INT. J. BIOL. BIOTECH., 4 (SPECIAL ISSUE): 1-12, 2007.

STATUS OF SHRIMP FISHERY IN PAKISTAN

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ABSTRACT:

The shrimp forms most important fishery in Pakistan because of its high foreign exchange earnings and also the employment, which it generates. Commercial shrimp trawling started in 1958, thereafter, the trawler fleet rapidly expanded with actual in operation of 300 to 450 vessels in 1970, 897 in 1980, and 1,730 in 1990 to 2,343 in 1999. This fleet is almost entirely based in the Karachi Fish Harbour and is considered the land of shrimp catches; the annual total shrimp landing rose steadily and has been fluctuating between 25,000 and 30,000 metric tons since 1980. In order to provide a realistic management advice based on up-to-date assessment, Marine Fisheries Department in collaboration with FAO has set up a stratified data collection system at Karachi fish harbour. In 1983 the Government announced a ban on shrimp fishing for the month of June & July of that year. A closed season by itself would not correct the adverse conditions of shrimp stocks due to over-fishing which is caused by very large size of fleet. The period of June-July, which had been promulgated under the law is differing from the suggestion of a closure in May-June made by the scientists, but still there is some dispute regarding the closed season; therefore in the present study, an attempt is made to review; why the closed season was imposed? "Is it necessary?"

Key–words: Shrimp fishery, Pakistan

INTRODUCTION

The long term sustainability of fisheries and aquaculture depends to a large extent on conservation of aquatic biodiversity. Most captured fisheries are direct and selective exploitation of wild life. Similarly, in Pakistan marine resources are free to access and selective, due to this the shrimp fisheries becomes the main coastal fisheries commodity in Pakistan and is a major source of foreign exchange. It provides high profit margin and job opportunities to thousands of local fishermen and has grown enormously to become the backbone of fishing industry. The uncontrolled and unregularized fishing poses threat of collapse of the fishing industry.

Since the early seventies, there has been a gradual decline in landings of shrimp due to over-fishing of the more valuable species (Jaira and Kalri). This has led to the necessity of managing fishery to prevent its eventual collapse and restore its viability. To obtain the data needed for proper management, Marine Fisheries Department set-up a stratified sampling scheme to provide the data base required for stock assessment and subsequent formulation of management advice. Initially the scheme was restricted to shrimp landed at Karachi fish harbour which receives the bulk of the landings and nearly all shrimp processing plants are situated in its vicinity. The data generated from this programme is reflected in the national fisheries statistic. This study is based on the data collected during January 1993 through to December 1999 under the above mentioned sampling scheme at Karachi fish harbour, using methodology as described in van Zalinge *et al*. (1987). The Table-1a,b,c,d show the estimated shrimp landings observed at Karachi fish harbour under this programme.

In 1983 the Government of Sindh vide section 4 of Sindh Fisheries Ordinance, 1980 announced a ban on shrimp fishing during June and July of that year, although it was pointed out that a closed season by itself would not correct the adverse conditions of shrimp stocks due to over-fishing. The period of June-July, recommended by Jaleel & Zaidi (1972), and had been promulgated vide *S. R. O. 329(1)/79,* was different from the suggestion of a close season in May-June made by FAO on the basis of above study.

A closed season for shrimp fishing of the same duration and timing or different period and timing is being repeatedly implemented every year (Table-2). The effectiveness of these strategies was discussed in Zupanovic (1971), van Zalinge *et al*. (1986a, 1987), and Majid and Wasim (1993). Still there is some discrepancies regarding the closed season; therefore in the present review; an attempt is made to review; why the closed season was imposed? "Is it necessary?"

ANALYSIS OF MAXIMUM SUSTAINABLE YIELD (MSY)

Marine Fisheries Department in collaboration of FAO in 1971 had carried out the first study regarding estimation of Maximum Sstainable Yield (MSY) using catch and effort data. In this study, data of total shrimp landing for the year 1959 to 1970 was analyzed by Zupanovic, (1971). Fig.1 shows how the production of shrimp

increases with the increase in number of shrimp trawlers whereas Fig.2 shows that Catch Per Unit Effort (CPUE) decreases with increase in fishing effort year after year. In that study, MSY of shrimp stocks between 16,000 to 18,000 metric tons was estimated, that could be exploited by 300 to 450 boats.

Again in 1983-85 Marine Fisheries Department in collaboration of FAO performed another stock assessment study which was also based on catch and effort data, but more detailed information about the catch and effort was collected i.e. catch per day-at-sea, catch per trip and total landings. Similarly, effort in terms of days-at-sea (Table-3a, 3b, 3c), trip duration, number of trips in each month and year, etc. was also determined. That study was based on analysis of the data on prime species of shrimps i.e. Jaira and Kalri for the years 1971 to 1982 (van Zalinge *et al*. 1986a and 1987). It appears from the Fig.3 that production of prime species was at its peak during the year 1971 and 1972 and declined thereafter continuously. CPUE of these species has a trend of continuous decline with the increase of fishing effort as shown in Fig.4. In that study MSY was estimated between 16,000 to 17,000 metric tons with optimum effort level of 550 to 600 trawlers.

