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Assessment of the Stock of Beaked Redfish in the
Flemish Cap Area (Division 3M)

by

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Abstract

Assessment of mean annual stock of beaked redfish in the Flemish Cap area for the 1958-1979 period is given here. Total allowable catch and fishing mortality coefficients at which the catch may be taken are estimated.

Fishing is analysed on the basis of biological data and results of calculations performed according to Beverton and Holt's model and by the VPA method, and advice on feasible catch of beaked redfish in the Flemish Cap area is given.

Introduction

Yearly catch of redfish in the Flemish Cap area is subject to notable fluctuations (Table 1). It had been growing steadily since the start of fishing up to 1959. In 1960 redfish catches dropped, and since 1966 the Flemish Cap area as an area of specialized fishing for redfish lost its significance. Redfish catches were taken sporadically during fishing for cod. Since 1972 redfish catches in the Flemish Cap area increased markedly. As compared with 1956-1971 when fishing was based on bottom concentrations, the major part of catches since 1972 was taken on pelagic concentrations. But we consider that both bottom and pelagic concentrations make up the united redfish stock in the Flemish Cap area(1).

The analysis of age-and-size compositions of beaked redfish, the basis of commercial redfish concentrations in the Flemish Cap area, shows that there were no significant fluctuations of year classes abundance during the past years (2). Though, undoubtedly, there were years of increased productivity (1963-1966 and 1970-1972 year classes), and, vice versa, some year classes ⁽¹⁹⁴⁹⁻¹⁹⁵³⁾ were of low abundance.

Entering of low abundant 1949-1953 year classes to fishery and intensive fishing resulted in depressing the state of commercial stock of beaked redfish in the Flemish Cap area in 1956-1959.

In 1976-1979 owing to introduction of quotas redfish catches were stabilized. The commercial stock is in good condition. 10-15-year old specimens (data of 1979) 32-38 cm long make up the bulk of catches.

Data of research cruises (total trawl survey) give reason to speak on entering of the next productive year classes of beaked redfish to fishery in this area in 1980-1983.

Results

Assessment of the stock and feasible beaked redfish catch in the Flemish Cap area is made by the VPA and Beverton and Holt's methods.

The equations of linear growth of beaked redfish males and females are as follows:

$$l_t = 52 (1 - \exp(-0.089 (t - 0.854)));$$

$$l_t = 55 (1 - \exp(-0.080 (t - 0.231))),$$

where t is the age.

While constructing the curves of relation of feasible catch per recruit Y_w/R and instantaneous rate of fishing mortality F the following values of parameters were assumed: $M=0.10$, $t_p=6$, $t_p'=9$, $t_A=22$ for males and t_A = for females (Fig.1).

Curves of feasible catch of males and females have their maximum in $F=0.6$ and $F=0.5$, corresponding to maximal feasible catches of 0.351 kg and 0.393 kg per recruit.

The results of biological and fishery statistics were the initial data for mathematical model of beaked redfish virtual populations (Table 1).

While calculating fishing mortality coefficients F for each year class at their last year of life first the coefficients of total mortality Z were calculated as natural logarithms of relation of mean abundance in the catch per trawling hour at their last but one year of life and mean abundance per trawling hour at their last year of life, then the accepted value $M=0.1$ was subtracted from calculated values of Z .

The results of assessment of the stock and beaked redfish mortality rates in the Flemish Cap area are given in Tables 2-7.

Having assumed the age of recruitment of beaked redfish commercial stock equal to 6, we receive the mean abundance for fishing period from 1958 to 1979, the mean abundance of males equal to 37601 thou. spec. and that of females - 41293 thou. spec. at this age.

With such an amount of beaked redfish male and female recruits the maximal possible catch of males will be 13 thou. tons, females - 16 thou. tons and males and females - 29 thou. tons.

The mean catch of specimens of both sexes for the considered period of fishing is 20 thou. tons which corresponds to beaked redfish catch in this area in 1979. In this case the mean values of fishing mortality rates of males $F=0.13$ and females $F=0.1$ are 5 times as low as the values of $F=0.6$ and $F=0.5$ when maximal feasible catch may be taken (Table 8).

