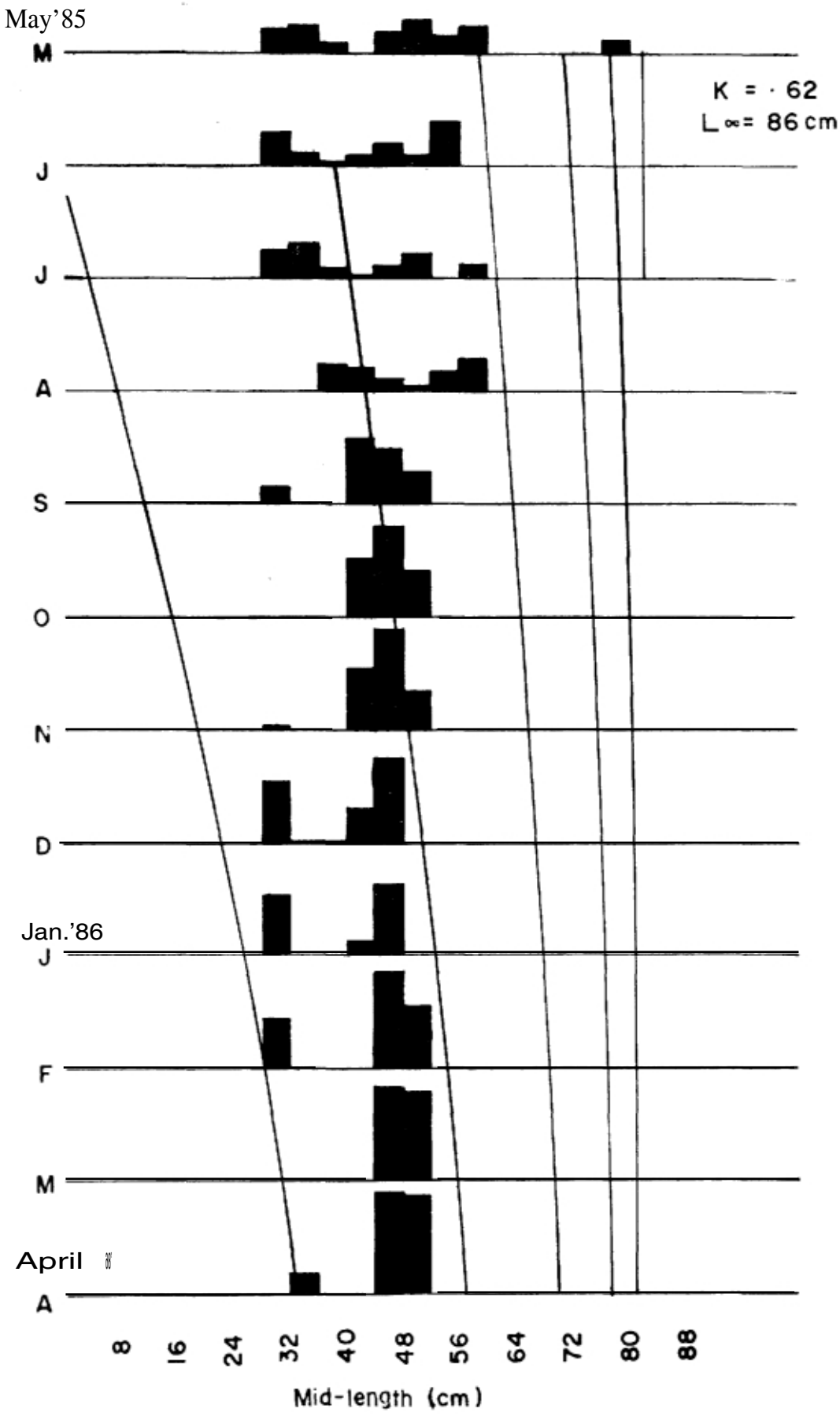

Fig. 5 Monthly length frequency distribution of *K. pelamis* caught by troll lines on the west coast of Sumatra (1985—1986).