Majid & Wasim (1993) observed that after the introduction of closed season again in 1990, there was some improvement in the total catch and CPUE of prime species but the improvement is lower than that observed during 1983-85 (Fig.5 and 6). They also estimated that the MSY of Kiddi; the smallest trade category of shrimp, lies between 16,000 to 18,000 metric tons exploitable by maximum effort level at 500 to 750 shrimp boats (Fig.7 and 8).

If we combine all the data of maximum sustainable yields then total MSY would be between 32,000 to 35,000 metric tons which is some what higher than that of 25,000 metric tons reported earlier in 1971. This might be due to the fact that at present fishing is now being carried out much deeper waters.

SHRIMP SPECIES

At least 21 shrimp species have been reported from Pakistan (Zupanovic, 1971; Tirmizi & Bashir, 1973; Ahmed, 1977), out of which 15 species occur regularly in varying quantities in the commercial landings, but only 5 or 6 species constitute the main bulk of the harvest. Following are main species of shrimp from Pakistan:
Penaeus merguiensis, P. penicillatus, P. indicus, P. monodon, P. semisulcatus, P. japonicus. Metapenaeus affinis, M. monoceros, M. brevicornis, M. stebbingii, Parapenaeopsis stylifera, Pp. hardwickii, Pp. sculptilis, Metapenaeopsis stridulans.

SPAWNING SEASON

The relative abundance of mature females in the catch is taken as a parameter of spawning activities at sea. It is estimated on a monthly basis using the catch rate in terms of numbers of females caught per day-at-sea and their average percentage of mature female. The spawning period of sale-categories as described in Zupanovic (1971) and van Zalinge *et al*. (1986a & 1987) are as under:

- *P. merguiensis*, Major in April-May, August and lesser extent also in October and January.
- *P. penicillatus*, October to May.
- *P. semisulcatus*, January to May.
- *M. monoceros*, February to May.

Parapenaeopsis stylifera, June to August and December.

RECRUITMENT OF SHRIMP TO THE FISHERY

Recruitment to fishery describe as an increase in the catch per unit effort and decrease in the average size of the shrimp. Recruitments period of different trade categories as suggested by van Zalinge *et al*. (1986a & 1987) and Majid & Wasim (1993) is as follows:

Jaira:

It is revealed from the average monthly catch rates for the years 1983-85 that recruitment starts in April and reaches a peak in May (Fig.9), probably also in July-August and again in October-December. From December to March no significant recruitment to the fishery takes place. During the period 1986-89 (in absence of close season) the peak of May has been shifted to July and the recruitment during autumn was also very low. The recruitment pattern for the years 1990-92 is same as 1983-85, whereas for the years 1993-99 the spring peak was shifted to the month of April, but the intensity was mush lower than previous years.

Sampling in the Indus delta revealed a major increase in the relative abundance of juveniles of *P. merguiensis* in June and not in May (van Zalinge *et al*.,1986b). Therefore it may be suggested that a part of the offsprings of the

autumn spawners winters in the Indus delta which subsequently migrate to sea in spring (April-May). Further more peaks of juvenile abundance appeared in August and November, after which a decline occurred until March.

Table 1a. Estimated Monthwise Landing of Jaira observed during sampling Programme at Karachi Fish Harbour (1993-99).

Quantity in Metric tons.

Months	1993	1994	1995	1996	1997	1998	1999
January	379	589	362	296	320	332	347
February	283	302	290	237	256	266	277
March	236	270	238	194	210	218	227
April	563	880	521	425	461	478	498
May	360	776	291	238	258	267	279
June	110	-	108	-	-	199	-
July	382	555	370	390	377	-	354
August	239	298	239	195	257	358	.332
September	218	352	194	158	171	316	185
October	492	543	487	398	431	447	466
November	554	824	523	427	462	479	500
December	286	632	280	229	248	257	268
Total (Jan-Dec)	**4,102**	**6,021**	**3,903**	**3,187**	**3,451**	**3,617**	**3,733**
Total (Jul-Jun)	**4,988**	**5,014**	**3,483**	**3,302**	**3,706**	**3,485**	

Kalri:

From the average monthly catch rates for the year 1983-85 it is established (Fig.10) that the peaks in the recruitment are apparent in May (minor) and in August-October (major) and a little recruitment is also expected occur from October to January. During the years 1986-89, the peak of May has been shifted to July but the peak in September who shorter than that of 1983-85. In 1990-92 and 1993-99 there is a gradual shift of minor peak to April and the major peak to October.

In Indus delta sampling of juvenile of *M. affinis* a peak in the June and more important one in September was observed. The "wintering" of a small part of the autumn cohort was also observed for this species.