Thus, taking into account further entering of abundant year classes to fishery, redfish catch may increase up to 29 thou. tons in 1980-1981 without causing damages to the stock.

Conclusions

Results of calculations made by the VPA method show that fishing for this species is below optimal level.

Beaked redfish catch of 29 thou. tons may be taken in the Flemish Cap area in 1980-1981 without causing damages to the stock.

The analysis of age and size composition by the data of research vessels testifies to further entering of new abundant beaked redfish year classes to fishery in the Flemish Cap area.

References

1. Chekhova, V.A., Konstantinov, K.G. Characteristics of the beaked redfish, Sebastes mentella Travin, in bottom and mid-water trawl catches of Flemish Cap. ICNAF 1978, Selected Papers, January, pp. 17-21.
2. Chekhova, V.A. On fluctuations of beaked redfish abundance in the Flemish Cap area. In: "Otsenka zapasov promyslovykh ryb i prognozirovaniye ulovov", 1980, pp. 56-60.

Table 1. Total catch, number of trawling hours and catch by age groups of beaked redfish in the Flemish Cap area.

Year of fishery	Number of trawling	Sex	Total catch	AGE ?												YEARS											
				4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
1958	23695,6	males 21462,6 females 33037,4		3	3	42	217	62	384	1589	4491	7218	11670	7184	4896	2821	1678	652	321	230	84	62	22	5	3		
1959	26100,0	males 22251,8 females 29948,2		5	64	80	498	98	368	1233	4137	7312	11883	7096	4741	2978	1998	856	455	452	175	121	69	27	13		
1960	5600,0	males 4053,0 females 4347,0		23	7	12	33	85	221	6042	1474	2624	1477	786	408	254	97	55	41	138	14	10	6	1	0,3		
1961	17444,4	males 5653,6 females 10046,4		4	2	14	18	51	192	708	1840	3593	2153	1282	690	407	140	63	395	16	13	4	2				
1962	14000,0	males 3538,9 females 3461,1		3	7	6	16	55	166	451	1078	2121	1333	778	465	313	114	51	32	11	55	5	2	1			
1963	8750,0	males 3808,7 females 3191,3		13	26	33	91	2	21	75	144	309	867	967	1147	977	764	336	208	246	117	36	4	2			
1964	14000,0	males 5642,6 females 8357,4		26	21	33	91	72	147	383	1125	2748	2109	1651	1070	693	246	113	338	77	28	20	6	2			
1965	36500,0	males 12179,6 females 17020,4		53	38	105	171	413	613	994	2010	4922	4246	3676	2486	1669	605	313	265	111	67	35	2	2			
1966	18000,0	males 2825,6 females 4374,4		4	3	33	40	50	97	134	200	358	848	731	663	536	416	188	173	89	93	132	15	7			
1967	2333,3	males 228,1 females 471,9		0,1	0,07	0,4	0,2	3	5	19	30	84	80	88	74	53	36	15	7	5	2	0,8	1	0,2			
1968	24000,0	males 2252,0 females 2546,0		3	3	6	22	53	155	266	350	781	722	738	555	353	118	43	31	6	9	56	34	3			
1969	2562,5	males 995,8 females 1104,2		1	1	9	20	48	169	276	250	395	312	261	172	103	30	11	10	3	19	9	3	3			
1970	10666,6	males 1701,2 females 1498,6		1	24	24	48	120	193	433	96	433	433	481	457	385	192	96	72	24	96	24	24	24			
1971	25666,6	males 4016,0 females 3364,0		24	13	54	158	357	721	1109	1753	1075	785	634	496	209	105	131	57	51	61	61	10	3			
1972	38706,3	males 16442,8 females 29457,2		21	33	189	408	963	1372	1844	2253	4368	3446	3562	3761	3520	1812	943	806	304	167	53	157	73			
1973	15342,5	males 10355,3 females 12044,7		41	37	331	773	2513	4865	5785	2661	2969	1783	1387	1087	825	328	163	138	46	21	9	21	18			
1974	18167,5	males 16543,1 females 16151,9		3	282	11	493	2294	7032	9940	5779	6286	3598	2050	1319	929	344	141	80	23	8	80	80	80			
1975	7092,5	males 6772,7 females 9827,4		327	823	801	846	1557	1972	3233	2833	2848	1127	549	326	252	104	104	74	59	104	104	74	44			
1976	9238,1	males 8423,8 females 8576,2		12	86	25	98	355	1151	2858	3381	3026	1409	857	698	551	307	147	159	49	49	122	12	12			
1977	11488,6	males 7795,4 females 12204,6		6	37	70	211	686	1725	2644	3791	1799	1238	1179	991	454	280	216	70	54	22	22	32	11			
1978	8510,6	males 7013,6 females 8986,4		176	136	477	356	564	641	1410	2267	3368	2199	1430	885	581	208	92	61	24	16	16	4	4			
1979	8849,6	males 8291,0 females 11709,0		56	18	286	654	1574	1729	1881	1743	2182	1775	1305	961	388	175	131	47	23	284	187	29	6			

