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Evaluation of Stern Trawler Operation in the Wadge Bank for Economic Exploitation of its Demersal Fish Resources

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Introduction

The Ceylon Fisheries Corporation operates five stern trawlers, namely, the "Gandara", "Beruwala", "Pesalai", "Meegamuwa" and "Myliddy". They are 238 ton trawlers which are similar in specifications. These trawlers can remain out of port for a maximum of twenty days. They do not have freezing facilities on board, the fish being stored on ice in a refrigerated fish hold. Under tropical conditions dressed fish can remain in good condition in the holds on ice for a maximum period of twelve days (Gunasekara & Lantz 1955). Accordingly, these trawlers can be economically operated only in fishing grounds with a fairly high productivity and in close proximity to a fishing port, thus enabling them to utilize the greater part of their time out of port in fishing. The Wadge Bank which is about 15 hours steaming from Colombo is one such fishing ground.

The records of the exploitation of demersal fish resources by trawlers during the past two decades indicated a decline in productivity and uneconomical fishing operations. The possible reasonsfor the decline can be deduced by analysis of the fishing records of trawlers that have fished in the banks. Such an analysis can also provide a basis for planned management in the exploitation of demersal stocks of fish. This paper attempts to provide such a basis for the Wadge Bank.

Annual Productivity

The term productivity is taken to mean the quantity and rate at which this quantity of fish is taken from the bank by commercial fishing trawlers.

The year for the purpose of this study is from November to October of the following year. This is considered appropriate as fish catches are influenced by the two monsoons, one from November to April and the other from May to October (Sivalingam 1966).

In the years prior to 1965–66 the fishing effort with two trawlers was comparatively moderate, except in the years 1960–61, 62–63 and 63–64 when the effort was very low (Table I), mainly due

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TABLE I

The Quarterly, Half Yearly and Yearly Distribution of Catch and Effort in the Wadge Bank and the Catch per Unit Effort in respect of each period

Period	Catch in (lbs.)	% in total for year	Effort (in hrs.)	Catch/ Unit Effort	Period	Catch in (lbs.)	% in total for year	Effort (in Hrs.)	Catch/ Unit Effort	Total Catch in (lbs.)	Effort (in hrs.)	Catch/ Unit Effort
1956 November-1957 January	409,080		1073·75	380·9	May-July	1,039,360		1618	642·3			
Feb-April ..	614,720		1527	402·5	Aug-Oct	1,045,280		1032	1012·8			
	1,023,800		2600·75	393·6		2,084,640		2650	786·6			
		32·9					67·1			3,108,440	5250·75	591·9
1957 November-1958 January	400,400		1068·5	374·7	May-July	964,640		865·25	1114·8			
Feb-April ..	486,480		1385·5	351·1	Aug-Oct	807,360		723·5	1115·9			
	886,880		2454	361·4		1,772·000		1588·75	1115·3			
		33·3					66·7			2,658,880	4042·75	657·6
1958 November-1959 January	507,440		1234·25	411·1	May-July	543,680		796·75	682·3			
Feb-April ..	404,880		1194·5	338·9	Aug-Oct	1,202,080		1478·5	813			
	912,320		2428·75	375·6		1,745,760		2275·25	767·2			
		34·3					65·7			2,658,080	4704	565
1959 November-1960 January	297,280		818·25	363·3	May-July	510,800		452	1130			
Feb-April ..	339,600		891·75	380·8	Aug-Oct	1,188,640		1400·75	848·5			
	636,880		1710	372·4		1,699,440		1852·75	917·2			
		27·2					72·8			2,336,320	3562·75	655·7
1960 November-1961 January	365,880		886	412·4	May-July	626,320		732	855·6			
Feb-April ..	395,600		770·75	513·2	Aug-Oct	557,200		543	1026·1			
	761,480		1636·75	465·2		1,183,520		1275	928·2			
		39·1					61·9			1,945,000	2911·75	667·9
1961 November-1962 January	439,260		951·5	461·6	May-July	622,000		686·75	905·7			
Feb-April ..	462,000		830·25	556.4	Aug-Oct	866,880		1191·5	727·5			
	901,260		1781·75	505·8		1,488,800		1878·25	792·6			
		37·7					62·3			2,390,140	3660	653

1962 November-1963 January	285,520		594	480·6	May-July	295,860		441·5	670·1			
Feb-April ..	282,160		586·5	481	Aug-Oct	486,280		700·5	664·1			
	567,680		1180·5	480·8		782,140		1142·	682·8			
		42·0					58·0			1,349,820	2322·5	581·1
1963 November-1964 January	185,389		529	350·4	May-July	326,997		433·75	753·8			
Feb-April ..	274,801		683·25	402·1	Aug-Oct	418,198		802·5	521·1			
	460,190		1212·25	379·6		745,195		1236·25	602·7			
		38·1					61·9			1,205,385	2448·5	492·2
1964 November-1965 January	321,381		773	415·7	May-July	603,041		1115·75	540·4			
Feb-April ..	371,269		738·25	502·9	Aug-Oct	989,718		1626	608·6			
	692,650		1511·25	458·3		1,592,759		2741·75	580·9			
		30·2					69·8			2,285,409	4253	537·3
1965 November-1966 January	653,274		1352·75	482·9	May-July	1,448,970		3120	464·4			
Feb-April ..	1,379,622		3384	407·6	Aug-Oct	1,684,119		3613·25	466			
	2,032,896		4736·75	429·1		3,133,089		6733·25	465·3			
		39·5					60·5			5,165,985	11470	450·4
1966 November-1967 January	1,023,827		3625·25	282·4	May-July	1,337,317		4034·5	331·4			
Feb-April ..	1,092,005		4282·75	254·9	Aug-Oct	1,070,754		2829	378·4			
	2,115,832		7908	267·5		2,408,071		6863·5	350·8			
		46·7					53·3			4,523,903	14771 5	306·2
1967 November-1968 January	598,756		2987·5	200·4	May-July	767,853		2051·25	374·3			
Feb-April ..	250,934		1182	212·2	Aug-Oct	1,238,788		2439·25	507·8			
	849,690		4169·5	203·7		2,006,641		4490·5	446·8			
		29·7					70·3			2,855,331	8660	329·7
1968 November-1969 January	807,411		2611·75	309·1	May-July	1,064,087		1849·5	575·3			
Feb-April ..	627,139		2221·5	282·3	Aug-Oct	1,532,866		3034·5	505·1			
	1434,550		4833·25	296·8		2,596,953		4884	531·7			
		35·5					64·5			4,031,503	9717·25	414·8

to one of the trawlers being tied up for part of the time. However, it will be seen from Table I that in 1963—64 the catch per unit effort remained high.