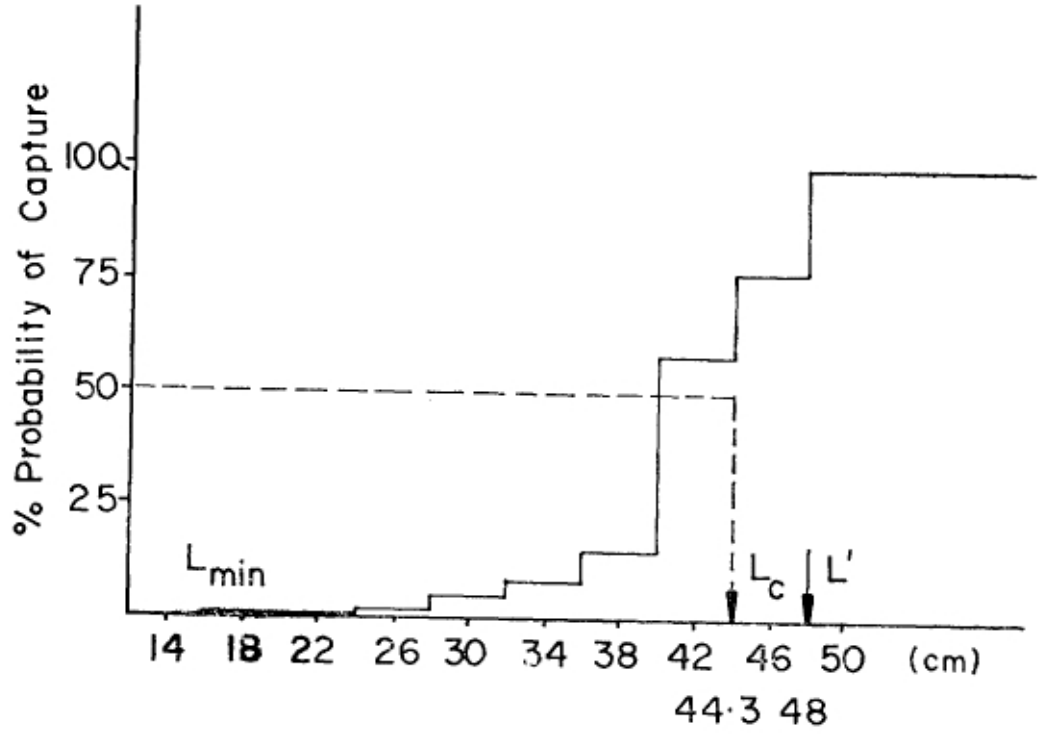

Fig. 6 Selection curve of *K. pelamis* caught by troll lines off West Sumatra (1985 —1986).