Kiddi:

The pattern of one large peak in August-September and another in February-April is clearly observed (Fig. 11). The Indus delta sampling found *Parapenaeopsis stylifera* to be abundant in July with a smaller peak in April-May. Wintering in the creek for this species does not apparently occur.

Table 1b. Estimated Monthwise Landing of Kalri observed during Stratified Sampling Programme at Karachi Fish Harbour (1993-99).

Months	1993	1994	1995	1996	1997	1998	1999
January	571	429	421	459	410	374	410
February	457	344	337	367	328	300	328
March	375	282	276	301	270	246	269
April	822	618	606	660	590	538	589
May	459	345	339	369	330	301	329
June	170	-	126	-	-	212	-
July	583	467	430	505	441	-	440
August	377	383	278	402	371	429	370
September	305	230	225	245	220	300	219
October	768	578	566	617	552	503	551
November	824	620	608	662	592	540	591
December	442	223	326	355	317	290	317
Total (Jan-Dec)	**6,153**	**4,519**	**4,538**	**4,942**	**4,421**	**4,033**	**4,413**
Total (Jul-Jun)	**5,317**	**4,606**	**4,589**	**4,714**	**4,464**	**3,987**	

Table 1c. Estiamted Monthwise Landing of Kiddi observed during Stratified Sampling Programme at Karachi Fish Harbour (1993-99)

Quantity in Metric tons.

Months	1993	1994	1995	1996	1997	1998	1999
January	874	625	540	552	663	362	314
February	721	528	414	410	480	425	501
March	589	439	485	497	1003	990	892
April	1816	1217	119	150	199	180	255
May	1498	1140	895	903	1540	1322	993
June	658	-	372	-	-	506	-
July	916	1156	682	1092	1089	-	427
August	872	1061	618	856	1107	788	658
September	3415	3211	2918	2957	3741	3645	2907
October	2916	2412	2660	2846	3050	2906	2544
November	3059	3152	2109	2254	2455	2325	2202
December	1298	1082	1107	1530	1395	1240	1196
Total (Jan-Dec)	**18,632**	**16,023**	**12,919**	**14,047**	**16,722**	**14,689**	**12,889**
Total (Jul-Jun)	**16,425**	**14,899**	**12,606**	**15,420**	**16,622**	**13,859**	

EXPLOITATION PROBLEM

The maximum sustainable yield is the level of the largest catch, which can be obtained from any stock without destroying it. Thus, increasing effort beyond this level results in lower total catches; as has been seen for Jaira and

Kalri over the previous years. The primary cause for this is increase in the fleet size of shrimp trawlers. It is the so-called "common problem", where commonly owned resources are freely opened for exploitation to private parties. In this situation, exploitation tends to increase to the level where income equals cost and profit becomes zero. The harvest of juvenile shrimps causes this phenomenon. Due to the increasing competition within the fleet there is a tendency to fish in more shallow waters, where in view of the life cycle of the shrimps the sizes are smaller (more juvenile) than in the deeper waters.

Table 1d. Estimated Monthwise Landing of three varieties of Shrims (Jaira, Kalri & Kiddi) observed during Stratified Sampling Programme at Karachi Fish Harbour (1993-99).

MONTHS	Combined all species						
	1993	1994	1995	1996	1997	1998	1999
January	1824	1,643	1,323	1,307	1,393	1,068	1,071
February	1461	1,174	1,041	1,014	1,064	991	1,106
March	1200	991	999	992	1,483	1,454	1,388
April	3201	2,715	1,246	1,235	1,250	1,196	1,342
May	2317	2,261	1,525	1,510	2,128	1,890	1,601
June	938	-	606	-	-	917	-
July	1881	2,178	1,482	1,987	1,907	-	1,221
August	1488	1,742	1,135	1,453	1,735	1,575	1,360
September	3938	3,793	3,337	3,360	4,132	4,261	3,311
October	4176	3,533	3,713	3,861	4,033	3,856	3,561
November	4437	4,596	3,240	3,343	3,509	3,344	3,293
December	2026	1,937	1,713	2,114	1,960	1,787	1,781
Total (Jan-Dec)	**28,887**	**26,563**	**21,360**	**22,176**	**24,594**	**22,339**	**21,035**
Total (Jul-Jun)	**26,730**	**24,519**	**20,678**	**23,436**	**24,792**	**21,331**	

Source: Stratified shrimp monitoring programme.

The lifecycle of shrimp is complicated and has several stages. In fact, the post-larval and juvenile shrimps, particularly of Jaira, grow up in the estuaries of the Indus delta and upon reaching a certain developmental stage migrate out to sea in order to attain sexual maturity. At certain time in the year, this migration (recruitment) to sea occurs on massive scale. This period is known as "recruitment period". When this recruitment/migration is takes place, the fleet of shrimp trawlers is lined up in front of the mouth of creeks in the Indus delta and scoop up as much shrimp as possible. Apart from the artisanal fishery, now-a-days even trawlers can be seen working inside the larger estuarine creeks. It is clear that this behaviour of the fleet would result in the harvest of younger shrimp of smaller sizes and lead a decline in total catch of shrimps of optimum marketable size.