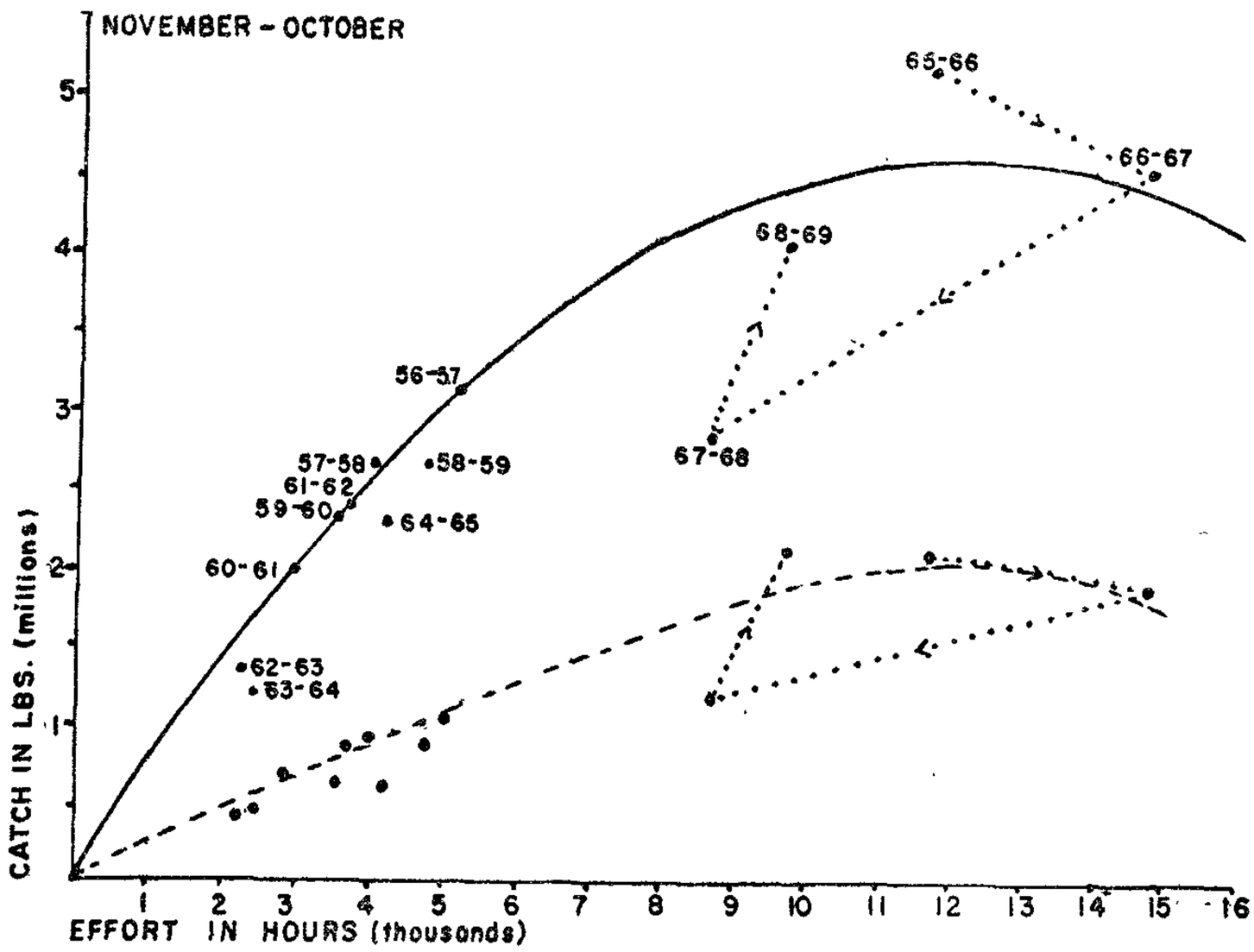

FIG.1 REGRESSION LINE RELATIVE TO CORRELATION BETWEEN CATCH AND EFFORT 1956 TO 1969 (—— Total Catch) ---- Big Fish Catch) IN WADGE BANK

From 1966 onwards there was heavy fishing in the banks with six trawlers operating from Colombo. This increased fishing pressure produced the highest catch in the year 1965—66 although the catch per unit effort was lower than in the previous years. (Fig. 1 and Table I). However, with this same fleet of trawlers, a further increase in effort in the following year 1966—67 did not bring about the desired result. Production dropped by 12.4% and the catch per unit effort which had shown a downward trend reached a new low in that year. A reduced effort in 1967—68 brought about a drop in production by 38% below that of the preceding year, but the signs of recovery were apparent, the catch per unit effort showing an upward trend (Table I). In 1968—69 production increased by 41%. This was achieved with only a 11%increase over the effort of the preceding year, and recovery of the fishery was almost complete as shown by the catch per unit effort (Table I).

