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Northern Shrimp (*Pandalus borealis*) Stock on Flemish Cap According to 1988-1996 surveys

by

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Introduction

Shrimp was regularly caught in Flemish Cap bottom trawl surveys from 1988 to 1996. Sampling results were previously published: Escalante et al., 1990; Mena, 1991-1992; Sainza, 1993a-1993b-1994-1995 and del Rio, 1996. The whole information is now reviewed to document the evolution of the stock abundance and structure during the period. This was a singular time period because of the active fishery started in April 1993.

Material and methods

All surveys were carried out according NAFO specifications (Doubleday, 1981). Technical characteristics of all this surveys have been described by Vázquez (1996):

Year	Vessel	Valid hauls	Dates
1988	Cornide de Saavedra	115	8/7 -22/7
1989	Cryos	116	12/7- 1/8
1990	Ignat Pavlyuchenkov	113	18/7- 6/8
1991	Cornide de Saavedra	117	24/6-11/7
1992	Cornide de Saavedra	117	29/6-18/7
1993	Cornide de Saavedra	101	23/6- 8/7
1994	Cornide de Saavedra	116	6/7-23/7
1995	Cornide de Saavedra	121	2/7-19/7
1996	Cornide de Saavedra	117	28/6-14/7

The gear used was a "Lofoten" type with a cod-end mesh-size of 35 mm, with the exception of 1994 survey, when a 40 mm cod-end mesh-size was used. Hauls lasted for thirty minutes at 3.5 knots. Samples of approximately one kilogram shrimp were taken in each tow this specie was present. Samples were frozen for posterior analysis. Males and females was separated according to the endopod of the first

pleopod (Rasmussen, 1953). Individuals in the changing sex phase were included with males. Females were further separated as inmatures (first time spawners) and matures (spawned previously) based on the condition of the sternal spines (McCrary, 1971). Oblique caparace length (CL): the distance from the base of the eye to the posterior dorsal edge of the carapace (Shumway et al, 1985) were measured to the lower 0.5 mm in years from 1993 to 1996. The lateral caparace length described by Horsted and Smidt (1956), from the base of the eye to the posterior lateral edge of the carapace was used in all previous surveys. The equivalence between both measurements was analyzed with a sample of 1940 individuals from 1992 survey, then the length frequency distribution from 1988 to 1992 was transformed to the equivalent oblique carapace length (Sainza, 1993b). Specimens were placed on tissue paper for draining and weighed to the nearest 0.1 g.

Results

Shrimp biomass estimates by the swept area method and average catch per mile are provided in Table 1 for the 1988-1996 period. The shrimp biomass from 1988 to 1990 was the lowest of these nine years. The noticeable increase observed in 1991, 1992 and 1993 was followed by a reduction in 1994 (the cod-end mesh-size was 40 mm in this year), 1995 and 1996, presumable, as a consequence of the shrimp fishery starting in April 1993 on the Flemish Cap.

Length frequencies and percentages by sex in these years are provided in Table 2. These length frequency are split in males, females, immature females, mature females and ovigerous females in Figure 1. Percentages by sex and between immatures, matures and ovigerous females showed highly variable size distribution year to year. Males shrimp only dominated in 1990 and 1996 while females dominated all other years. The percentages of males increased from about 26% in 1994 to 34% in 1995 and 54% in 1996. The group of mature is the most abundant (only in 1988 and 1990 immature females dominated). Ovigerous females were the less abundant in all cases. The spawning period in Flemish Cap begins between the end of July and early August (Mena, 1991), the same period the surveys were made. So, in 1990 when the survey was carried out later into the year than other ones, the spawning biomass estimated was the greatest observed for the 1988 - 1996 period. Males presented a CL between 10 and 29 mm. Females presented a CL between 17 and 34 mm split as: 17-31.5 mm immature, 17.5-33 mm mature and 21.5-34 mm ovigerous.

Length frequencies by strata are provided in Table 3 (1988-1996). Frequencies of the same depth range from different years were amounted to prepare Figure 2. From both: the Table 3 and Figure 2, it is observed that shrimp distribution in the area is different for each sex. Depth seems to be the dominant factor: shrimp are scarce in depths shallower than 257 m (140 fathoms) and in depths greater than 554 m (300 fathoms). Shrimp primary occupy strata between 257 and 554 m. (strata from 7 to 15). The small size individuals, males shrimp dominated, occupy shallowest and large females deepest strata. Small size individuals are scarce in strata deepest than 554 m (300 fathoms), where the minimum length measured was 19 mm CL.

Northern shrimp biomass estimated by swept area method by strata from 1988 to 1996 is provided in Table 4. In 1993 two of the deepest strata: 14 and 18, were not sampled and only one haul was made in

stratum 17. Shrimp biomass in missing strata were calculated by a multiplicative model assuming the constancy over the years of the ratio between the biomass in that stratum and the biomass in all other strata at each survey (Sainza, 1993b). Strata characterised by a scarce shrimp abundance are approximately the same every year. It was observed no shrimp in strata 1 and 4. In strata 12 and 15 biomass estimated was the greatest, these strata have both the same depth.

Mean weight at length of shrimp population from 1989 to 1996 were compared in Table 5. It was observed that shrimp weight increases in all length-classes from 1989 to 1992 but in the 1993-1996 period the weight only increases for sizes greater than 27.5 mm CL and decreases for all smaller sizes (del Rio, 1996). Mean weights in the last year (1996) are approximately 1.5 to 2.5 g higher in large sizes than those observed in 1989.

Discussion

Shrimp length distribution on Flemish Cap for 1988- 1996 surveys are provided in Figure 3. The modal groups named with the same letter are comprised by individuals of the same year-class. The abundant modal groups named E allows us to follow the shrimp population structure through these years. All individuals of this year-class were males in 1990 and have a size range 16-20 mm CL, gradually became females in 1991 and 1992 (size range 20-27 mm CL) and were females in 1993 with a size range 24-31 mm CL. According to these data the full transition from males to females lasted two years. In all other modal groups of these time series (named C, D, F, H in Figure 3) sex change took place in one year. This seems to indicate that males have a similar size range than immature females of the previous year when the females abundance is high and, consequently, the sex change is delayed (Sainza, 1993a). According to the current age interpretation (NAFO SC, 1996) the modal groups named E in Figure 3 belong to the 1988 year-class. This year-class has a modal length of 23 mm CL in 1991, 25 mm CL in 1992, 26 mm CL in 1993 and 28 mm CL in 1994. These large 1994 females were the remains of the 1988 year-class. So large females in 1994 even were from the 1988 year-class. The percentage of males increased from 1994 to 1996 up to 54,1% in 1996 (named J in Figure 3) mainly due to females from the abundant 1988 year-class became mature and produced a healthy 1993 year-class. Shrimp abundance decreased since 1993, not only due to the natural mortality but also as consequence of the shrimp fishing in this zone. The abundance level observed in the 1994 survey is anomalous reduced by the use of a 40 mm mesh-size cod-end at that time.

Survey catch distribution are compared from 1988 to 1996 in Figure 4. Shrimp population have a distribution as a ring around the Cap and catches never exceeded 8 kg/tow in central and slope portions of the Flemish Cap. In 1988 and 1989 the shrimp distribution is so, but concentrated in north and north-east part. Shrimp was also concentrated in the west in 1990. During 1991-1995 period the abundance increases and the distribution is more wider spreading towards Southwest area. Best catches were higer than 50 kg per half an our tow in these years and reached up to 200 kg/tow in 1992. Finally, in 1996 the shrimp moved to the eastern part of Flemish Cap and survey catches never exceeded 50 kg/tow.