It appears that fishing effort, in terms of number of trawlers and number of day-at-sea, is remarkably increasing year after year (Table-4) and that observing a close season itself is not enough to reduce the fishing effort and to protect the shrimp resources.

Table 2. Periods of closed season for shrimp fishing during 1983-2000.

Year	Period of close season
1983	June and July
1984	June and July
1985	20 June to 20 August
1986	No ban on shrimp
1987	No ban on shrimp
1988	No ban on shrimp
1989	No ban on shrimp
1990	During July
1991	During July
1992	During July (partially)
1993	20 June to 20 July
1994	During June
1995	15 June to 15 July
1996	During June
1997	1st June to 15 July
1998	During July
1999	1st June to 15 July
2000	2nd June to 12 July

Table 3a. Estimated fishing effort in day-at-sea of ICE fishery for shrimp trawler operating from Karachi fish harbour during 1993-1999.

Days-at-sea

Month	Trip duration	% of day-at-sea	1993	1994	1995	1996	1997	1998	1999
Jan	10.6	9.66	23,851	28,115	28,453	28,937	29,420	29,904	32,841
Feb	10.3	8.06	23,196	23,458	23,741	24,144	24,548	24,951	27,402
Mar	9.2	9.08	26,132	26,427	26,745	27,200	27,654	28,109	30,869
Apr	8.0	8.83	25,412	25,699	26,009	26,451	26,893	27,335	30,019
May	6.1	7.95	22,880	23,138	23,417	23,815	24,213	24,610	27,028
Jun	5.1	5.28	15,195	15,367	15,552	15,816	16,081	16,345	17,950
Jul	4.5	5.88	16,922	17,113	17,319	17,614	17,908	18,202	19,990
Aug	5.9	6.95	20,002	20,228	20,471	20,819	21,167	21,515	23,628
Sep	7.0	7.03	20,232	20,460	20,707	21,059	21,411	21,762	23,900
Oct	9.6	9.30	26,765	27,067	27,393	27,859	28,324	28,790	31,617
Nov	10.2	10.83	31,168	31,520	31,900	32,442	32,984	33,526	36,819
Dec	11.5	11.15	32,089	32,452	32,842	33,400	33,958	34,516	37,907
Total		**100.00**	**283,843**	**291,045**	**294,549**	**299,554**	**304,560**	**309,565**	**339,970**

Table 3b.Estimated fishing effort in day-at-sea of HELLA fishery for shrimp trawler operating from Karachi Fish Harbour during 1993-1999.

Month	Trip duration	% of day-at-sea	1993	1994	1995	1996	1997	1998	1999
Jan	0.4	0.94	148	150	152	154	157	160	175
Feb	0.6	2.27	358	362	367	373	379	385	423
Mar	0.5	3.75	592	599	606	616	626	637	699
Apr	0.6	11.17	1,763	1,783	1,805	1,835	1,866	1,897	2,083
May	0.6	18.79	2,966	3,000	3,036	3,087	3,139	3,191	3,504
Jun	0.7	21.63	3,415	3,453	3,495	3,554	3,614	3,673	4,034
Jul	0.8	18.83	2,973	3,006	3,042	3,094	3,146	3,197	3,511
Aug	0.6	12.02	1,897	1,919	1,942	1,975	2,008	2,041	2,241
Sep	0.6	6.51	1,028	1,039	1,052	1,070	1,088	1,105	1,214
Oct	0.6	1.57	248	251	254	258	262	267	293
Nov	0.6	1.12	177	179	181	184	187	190	209
Dec	0.6	1.40	221	224	226	230	234	238	261
Total		**100.00**	**15,786**	**15,965**	**16,157**	**16,431**	**16,706**	**16,980**	**18,648**

Table 3c. Estimated fishing effort in day-at-sea of ICE & HELLA (combined) fishery for shrimp trawler operating from Karachi fish harbour during 1993-99.

Days-at-sea

Month	1993	1994	1995	1996	1997	1998	1999
Jan	23,999	28,265	28,605	29,091	29,578	30,064	33,016
Feb	23,554	23,821	24,107	24,517	24,927	25,336	27,825
Mar	26,724	27,026	27,351	27,816	28,281	28,745	31,569
Apr	27,175	27,483	27,813	28,286	28,759	29,231	32,102
May	25,846	26,138	26,453	26,902	27,352	27,801	30,532
Jun	18,610	18,820	19,047	19,370	19,694	20,018	21,984
Jul	19,895	20,120	20,362	20,708	21,054	21,400	23,502
Aug	21,899	22,147	22,413	22,794	23,175	23,556	25,869
Sep	21,260	21,500	21,759	22,128	22,498	22,868	25,114
Oct	27,013	27,318	27,647	28,116	28,586	29,056	31,910
Nov	31,345	31,699	32,081	32,626	33,171	33,716	37,028
Dec	32,310	32,675	33,068	33,630	34,192	34,754	38,168
Total	**299,629**	**307,010**	**310,706**	**315,985**	**321,266**	**326,545**	**358,618**

Several management measures are being used to protect the juvenile shrimps from being harvested in many countries which includes: limit the number and size of fishing vessels; regulate age at first capture; mesh-size

regulation; observe close area and close period. The closed season has been selected due to its ease in its implementation as compared to other measures, but implementation of only one measure is not enough to protect the shrimp resources. Therefore, it is again recommended that besides closed season; size of the fleet should be restricted in between 550-600 trawlers for the harvest of shrimp.

