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Variation in Cod Stock Abundance in NAFO Subdivision 3Ps on the Period 1978-1990

by

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Abstract

Variation in Cod stock abundance in Subdivision 3Ps have been observed on the period 1978-1990. Two general sources acting in a combined way on the stock may have been identified.

Variability in the recruitment abundance (age 3), distribution of this stock, and migrations of Cod stocks from neighbouring areas (which affect the estimation of the Cod stock abundance in Subdivision 3Ps) are a reply to changes in annual environmental conditions. The stock condition, especially the spawning biomass level, is a result of the high fishing intensity developed in last years, consequence of rising fishing capacity level and limitations of access to canadian waters by the french trawler fleets.

1. Introduction.

Cod stock is the major ressource exploited in the NAFO Subdivision 3Ps (Fig. 1) and this fishery represent 82 to 90 percent of the total. Since 1978, only Canada and France have participated in it. While canadian catches are taken from May to September traditionnally by fixed gears in inshore waters, the french catches are realised from October to June by trawler fleets in offshore waters.

A study of this activity is conducted by french fisheries laboratory IFREMER at Saint-Pierre and Miquelon. Research surveys are annually carried out in late winter and samplings of landings from trawler fleets are systematically realised to estimate the catch at age composition. Annual assessment is conducted.

On the study period, variations were observed in the annual abundance of this stock and in some of its components. These variations are presented here, and some sources which have been identified are discussed.

2. Material and method.

Research survey.

The standard process, which is annually conducted in late winter (February-March) since 1978 by french scientists, is described by Forest *et al.* (1981). The sampling design consist in a random selection of trawling stations, their number being proportional to the variance observed in Cod abundance (main species sought) in each stratum of the area (Fig. 2). Trawling operations are standardized (30 minutes, 4 knots).

Abundance and biomasses are estimated, per 30 minutes, for each trawling set, and the average values are calculated by stratum in the reference area (strata 306-325, 705-708, 715, 716). On the other hand, water temperature is recorded from surface to the bottom at the end of each trawling operation by means of XBT casts.

. Assessment.

From 1984 to 1988, the Cod stock assessment in NAFO Subdivision 3Ps was carried out by the standing committee on fisheries sciences (STACFIS) of the Scientific Council of the NAFO. Since this date, no evaluations were realised at this meeting, and separate assessments are carried out by Canada and France.

Analytical analysis is yearly conducted by France. Sampling of Saint-Pierre and Miquelon trawler fleets are systematically done to obtain the annual age composition in catches. These data are exchanged with canadian scientists.

Laurec and Shepherd (1983) tuning method, with calibration by survey indices (annual abundance observed at age) and Saint-Pierre and Miquelon trawler fleets catch rate indexes, is used to estimate the annual fishing mortality at age.

The annual, total, exploitable and spawning biomasses and recruitment (age 3) abundance are then estimated.

3. Results and discussion.

. Research surveys indices.

Annual abundance and biomass indices estimated during surveys carried out in late winters increased until 1986 and declined strongly after, to become close to the 1978 level (Fig. 4, Tabl. 8 to 11).

High values reached in 1982, 1984 and 1986, especially for this last year, were the consequences of Cod migrations from neighbouring areas, gulf of Saint-Lawrence (divisions 4RS and Subdivision 3Pn) in the northern part of Subdivision 3Ps, Grand Bank (divisions 3NO) in the southern part. These migrations took place in winter and their intensity were variable. In the northern part of Subdivision 3Ps they were greatly influenced by oceanographic conditions in the gulf of Saint-Lawrence. This migration activity affects the abundance and biomass indices which are over estimated for the years 1982, 1984 and 1986. As in several areas of the Northwest Atlantic, Cod have changed its distribution in Subdivision 3Ps on the last winter. This species is encountered in deeper waters (400-500 m), and particularly in Laurentian channel area, on the Saint-Pierre bank slope. French survey estimations do not include this area (strata 711-714) not being systematically sampled in the past. So abundance and biomass indices of this stock have been under estimated for 1990.

. Commercial catches.

From 1978 to 1987, catches have increased gradually until 1984 (11000 t) and then rapidly (59000 t in 1987), mostly because of increased french catches (Fig. 5, Tabl. 1 to 3). This was due to the combination of limitation of access to canadian fishing zones in gulf of Saint-Lawrence and Labrador (divisions 2J 3KL) by the french fleet from 1986, and an increase in its fishing capacity (arrivals of new trawlers in Saint-Pierre and Miquelon fleets). Catches have then declined to 38000 t in 1989 as a result of lower french activity in Subdivision 3Ps, metropolitan fleet have drastically been reduced (only 2 vessels in 1989) and quotas have been allowed in canadian waters by the 30th March 1989 canadian-french agreement (Fig. 3).

. Annuals catch at age composition.

At the origin, the Cod fishery in Subdivision 3Ps was based on the exploitation of several age-classes (5 age old and more), with a major part of adults (Fig. 7 and 8, Tabl. 4 and 6). The increase in the fishing activity on the period 1985-1987 (Fig. 6 and 10, Tabl. 5), was conducted on the oldest age-classes and their proportion in the stock have been reduced. On the same period, good recruitments came into the fishery, therefore in 1989 and 1990, the major part of catches was made by individuals belonging to younger age-classes (4 and 5), most of them being immatures.

. Cod stock biomasses (total, exploitable, spawning).

On the 1978-1989 period, total biomass of Cod stock have increased until 1985 and declined after (Fig. 9, Tabl. 7). Exploitable and spawning biomasses have more or less followed the same variation, but decreasing more strongly in 1988 and 1989 (Fig. 9, Tabl. 7). International fishing activity limitation in Subdivision 3Ps as the result of the extension of territorial limits at 200 milles in 1977 by Canada associated to good recruitments permitted the reconstitution of this stock. Limitation of the french fleets fishing activity in canadians waters from 1986 to 1988, and the increase of their fishing capacity on the same period lead to the reduction of the biomass of this stock, and as the fishery was conducted on adults, the decline of the spawning biomass.

. Recruitment abundance (age 3).

On the period 1978-1989, Cod stock recruitment abundance in Subdivision 3Ps was very variable, being stronger in 1981, 1983, 1984 and 1988 (Fig. 10, Tabl. 7). From 1983 to 1986, the recruitment abundance drastically declined but has increased from then, while the spawning biomass was still declining. As for most of other stocks, these variations are not related to the spawning stock biomass (Fig. 11, Tabl. 7) and are more the results of the combination of several environmental factors.