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Table 1.- Total biomass estimated by swept area method and average catch per mile

Year	Biomass (t)	Average catch per mile (Kg)
1988	2164	1.54 ± 0.28
1989	1923	1.37 ± 0.24
1990	2139	1.53 ± 0.21
1991	8211	5.83 ± 0.71
1992	16531	11.75 ± 1.86
1993	9256	6.57 ± 1.04
1994*	3337	2.37 ± 0.35
1995	5413	3.85 ± 0.44
1996	6502	4.62 ± 0.34

* cod-end mesh-size 40 mm

1988

Length (mm)	Males	Immature Females	Mature Females	Ovigerous Females
10.0				
10.5				
11.0				
11.5				
12.0				
12.5				
13.0				
13.5				
14.0				
14.5	9			
15.0	94	1		
15.5	133	66		
16.0	274			
16.5	478	47	15	
17.0	948	86		
17.5	1318	59		
18.0	1162	260	11	
18.5	965	795	20	
19.0	405	1413	14	
19.5	247	2625	59	
20.0	267	2738	181	
20.5	304	3128	322	
21.0	408	2316	599	
21.5	533	2329	625	
22.0	1042	2758	714	
22.5	767	2533	529	
23.0	595	3165	532	
23.5	231	1179	629	
24.0	36	1465	578	
24.5	18	474	722	
25.0	6	633	269	
25.5	7	342	334	
26.0	5	231	108	
26.5	1	114	144	
27.0	1	49	78	
27.5	1	41	53	
28.0		9	26	
28.5			11	
29.0			9	
29.5			2	
30.0				
30.5				
31.0				
31.5				
32.0				
32.5				
33.0				
33.5				
34.0				
frequency x 10⁴	22.4%	63.2%	14.4%	

1989

Length (mm)	Males	Immature Females	Mature Females	Ovigerous Females
10.0				
10.5				
11.0				
11.5				
12.0	2			
12.5	5			
13.0	4			
13.5	1			
14.0	5			
14.5	4			
15.0	16			
15.5	52			
16.0	91			
16.5	193			
17.0	376			
17.5	689	1	3	
18.0	894	2	4	
18.5	783	3	7	
19.0	384	5	13	
19.5	295	7	20	
20.0	540	17	48	
20.5	762	11	32	
21.0	1031	24	69	
21.5	777	75	213	
22.0	486	83	234	
22.5	266	85	241	
23.0	103	84	237	
23.5	105	103	292	
24.0	91	208	588	
24.5	90	273	772	
25.0	42	334	946	
25.5	10	391	1105	
26.0	2	349	987	
26.5		247	699	
27.0		116	328	
27.5		87	247	
28.0		103	292	
28.5		52	148	
29.0		43	121	
29.5		32	92	
30.0		13	36	
30.5		6	16	
31.0			1	
31.5				
32.0				
32.5				
33.0				
33.5				
34.0				
frequency x 10⁴	43.4%	14.7%	41.9%	

1990

Length (mm)	Males	Immature Females	Mature Females	Ovigerous Females
10.0				
10.5				
11.0				
11.5				
12.0				
12.5				
13.0				
13.5				
14.0				
14.5	8			
15.0	7			
15.5	55		5	
16.0	195		55	
16.5	587		118	
17.0	1652	3	57	
17.5	3196	9	54	
18.0	4447	45	104	
18.5	4158	93	127	
19.0	2310	263	32	
19.5	1027	349	328	
20.0	270	260	283	
20.5	191	227	357	
21.0	193	230	359	
21.5	254	445	379	
22.0	329	792	242	48
22.5	276	1004	379	103
23.0	277	602	395	122
23.5	223	524	249	167
24.0	177	489	201	110
24.5	91	359	114	47
25.0	0	224	55	54
25.5	7	309	36	22
26.0	12	152	21	8
26.5	3	32	14	
27.0			10	
27.5			3	
28.0				
28.5				
29.0				
29.5				
30.0				
30.5				
31.0				
31.5				
32.0				
32.5				
33.0				
33.5				1
34.0				2
frequency x 10⁴	63.2%	22.0%	12.6%	2.2%

Table 2.- Length frequencies and percentages by sex

1991

Length (mm)	Males	Females
10.0		
10.5		
11.0		
11.5		
12.0		
12.5		
13.0		
13.5	4	
14.0	11	
14.5	96	
15.0	240	
15.5	495	
16.0	793	
16.5	1541	
17.0	2849	
17.5	3042	3
18.0	2388	1
18.5	1067	2
19.0	390	4
19.5	516	19
20.0	2153	85
20.5	4444	354
21.0	7102	846
21.5	8058	1151
22.0	5479	2845
22.5	2751	5657
23.0	907	7411
23.5	185	7771
24.0	93	5904
24.5	151	3793
25.0	80	2564
25.5	78	2331
26.0	51	2593
26.5	8	2496
27.0	1	2205
27.5		1393
28.0		1181
28.5		456
29.0		262
29.5		88
30.0		70
30.5		22
31.0		4
31.5		0
32.0		4
32.5		35
33.0		
33.5		
34.0		
frequency x 10⁴	46.6%	53.4%

1992

Length (mm)	Males	Immature Females	Mature Females	Ovigerous Females
10.0				
10.5				
11.0				
11.5				
12.0				
12.5				
13.0				
13.5				
14.0	50			
14.5	76			
15.0	649			
15.5	1603			
16.0	1956			
16.5	1783			
17.0	1969			
17.5	1952			
18.0	914	27		
18.5	312		41	
19.0	279		41	
19.5	1278		30	
20.0	3165		129	
20.5	6119	47	185	
21.0	7242	175	341	
21.5	6896	151	1032	
22.0	6115	1176	979	
22.5	5669	1425	1794	
23.0	8002	1567	4083	
23.5	6891	2225	8559	
24.0	5335	3030	12895	
24.5	3497	4962	13124	
25.0	1360	5714	11044	
25.5	776	4749	8425	
26.0	149	3789	6843	
26.5	89	1769	3952	
27.0	17	796	2958	
27.5		254	3856	
28.0		117	1971	
28.5	11	17	1088	
29.0	7		625	
29.5			343	
30.0			84	
30.5			30	
31.0			26	
31.5				
32.0				
32.5				
33.0				
33.5				
34.0				
frequency x 10⁴	38.9%	16.8%	44.3%	

1993

Length (mm)	Males	Immature Females	Mature Females	Ovigerous Females
10.0				
10.5				
11.0				
11.5				
12.0	1			
12.5				
13.0	52			
13.5	182			
14.0	377			
14.5	1085			
15.0	2580			
15.5	3145			
16.0	3584			
16.5	2680			
17.0	1449			
17.5	379			
18.0	531			
18.5	666	11	19	
19.0	1314	8	17	
19.5	3017	24		
20.0	2306	50	18	
20.5	2862	88	53	
21.0	1777	334	78	
21.5	1687	469	67	
22.0	741	364	52	
22.5	602	303	286	
23.0	1364	237	586	
23.5	1849	676	971	
24.0	1362	1320	1791	
24.5	846	1343	4012	
25.0	520	2109	5993	
25.5	275	2168	6407	
26.0	115	2002	6133	
26.5	21	1672	4420	
27.0	25	1554	2850	
27.5		548	2037	
28.0		372	1330	
28.5	40	176	609	
29.0		16	416	
29.5			217	
30.0			69	
30.5			79	
31.0			4	
31.5				
32.0				
32.5				
33.0				
33.5				
34.0				
frequency x 10⁴	40.8%	17.3%	41.9%	