Table 4. Animal increase of effort in number of trwlers and days-at-sea.

Year	No. of trawlers	% increase	No. of days-at-sea	% increase
1982	765		143,400	
1983	848	10.8	166,200	15.90
1984	991	29.5	187,100	30.47
1985	1,070	39.9	192,386	34.16
1986	1,142	49.3	193,423	34.88
1987	1,340	75.2	226,233	57.76
1988	1,587	107.5	258,834	80.50
1989	1,671	118.4	269,921	88.23
1990	1,730	126.1	260,446	81.62
1991	1,817	137.5	270,247	88.46
1992	1,909	149.5	301,335	110.14
1993	1,926	151.8	303,579	111.70
1994	1,952	155.2	307,010	114.09
1995	1,980	158.8	310,706	116.67
1996	2,020	164.1	315,986	120.35
1997	2,060	169.3	321,265	124.03
1998	2,100	174.5	326,545	127.72
1999	2,343	206.3	358,618	150.08
2000	1,675	119.0	270,449	88.60
2001	1,770	131.4	282,988	97.34

THE EFFECT OF CLOSED SEASON

After the introduction of close period, fishing season starts from June and ends in July. The annual means of the average monthly catch rates (in kg/day-at-sea) and the estimated total landings (in tons) of various trade-categories of

the shrimp from trawler fleet operating from the Karachi fish harbour are given in Table-5. In general, increases in the average catch rate is observed following a 'close season'.

Table 5. Animal means catch rate (kg/day-at-sea) and total landings of each categories in different fishing seasond (1982-1999).

Period	Closure	JAIRA		KALRI		KIDDI		TOTAL	
		Annual mean catch rate (kg/day-at-sea)	Total landings (tons)	Annual mean catch rate (kg/day-at-sea)	Total landings (tons)	Annual mean catch rate (kg/day-at-sea)	Total landings (tons)	Annual mean catch rate (kg/day-at-sea)	Total landings (tons)
June'82-May'83	no	17.0	2,890	22.1	3,373	-	-	44	6,714
Aug'83-May'84	yes	18.7	3,424	26.2	4,634	51.1	11,557	103	21,643
Aug'84-May'85	yes	22.1	3,930	19.1	3,605	77	16,282	122	24,618
Aug'85-May'86	yes	20.5	3,944	17.9	3,444	78.4	15,083	120	23,125
Aug'86-Jul'87	no	16.9	3,283	18.1	3,301	117.8	16,088	156	23,165
Aug'87-Jul'88	no	19.8	4,277	24.8	4,553	102.5	14,504	152	24,312
Aug'88-Jul'89	no	17.0	3,424	22.2	4,590	100.1	12,680	144	23,642
Aug'89-Jun'90	no	14.2	2,513	20.1	3,333	95.6	13,666	134	19,506
Aug'90-Jun'91	yes	23.4	4,183	28.0	4,369	90.2	16,406	146	23,179
Aug'91-Jun'92	yes	20.2	3,808	22.6	3,620	82.4	12,693	129	24,736
Jul'92-Jun'93	*yes	22.9	3,327	24.2	4,542	102.4	18,632	155	22,150
Jul'93-May'94	yes	15.7	4,988	23.7	4,679	95.5	16,023	140	29,549
Jul'94-May'95	yes	14.9	5,014	19.3	4,816	84.0	12,919	121	26,573
Jul'95-May'96	yes	10.2	3,483	20.0	3,931	94.3	14,047	126	20,914
Jul'96-May'97	yes	9.4	3,302	19.8	4,225	95.1	16,722	126	22,205
Jul'97-May'98	yes	10.9	3,706	17.9	3,965	75.3	14,689	106	24,986
Jul'98-May'99	yes	10.8	3,485	16.3	3,697	64.4	12,889	93	22,434

* Partial closure

It is estimated (van Zalinge *et al*., 1987) that a one-month closing during the estuarine phase (at age of 2 month in June) would increase the yield per recruit by 13%, the value per recruit by 28% and the spawning biomass per recruit by 32%. Benefits of a two-month closure (at ages of 2 and 3 months, June-July) would be 16%, 39% and 75% on yield, value and spawning biomass per recruit, respectively.