4. Conclusion.

Variations observed in Cod stock abundance in Subdivision 3Ps are the results of combination between biological factors and fishing activity.

Recruitment abundance, distribution and migrations of Cod stock from neighbouring areas, gulf of Saint-Lawrence and Grand Bank are variable from year to year. Some sources of variations have been identified and they are essentially a reply to changes in environmental conditions.

The intensity of the fishing exploitation is mainly related to the limitation, or not, in the access to the canadians waters by the Saint-Pierre and Miquelon trawler fleets. From 1986 to 1988 when this access was reduced, and the fishing capacity at a high level, the impact of the fishing activity on Cod stock was strong and from this years spawning biomass is at a low level. From 1989, increase of fishing capacity of these fleets have been compensated by the decline of the metropolitan trawler fleets.

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Year	Canada (N)		Can (M)	France		TOTAL					
	Offshore	Inshore		(1)	(2)	Spain	Portugal	Others	Canada	France	Total
1959	2726	32718	4784	3078	4952	7794	3647	471	40228	8030	60170
1960	1780	40059	5095	3634	2460	17223	262	2123	46934	6094	72636
1961	2167	32506	3883	4140	11490	21015	4985	3434	38556	15630	83620
1962	1176	29888	1474	2241	4138	10289	1873	1560	32538	6379	52639
1963	1099	30447	331	1757	324	10826	209	6828	31877	2081	51821
1964	2161	23897	370	2097	2777	15216	169	9880	26428	4874	56567
1965	2459	25902	1203	2570	1781	13404		4535	29564	4351	51854
1966	5473	23785	583	3207	4607	23678	519	4355	29841	7814	66207
1967	3861	26331	1259	2244	3204	20851	980	4044	31451	5448	62774
1968	6536	22938	585	1880	1126	26868	8	18613	30059	3006	78554
1969	4269	20009	849	2477	15	28141	57	7982	25127	2492	63799
1970	4650	23410	2166	1970	35	35750	143	8734	30226	2005	76858
1971	8657	26651	731	1651	2730	19169	81	2778	36039	4381	62448
1972	3323	19276	252	1436		18550	109	1267	22851	1436	44213
1973	3107	21349	181	1165		19952	1180	5707	24637	1165	52641
1974	3770	15999	657	948	5366	14937	1246	3789	20426	6314	46712
1975	741	14332	122	775	3549	12234	1350	2270	15195	4324	35373
1976	2013	20978	317	904	1501	9236	177	2007	23308	2405	37133
1977	3333	23755	2171	1252	1734				29259	2986	32245
1978	2082	19560	700	1974	2860			45	22342	4834	27221
1979	2381	23413	863	4289	2060				26657	6349	33006
1980	2809	29427	715	1936	2681				32951	4617	37568
1981	2696	26068	2321	4101	3706				31085	7807	38892
1982	2639	21351	2948	4780	2184				26938	6964	33902
1983	2100	23915	2580	5618	4238				28595	9856	38451
1984	895	22865	1969	7550	3671				25729	11221	36950
1985	4529	24854	3476	10064	8444				32859	18508	51367
1986	5155	24884	1963	14042	11939			7	32002	25981	57990
1987	4087	26781	2517	15854	9965				33385	25819	59204
1988	3461 ^b	19943 ^b	2303	10293	7373			4	25707	17666	43377
1989 ^a	2774 ^c	22886 ^c	2366 ^a	9979 ^a	892 ^a				28026 ^a	10871 ^a	38897 ^a
1990 ^a	3028 ^c	20236 ^c	3129 ^a	14927 ^a	0				26393 ^a	14929 ^a	41322 ^a

Can (N): Canada, Newfoundland

Can (M): Canada, Maritimes

France (1) 1959-1985 : SPM ; since 1986 : inshore SPM + OTB 5

France (2) 1959-1985 : Métropolitans ; since 1986 : OTB 6-7

a provisional data

b ratio inshore/offshore from NAFO data and Fisheries and Oceans laboratory St John's, NFLD

c ratio inshore/offshore from provisional data and Fisheries and Oceans laboratory St John's, NFLD

Table 1.- Cod catches (metric tons) in NAFO Subdivision 3Ps by country for the period 1959-1990.

	France				Can (M)					Can (N)					
	Insh.	OTB (5)	OTB (6-7)	TOT.	OT	GN	LL	HL	TOT.	OT	GN	LL	HL	FPN	TOT.
1978	360	1614	2860	4834	693		7		700	2082	2374	11811	3130	2245	21642
1979	495	3794	2060	6349	695		168		863	2381	3955	14292	3123	2030	25781
1980	214	1722	2681	4617	703		12		715	2809	5493	19312	2545	2077	32236
1981	333	3768	3706	7807	826		1495		2321	2696	4998	18980	1142	948	28764
1982	1009	3771	2184	6964	993		1955		2948	2639	6281	11542	1597	1929	23988
1983	843	4775	4238	9856	1479		1101		2580	2100	6144	11588	2540	3643	26015
1984	777	6773	3671	11221	1776		193		1969	895	7275	9376	2942	3271	23759
1985	642	9422	8444	18508	3461		15		3476	4529	7086	10261	1832	5674	29382
1986	389	13653	11939	25981	1418		545		1963	5155	8570	10951	1078	4059	29813
1987	550	15304	9965	25819	1667		850		2517	4087	9128	10857	1628	4901	30601
1988	286	10005	7373	17664	1657		651		2308	3426	6494	9327	1522	2398	23167
1989	338	9641	892	10871	1232	40	1091	3	2366	2774	5885	9264	1664	6074	25661
1990	158	14769		14927	1545	258	1385		3158	2898	6633	7391	2246	3777	22935

Table 2.- Cod catches (metric tons) by main gear type in NAFO Subdivision 3Ps from 1978 to 1990.