Table 2. Mean annual biomass of beaked redfish males in the Flemish Cap area, tons.

Age, years	Y E A R S O F F I S H E R Y																					
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
6	3849	3694	2644	2656	3408	3537	3664	3946	4488	4856	5874	7550	9759	9193	7092	5831	4602	5783	10133	20042	21773	14452
7	4029	3904	3751	2687	2701	3468	3596	3708	3999	4565	4942	5978	7677	9928	9313	7118	5851	4566	5792	10299	20360	22047
8	4593	4000	3905	3761	2693	2711	3477	3562	3698	4014	4584	4961	6002	7692	9861	9018	6805	5642	4441	5782	9252	20244
9	6921	5057	4529	4464	4307	3088	3102	3909	4031	4252	4608	5255	5704	6863	8644	10493	8955	7239	6075	4953	6544	11518
10	8157	6577	5250	4827	4807	4695	3322	3211	4170	4421	4639	5005	5745	6143	7165	8194	8834	8113	6975	6135	5083	6757
11	10130	6003	5785	4974	4686	4883	4649	2958	3094	4324	4556	4756	5149	5758	5801	6567	6183	6823	6961	6044	5598	4672
12	8271	5507	3988	4685	4162	4350	4238	3188	2391	3069	4231	4492	4695	4798	4522	4693	4469	4403	5206	5277	4760	4436
13	5564	3421	2604	2698	3402	3316	3467	2232	1877	2116	2787	3865	4181	4183	3301	2956	2865	2716	3221	3579	3690	3283
14	4224	2285	1665	1875	1972	2805	2616	1702	1107	1702	1914	2576	3721	3918	2816	2084	1895	1886	2231	2496	2745	2646
15	2556	1726	973	1162	1313	1359	2065	1130	617	872	1443	1589	2270	3256	2183	1447	1176	1193	1443	1531	1778	1819
16	1350	867	823	677	815	852	781	1029	338	433	704	1184	1355	1890	1491	848	736	689	841	820	938	1109
17	681	453	305	666	488	562	504	277	470	203	365	562	1060	1115	868	446	441	409	475	448	430	579
18	508	226	171	227	512	331	370	254	48	375	166	295	474	878	544	271	255	262	287	232	243	334
19	266	147	79	135	196	356	231	200	58	15	366	150	267	393	442	205	184	178	154	130	121	154
20	175	71	23	57	115	125	258	148	66	12	10	366	141	218	166	166	147	127	129	59	48	76
21	124	41	9	7	41	52	56	180	21	27	4	5	313	87	60	40	123	56	61	64	18	20
22	16	55	3	2	1	13	22	26	60	0	14	0	2	284	29	7	17	48	14	28	34	7
	61414	44034	36508	35560	35619	36503	36418	31668	30533	35252	41207	48559	58515	66597	64298	60384	53538	50133	54439	67919	83415	94153

Table 3. Mean annual abundance of beaked redfish males in the Flemish Cap area, thou. spec.