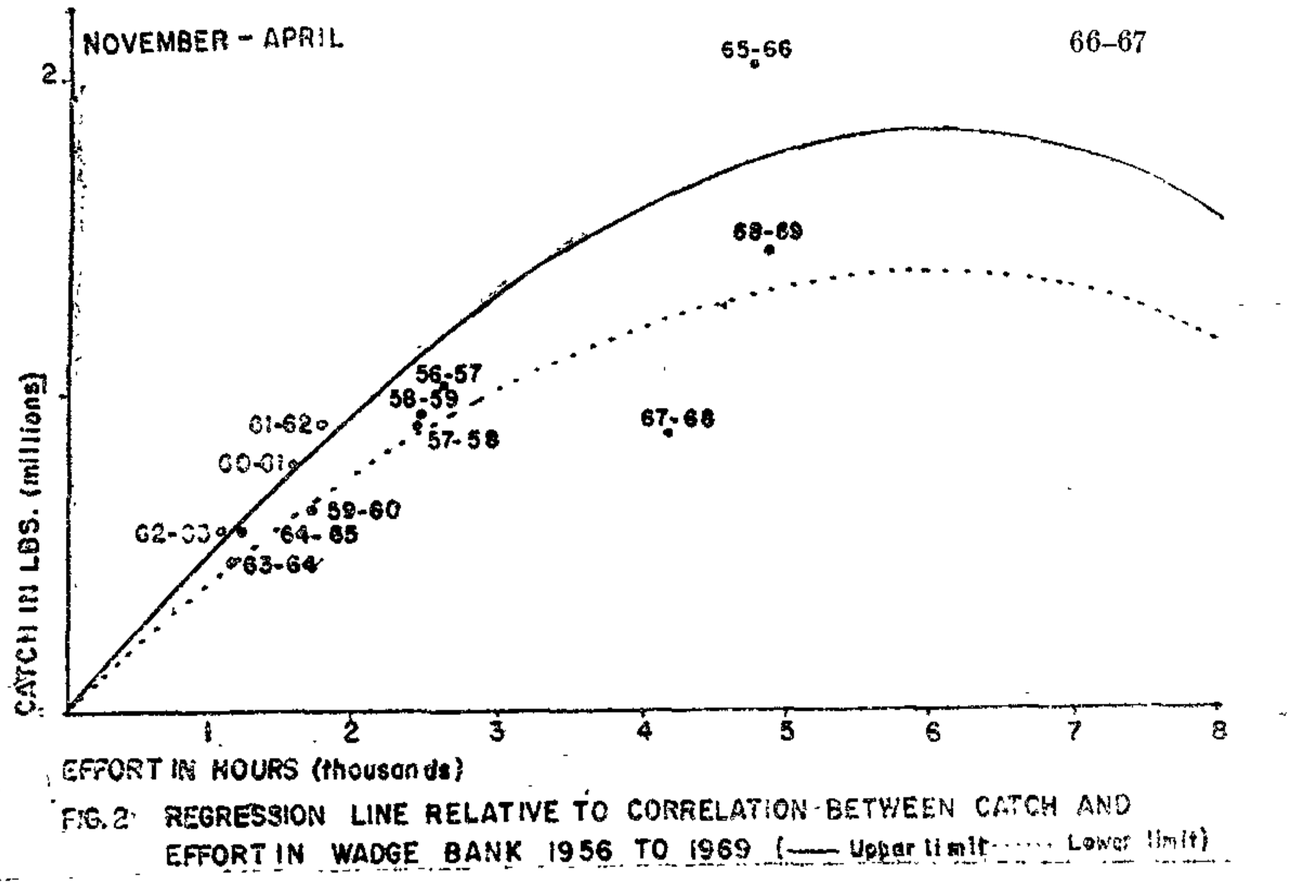

FIG. 2 REGRESSION LINE RELATIVE TO CORRELATION BETWEEN CATCH AND EFFORT IN WADGE BANK 1956 TO 1969 (—— Upper limit ..... Lower limit)

Seasonal Productivity

Two distinct levels of productivity are discernible from a study of Table I. The lower level is during the period of the North East monsoon (November to April—Fig. 2), and the higher level is during the South West monsoon (May to October—Fig. 3). The higher productivity during the South West monsoon is chiefly due to the availability of more fish for capture, brought about by the influx of some migrant groups of fish (Table II), which are generally not found in abundance at other times of the year. (Sivalingam & Medcof 1957).

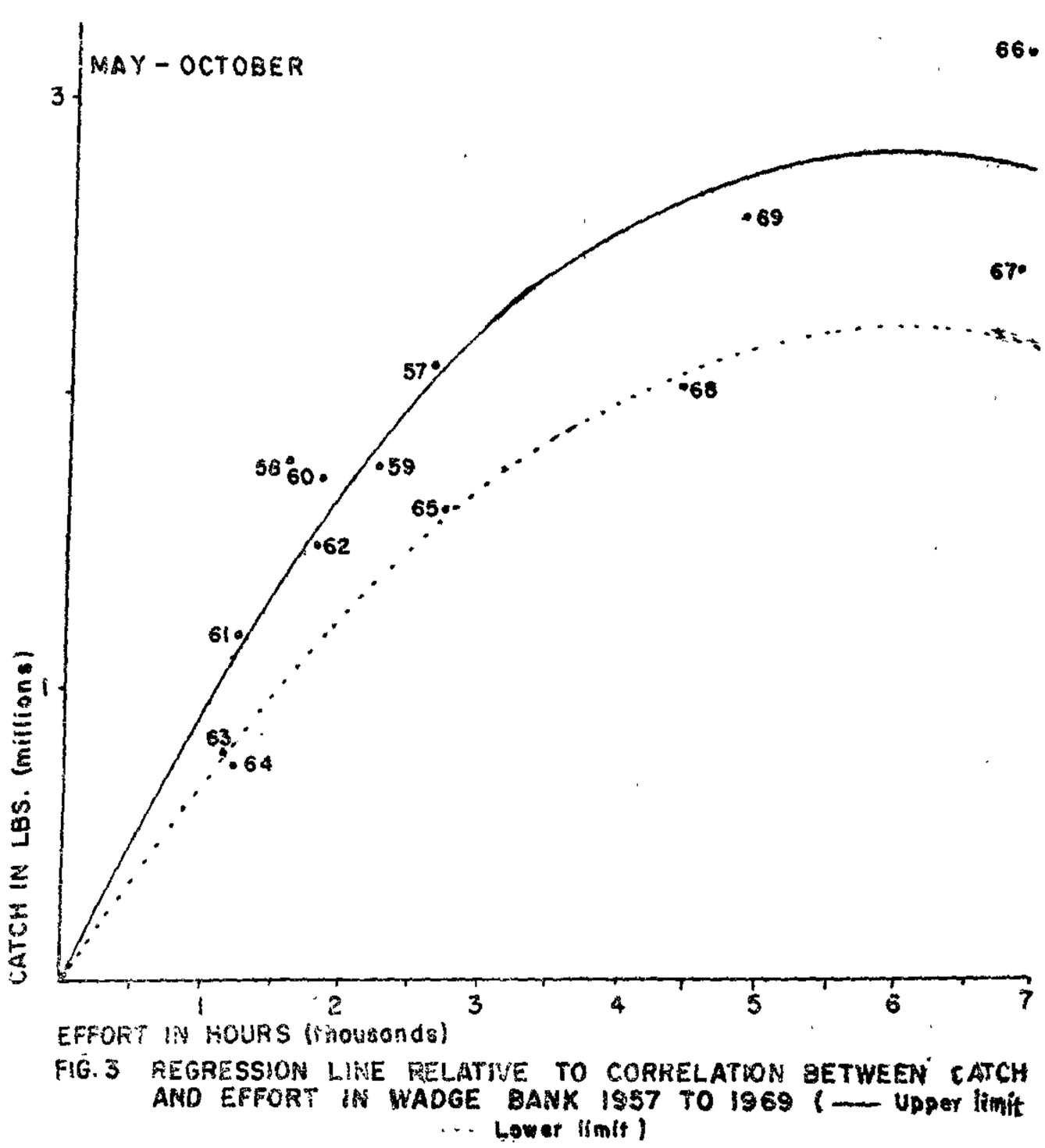

FIG. 3 REGRESSION LINE RELATIVE TO CORRELATION BETWEEN CATCH AND EFFORT IN WADGE BANK 1957 TO 1969 (—— Upper limit ··· Lower limit)

(*a*) November to April

Fig. 2 shows the regression curve relative to the correlation between catch and effort for this period. An increase in effort in 1966—67 did result in a small increase in production over 1965—66. An additional effort of 3172 hours producing 82,936 lbs. more fish (a rate of 26 lbs. per hour). The trend in subsequent years was similar to that shown in Fig. 1.

There was a rapid increase in fishing pressure in February to April 1966 due to the introduction of two new stern trawlers "Beruwala" and "Pesalai" making a total of four trawlers. An increased effort during the same period in 1967 saw a drop in the catch (Fig. 4B).

This was followed by low catches in November to January 1967—68 (Fig. 4A & Table I) and February to April 1968 (Fig. 4B & Table I). The catch per unit effort in respect of the "Resident" groups of fish for the same period was the lowest (Table II).