	France			Can (M)				Can (N)				
	Insh..	OTB (5)	OTB (6-7)	OT	GN	LL	HL	OT	GN	LL	HL	FPN
1978	7.4	33.4	59.2	99.0		1.0		9.6	11.0	54.6	14.5	10.4
1979	7.8	59.8	32.4	80.5		19.5		9.2	15.3	55.4	12.1	7.9
1980	4.6	37.3	58.1	98.3		1.7		8.7	17.0	59.9	7.9	6.4
1981	4.3	48.3	47.5	35.6		64.4		9.4	17.4	66.0	4.0	3.3
1982	14.5	54.1	31.4	33.7		66.3		11.0	26.2	48.1	6.7	8.0
1983	8.6	48.4	43.0	57.3		42.7		3.8	30.6	39.5	12.4	13.8
1984	6.9	60.4	32.7	90.2		9.8		3.8	30.6	39.5	12.4	13.8
1985	3.5	50.9	45.6	99.6		15		15.4	24.1	34.9	6.2	19.3
1986	1.5	52.5	46.0	72.2		27.8		17.3	28.7	36.7	3.6	13.6
1987	2.1	59.3	38.6	66.2		33.8		13.4	29.8	35.5	5.3	16.0
1988	1.6	56.6	41.7	71.8		28.2		14.8	28.0	40.3	6.6	10.3
1989	3.1	88.7	8.2	52.1	1.7	46.1	0.1	10.8	22.9	36.1	6.5	23.7
1990	1.0	99.0		48.7	8.1	43.2		12.6	28.9	32.2	9.8	16.5

Table 3- Cod catches (%) by main gear type in NAFO Subdivision 3Ps from 1978 to 1990.

ANNEE	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
AGE													
3	502	135	368	1022	130	760	203	206	277	585	946	1118	2006
4	5146	3072	1625	2888	5092	2682	4521	4718	4924	2956	4945	9190	8629
5	6096	10321	5054	3136	4430	9174	4538	11473	10159	11023	4848	7973	8195
6	4006	5066	8156	4652	2348	4080	7018	6118	11180	9763	6289	2893	3329
7	1753	2353	3379	5855	2861	1752	2221	5072	4247	5453	4971	2546	1483
8	653	721	1254	1622	2939	1150	584	1496	2144	1416	1783	1089	1237
9	235	233	327	539	640	1041	542	417	639	1107	627	592	692
10	178	84	114	175	243	244	338	377	220	341	281	220	350
11	72	53	56	67	83	91	134	333	168	149	121	138	142
12	27	24	45	35	30	37	35	131	141	78	77	55	104
13	17	13	21	18	11	18	8	24	78	218	126	91	47
14	10	10	25	2	7	8	8	12	23	1	1	1	109

Table 4 - Age composition (numbers in thousands) of cod catches in Subdivision 3Ps from 1978 to 1990.

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	F(87-89)
3	.0148	.0068	.0120	.0188	.0034	.0114	.0034	.0050	.0034	.0175	.0153	.0108	.0145
4	.1021	.1179	.1057	.1231	.1223	.0883	.0869	.1027	.1272	.1989	.2005	.2017	.2003
5	.2963	.3046	.2888	.3037	.2808	.3358	.2111	.3288	.4648	.5966	.5764	.5701	.5810
6	.4611	.4296	.4201	.4704	.3916	.4521	.4654	.4865	.7875	.7460	.8356	.8344	.8053
7	.6024	.5443	.5730	.6095	.5984	.5719	.4778	.7358	.8910	.9184	1.1549	1.0324	1.0352
8	.6426	.5373	.6352	.6039	.7211	.5153	.3786	.6974	.5737	.7449	.9193	.8775	.8472
9	.5406	.5005	.5013	.6272	.5113	.6124	.4914	.5116	.4743	.9829	.9082	.9444	.9452
10	.5779	.3768	.4914	.5536	.6543	.3732	.4098	.7695	.3106	.7988	.7351	1.0032	.8457
11	.6426	.3364	.4653	.6064	.5592	.5504	.3617	.9272	.4498	.6628	.7558	1.0441	.8209
12	.6012	.4590	.5333	.6001	.6089	.5247	.4239	.7283	.5399	.8216	.8947	.9803	.8988
F(7-11)	.6012	.4591	.5332	.6001	.6088	.5246	.4239	.7283	.5399	.8216	.8947	.9803	.8988

Table 5 - Fishing mortality at age for the Subdivision 3Ps Cod stock estimated from a cohort analysis from 1978 to 1989.

	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
3	37693	21945	33933	60614	42867	73954	65271	45636	22087	37207	68611	114655	0
4	58372	30407	17845	27450	48704	34979	59862	53256	37178	18023	29934	55319	92862
5	26103	43150	22125	13145	19871	35285	26219	44933	39348	26803	12095	20056	37018
6	11873	15891	26052	13571	7944	12286	20648	17381	26480	20240	12085	5564	9286
7	4232	6130	8467	14013	6941	4396	6400	10614	8748	9864	7859	4290	1978
8	1504	1897	2912	3908	6237	3124	2032	3250	4164	2938	3223	2027	1251
9	615	647	907	1263	1749	2483	1528	1139	1325	1921	1142	1053	690
10	443	293	321	450	552	859	1102	765	559	675	588	377	335
11	166	204	165	161	212	235	484	599	290	336	249	231	113
12	65	71	119	85	72	99	111	276	194	152	142	96	67
+ gp	65	68	122	48	43	70	51	76	223	426	234	160	78
Total	141130	120704	112969	134709	135191	167769	183707	177925	140595	118584	136161	203829	143678

Table 6 - Total numbers of Cod (in thousands) in the NAFO Subdivision 3Ps stock estimated from a cohort analysis from 1978 to 1990.

	Recruitment (thousands)	Total biomass (metric tons)	Exploitable biomass (metric tons)	Spawning biomass (tonnes)	Average F (7-11 years)	Ratio catch/spawning biomass
1978	37693	132626	69799	53930	.6012	0.505
1979	21978	133303	92152	71949	.4590	0.459
1980	33981	141807	101350	88071	.5331	0.427
1981	60390	149917	100982	84276	.6000	0.462
1982	42736	143076	88228	70762	.6087	0.479
1983	74596	186165	99983	80426	.5241	0.478
1984	68446	216491	107529	89478	.4230	0.413
1985	54952	213894	115437	96940	.7286	0.531
1986	29681	175935	105190	86606	.5425	0.678
1987	48255	175780	114562	86880	.8215	0.722
1988	85448	178542	90981	67958	.8448	0.762
1989	187435	276546	101159	64417	.8679	0.910

Table 7 - Recruitment, biomasses (total, exploitable and spawning), average fishing mortality, ratio catch/spawning biomass (7-11 years) for the Cod stock of the Subdivision 3Ps estimated, from a cohort analysis, on the period 1978-1989.