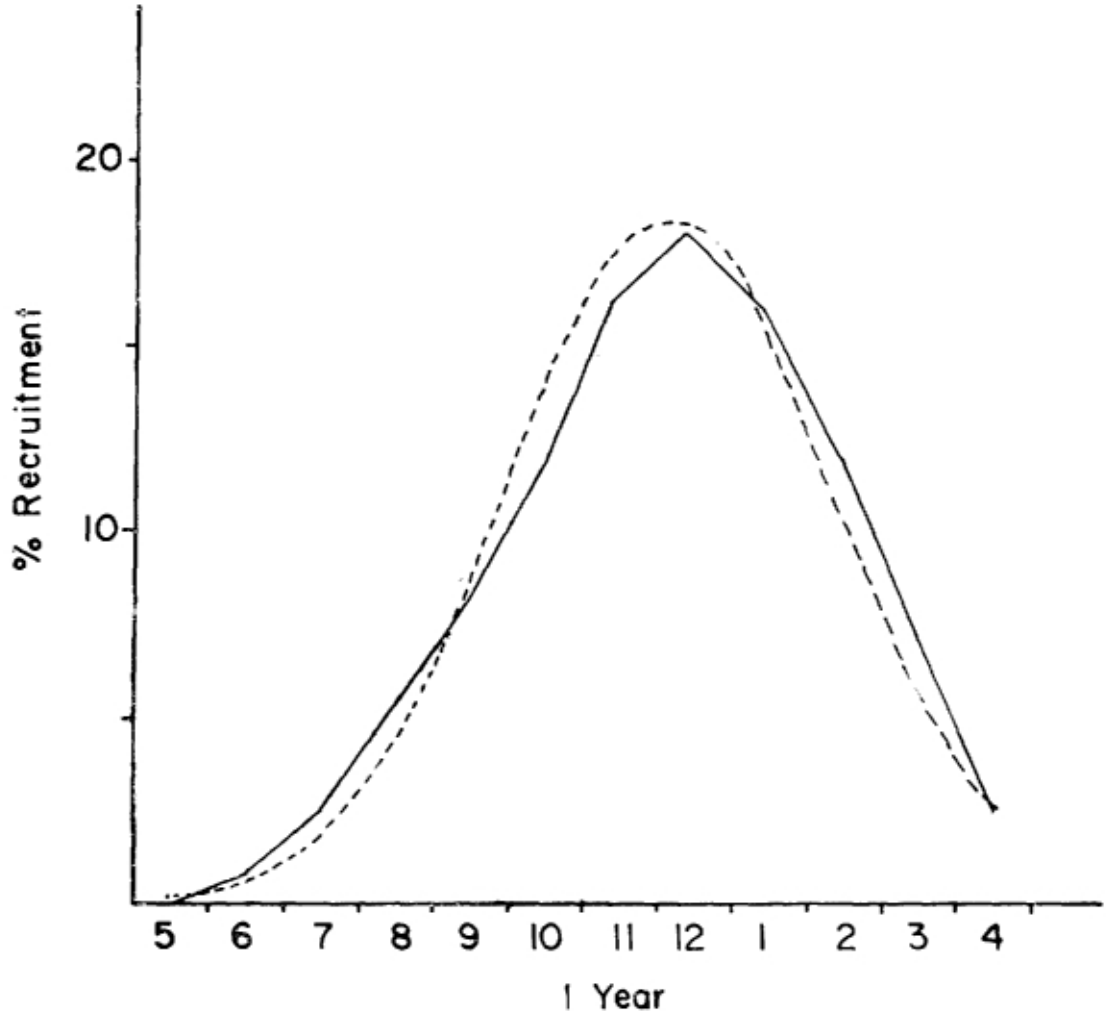

Fig. 7 The annual recruitment pattern of *K. pelamis* from West Sumatra (1985—1 986)

Fig. 8 Length converted catch curve for *A. thazard* from West Sumatra.