TABLE II

The Catch per Unit Effort in Respect of the Major Groups of fish in the Wadge Bank Trawler Fishery

Period of Year	Group	CPUE In lbs/hr for Resident Groups				Group	CPUE in lbs/hr for Migrant Groups			
		1965—66	1966—67	1967—68	1968—69		1965—66	1966—67	1967—68	1968—69
November to April ..	Big Fish	216	137	103	152	Parati	7	4	2	2
	Small Fish	110	35	28	17	Paraw	2	2	3	3
	Shark	19	6	5	11	Dog Fish	6	4	3	6
	Skate	23	31	15	16	Cat Fish	11	11	11	21
May to October ..	Big Fish	148	112	158	279	Parati	49	21	12	6
	Small Fish	45	47	23	16	Paraw	33	13	34	3
	Shark	31	18	13	39	Dog Fish	23	18	22	23
	Skate	38	38	44	85	Cat Fish	19	55	41	41
November to October ..	Big Fish	176	126	132	218	Parati	31	12	7	4
	Small Fish	71	40	25	16	Paraw	20	6	19	3
	Shark	26	12	9	25	Dog Fish	16	11	13	14
	Skate	32	34	30	52	Cat Fish	14	31	26	32

Note:— Big Fish — Lutianids, Lethrinids, Epinephelids, Plectorhynchids, Sciaenids.
Small Fish — Small Lutianids, Lethrinids, Epinephelids, Plectorhynchids, Sciaenids, Mullids, Ephippids, Scolopsids, Pomadasyids.
Shark — Carcharinids (large)
Skate — Trygonids
Parati — Small Carangids
Paraw — Large Carangids
Dog Fish — Small Carcharinids
Cat Fish — Tachysurids

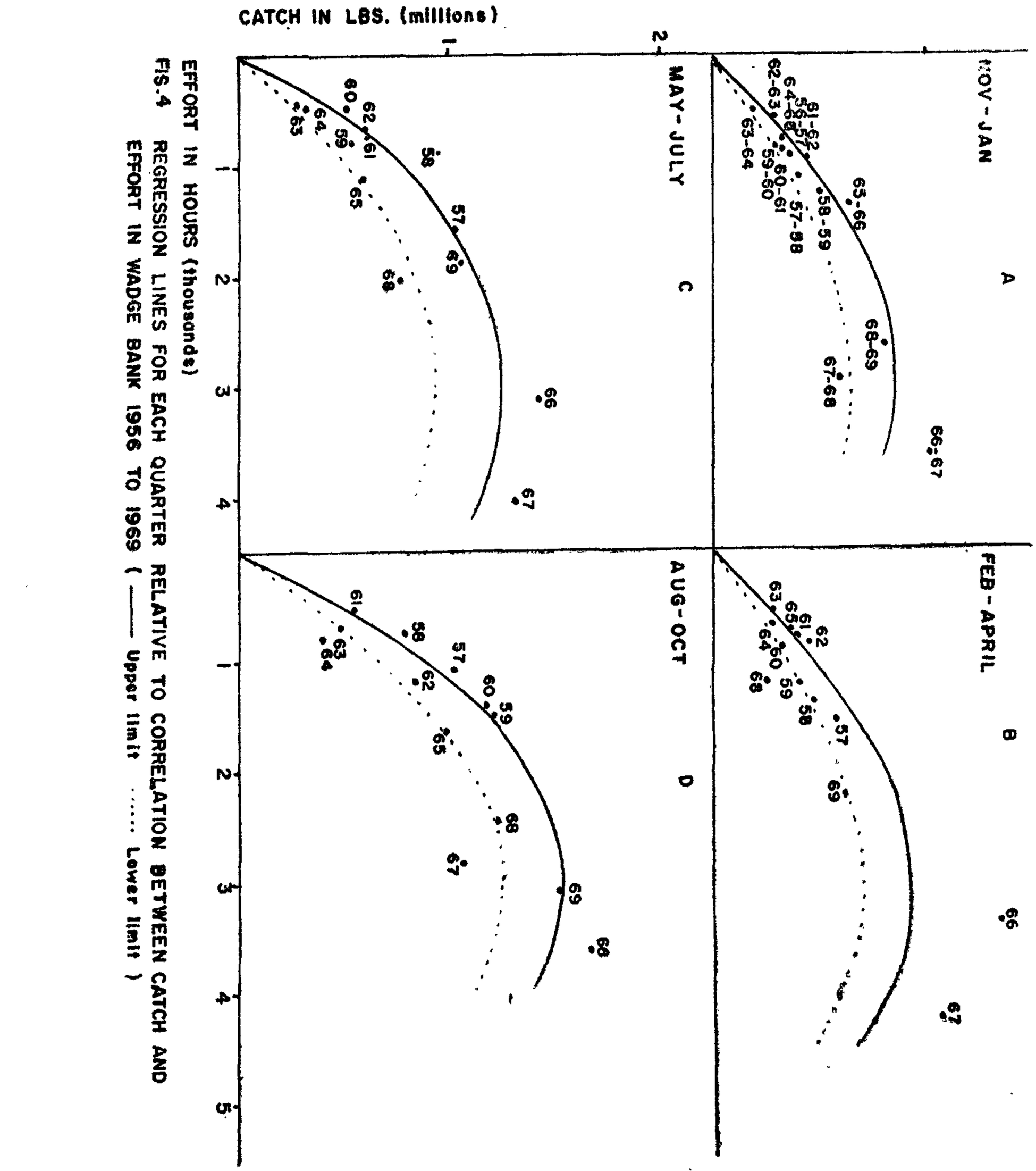

FIG.4 REGRESSION LINES FOR EACH QUARTER RELATIVE TO CORRELATION BETWEEN CATCH AND EFFORT IN WADGE BANK 1956 TO 1969 (—— Upper limit ..... Lower limit)

One other aspect brought out by this analysis is that from November to April a larger percentage of the catch is taken at night (Table III). A probable explanation is that the greater percentage of fish of the "Resident" group is concentrated at or near the bottom at night than during the day.

TABLE III

Seasonal Variation in the Proportion of Day and Night Catches in the Wadge Bank

Period	% of Catch	
	Day	Night
November—January	47	53
February—April	45	55
November—April	46	54
May—July	57	43
August—October	58	42
May—October	58	42

(*b*) May to October

Fig. 3 shows the regression curve for the correlation between catch and effort for this period. An almost equal effort in 1967 to that of 1966 produced a smaller catch in that year (Table I), the trend being similar in subsequent years to that in Fig. 1. This period too has been broken up into two quarters, May to July and August to October. Here too there are two levels of productivity, the second quarter being generally more productive than the first. A comparision of Figs. 4C and D shows this very clearly.

A further increase in fishing pressure in August to October 1966 took place with the introduction of two more stern trawlers "Meegamuwa" and "Myliddy" (Six trawlers in all were in operation). An increase in effort in May to July 1967 showed a drop in the catch (Fig. 4C). Low catches were recorded for the period August to October 1967 (Fig. 4D & Table I). From May to July 1968 (Fig. 4C & Table I) catches began improving not withstanding reduced pressure (only 4 trawlers were fishing the bank). This is reflected in the catch per unit effort in respect of both "Resident" and "Migrant" groups of fish for the same period (Table II).