Depth (m)	Strata	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
< 55	314	17	0	-	1390	111	30	0	7	13	133	-	17	0
	320	108	814	-	3797	513	2803	3526	104	14	-	0	316	222
	Total	125	814	-	5187	624	2833	3526	111	27	133	0	333	222
56-90	308	371	9	150	88	299	151	111	65	100	29	6	25	0
	312	820	270	112	2304	454	636	1403	145	343	0	28	55	2
	315	771	850	0	1076	821	326	16918	8	1813	2058	2134	198	41
	321	183	4785	3746	2199	3746	1362	1026	3	543	-	649	0	0
	325	-	-	-	2101	-	1332	1466	81	259	0	453	0	0
	Total	2145	5914	4008	7768	5320	3807	20924	302	3058	2087	3270	278	43
91-180	307	3598	2714	4428	1876	9009	6269	5384	2976	23172	8089	565	6168	215
	311	87	3199	1136	5797	8202	3572	19599	1276	20627	1356	4815	675	267
	317	0	260	-	813	454	421	21353	1502	2562	1049	815	974	226
	319	997	5810	1303	4435	4078	11349	8101	2831	3179	5746	5434	5889	3067
	322	605	1945	3381	1793	2404	967	1122	2388	5944	2734	215	864	172
	323	91	572	858	822	54	794	803	512	2399	953	311	60	10
	324	-	-	-	0	-	815	964	594	288	99	171	90	44
Total	5378	14500	11106	15536	24201	24187	57326	12079	58171	20026	12326	14720	4001	
181-270	306	3080	2660	2162	12197	3716	11967	2296	804	23131	8294	4041	4690	663
	309	167	2743	804	2176	1122	3318	3852	1581	7434	1901	4827	7947	6726
	310	411	190	19	481	1683	739	229	4675	169	503	739	164	93
	313	113	331	1	1099	1279	840	170	1753	142	562	26	373	240
	316	91	121	39	282	544	36	332	38395	695	334	320	2324	4464
	318	42	25	-	593	34	5282	786	1828	28349	259	4558	941	2096
	Total	3904	6070	3025	16828	8378	22182	7665	49036	59920	11853	14511	16439	14282
271-365	705	321	1115	13	574	4550	984	1661	99	414	354	394	325	49
	706	11	0	293	952	4010	375	1141	333	3896	13845	1413	296	768
	707	-	1303	-	13	10980	652	49	2314	3338	134	102	118	193
	715	836	832	1564	827	4159	1261	3806	2282	2613	1908	1772	542	1759
	716	178	455	1169	554	2104	1934	2326	86	2775	5685	6264	439	1096
	Total	1346	3705	3039	2920	25803	5206	8983	5114	13036	21926	9945	1720	3865
366-545	708	-	-	-	85	373	44	8	593	849	6136	264	429	899
	711	-	-	-	0	-	296	-	-	-	-	-	0	1058
	712	-	-	-	0	-	300	-	-	-	-	-	0	2926
	713	-	-	-	108	-	-	-	-	-	-	-	0	2268
	714	-	-	-	354	-	0	-	-	-	-	-	0	9677
	Total	-	-	-	547	373	640	8	593	849	6136	264	429	16788
0-545	Total	12899	31002	21178	48787	64699	58856	98433	67235	135061	62164	40316	33918	39169

Table 8 - Estimated Cod biomass (in metric tons) in Subdivision 3Ps from french stratified surveys, yearly conducted in late winter (February-March) on the period 1978 to 1991.

Depth (m)	Strata	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
< 55	314	33	0	(73)	267	22	133	0	33	33	67	(354)	33	0
	320	36	241	(256)	784	90	572	663	136	45	(785)	0	90	181
	Total	69	241	329	1051	112	705	663	169	78	852	354	123	181
56-90	308	189	12	35	35	161	46	157	50	134	31	38	65	0
	312	605	99	28	677	456	99	6837	155	298	0	75	56	5
	315	368	57	0	269	113	85	3597	28	321	868	265	28	28
	321	20	896	326	502	387	221	147	16	55	(628)	1222	0	0
	325	(108)	(152)	(138)	129	(567)	275	647	65	226	0	485	0	0
	Total	1290	1216	527	1612	1684	726	11385	314	1034	1527	2085	149	33
91-180	307	1948	1154	3084	640	4662	2958	2624	785	21238	4694	1136	8851	1144
	311	402	1628	1158	4357	3995	4147	15162	1954	18038	9503	16231	5973	1040
	317	0	119	(697)	724	4940	1696	16436	989	1182	8457	5410	7993	859
	319	1051	4583	1146	3262	3516	7666	5473	3909	2887	5695	3639	9413	13319
	322	939	617	5742	1149	4916	5720	2603	4239	4883	11270	4776	6735	912
	323	349	226	318	1156	572	3671	3683	2670	4576	1907	1668	1621	95
	324	(479)	(611)	(570)	0	(1845)	2605	3147	1607	727	237	3164	1878	85
	Total	5168	8938	12715	11288	24446	28463	49128	16153	53531	41763	36024	42464	17454
181-270	306	765	870	698	9691	2841	6333	947	278	14560	2956	2589	3935	2759
	309	355	1642	264	1453	595	1500	1588	872	4906	831	2859	5852	13611
	310	396	186	15	489	1095	935	105	9513	175	382	2276	146	553
	313	130	328	11	859	814	678	83	2359	138	1432	23	1639	995
	316	65	95	39	165	423	30	173	4088	826	215	667	4871	6236
	318	21	8	(191)	247	34	1182	604	576	5810	101	2786	1097	1936
	Total	1732	3129	1218	12904	5802	10658	3500	17686	26415	5917	11200	17540	26090
271-365	705	254	982	27	423	3286	672	908	69	224	220	274	267	87
	706	22	0	98	672	3054	179	532	163	1981	8977	791	158	717
	707	(140)	586	(166)	13	2603	183	19	827	1172	81	80	51	73
	715	922	597	895	628	2473	588	1636	917	1132	961	882	276	2048
	716	123	357	923	455	1772	1196	1058	25	2258	5353	4836	406	1707
	Total	1461	2522	2109	2191	13188	2818	4153	2001	6767	15592	6863	1158	4632
366-545	708	(52)	(68)	(63)	45	353	8	4	315	381	1543	88	172	297
	711				0		33						0	823
	712				0		133						0	2466
	713				21		-						0	1854
	714				137		0						0	9877
Total	52	68	63	203	353	174	4	315	381	1543	88	172	15317	
0-545	Total	9775	16115	16960	29249	45585	43544	68833	36638	88206	67194	56614	61608	63707

Table 9 - Estimated Cod abundance (in thousands) in Subdivision 3Ps from french stratified surveys, yearly conducted in late winter (February-March) on the period 1978-1991.