Age, years	YEARS OF FISHERY																					
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
6	29380	28876	21957	22165	28283	28738	29114	30563	34112	36592	43521	54488	68597	64541	50658	42445	33825	42360	74900	187786	161066	107778
7	25955	25198	24810	18363	19063	24336	24715	24961	26225	29346	31488	37451	46860	59014	55341	43140	36146	28575	36552	64395	127010	138100
8	24985	22132	21606	21314	15770	16390	20909	21053	21361	22549	25232	27072	32203	40225	50299	46217	35691	30129	23990	31293	55118	108392
9	28606	20729	18779	18465	18242	13513	14026	17664	17874	18340	19331	21611	23237	27519	33879	40452	35145	28773	24547	20102	26528	46345
10	24889	21850	16888	15719	15587	15557	11409	11516	14837	15320	15653	16436	18468	19608	22618	25639	27651	25648	22117	19649	16304	21621
11	25703	15677	16313	13424	12686	13067	12771	8636	9305	12668	13009	13233	13931	15296	15432	17337	16645	18313	18592	16181	15031	12552
12	18315	12447	9193	11564	9692	10022	9712	7869	6160	7811	10505	10850	11098	11029	10412	10789	10426	10483	12207	12309	11073	10348
13	11347	7197	5576	5700	7786	6961	7173	4856	4471	4898	6327	8548	8953	8750	6930	6267	6116	5924	7028	7728	7893	7008
14	7738	4236	3192	3517	3627	5606	4726	3182	2249	3499	3810	5006	6984	7127	5143	3861	3557	3564	4213	4751	5162	4956
15	4275	3087	1745	2062	2263	2283	3833	1934	1154	1632	2699	2880	3967	5487	3672	2477	2042	2085	2483	2667	3117	3165
16	2119	1392	1417	1119	1330	1344	1197	1927	580	758	1201	2037	2211	2969	2344	1950	1180	1113	1341	1310	1515	1805
17	983	683	479	1041	738	838	727	392	937	331	577	872	1612	1634	1269	681	655	609	699	665	641	862
18	705	322	262	339	760	478	526	330	68	723	257	441	689	1253	771	399	381	373	404	333	349	373
19	322	177	102	179	249	459	288	255	71	19	604	197	339	485	554	260	235	231	189	160	152	191
20	185	75	24	63	130	136	283	155	72	12	11	505	153	232	176	184	157	139	143	63	52	81
21	197	43	10	7	45	62	63	197	22	30	4	5	427	95	65	44	85	62	69	73	20	22
22	15	52	3	2	1	12	24	25	56	0	13	0	2	331	28	6	16	45	13	28	34	6
	205623	164153	141856	135043	136252	139802	141496	135535	139554	154528	174242	201632	239671	265595	259391	241548	210003	199026	229556	329493	431065	463605

Table 4. Instantaneous rates of fishing mortality F of beaked redfish males in the Flemish Cap area.