Table 2.- (continuation)

1994

Length (mm)	Males	Immature Females	Mature Females	Ovigerous Females
10.0				
10.5				
11.0				
11.5				
12.0				
12.5				
13.0	6			
13.5	13			
14.0	62			
14.5	65			
15.0	147			
15.5	194			
16.0	300			
16.5	212			
17.0	131			
17.5	45	6		
18.0	81			
18.5	214			
19.0	611	28	4	
19.5	914	30	3	
20.0	1271	50		
20.5	989	115	6	
21.0	592	64	22	
21.5	420	101	66	
22.0	417	200	75	
22.5	546	348	107	
23.0	477	605	194	
23.5	136	880	373	
24.0	39	577	631	4
24.5	24	568	1413	18
25.0	14	730	2043	7
25.5	8	487	2995	20
26.0	20	426	2699	28
26.5	1	378	2336	22
27.0		62	1564	34
27.5		24	732	2
28.0		6	500	14
28.5			212	
29.0		7	162	
29.5			83	
30.0			8	
30.5			26	
31.0			7	
31.5				
32.0				
32.5				
33.0				
33.5				
34.0				
frequency x 10⁻⁴	26.5%	18.9%	54.1%	0.5%

1995

Length (mm)	Males	Immature Females	Mature Females	Ovigerous Females
10.0				
10.5				
11.0				
11.5				
12.0				
12.5				
13.0	3			
13.5	25			
14.0	48			
14.5	140			
15.0	361			
15.5	540			
16.0	867			
16.5	1242			
17.0	1160			
17.5	707			
18.0	375			
18.5	170	5		
19.0	182	16	2	
19.5	694	6	2	
20.0	1206	17		
20.5	2002	89	7	
21.0	2917	266	18	
21.5	3257	657	77	7
22.0	2437	1069	181	
22.5	1214	1119	176	
23.0	404	1191	492	
23.5	310	889	402	
24.0	283	601	587	6
24.5	381	874	776	90
25.0	306	1359	1177	84
25.5	70	1450	1846	
26.0	55	1377	2210	22
26.5	5	1261	2297	7
27.0	1	687	2279	18
27.5		428	2113	
28.0		209	2215	40
28.5		69	2042	18
29.0		29	1998	
29.5		32	1696	
30.0		9	918	
30.5			583	
31.0			234	
31.5			85	
32.0			16	
32.5			10	
33.0				
33.5				
34.0				
frequency x 10⁻⁴	34.5%	23.4%	41.6%	0.5%

1996

Length (mm)	Males	Immature Females	Mature Females	Ovigerous Females
10.0				
10.5				
11.0				
11.5				
12.0	47			
12.5	152			
13.0	290			
13.5	617			
14.0	731			
14.5	652			
15.0	471			
15.5	447			
16.0	401			
16.5	335			
17.0	448			
17.5	272			
18.0	599	2		
18.5	1176	10	7	
19.0	2284	15	83	
19.5	5004	157	119	
20.0	6041	271	267	
20.5	7435	368	397	9
21.0	6435	865	830	65
21.5	6021	1251	559	108
22.0	2736	993	1243	353
22.5	1767	1174	1241	318
23.0	565	1096	2008	122
23.5	398	1087	2115	196
24.0	469	1315	2191	77
24.5	265	1884	2023	17
25.0	272	2121	2069	44
25.5	189	1290	1262	13
26.0	54	729	1544	10
26.5	53	639	1155	12
27.0		437	1069	28
27.5		202	830	
28.0		105	813	
28.5		36	695	
29.0		27	216	
29.5		39	144	3
30.0			71	28
30.5		12	91	
31.0			6	
31.5				
32.0				
32.5				
33.0				
33.5				
34.0				
frequency x 10⁻⁴	54.1%	17.6%	26.7%	1.6%

Table 2.- (continuation)

1988

Length	9	10	11	12	14	15	16	19	Total
					STRATA				
10.0									
10.5									
11.0									
11.5									
12.0									
12.5									
13.0									
13.5									
14.0									
14.5				8					9
15.0			10	78					94
15.5			77	34	8		8		133
16.0		15	149	40	21		36		274
16.5		62	226	114	13		38		478
17.0		83	391	277	78		72		948
17.5		193	484	331	196		48		1318
18.0		146	298	420	173		67		1162
18.5		123	277	263	135	20	100		966
19.0		89	32	246	42	4	45	2	486
19.5		37	40	108	45		6		247
20.0	3	12	21	181	30	1	58	1	325
20.5	6	11		186	50	14	117	6	409
21.0		19	11	183	90	28	116	12	481
21.5		49	21	357	130	20	224	8	852
22.0	35	213	21	639	266	289	430	24	2017
22.5	40	197	108	1181	210	303	296	42	2501
23.0	5	247	108	2077	198	435	488	67	3815
23.5	51	211	149	1640	145	805	348	61	3591
24.0	10	183	21	2124	156	604	529	51	3873
24.5	13	77	21	1473	259	463	360	50	2860
25.0	19	81	12	1074	297	770	383	83	2864
25.5	40	88	12	800	470	1254	431	127	3391
26.0	81	64	8	922	590	875	303	114	3113
26.5	123	97		1229	482	774	865	119	3884
27.0	100	42		378	273	342	171	70	1448
27.5	78	53		839	304	178	192	62	1797
28.0	89			67	93	117	162	27	582
28.5	67			259	126	81	179	26	777
29.0	74			151	17	55	84	17	419
29.5	20			91	25	64	51	17	283
30.0	11			40	23	22	22	14	139
30.5	32					16		9	61
31.0	38					4		5	50
31.5	5							5	11
32.0									
32.5									
33.0									
33.5									
34.0									

frequency x 10 [4]