Age	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
1		.07		.06	1.03	4.63	.03	.13	.08	3.29	5.27	1.87	.38
2	.73	.43	7.38	.18	12.00	10.79	11.58	5.49	7.24	20.62	14.86	24.70	3.11
3	1.57	.39	1.72	4.91	1.96	5.40	7.64	14.49	4.21	11.51	14.89	16.02	21.84
4	3.08	2.08	.50	4.94	8.32	2.98	15.07	7.47	15.19	2.83	9.22	8.20	20.12
5	2.05	7.29	2.67	5.14	7.97	7.21	8.74	3.93	26.47	8.30	3.62	5.81	5.64
6	1.20	3.27	4.52	7.45	6.06	6.11	18.97	1.06	21.66	12.49	6.53	3.48	1.20
7	.89	1.82	1.66	5.64	4.55	4.55	5.59	1.95	9.12	8.32	4.69	4.43	.29
8	.52	.96	.67	1.60	5.30	2.77	2.13	1.14	6.97	2.95	1.60	2.03	.49
9	.30	.38	.29	1.19	1.58	2.08	3.09	.78	3.85	1.94	.78	1.01	.32
10	.22	.22	.22	.47	.87	.75	2.21	.86	.79	.95	.35	.27	.17
11	.02	.29	.18	.15	.42	.25	.61	1.09	.59	.20	.35	.13	.08
12	.04	.09	.11	.14	.15	.19	.16	1.32	.72	.36	.16	.06	.07
13	.01	.10	.08	.06	.21	.08	.13	.12	.22	.15	.15	.07	.01
14+	.03	.22	.18	.13	.10	.06	.12	.23	.32	.29	.33	.08	.05
3+	9.94	17.12	12.80	31.82	37.49	32.42	64.46	34.43	90.11	50.25	42.64	41.59	50.28
6+	3.23	7.35	7.92	16.83	19.23	16.84	33.00	8.55	44.25	27.62	14.93	11.56	2.68
Total	10.72	17.71	20.25	32.14	50.59	47.92	76.11	40.05	97.47	74.24	62.76	68.16	53.77
N° sets	69	64	40	83	74	88	74	84	82	69	73	106	107
	Feb.21 Mar.25	Feb.21 Mar.20	Mar. 03-12	Feb.24 Mar.31	Mar.5 April 2	Feb.10 Mar.19	Feb.15 Mar.19	Feb.09 Mar.10	Feb.09 Mar.10	Feb.04 Mar.06	Feb.09 Mar.11	Feb.15 Mar.18	Feb.26 Mar.28

Table 10 - Average number of Cod per set and age in late winter surveys (strata 306-325, 705-708, 715, 716) in Subdivision 3Ps from 1978 to 1991.

		1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
Kg/30mn	1	15.21	35.43	27.98	53.46	73.85	64.45	108.89	74.38	149.41	72.05	44.88	37.52	25.79
	2	2.43	7.13	4.51	10.78	16.22	9.79	35.24	39.86	45.37	18.98	7.96	10.65	7.47
Nb/30mn	1	10.81	17.83	18.76	32.18	50.43	47.99	76.14	40.53	97.58	74.33	62.62	68.15	53.86
	2	1.36	3.37	1.45	6.80	7.70	5.10	24.73	6.84	26.90	13.59	11.58	11.59	16.89

1 : Abundance indices 2 : Standard deviation

Table 11 - Cod abundance indices in weight and number, per 30 minutes, from french research surveys in Subdivision 3Ps from 1978 to 1991.

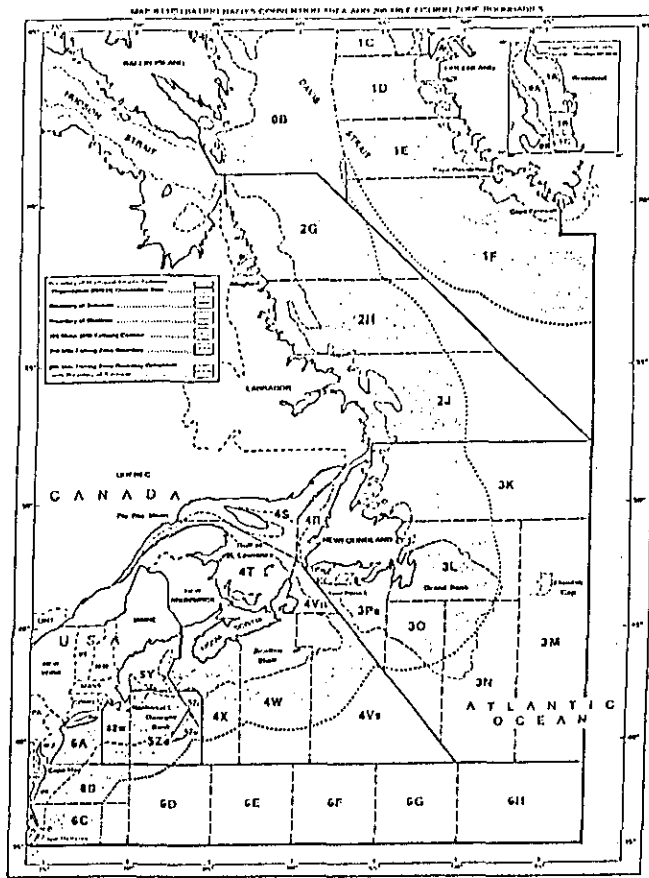


Figure 1. Localization of Subdivision 3 Ps in NAFO regulated area.