In shrimp trawling, trawl net is used primarily to catch shrimp but other fish species are also caught as by-catch because it is not selective fishing gear with respect to species and sizes. In trawling, shrimp constitutes a maximum of 20% of the catch and the remaining 80% is composed of mixed demersal fauna, predominately finfish. The total catch is usually composed of shrimps (10%; exported), some large fishes (5%, consumed locally or exported), small fish (15%; consumed locally) and trash fish (70%; very small fish reduced to fishmeal) (Niazi, 1995, Ex-Deputy Director, Marine Fisheries Department, Government of Pakistan, Karachi, unpublished data). The ratio of small fish species to that of undersized forms (< 10 cm in length) of the commercial fish species is 1:3. This indicates that shrimp trawlers harvest a large quantity of commercial species as trash, which is presently being used in fishmeal production. This high percentage of undersized (juvenile) fishes is detrimental to fisheries resources and also to the biodiversity. Thus, the shrimp trawl net that is being used at present are destructive gear and should not be allowed

to operate in the existing form. It is necessary to develop new more efficient gears for the harvest of shrimp that has an escape device to make it selective for shrimp and to avoid capture of undersized food fishes.

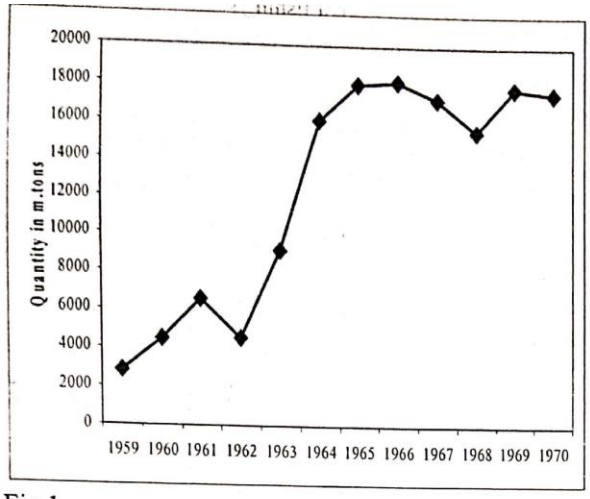


Fig.1.

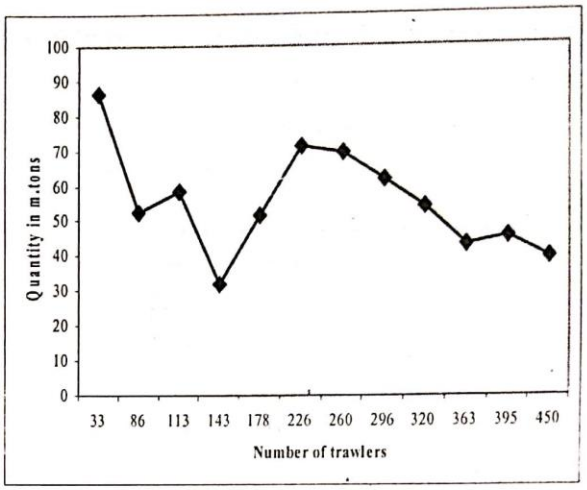
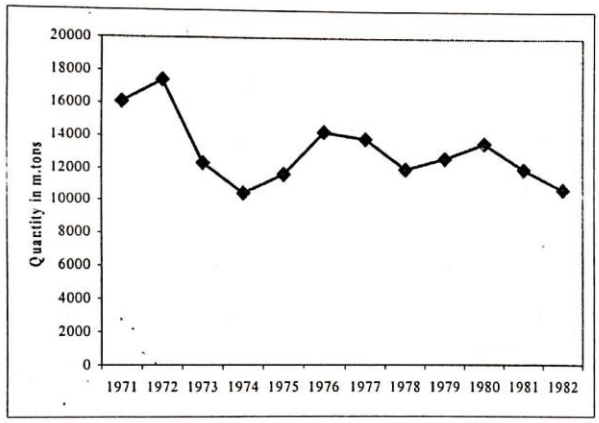


Fig.2.



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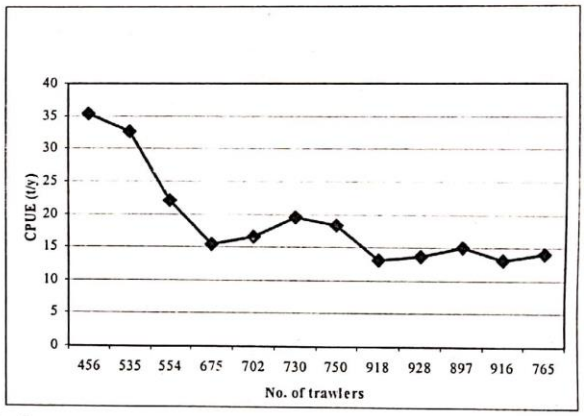

Fig.4.