Table 3.- Lenght frequencies by strata

1989

					STRATA					
Length	7	9	10	12	13	14	15	16	19	Total
10.0										
10.5										
11.0										
11.5										
12.0	2									2
12.5	3		1							5
13.0	3		1							4
13.5	1									1
14.0	3		2							5
14.5	4	1								4
15.0	6	7	1				3			16
15.5	4	6	6	3	2	6	22	1		52
16.0	7	7	21	5	4	13	30	3		91
16.5	8	18	55	5	3	34	68			196
17.0	10	36	79	9	3	64	172			383
17.5	28	45	118	9		108	368		2	699
18.0	15	68	86	37	5	158	501	15	1	914
18.5	24	55	72	20	18	178	403	6		801
19.0	13	28	30	26	6	116	164	6	5	405
19.5	6	10	8	94	3	37	92	18	46	322
20.0	6	9	5	171	12	14	197	29	145	607
20.5	14	11	10	255	10	61	175	55	194	809
21.0	14	19	22	242	17	141	244	93	303	1130
21.5	21	31	44	239	18	228	159	60	240	1070
22.0	28	38	36	224	27	175	136	33	84	804
22.5	23	42	31	131	11	139	72	69	58	593
23.0	11	53	22	74	7	77	45	45	85	431
23.5	7	43	20	79	23	79	107	69	67	508
24.0	8	30	10	282	53	37	183	90	181	900
24.5	8	30	5	357	49	96	199	158	208	1146
25.0	2	22	6	454	35	157	177	225	222	1341
25.5		10	7	635	49	131	138	250	252	1519
26.0	2	10	8	425	66	108	174	250	265	1349
26.5	1	5	5	256	32	95	141	130	261	955
27.0		3	1	90	30	65	30	106	105	445
27.5		2	2	35	9	93	27	125	32	335
28.0				8	24	99	29	67	157	396
28.5				12	11	47	33	50	41	201
29.0				44	7	34	9	46	21	164
29.5				20	7	26	0	35	33	125
30.0				21	3	5	8	9	2	49
30.5				13		2	5	2		22
31.0						1				1
31.5										
32.0										
32.5										
33.0										
33.5										
34.0										

frequency x 10 ^{4}

Table 3.- (continuation)

1990

	STRATA										
Length	7	8	9	10	11	12	13	14	15	16	Total
10.0											
10.5											
11.0											
11.5											
12.0											
12.5											
13.0											
13.5											
14.0											
14.5					8						8
15.0				2	2	4					8
15.5	7	2		18	9	16		4			55
16.0	36	8	4	70	9	34	1	26	9		195
16.5	99	27	20	144	42	121	7	75	39	12	587
17.0	280	89	20	296	91	302	15	308	200	51	1655
17.5	570	130	31	392	136	543	39	686	495	180	3205
18.0	713	191	50	537	217	803	81	903	748	243	4492
18.5	519	155	37	507	165	709	90	1079	701	285	4251
19.0	279	53	21	322	174	494	46	630	325	231	2578
19.5	181	41	8	152	155	301	23	291	187	88	1431
20.0	103	26	5	55	153	95	6	103	70	33	649
20.5	104	9	3	42	87	48	7	73	83	21	477
21.0	55	11	5	47	70	41	11	107	145	39	531
21.5	94	23	12	90	45	41	13	151	287	57	816
22.0	187	27	7	108	48	64	22	205	539	88	1299
22.5	177	14	16	126	40	150	34	188	523	145	1416
23.0	111	26	18	143	20	192	32	214	627	163	1548
23.5	78	21	26	78	10	233	33	191	632	210	1514
24.0	37	13	15	32	19	165	30	176	460	186	1133
24.5	39	2	6	22	13	128	20	150	351	125	857
25.0	14	6	7	7	4	116	20	132	232	118	657
25.5		3	9	10	9	111	22	103	163	148	579
26.0	14		5	3	3	74	16	104	207	124	551
26.5	15		7			31	5	87	185	101	431
27.0	2		1			18	3	24	90	110	249
27.5						1	2	28	83	87	201
28.0						3		14	20	77	114
28.5								4	15	36	55
29.0								14		23	36
29.5								5	6	10	21
30.0								3	6	5	14
30.5								5		6	10
31.0								1		2	3
31.5											
32.0											
32.5											
33.0											
33.5							1				1
34.0							2				2

frequency x 10^4

Table 3.- (continuation)

1991

Length						STRATA							
	3	6	7	8	10	11	12	13	14	15	16	19	Total
10.0													
10.5													
11.0													
11.5													
12.0													
12.5													
13.0													
13.5						4							4
14.0		2	2		5	3							11
14.5	3	4	75	2	1	11							96
15.0	2	8	85	28	4	77	35						240
15.5	2	8	204	51	10	68	124			22			495
16.0	7	11	433	86	37	131	35			45			793
16.5	6	17	880	120	37	158	193			113			1541
17.0	2	21	1486	165	35	305	522	14	87	180			2850
17.5	5	21	1248	132	288	418	559	40	115	185			3045
18.0	2	11	768	124	389	172	396	38	94	369			2389
18.5		7	225	39	155	44	225	36	57	271			1069
19.0	1		46	14	33	58	80	32	39	87			393
19.5	1		1	37	177	150	77		47	41			534
20.0	0	2	64	18	916	335	554		43	234	7	39	2238
20.5	2	6	358	67	1161	1120	983	5	191	737	30	84	4799
21.0	3	14	680	196	1842	1287	1737	18	567	1440	42	31	7947
21.5	6	23	591	194	2517	1120	1852	46	934	1403	81	335	9209
22.0	7	30	453	174	2494	906	1624	68	837	1326	59	253	8324
22.5	11	37	638	162	2357	971	1799	51	784	1123	147	234	8408
23.0	11	29	1210	196	1825	1057	1157	70	758	1642	14	254	8318
23.5	9	20	744	178	1999	711	1508	75	734	1437	78	372	7956
24.0	5	10	606	106	1226	333	1273	37	779	1225	41	288	5997
24.5	2	4	266	77	516	376	826	67	733	813	44	177	3944
25.0	1		70	23	197	214	434	25	395	757	57	443	2644
25.5			66	11	117	41	462	25	480	818	53	310	2408
26.0			50		38	10	669	36	212	886	65	652	2645
26.5			9		5	7	903	18	151	631	162	590	2504
27.0		1			1	1	720	2	190	311	140	816	2207
27.5						0	447	32	79	312	109	397	1393
28.0						1	348		16	293	56	454	1181
28.5						3	163		37	54	39	155	456
29.0							42	4	6	17	75	114	262
29.5							11	7	10	5	28	28	88
30.0							23			2	21	23	70
30.5							8				6	8	22
31.0											4		4
31.5													
32.0							3				1		4
32.5							35						35
33.0													
33.5													
34.0													

frequency x 10^{-4}

Table 3.- (continuation)

1992

Length							STRATA						
	5	6	7	8	10	11	12	13	14	15	16	19	Total
10.0													
10.5													
11.0													
11.5													
12.0													
12.5													
13.0													
13.5													
14.0					20	30							50
14.5			61		6								79
15.0			465	74	62	7			57				676
15.5	3		932	266	51	96			246				1603
16.0	7		1532		85	258			87				1969
16.5			1175		218	407							1799
17.0			1031		209	514	34		175				1969
17.5			985		134	352	16		392	86			1968
18.0			397		161	245	0		110	24			945
18.5			24		247	81	1		3	0			356
19.0			81		114	6	80			29			320
19.5			404		73	77	498		31	227		2	1316
20.0			850		203	407	1489		102	257		8	3323
20.5			1853	159	326	1021	2072		156	761			6363
21.0	6		1695	576	568	1694	1864		397	895	47		7776
21.5	4	7	913	1000	757	2487	1618		177	1038	61		8091
22.0		3	610	1422	1009	1915	2000		443	729	101		8269
22.5	9		758	576	944	2448	1889		1081	1090	21	46	8897
23.0	11	10	1689	379	1852	3050	2218		2602	1591	153	66	13655
23.5	11		3095	635	1677	3246	2973	13	3111	2743	106	87	17747
24.0	11		3901	2113	3178	2798	2185	22	3341	3272	272	140	21324
24.5	7		3085	1398	3819	3164	2310	22	3282	3988	381	145	21693
25.0			2633	1652	3194	2943	2632	27	1763	2814	212	180	18118
25.5			1059	1256	3172	2211	2298	33	690	2743	302	191	14004
26.0			602	1117	2013	1548	2131	26	780	1965	293	290	10817
26.5			196	388	808	849	1410	31	279	1381	253	218	5844
27.0			110		167	483	1370	33	279	690	218	461	3805
27.5			246		54	96	2337	13	190	507	357	302	4111
28.0						66	1024	19	63	501	110	308	2091
28.5							624		42	199	64	189	1124
29.0							344		25	73	95	77	632
29.5							188	5	6	78	24	30	343
30.0							56	5	13				84
30.5							19		7				30
31.0							26						26
31.5							4						4
32.0													
32.5													
33.0													
33.5													
34.0													

frequency x 10^4

Table 3.- (continuation)