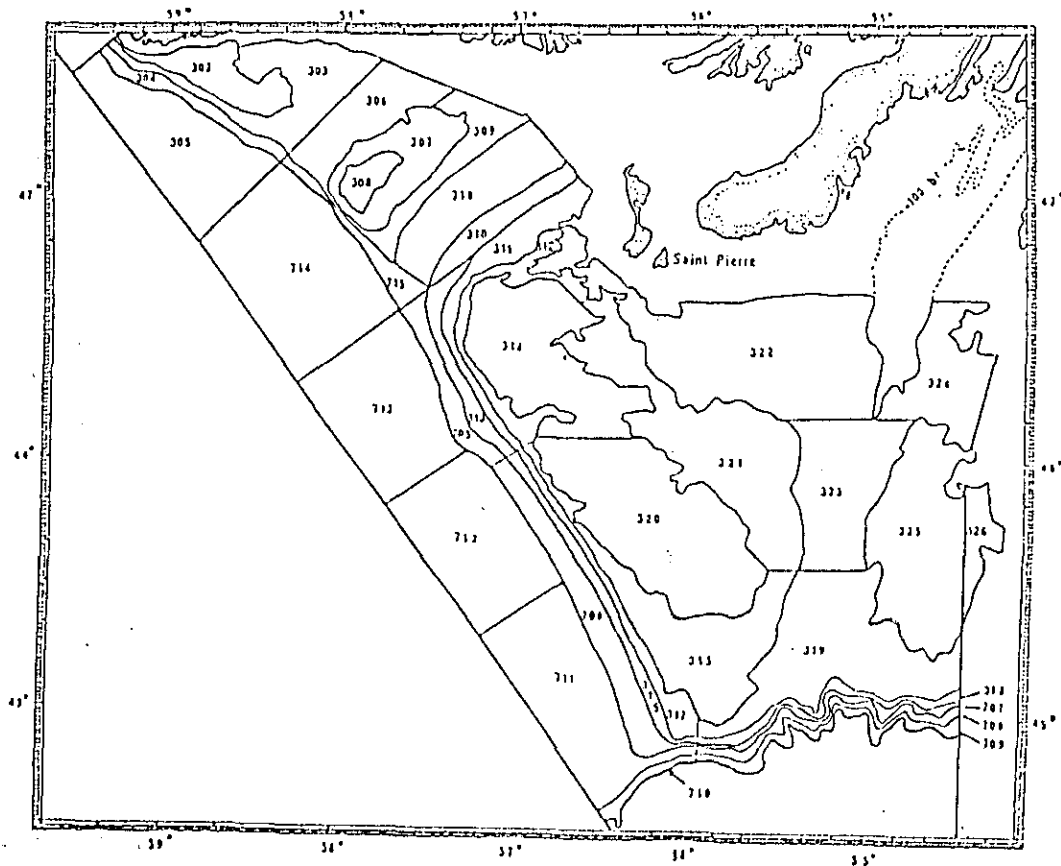


Figure 2. NAFO stratification scheme in Subdivisions 3Pn and 3Ps.

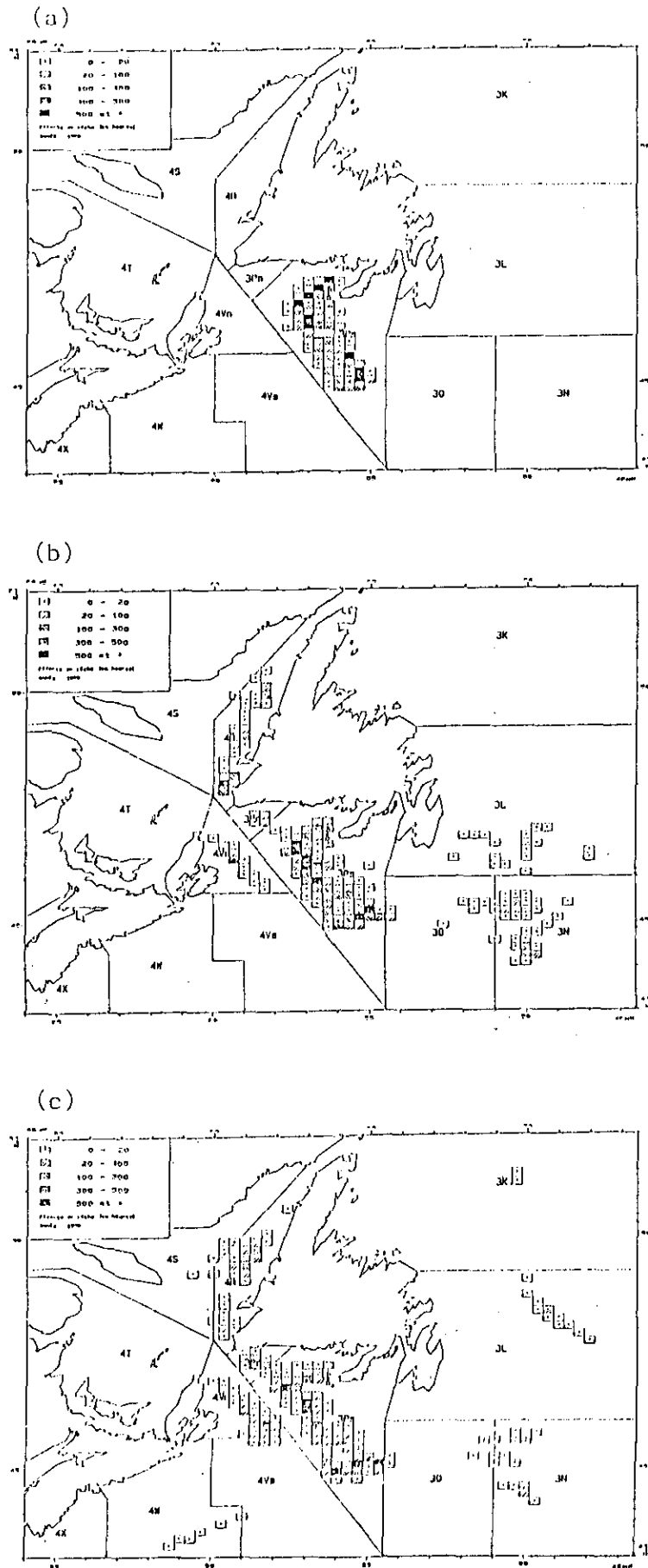


Figure 3. Cartography of the fishing effort deployed by Saint-Pierre and Miquelon trawler fleets in 1988 (a), 1989(b) and (1990) in the NAFO regulated area.