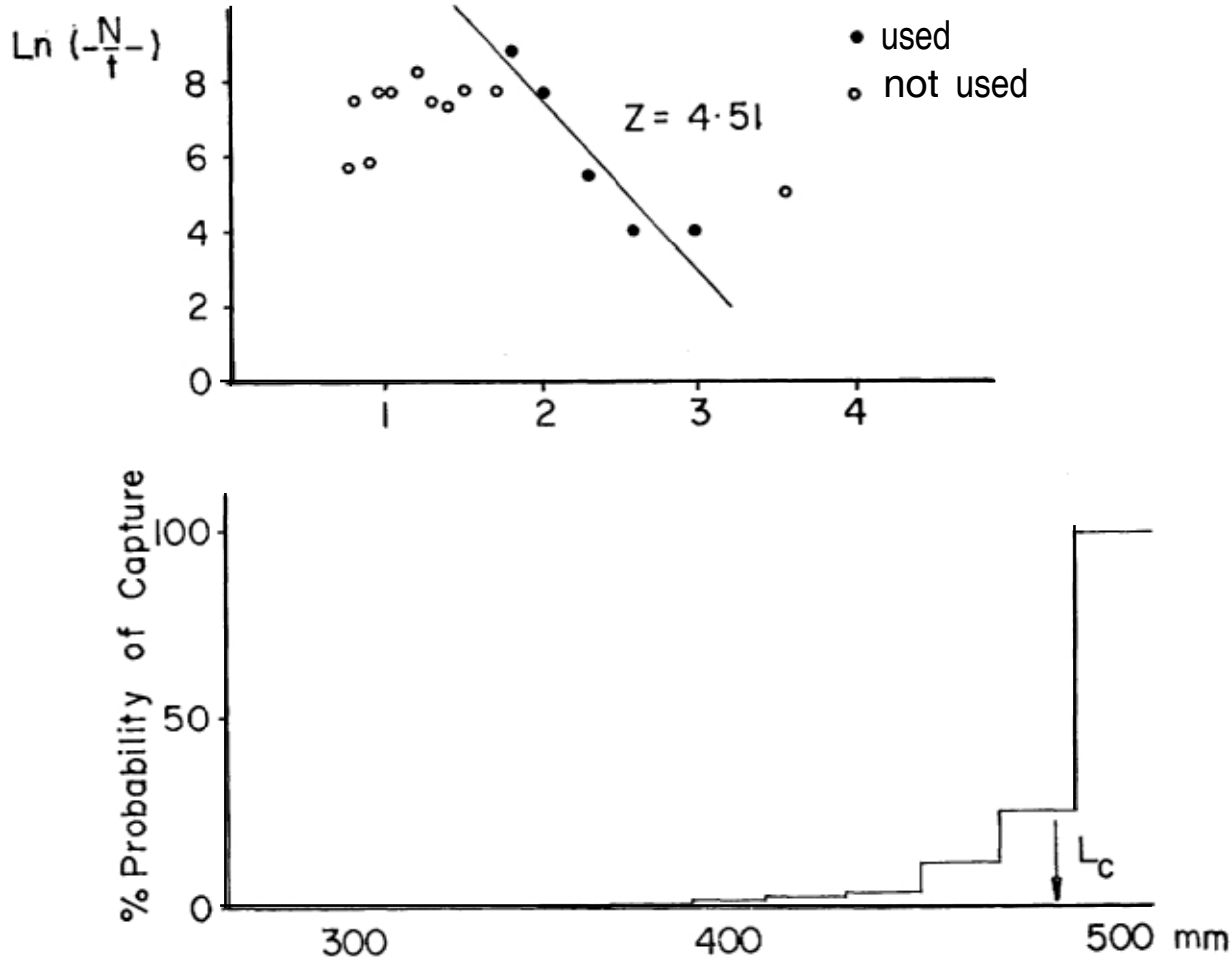

Fig. 9 Selectivity pattern of *A. thazard* troll fishery in West Sumatra.

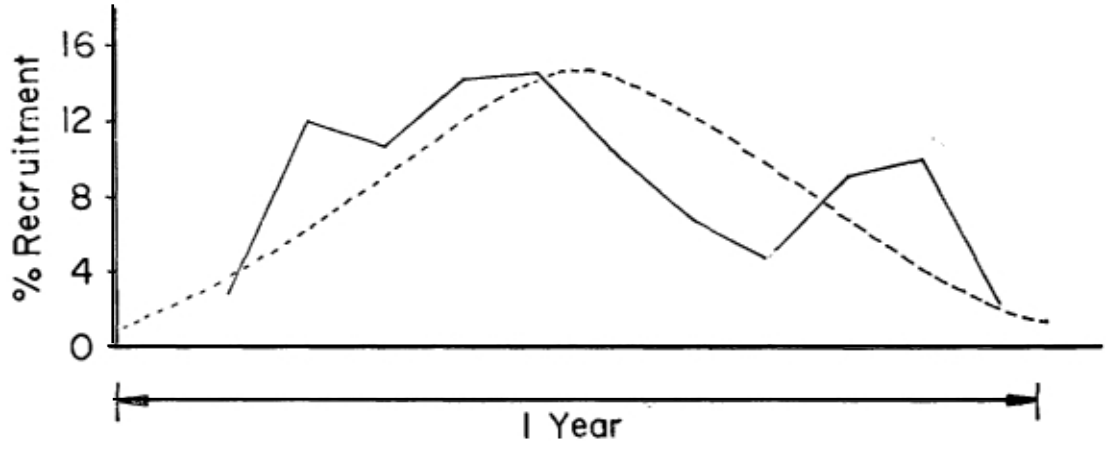

Fig. 10 Annual recruitment pattern of A. *thazard* from west coast of Sumatra.