1993

	STRATA												
Length	6	7	8	9	10	11	12	13	15	16	17	19	Total
10.0		1											1
10.5													
11.0													
11.5													
12.0													
12.5													
13.0		50				2							52
13.5		86	16		80								182
14.0	1	119	24		148	84							377
14.5	1	559	89	3	376	56							1085
15.0	3	1190	278	2	736	319	51						2580
15.5	3	1535	351	1	662	447	146						3145
16.0	1	1791	492		809	325	164						3584
16.5	1	912	323	2	794	534	113						2680
17.0	1	486	222	1	405	256	78						1449
17.5		93	117		114	46		9					379
18.0		134	77		236	74		9					531
18.5		409			139	77	51						677
19.0		628	8		412	171	113	9					1341
19.5	1	1864	77		872	119		37	89				3058
20.0		538	101	13	885	367	298	46	93	14			2356
20.5	3	1526	162	61	571	342	127	18	152	4			2968
21.0	2	728	162	15	433	541	228	55					2164
21.5	1	688	231	2	434	494	222	27	133			2	2234
22.0		421		26	201	325	153	37		9			1172
22.5		169	77	5	125	136	206	9	203	9		19	957
23.0	2	210	284	51	133	147	664		349	47		2	1887
23.5	5	627	146	14	360	404	790	27	634	79		24	3111
24.0	5	664	344	18	557	820	614	24	531	54	5	19	3653
24.5		665	497	127	549	425	607		1052	25		32	3980
25.0	2	1183	453	209	894	1042	1062	51	1616	31	5	91	6641
25.5	3	1442	505	148	1245	1073	1807	76	1906	48	5	177	8436
26.0	1	1387	805	186	907	829	1874	94	2266	62	19	92	8524
26.5	1	619	291	111	586	533	2090	170	3095	70	28	232	7826
27.0	1	269	223	24	222	366	2346	126	2086	92	38	205	5999
27.5		109	8	62	106	229	1146	79	1365	126	46	122	3398
28.0		84	138		18	68	922	61	947	58	28	86	2409
28.5		84					365	42	796	163	14	81	1546
29.0							200	6	271	76	33	42	625
29.5							112	22	176	32	23	51	416
30.0							52	17	74	31	5	38	217
30.5							14	6	17	16	5	11	69
31.0								6	50	11	5	8	79
31.5												4	4
32.0													
32.5													
33.0													
33.5													
34.0													

frequency x 10 ^{4}

Table 3.- (continuation)

1994

					STRATA					
Length	7	8	10	11	12	14	15	16	19	Total
10.0										
10.5										
11.0										
11.5										
12.0										
12.5										
13.0										
13.5										
14.0										
14.5			3	4						6
15.0			13							13
15.5			32	30						62
16.0		1	28	36						65
16.5	13		61	66			7			147
17.0			59	116			19			194
17.5		2	113	90		13	82			300
18.0			99	63			39		11	212
18.5			51	48			33			131
19.0			24	6		15				45
19.5			65	7			13		2	87
20.0			83	18	13	19	72	3	6	214
20.5	13	1	186	63	38	91	201		17	611
21.0	1	1	178	155	35	190	346	5	37	946
21.5		2	216	133	105	373	418	9	47	1304
22.0	2	1	116	97	99	289	379	7	50	1039
22.5	16	2	131	78	70	155	246	7	7	713
23.0	1		34	67	63	175	120	6	39	506
23.5		1	63	96	67	68	233	8	48	584
24.0	58	2	122	100	106	177	193	11	51	821
24.5	52	4	166	173	122	212	154	7	44	936
25.0	32	1	274	182	112	66	247	11	29	953
25.5	137	4	327	283	111	85	318	10	25	1299
26.0	101	1	286	177	203	56	397	17	15	1252
26.5	108	5	452	421	307	205	483	14	29	2023
27.0	110	4	606	307	596	370	675	35	77	2781
27.5	150		894	380	657	541	785	48	69	3524
28.0	80		562	210	581	662	966	42	57	3160
28.5	40		375	87	627	650	830	42	64	2716
29.0			213	62	343	407	535	35	45	1640
29.5			53	4	192	213	220	25	49	756
30.0			5	4	201	108	134	12	42	506
30.5			5		56	24	99	7	20	212
31.0			3		14	53	78	2	20	169
31.5					54	1	26	3		83
32.0					4			1	3	8
32.5					12	14				26
33.0						1			6	7
33.5										
34.0										

frequency x 10 [4]

Table 3.- (continuation)

1995

							STRATA							
Length	2	6	7	8	9	10	11	12	13	14	15	16	19	Total
10.0														
10.5														
11.0														
11.5														
12.0														
12.5														
13.0		3												3
13.5			8			17								25
14.0		2	12			24	6			4				48
14.5		3	26	3		61	24	17		4				140
15.0		5	106		16	129	39	32		33	1			361
15.5		3	117	3		222	64	125		4	1			540
16.0	29	5	158	14	87	301	135	138			1			867
16.5	116		220	25	64	385	148	179		49	54			1242
17.0	58	2	145	21	87	239	136	173		109	186		4	1160
17.5	43	3	87	33	87	124	84	81		36	128			707
18.0	58	2	23	1	19	40	61	58		32	82			375
18.5	29		15			14	6	57		16	39			175
19.0	14	2	17			74	29	41		18	5			200
19.5	29		41	7		203	66	75		41	221		18	702
20.0	101	2	64	12	53	200	86	224		61	362		57	1223
20.5	72		117	13	91	419	195	241		361	512	14	61	2098
21.0	86	2	167	32	231	822	217	431		365	705	7	132	3201
21.5	115	12	333	75	254	586	324	668		513	919	18	174	3998
22.0	29	26	382	102	261	581	333	659	7	441	626	24	212	3683
22.5	101	25	352	71	87	397	276	374	2	284	392	15	129	2509
23.0		27	322	231	69	474	315	309		139	156	13	29	2087
23.5	29	9	222	95	102	379	266	221	7	74	131	16	47	1601
24.0	43	9	131	63	147	360	227	166	7	64	174	18	67	1477
24.5	86	8	163	129	184	407	283	274		190	247	21	126	2121
25.0	101	8	217	245	199	627	262	389	2	260	448	31	134	2926
25.5	188	2	189	221	256	567	302	628	2	228	573	43	163	3366
26.0	115	2	165	233	295	647	289	559	7	255	801	40	248	3664
26.5	203	2	129	195	411	407	261	482	7	336	781	28	322	3570
27.0	43	2	94	99	460	410	212	574		160	657	27	243	2985
27.5	14	2	63	48	261	432	202	455	9	171	601	30	249	2541
28.0	43		64	34	259	382	165	420	18	309	478	11	276	2464
28.5	58		30	13	187	305	175	287	23	361	407	23	258	2129
29.0	14		30	1	247	239	66	229	39	427	450	18	266	2027
29.5	43		23	12	166	228	66	131	21	395	452	16	173	1728
30.0	58		1	3	166	60	16	51	14	142	270	20	124	927
30.5	14				77	4		70	14	213	91	6	94	583
31.0					19	9	13	31	5	101	47	5	4	234
31.5						6			14	49	5	3	8	85
32.0							6		2			1	5	16
32.5			2						2	4			4	10
33.0														
33.5														
34.0														

frequency x 10^{-1}

Table 3.- (continuation)