During this period May to October a larger percentage of the catch is taken during the day (Table III). A probable explanation is that most of the "migrant" groups of fish present in the fishing grounds move away from at or near the bottom at night

Decline in Productivity after 1967

It was indicated above that an increase in effort in 1967 over that of the previous year did not result in a proportionate increase in the catch. The catch fell well below that of the previous year. A reduction in the effort brought about a marked improvement in the catch per unit effort in 1968—69.

The revovery in productivity commenced in May—October 1968. (Table 1 & Fig. 3). The extent to which the "Big Fish" group (note in Table II) influenced the total catch from the bank is shown in Fig. 1. There appears to be a remarkable similarity in production trend as shown by the curves for total catch and "Big Fish" catch. This is even more striking in the years 1965—66 to 1968—69.

The only other group that showed a similar trend in catch rate as "Big Fish" was the "Skates". The catch rate for all other major groups showed a gradual decline (Table II).

A few inferences may be drawn from this result ; viz., the combined fishing and natural mortality rate exceeded the rate of recruitment of the species comprising the catch in the years 1965—66 and 1966—67, or less fish were available for capture possibly brought about by a change in the ecosystem due to continuous breaking up of the sea bottom by the trawl, or a drop in efficiency of the stern trawlers. In the absence of conclusive evidence for the first inference, except a decline in productivity despite an increased effort in 1966—67, the second or third could be the main cause for a decline in productivity. A more detailed study of the physical and biological characteristics of the fishing grounds will be necessary to establish the second alternative. It may not seem inappropriate to assume the third as the main cause for a decline in productivity. Failure to catch the more active and pelagic groups such as the "Paraw" and Parati" (Carangids) in sufficiently large numbers although they were in the fishing grounds as shown in Table II, seems to indicate a drop in efficiency of the stern trawlers.

Unit of Production

The smallest economic unit of production for all practical purposes is the fishing day. If the average catch per day during a fishing trip exceeds the cost of production, the fishing operation will be a profitable one. It follows, there fore, that the duration of a fishing trip is of economic importance because the production trend could be of three types-increasing, decreeasing and steady.

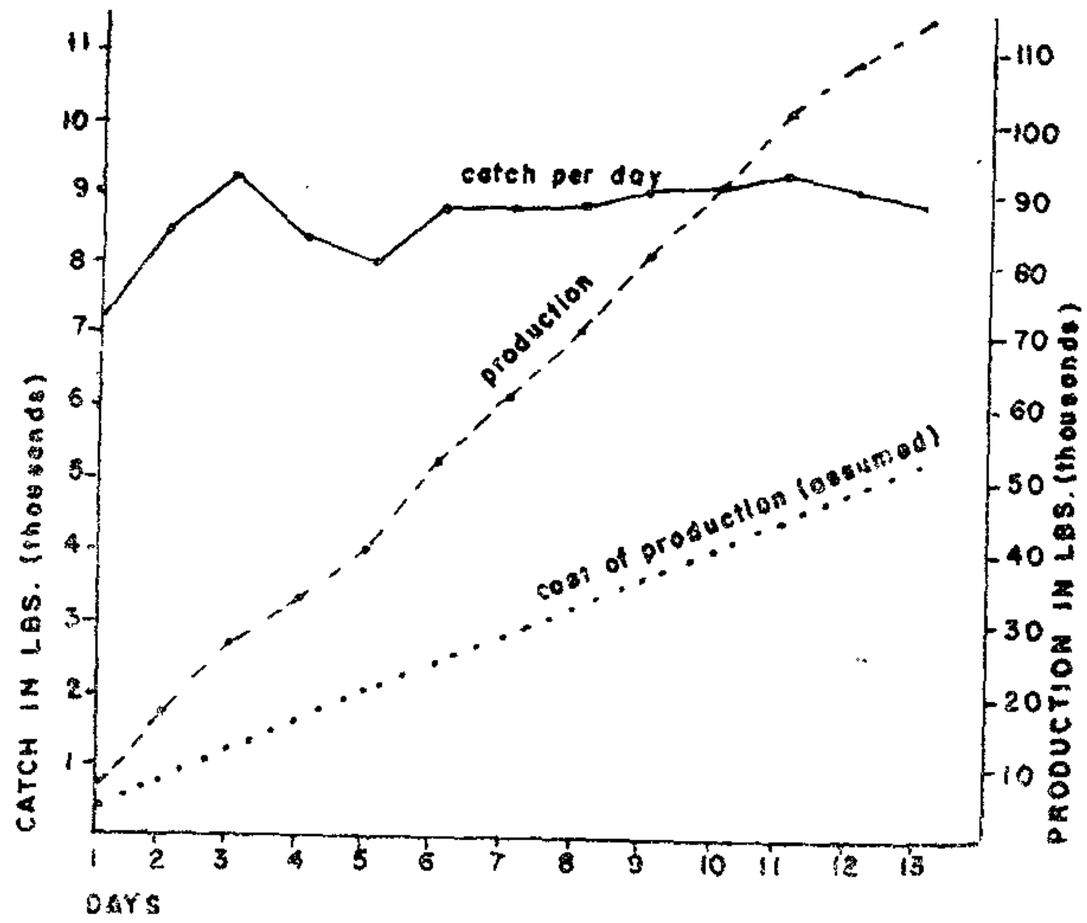

Fig. 5 Production trend during Pesalai's voyage No. 1 From 22.3.66 to 5.4.66

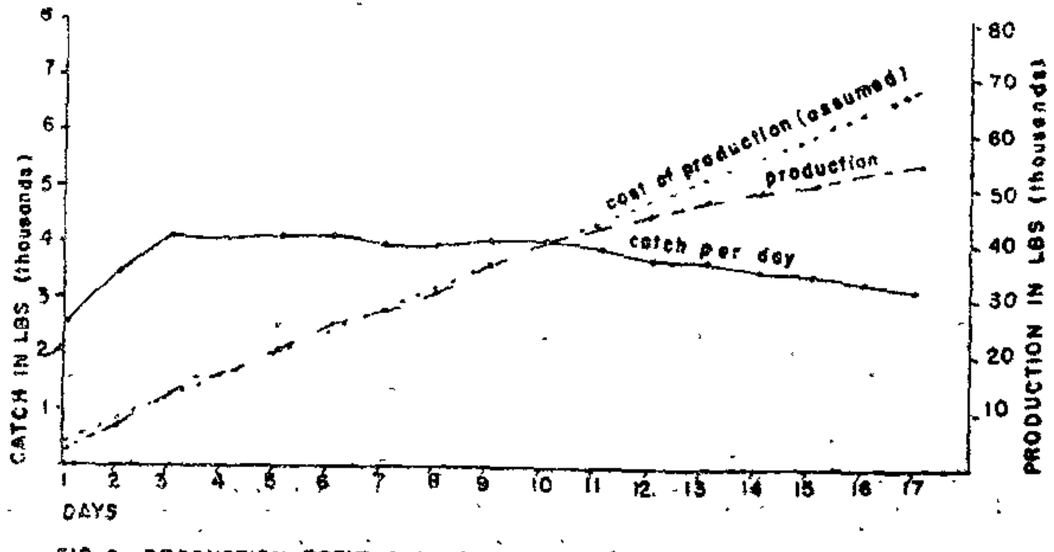

FIG. 6 PRODUCTION TREND DURING SERUWALA'S VOYAGE No 17 FROM 21.11.67 TO 10.12.67

The fishing records for the years 1966 to 1969 have been examined for this porpose. The results showed that the duration of a fishing trip varied between a minimum of 3 days and a maximum of 19 days. The production trend for fishing trips of 13, 17, 15 and 10 days duration are presented in Figs. 5, 6 7 and 8 respectively and Table IV. The cost of production at source in terms of fish has been assumed to be approximately 4000 lbs. (Appendix) per day to show the day to day contrast between it and production.