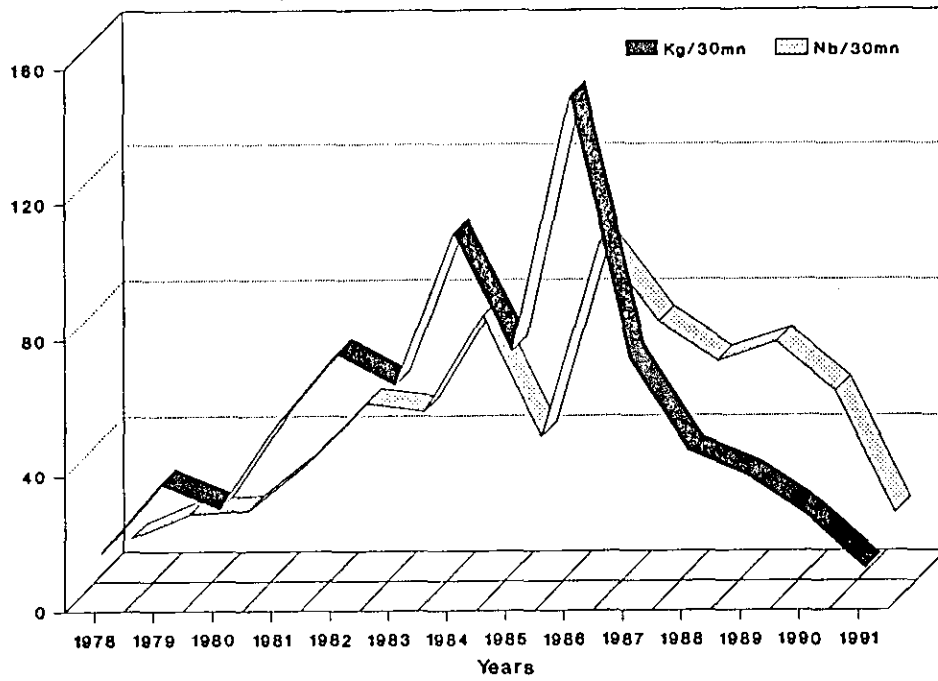


Figure 4 - Yearly variations of cod abundance and biomass Indices in Subdivision 3Ps (french surveys in late winter).

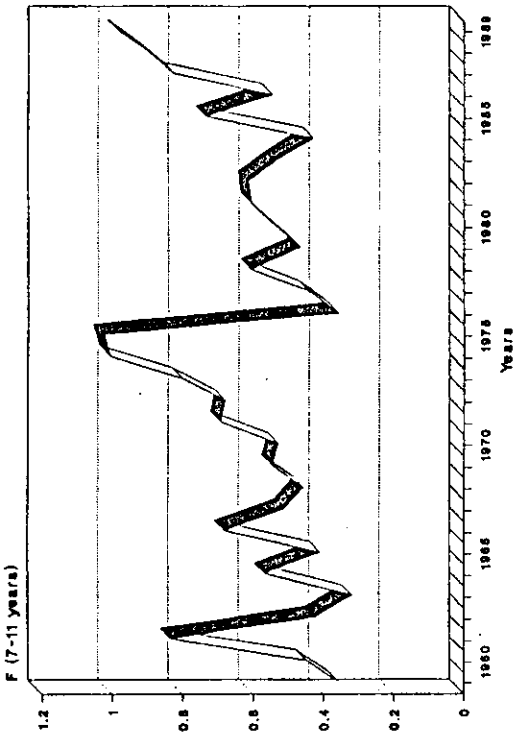


Figure 6 - Annual fishing mortality (7-11 years) from 1959 to 1989

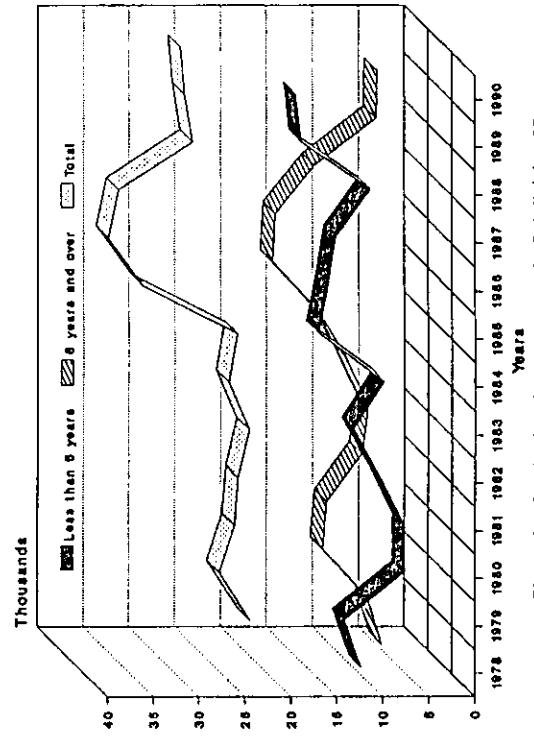


Figure 8 - Catch of cod by age group in Subdivision 3Ps from 1987 to 1990.

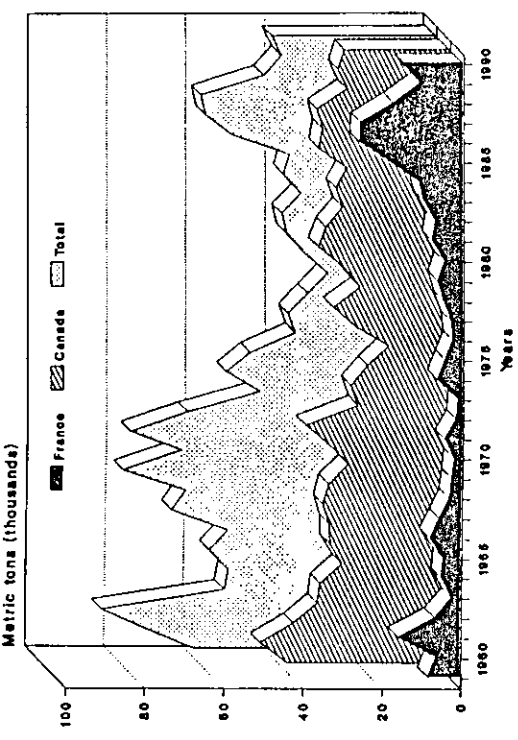


Figure 5 - Total cod catches in Subdivision 3Ps from 1959 to 1990.