1996

Length							STRATA									
	3	5	6	7	8	9	10	11	12	13	14	15	16	18	19	Total
10.0																
10.5																
11.0																
11.5																47
12.0			47													47
12.5			142					10								152
13.0			236				28	25								290
13.5	14	4	425	47			25	102								617
14.0	14	7	520		12		36	142								731
14.5	36	2	331		24		94	165								652
15.0	22	11	142		12	10	138	138								471
15.5	50	9		110	12	10	146	110								447
16.0	50	13		63	24	40	79	103				29				401
16.5	14	12	47	47	50	10	67	78		10						335
17.0	22	7		95	69	10	82	112				29	23			448
17.5	7	4	47		26	20	71	46				29	23			272
18.0	22	9		126	41	30	123	165		10		28	46			601
18.5	7	9		205	32	89	211	292	28	105	126	82				1186
19.0	7	13		614	118	190	407	469	55	63	115	179	46		24	2299
19.5	36	1	141	1447	328	357	831	769	158	104	572	369	23	13	12	5161
20.0	36	11	94	1544	396	263	819	788	369	356	723	767	91	7	49	6312
20.5	14	10	94	1700	617	321	810	833	442	565	1339	896	46	26	95	7810
21.0	58	11	283	1213	713	287	509	665	870	597	829	1012	137	33	168	7383
21.5	71	21	236	1038	613	271	404	553	1191	1122	911	524	159	23	252	7391
22.0	123	16	142	566	398	118	203	414	606	713	210	259	160	16	53	3996
22.5	100	10	47	299	294	40	279	423	517	579	325	101	228	7	88	3338
23.0	223	7	47	503	248	46	181	356	325	177	56	160	114	7	51	2500
23.5	35	8		298	163	42	300	454	112	178	88	315	68	13	35	2109
24.0	72	11		378	187	102	440	599	326	126	226	493	46	14	118	3135
24.5	43	7		314	122	156	562	542	359	169	815	455	46	36	117	3743
25.0	101	8		409	324	200	541	550	861	136	345	906	182	30	127	4719
25.5	14	1		283	227	89	375	262	767	116	400	750	273	19	138	3716
26.0	21	2	47	189	213	212	419	263	758	83	234	547	46	13	123	3170
26.5				31	120	134	290	245	861	210	267	539		16	81	2792
27.0	14	1		79	161	211	222	201	475	73	265	591	46	10	174	2523
27.5	7				100	104	168	101	359	126	142	277		19	102	1508
28.0	14			31	63	183	134	135	257		202	426	23	13	182	1662
28.5					17	81	133	123	246	53	188	196		13	150	1201
29.0				47		47	167	26	243		182	135			260	1108
29.5						36	116	97	194	116	86	79	23	3	149	897
30.0				31	17	24	103	26	35	53	182	179		7	157	813
30.5	7				23	17	67	39	111	53	129	102	23	6	133	710
31.0					11	24	6	24	28		31	12	23		86	244
31.5					17	12	11				6	13	46		39	144
32.0					6	12	6					12			36	71
32.5						12			28			13	23	3	12	91
33.0											6					6
33.5																
34.0																

frequency x 10^4

Table 3.- (continuation)

Table 4.- Total biomass survey estimated by strata (tons)

Stratum	Depth (fathoms)	1988	1989	1990	1991	1992	1993	1994	1995	1996	TOTAL
1	70-80	0	0	0	0	0	0	0	0	0	0
2	81-100	0	0	0	0	0	0	0	162	0	162
3	101-140	0	0	0	5	0	1	0	2	86	94
4	101-140	0	0	0	0	0	0	0	0	0	0
5	101-140	0	0	0	4	8	0	0	6	12	30
6	101-140	0	0	2	19	3	3	0	11	94	132
7	141-200	18	20	212	713	2134	1404	93	299	684	5577
8	141-200	9	51	46	158	1130	545	3	183	412	2537
9	141-200	57	47	24	150	88	109	0	506	324	1305
10	141-200	115	44	188	1499	2278	972	658	873	707	7334
11	141-200	89	0	105	733	2714	794	358	452	699	5944
12	201-300	786	582	313	1733	3329	1786	599	778	910	10816
13	201-300	64	58	42	63	28	120	0	28	416	819
14	201-300	255	218	407	814	1640	(1161)	556	632	706	5228
15	201-300	404	328	558	1485	2522	2029	916	1021	922	10185
16	301-400	308	234	239	171	303	133	44	47	148	1627
17	301-400	2	10	0	0	0	(36)	0	0	0	12
18	301-400	0	0	0	0	0	0	0	1	30	31
19	301-400	56	331	4	663	354	163	111	412	351	2445
Total:		2164	1923	2139	8211	16531	9256	3337	5413	6502	54278

(no sampled strata)