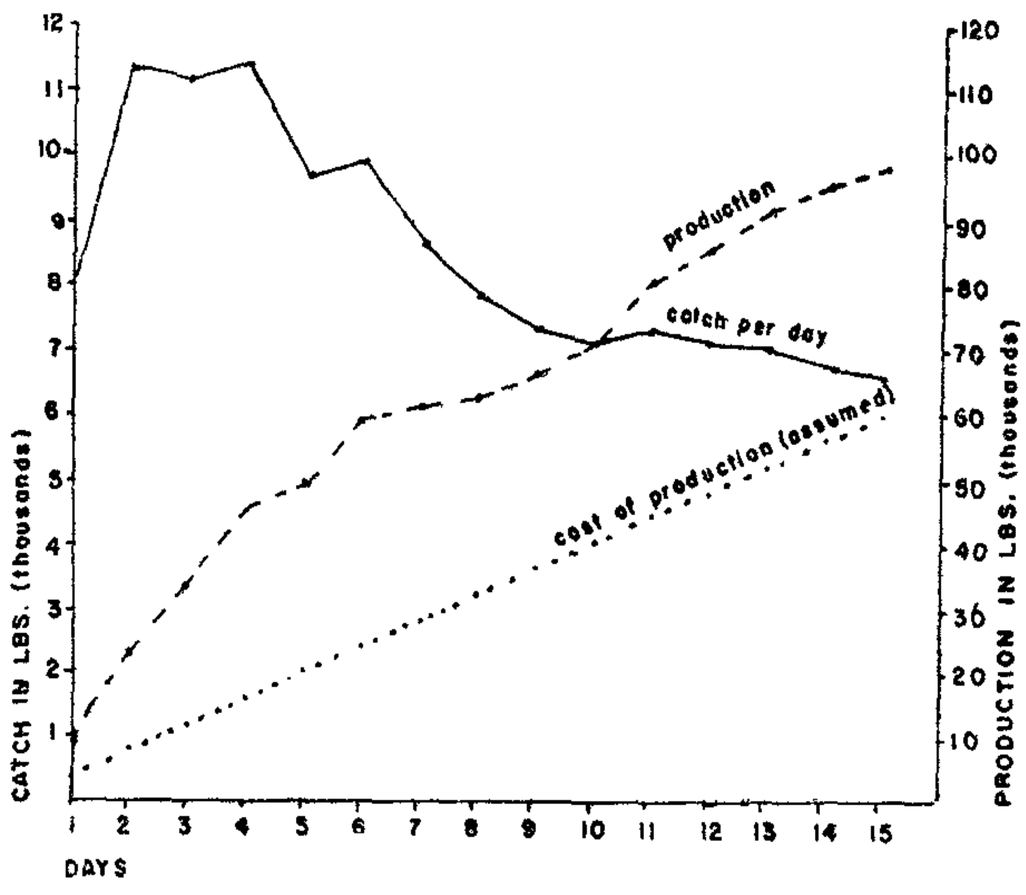

FIG.7 PRODUCTION TREND DURING GANDARA'S VOYAGE No.5 FROM 10.5.69 TO 28.5.69

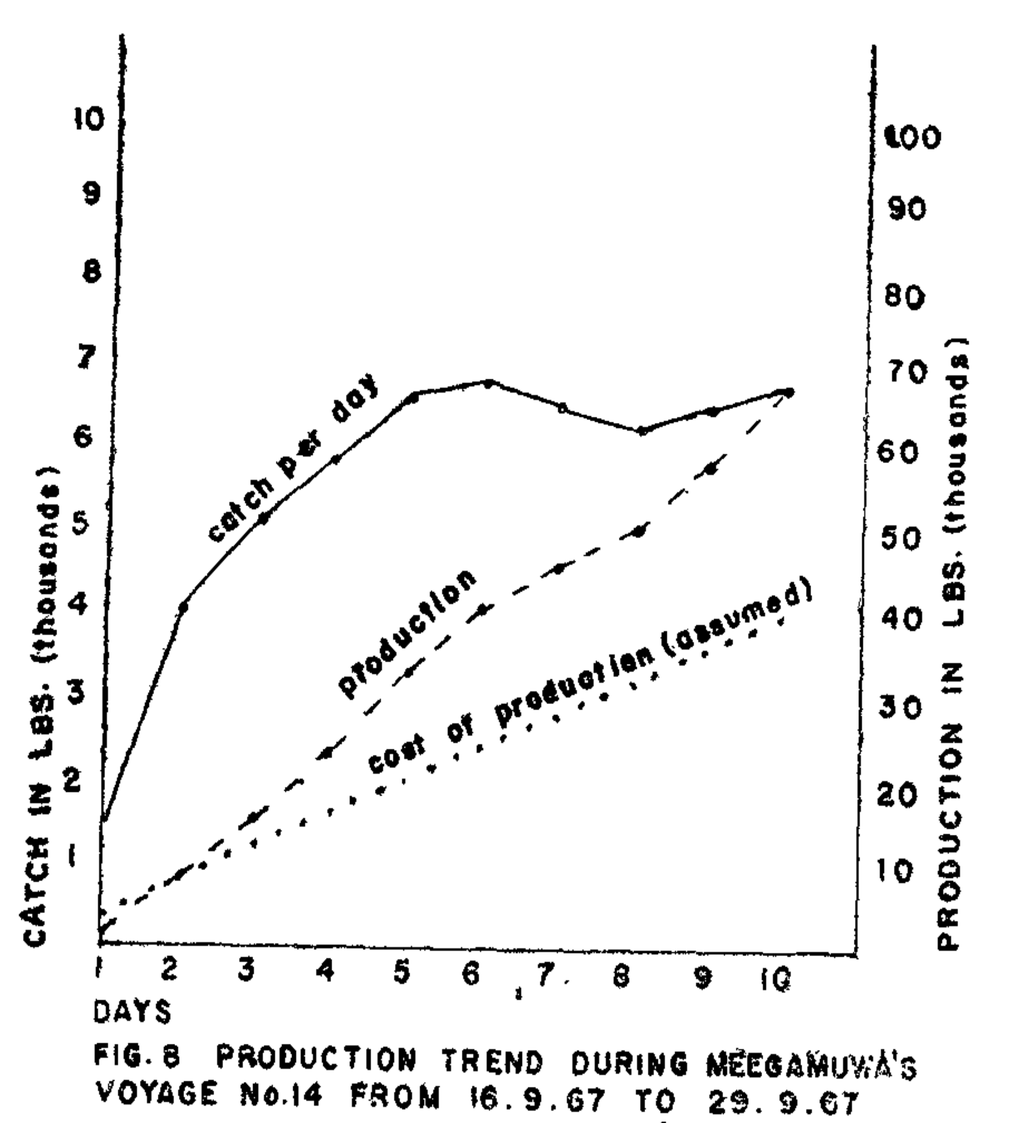

FIG. 8 PRODUCTION TREND DURING MEEGAMUWA'S VOYAGE No.14 FROM 16.9.67 TO 29.9.67

In this context Fig. 5 shows the trend to be steady. This is evident from the catch per day curve. However, the average catch per day fell by 239 lbs. below the 10th day average. (Table IV). Fig. 6 shows the trend to be decreasing and the trip to be more and more uneconomical following every additional day's fishing. Fig. 7 shows the trend to be decreasing and the trip to be profitable due to the very high average achieved at the commencement of fishing. However, the average catch for the last five days fell by 500 lbs. below the average achieved on the 10th day (Table IV). Fig. 8 shows the production trend to be increasing right up to the 10th day and the trip to be profitable.

TABLE IV

Production and Production Trend for Fishing Trips of 13, 17, 15, and 10 days duration in the Wadge Bank

Vessel, Voyage & Date	Days	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th	11th	12th	13th	14th	15th	16th	17th
Pesalai 1/66 22. 3.66to 5. 4.66	Production in lbs.	7,394	17,064	27,776	33,843	40,479	53,277	61,999	71,194	81,907	91,387	102,194	109,494	115,797				
	Ave. Catch per day in lbs.	7,394	8,532	9,255	8,461	8,096	8,880	8,857	8,899	9,100	9,138	9,290	9,124	8,907				
Beruwala 17/67 21.11.67to10.12.67	Production in lbs.	2,571	6,923	12,362	16,120	20,274	24,922	27,988	31,252	36,197	40,450	43,021	45,197	47,966	49,746	50,834	53,010	54,330
	Ave. Catch per day in lbs.	2,571	3,461	4,120	4,030	4,055	4,153	3,998	3,906	4,022	4,055	3,911	3,758	3,690	3,554	3,488	3,313	3,196
Gandara 5/69 10. 5.69to25. 5.69	Production in lbs.	8,151	22,847	33,592	45,818	48,535	59,527	60,515	62,491	66,072	71,012	80,769	85,215	91,513	95,095	98,955		
	Ave. Catch per day in lbs.	8,151	11,413	11,197	11,454	9,707	9,921	8,645	7,811	7,343	7,101	7,342	7,101	7,040	6,792	6,597		
Meegamuwa 14/67 16.9 .67to29. 9.67	Production in lbs.	1,512	8,221	15,592	23,625	33,547	41,580	46,305	51,124	59,535	68,513							
	Ave. Catch per day in lbs.	1,512	4,110	5,197	5,906	6,709	6,930	6,615	6,390	6,615	6,851							

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TABLE V

Showing Seasonal Variation and Distribution of Catch per hour in Wadge Bank

	J	F	M	A	M	J	J	A	S	O	N	D