Age	YEARS OF FISHERY																					
	1958-1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	
6	0.001	0.002	0.001	0.001	0.000	0.001	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.004	0.008	0.008	0.019	0.001	0.000	0.003	0.003	0.003
7	0.002	0.004	0.001	0.001	0.000	0.002	0.007	0.002	0.000	0.000	0.000	0.000	0.001	0.007	0.018	0.014	0.030	0.004	0.001	0.003	0.003	0.005
8	0.015	0.017	0.004	0.002	0.001	0.003	0.020	0.005	0.000	0.002	0.002	0.002	0.004	0.039	0.054	0.063	0.052	0.020	0.007	0.010	0.010	0.015
9	0.056	0.059	0.012	0.010	0.009	0.006	0.010	0.035	0.007	0.000	0.008	0.008	0.013	0.040	0.120	0.200	0.069	0.058	0.034	0.024	0.037	0.037
10	0.180	0.189	0.038	0.045	0.029	0.009	0.034	0.086	0.013	0.001	0.017	0.017	0.006	0.037	0.082	0.226	0.126	0.162	0.088	0.086	0.087	0.087
11	0.281	0.466	0.090	0.137	0.085	0.024	0.068	0.233	0.088	0.002	0.027	0.019	0.014	0.073	0.147	0.153	0.347	0.155	0.223	0.163	0.151	0.139
12	0.637	0.955	0.285	0.311	0.219	0.087	0.283	0.625	0.138	0.011	0.074	0.036	0.045	0.159	0.419	0.277	0.603	0.272	0.371	0.308	0.304	0.306
13	0.633	0.986	0.265	0.376	0.171	0.139	0.294	0.874	0.163	0.016	0.114	0.036	0.048	0.123	0.497	0.284	0.588	0.190	0.225	0.233	0.279	0.311
14	0.633	1.119	0.246	0.364	0.214	0.187	0.349	1.155	0.295	0.021	0.194	0.052	0.069	0.110	0.693	0.359	0.576	0.154	0.192	0.261	0.277	0.358
15	0.660	0.971	0.234	0.333	0.203	0.428	0.279	1.285	0.464	0.032	0.206	0.060	0.115	0.116	1.024	0.439	0.646	0.156	0.276	0.442	0.284	0.412
16	0.794	1.435	0.179	0.363	0.235	0.568	0.579	0.866	0.717	0.047	0.294	0.051	0.174	0.167	1.501	0.611	0.787	0.226	0.447	0.756	0.383	0.532
17	0.663	1.253	0.202	0.134	0.154	0.401	0.338	1.541	0.200	0.045	0.204	0.034	0.119	0.128	1.427	0.481	0.525	0.171	0.421	0.682	0.324	0.450
18	0.455	1.412	0.209	0.185	0.199	0.435	0.215	0.894	1.691	0.010	0.167	0.025	0.139	0.084	1.223	0.408	0.370	0.279	0.363	0.810	0.263	0.468
19	0.713	2.543	0.399	0.250	0.128	0.535	0.267	1.037	2.429	0.255	0.051	0.051	0.212	0.270	1.455	0.523	0.339	0.319	0.837	1.343	0.399	0.684
20	0.453	2.333	0.564	0.252	0.084	0.858	0.099	0.714	1.234	0.154	0.518	0.006	0.156	0.245	1.710	0.250	0.146	0.424	0.341	1.102	0.461	0.577
21	0.452	2.750	0.987	1.644	0.110	1.226	0.317	0.339	4.087	0.067	1.912	0.502	0.030	0.535	2.551	0.467	0.059	1.663	0.709	0.730	0.767	1.043
22	1.382	1.315	1.903	1.502	1.382	2.872	0.249	1.382	2.340	1.382	1.382	1.382	1.382	1.84	1.845	1.382	1.382	2.274	0.863	0.772	0.464	1.382

Table 5. Mean annual biomass of beaked redfish females in the Flemish Cap area, tons.