Table 5.- Mean weigth of shrimp in the years 1989-1996

Length (mm)	Mean weight (g)							
	1989	1990	1991	1992	1993	1994	1995	1996
10.0	0.6	0.6	0.7	0.7	0.8	0.7	0.6	0.6
12.5	1.2	1.2	1.3	1.4	1.4	1.3	1.2	1.1
15.0	2	2	2.1	2.3	2.4	2.2	2.1	2
17.5	3.1	3.2	3.3	3.5	3.6	3.4	3.3	3.2
20.0	4.6	4.7	4.9	5.1	5.2	5	4.9	4.8
22.5	6.5	6.6	6.9	7.1	7.3	7.1	7	6.9
25.0	8.9	9	9.3	9.5	9.7	9.6	9.5	9.5
27.5	11.7	11.8	12.3	12.4	12.7	12.6	12.6	12.7
30.0	15.1	15.3	15.8	15.9	16.1	16.2	16.3	16.6
32.5	19.1	19.3	19.9	19.9	20.1	20.4	20.7	21.2
35.0	23.7	23.9	24.7	24.5	24.8	25.3	25.8	26.6
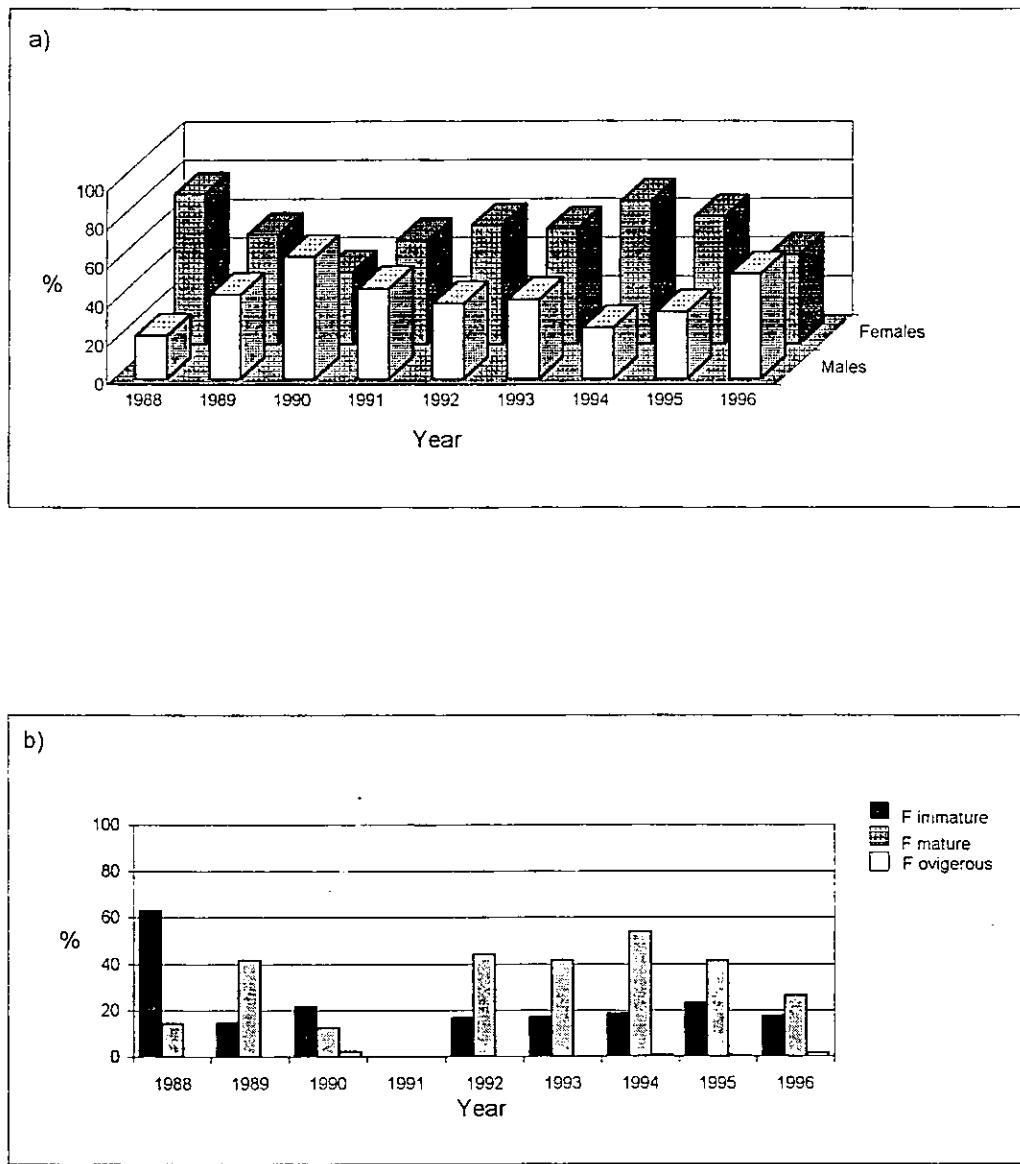
1991 = no data

Figure 1.- a) Sex percentage of shrimp.

b) Percentage of development stage in females shrimp.
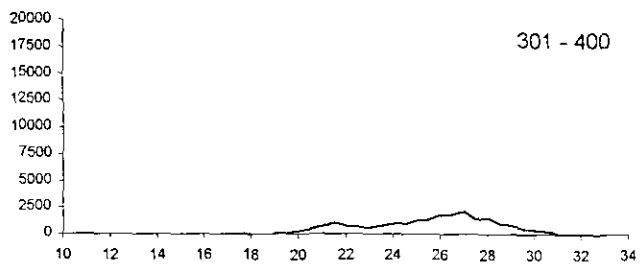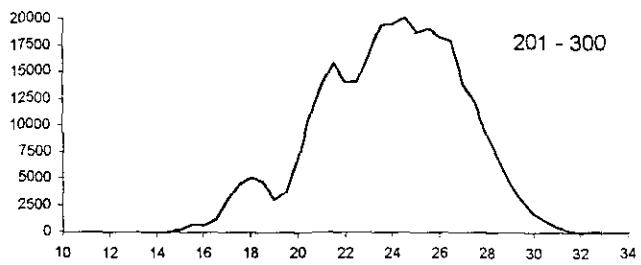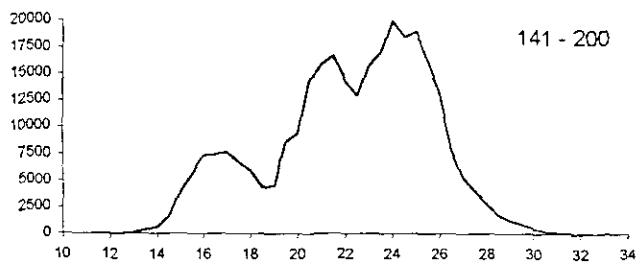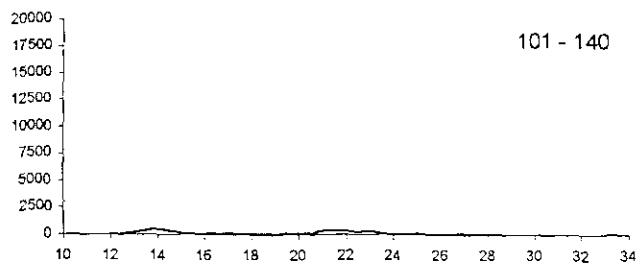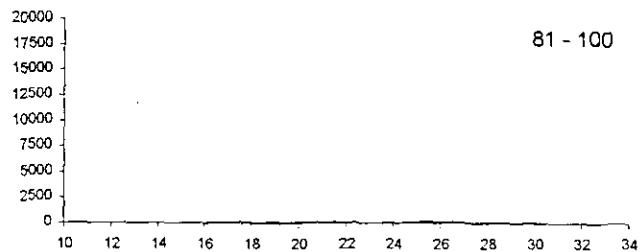
Figure 2.-Shrimp length distribution by depth range (fathoms). Y-Axis = Frequency (10^4) X-Axis = Length (mm)
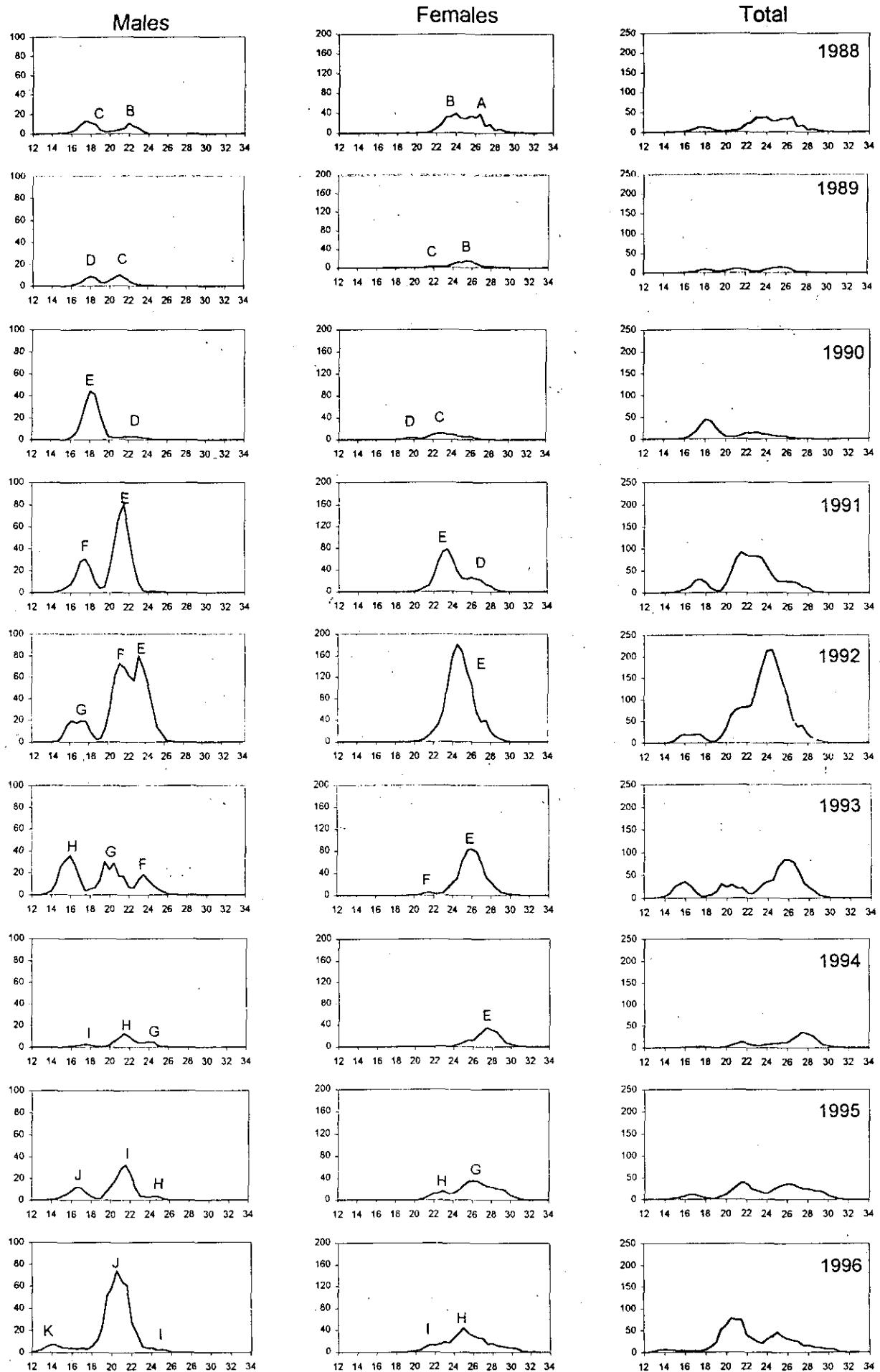
Figure 3 .-Shrimp length distribution on Flemish Cap 1988 -1996 surveys.   Y-Axis = Frequency (10^6) X-Axis = Length (mm)