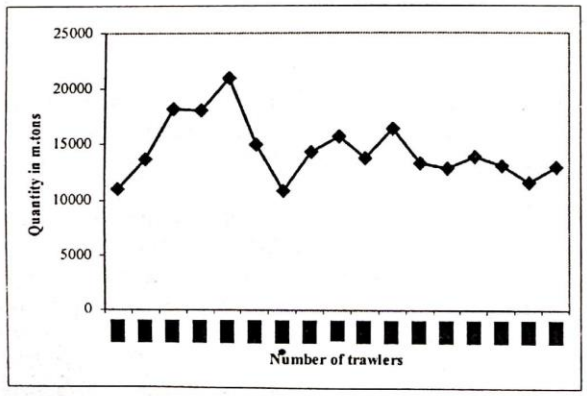

Fig.5.

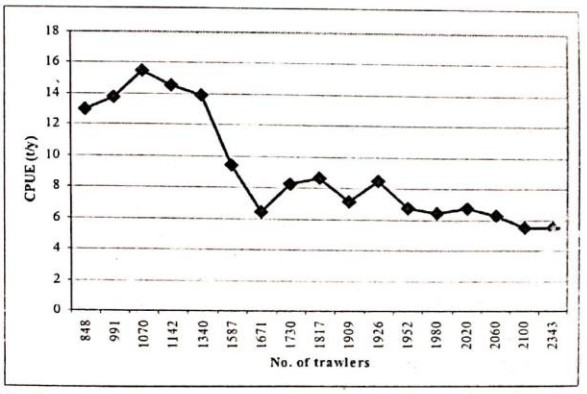

Fig.6.

Fig.1. Total production of shrimp during 1959-70 (Source: Zupanovic, 1971)
Fig.2. Catch per unit effort (CPUE) of shrimp trawler during 1959-70 (Source: Zupanovic, 1971)
Fig.3. Total production of Jaira & Kalri shrimp during 1971-82 (Source: Zalinge *et al.* 1986a, 1987)
Fig.4. CPUE of Jaira & Kalri shrimp during 1971-82 (Source: Zalinge *et al.* 1986a, 1987)
Fig.5. Total production of Jaira & Kalri shrimp during 1983-99
Fig.6. CPUE of Jaira & Kalri shrimp during 1983-99

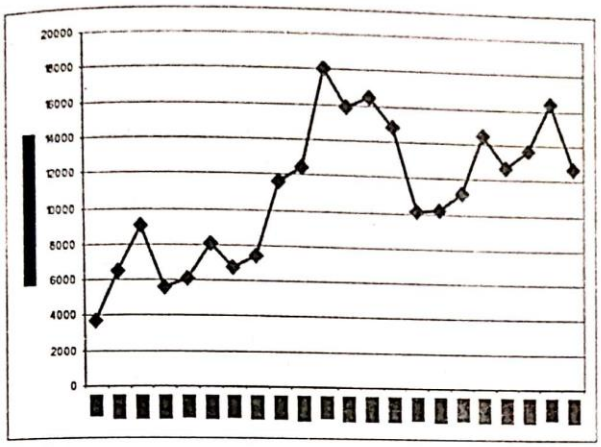

Fig.7.

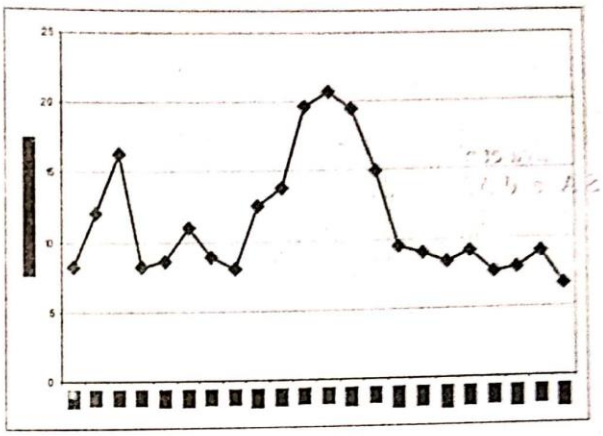

Fig.8.

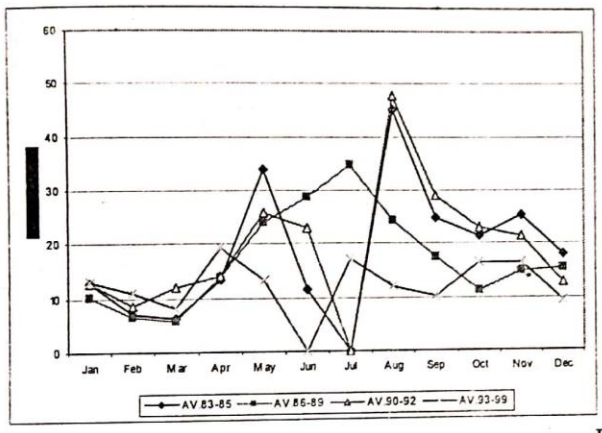

Fig.9.