Area 1	O-T 25–30	O-T 25–30	O-T 19–24	O-T 13–18	I-N 19–24	I-N 13–18	I-N 25–30	O-T 13–18	I-N 13–18	O-T 13–18	I-N 25–30	O-T 25–30
C.P.H.	291	331	433	575	755	725	684	1340	823	763	404	401
Area 2	C-H 25–30	I-N 19–24	O-T 25-30	I-N 7–12	I-N 13–18	O-T 25–30	O-T 13–18	O-T 7–12	O-T 19–24	O-T 19–24	C-H 25–30	I-N 25–30
C.P.H.	291	326	399	398	740	640	662	1135	668	667	399	381
Area 3	C-H 7–12	I-N 25–30	I-N 25–30	C-H 13–18	C-H 13–18	I-N 25–30	O-T 7–12	I-N 13–18	O-T 13–18	I-N 13–18	O-T 25–30	C-H 13–18
C.P.H.	270	301	342	389	419	606	627	888	616	631	380	349
Area 4	O-T 1– 6	C-H 19–24	I-N 19–24	O-T 19–24	I-N 25–30	O-T 13–18	I-N 13–18	I-N 19–24	C-H 7–12	O-T 7–12	O-T 13–18	I-N 13–18
C.P.H.	264	298	322	386	414	589	615	756	598	616	353	332
Area 5	I-N 25–30	O-T 7–12	C-H 25–30	I-N 1– 6	C-H 19–24	I-N 19–24	O-T 19–24	O-T 19–24	I-N 19–24	I-N 19–24	C-H 19–24	I-N 19–24
C.P.H.	261	259	276	368	371	558	587	705	558	563	327	329
Area 6	O-T 7–12	I-N 13–18	I-N 13–18	O-T 7–12	O-T 19–24	O-T 19–24	I-N 19–24	C-H 25–30	I-N 25–30	O-T 1– 6	C-H 13–18	I-N 7–12
C.P.H.	255	248	259	350	354	543	539	664	514	559	307	317
Area 7	I-N 1– 6	O-T 19–24	C-H 19–24	I-N 25–30	O-T 13–18	C-H 13–18	C-H 13–18	O-T 25–30	C-H 25–30	C-H 1– 6	C-H 7–12	O-T 1– 6
C.P.H.	231	224	220	343	312	487	517	559	509	541	297	310
Area 8	O-T 19–24	C-H 13–18	I-N 1– 6	C-H 19–24	I-N 7–12	O-T 7–12	I-N 1– 6	I-N 25–30	C-H 13–18	I-N 25–30	I-N 19–24	I-N 1– 6
C.P.H.	231	196	179	340	308	339	504	523	476	513	297	307
Area 9	C-H 13–18	O-T 1– 6	C-H 13–18	I-N 13–18	O-T 25–30	C-H 19–24	C-H 25–30	C-H 19–24	I-N 1– 6	O-T 25–30	I-N 13–18	C-H 19–24
C.P.H.	228	192	178	334	276	333	491	521	469	505	285	287
Area 10	I-N 7–12	C-H 25–30	I-N 7–12	I-N 19–24	I-N 1– 6	I-N 7–12	O-T 25–30	I-N 1– 6	C-H 1– 6	C-H 7–12	I-N 1– 6	O-T 7–12
C.P.H.	224	188	174	313	270	262	462	469	456	483	282	282
Area 11	I-N 19–24	I-N 1– 6	C-H 7–12	C-H 25–30	C-H 25–30		I-N 7–12	C-H 13–18	I-N 7–12	C-H 19–24	I-N 7–12	C-H 7–12
C.P.H.	208	187	155	311	220		456	446	444	467	279	226
Area 12	C-H 19–24	I-N 7–12		O-T 25–30	O-T 7–12		C-H 19–24	I-N 7–12	C-H 19–24	I-N 7–12	O-T 19–24	C-H 1– 6
C.P.H.	208	186		306	160		420	433	436	406	260	222
Area 13	I-N 13–18	C-H 1– 6		C-H 7–12			C-H 7–12		O-T 25–30	C-H 13–18	O-T 1– 6	
C.P.H.	197	168		297			335		423	397	255	
Area 14	O-T 13–18	C-H 7–12		C-H 1– 6			O-T 1– 6			C-H 25–30	O-T 7–12	
C.P.H.	161	162		236			325			385	229	
Area 15				O-T 1– 6						I-N 1– 6	C-H 1– 6	
C.P.H.				226						332	208	