	0 - 8	kg / tow
8 - 20	kg / tow
20 - 50	kg / tow
> 50	kg / tow
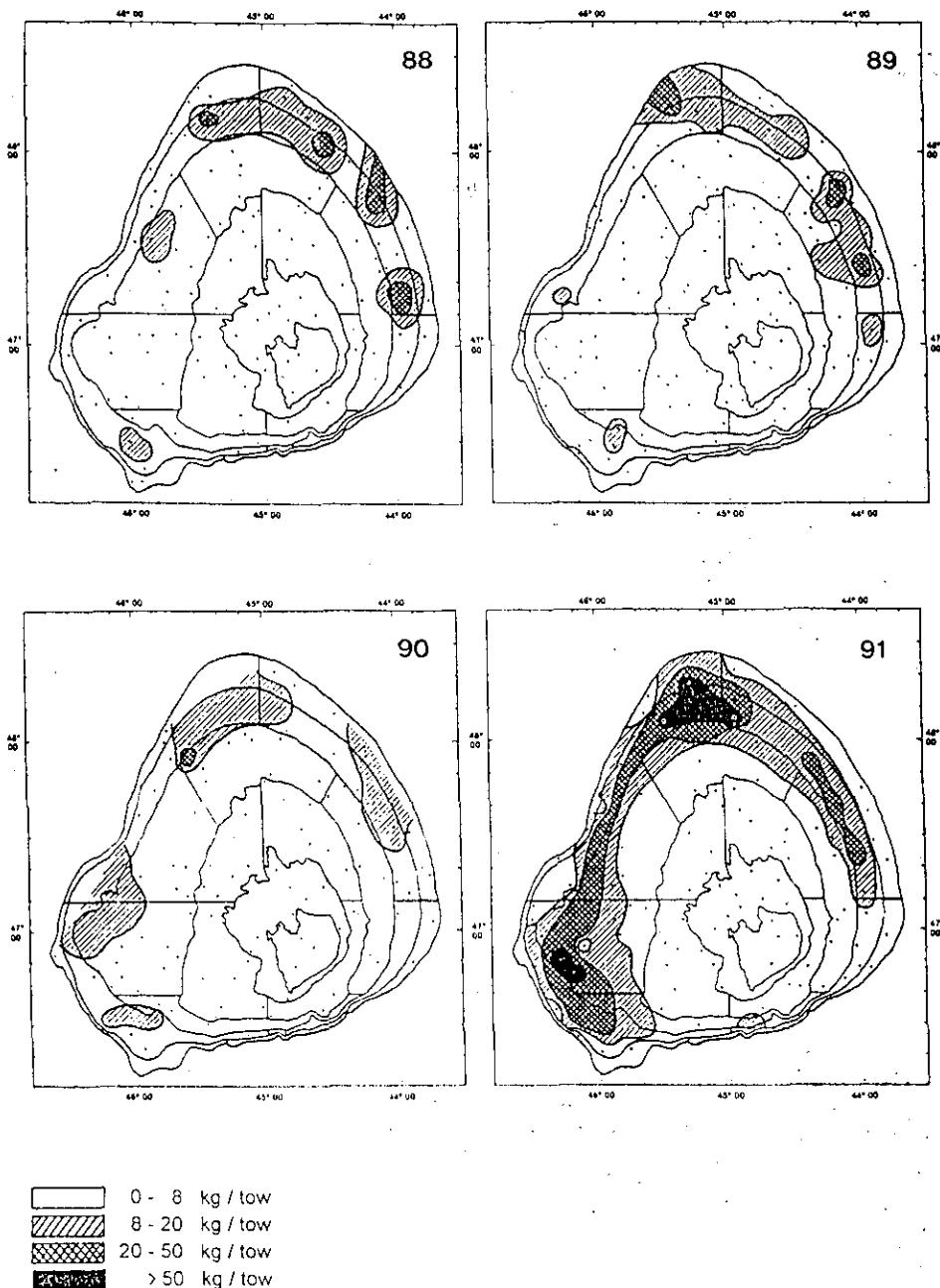
Figure 4.- Shrimp catch distribution on Flemish Cap according to surveys in the 1988-1996 period.

Figure 4.- (continuation)