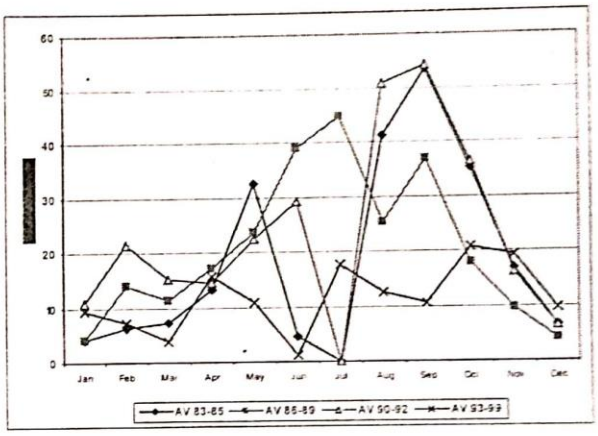

Fig.10.

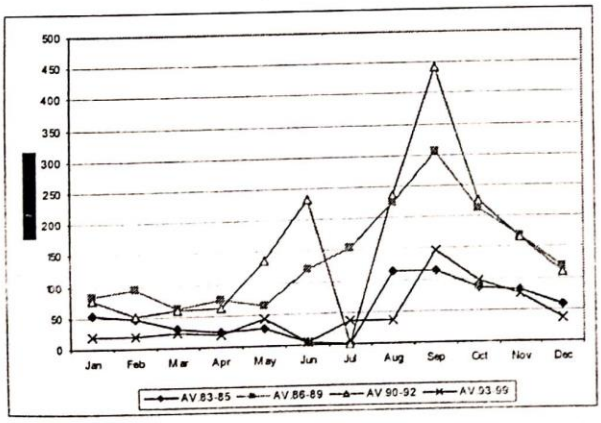

Fig.11.

Fig.7. Total Production of Kiddi shrimp (1971-92) (Source: Majid & Wasim 1993)
Fig.8. CPUE of Kiddi shrimp (1971-92) (Source: Majid & Wasim 1993)
Fig.9. Average monthly catch rates of Jaira shrimp per trawler.
Fig.10.Average catch rates of Kalri shrimp per trawler.
Fig.11.Average catch rates of Kiddi shrimp per trawler.

CONCLUSION AND RECOMMENDATIONS

In the light of the above mentioned discussion, it may be concluded that close season should be implemented for shrimp fishing to conserve juvenile shrimps and restore recuitment to stock. Reduce effort to optimal level to promote sustainable stocks. May 15 – July 15 appears to be appropriate 'close season' based on the available data on biology and physiology of shrimp species. Modification in the shrimp trawl net is recommended to avoid the undersized commercial species.

REFERENCES

Ahmed, M (1977): Species composition of the kiddi group of penaeid shrimps landed at Karachi fish harbour. *Kar. Univ. J. Sci*., 5: 75-80.

FAO (1974): Report to the Government of Pakistan by the Fisheries Policy Study Mission, based on the work of L.I.J. Silva et al., UNDP/FAO, TA 3296, 67 p.

Jaleel, S.A. and A.H. zaidai (1972): Survey report on the growth of marine fisheries of Karachi, Marine Fisheries Department, Government of Pakistan, Karachi, 97 p.

Majid, A. and M. Wasim Khan (1993): Present status of shrimp fishery in Pakistan. In Thompson, M. F & Tirmizi, N.M (eds.) The Arabian Sea living marine resources and the environment. Vanguard Book (Pvt.) Ltd., Lahore, Pakistan, pp: 265-277.

Niazi, M.S (1995): A Study on the shrimp by-catch landed at Karachi fish harbour, Marine Fisheries Department, Government of Pakistan (unpublished MS), 8 p.

Tirmizi,N.M. and Q. Bashir (1973): Shore and offshore penaeid of northern Arabian sea. Publication of Karachi University: pp 1-71.

Van Zalinge, N.P., M. Khaliluddin and W. Khan (1986a): Update status of Pakistan,s shrimp fisheries and the management implecations. FAO, Rome. FAO/UNDP, Marine Fisheries Development Project, FI: DP/PAK/77/033

Van Zalinge, N.P., M. Khaliluddin and W. Khan (1986b): Results of the sampling programme for juvenile shrimp in the Korangi/Phitti/Gharo creek area of the Indus delta. May 1985-April 1986. Rome, FAO. FAO/UNDP/GOP Marine Fisheries Development Project FI: DP/PAK/77/033/5: 1-16 p.

Van Zalinge, N.P., M. Khaliluddin and W. Khan (1987): Description of the shrimp fishery including a stratified sampling scheme for shrimp landings and effort at Karachi fish harbour. FAO, Rome. FI:DP/PAK/77/033/7, 73 p.

Zupanovic, S (1971): Report to the Government of Pakistan on the Pakistan shrimp resources. FAO/UNDP/TA project., Rome. Report No. TA 3218, 97 p.

(*Accepted for publication January 2007*)