Planned Production

The results from the present analysis provide the guide lines for proper management and economical exploitation of the Wadge Bank's demersal fish resources based on a more realistic distribution of effort and assessment of anticipated production.

The seasonal variation in the catch rate (catch per hour) for different areas in the Wadge Bank (Munasinghe 1969) has been arrived at from an analysis of productivity for these different areas during a five year period, 1958, 1959, and 1966 to 1968. The average catch per hour for each area for each month in order of magnitude is set out in Table V. The catch per hour shown in Table VI

TABLE VI

Showing Anticipated Production based on the Seasonal Variation in Catch rate and Economical effort for the same period

Month	*Ave. Catch per hour (in lbs.)**	*Total Effort in hours†*	*Anticipated Production*	
November	317	720	228,240	
December	329	720	236,880	
January	275	560	154,000	
		2,000		619,120
February	303	700	212,100	
March	338	900	304,200	
April	362	900	325,800	
		2,500		842,100
May	421	700	294,700	
June	508	900	457,200	
July	516	900	464,400	
		2,500		1,216,300
August	703	1,200	843,600	
September	537	1,000	537,000	
October	522	800	417,600	
		3,000		1,798,200
	Total	10,000	4,475,720	

*The figures in this column have been arrived at by averaging the catch per hour for areas showing a rate above 250 lbs. per hour shown in Table V.

†The figures in this column are relative to the average catch per hour in column 2.

is the average for all areas with a rate above 250 lbs. per hour. Fishing in these areas will ensure the economic success of a fishing trip with production per 18 hour fishing day (time the net is in the water) exceeding 4000 lbs.

November to April

As mentioned earlier, within this period there are two levels of productivity, one in November to January and the other in February to April (Figs. 4A & B). In Fig. 4A which represents the regression relative to the catch and effort in November to January, the catch per unit effort as shown by the curve decreases rapidly above 2000 hours. The rate of production for different degrees of increase in effort is presented in Table VII. Production becomes uneconomical above this degree of effort. The anticipated production from this degree of effort is 619, 120 lbs. (Table VI).

In Fig. 4B, which represents the regression relative to the catch and effort in February to April, the catch per unit effort as shown by the curve and Table VII decreases rapidly above 2500 hours, productivity becoming uneconomical above this figure. The anticipated production is 842,100 lbs. from this degree of effort (Table VI). The maximum economical effort needed for the whole period is 4500 hours for an anticipated production of 1,461,220 lbs. Fig. 2 and Table VI.

May to October

The two levels of productivity within this period are shown in Fig. 4C and D. They are from May to July and August to October. Table VII places the optimum effort at 2500 hours and Table VI shows the anticipated production from this effort as 1,216,300 lbs. for the period May to July. Simi-

TABLE VII

Rate of production for different degrees of increase in Effort in respect of each quarter, half year and year

Period	*Effort in hours*			*Rate of Production lbs./hr.*
	From		*To*	
November–January	1,500	—	2,000	250
	2,000	—	2,500	100
	2,500	—	3,000	50
February–April	1,500	—	2,000	330
	2,000	—	2,500	160
	2,500	—	3,000	100
November–April	4,000	—	4,500	220
	4,500	—	5,000	100
	5,000	—	6,000	75
May–July	1,500	—	2,000	300
	2,000	—	2,500	180
	2,500	—	3,000	60
August–October	1,500	—	2,000	360
	2,000	—	2,500	240
	2,500	—	3,000	120
May–October	4,000	—	4,500	240
	4,500	—	5,000	180
	5,000	—	5,500	120
	5,500	—	6,000	50
November–October	8,000	—	9,000	200
	9,000	—	10,000	175
	10,000	—	11,000	100
	11,000	—	12,000	50

larly the optimum effort is 3000 hours for an anticipated production of 1,798,200 lbs. during the period August to October (Table VI & VII). It follows from the above that the optimum effort for the period May to October is 5500 hours for an anticipated production of 3,014,500 lbs. fish. Fig. 3 and Table VI.

November to October

The optimum effort in economic terms for an year from November to October is 10000 hours (Table VII). The anticipated production from this effort is 4,475,729 lbs. (Table VI). This figure corresponds very closely with that shown in the regression curve in Fig. 1.

Summary

The fishing records of trawlers operated in the Wadge Bank since 1956 have been examined to evaluate the performance of stern trawlers introduced in 1965—66. The study reveals that a planned approach for economical exploitation of the demersal fish stock is necessary for productivity to be economical.

The duration of a fishing trip which is an important economic unit of production needs to be limited to 13 days. Production during day and night seems to vary from season to season and the need to confine, as far as possible, maximum fishing activity to the more productive times, night during November to April, and day during May to October, has been shown.

There are two levels of productivity. The lower level is from November to April during which an optimum economical effort of 4500 hours is needed for an anticipated production target of 1,416,200 lbs. The higher level is from May to October during which period an optimum economical effort of 5500 hours is required for an anticipated production target of 3,014,500 lbs. The annual optimum economical effort is 10000 hours for an anticipated production amounting to 4,475,720 lbs. fish.

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APPENDIX

* Operational cost of six Trawlers for a year	..	.. Rs. 3,793,844	at 43 cts. per lb.
Anticipated production ..	..	.. 8,870,400 lbs.	
For an anticipated production (at same rate) of		.. 4,475,000 lbs.	
Anticipated Cost ..	..	.. .. Rs. 1,913,000	
For 3 trawlers operating in Wadge Bank for 1 year anticipated cost		.. Rs. 956,500	
Anticipated Fishing Effort—			
in hours ..	..	.. ..	10,000 hours
in days ..	..	.. ..	555 days
Operational cost per day (in rupees) ..		.. ..	1,725
Operational cost per day (in lbs.) ..		.. ..	4,007 lbs.

*Reference—Production, Trading and Profit and Loss Budgets April 1968—March 1969. Ceylon Fisheries Corporation.