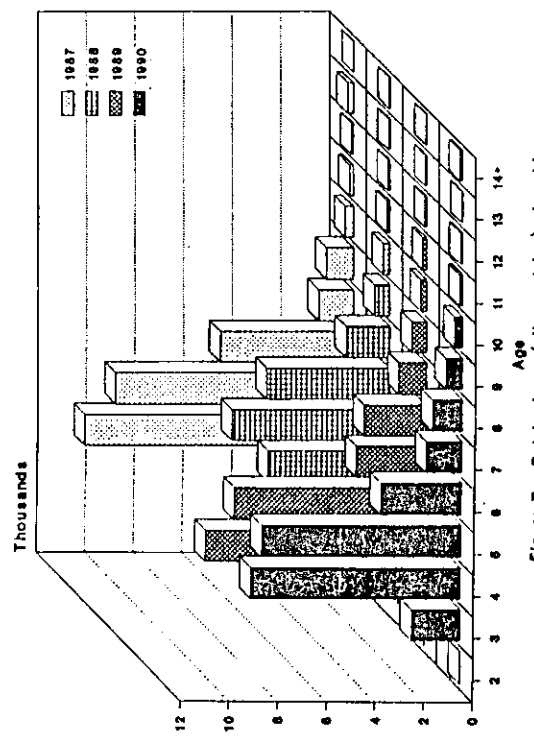


Figure 7 - Catch at age (all countries) of cod in Subdivision 3Ps from 1987 to 1990.

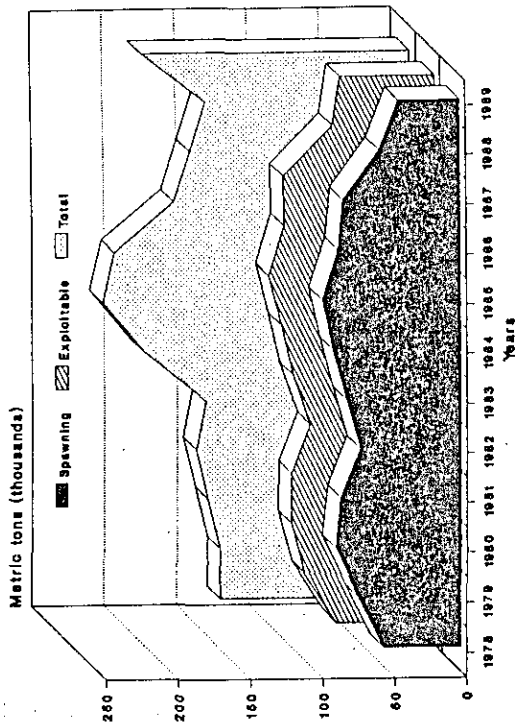


Figure 9 - Annual spawning, exploitable and total biomasses from 1978 to 1989.

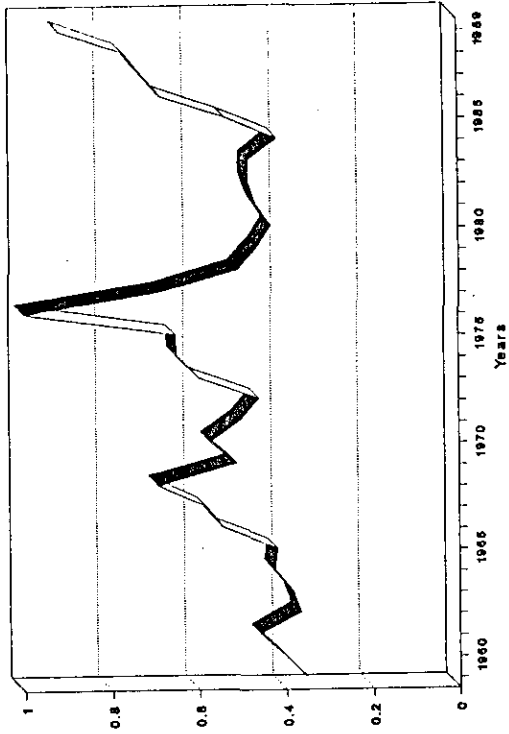


Figure 10 - Variations of the catch/spawning biomass ratio from 1959 to 1989.

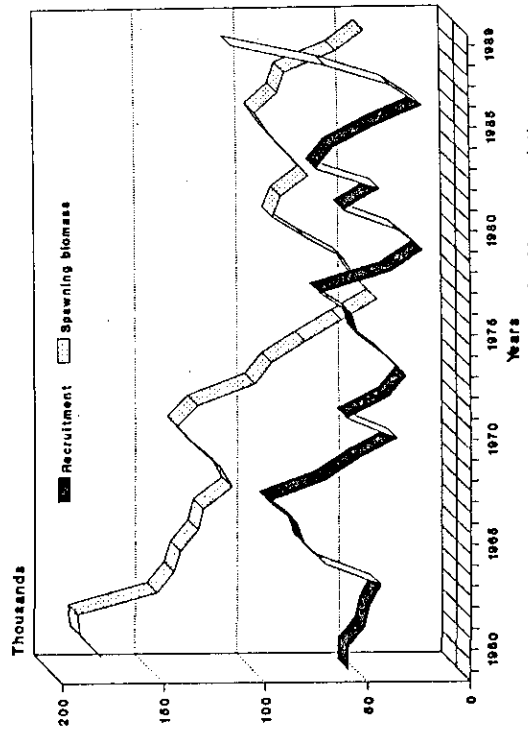


Figure 11 - Recruitment and spawning biomass variations on the period 1959-1989.

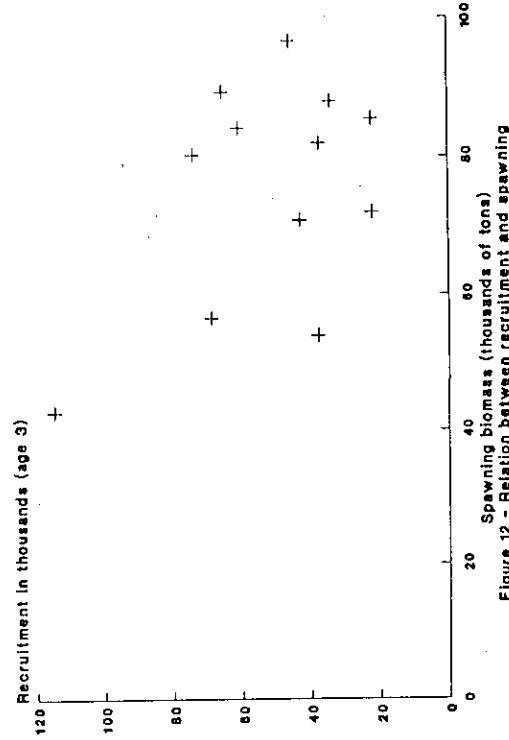


Figure 12 - Relation between recruitment and spawning biomass for the period 1978-1989.