Years	Y E A R S O F F I S H E R Y																					
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
6	3643	3517	2653	2574	2879	2943	3312	3485	3605	3665	4321	5654	7267	7474	6134	4617	3515	4092	7358	11271	14289	12557
7	5696	5225	5081	3941	3725	4171	4255	4754	5028	5220	5309	6258	8186	10520	10740	8707	6613	4833	5858	10656	16241	20549
8	7687	6936	6420	6306	4765	4631	5183	5233	5853	6243	6487	6589	7766	10144	12917	12699	10139	7881	5643	7253	13211	19887
9	9077	7964	7537	7096	6982	5291	5136	5661	5755	6514	6937	7175	7322	8528	10919	13077	12306	10187	8273	6135	7921	14324
10	9593	8073	7858	7766	7374	7301	5506	5224	5838	6062	6862	7258	7530	7553	8534	10315	11486	11038	9615	8264	6084	7927
11	10317	7209	7164	7564	7639	7363	7235	5245	5120	5956	6197	6969	7387	7431	7144	7938	8887	9945	9787	8778	7727	5637
12	10583	6926	5835	6516	7285	7668	7081	6514	5069	5355	6243	6491	7317	7432	6861	6708	7104	8018	8977	8694	8073	7088
13	9303	6106	4701	4577	5403	6700	6742	5312	5408	4875	5226	6100	6392	7007	6302	5803	5518	5968	7025	7438	7292	6757
14	7874	4818	3977	3453	3485	4813	5688	4572	3904	5090	4634	4992	5859	6074	5655	5145	4494	4507	5302	5744	6107	5931
15	6100	3642	2774	2926	2545	2982	3881	3519	2980	3553	4845	4395	4797	5561	4399	4277	3686	3428	3993	4176	4439	4782
16	3680	2698	1803	1956	2072	2203	2163	1972	2003	2585	3275	4539	4167	4516	3392	2727	2884	2525	2919	3002	2935	3219
17	2361	1480	1306	1330	1373	1781	1721	1002	881	1656	2350	2967	4293	3897	2993	1939	1861	1940	2117	2264	2106	2111
18	1923	921	763	945	987	1167	1419	834	352	668	1434	2081	2702	3957	2272	1629	1264	1320	1604	1555	1654	1499
19	1333	650	388	459	683	832	906	641	232	201	520	1273	1928	2517	2003	973	1030	840	1052	1060	1083	1111
20	967	411	211	200	262	585	673	450	169	100	123	413	1222	1851	1254	703	547	665	653	651	677	722
21	798	224	116	67	80	174	427	303	112	73	46	61	309	1033	684	308	389	262	407	257	332	368
22	260	120	28	25	10	36	103	141	32	42	42	17	37	227	268	68	138	98	98	128	67	129
23	57	43	1	3	3	3	13	40	13	0	17	22	9	11	75	10	8	29	10	15	34	20
	91252	66963	58616	57604	57552	60644	61444	54902	52354	57858	64868	73254	84490	95733	92746	87643	81869	77574	80691	87341	100272	114618

Table 6. Mean annual abundance of beaked redfish females in the Flemish Cap area, thou. spec.

Age	YEARS OF FISHERY																						
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979	
6	27389	26441	19948	19350	21647	22126	24902	26802	27803	27559	2487	42508	54638	56195	46119	2714	26428	30766	55325	84741	107436	94417	
7	26740	24531	23854	18032	17489	19584	19975	22319	23606	24505	24925	29381	38433	49322	50422	40878	31048	22691	27505	50028	76250	96474	
8	26236	23674	21914	21521	16264	15804	17680	17859	19976	21307	22139	22487	26504	24822	44085	43342	24604	28897	19259	24754	45089	67875	
9	25144	22060	20897	19656	19341	14656	14226	15682	15941	18043	19215	19876	20283	23624	30246	36223	24090	28219	22918	16994	21942	39680	
10	22733	19131	18620	18404	17474	17302	13048	12379	13684	14366	16260	17200	17844	17897	20223	24444	27238	26156	22784	19594	18416	18784	
11	21539	15051	14956	15792	15948	15371	15105	10950	10688	12435	12937	14949	15421	15513	14914	16573	18574	20762	20433	18326	16132	11769	
12	18831	12323	10382	11595	12962	13644	12599	11590	9020	9528	11109	11550	13019	13225	12209	11936	12641	14267	15974	15470	14364	12612	
13	15005	9849	7582	7382	8715	10807	10874	8568	8723	7863	8429	9839	10309	11302	10165	9660	8900	9625	11330	11996	11761	10898	
14	11630	7117	5874	5100	5147	7109	8402	6754	5766	7519	6945	7373	8654	8972	8353	7600	6638	6657	7831	8485	9021	8761	
15	8166	4875	3714	3917	3407	3992	5196	4711	3989	4757	6486	5884	6422	7444	5889	5726	4934	4587	5345	5591	5943	6401	
16	4504	3302	2308	2394	2537	2697	2648	2414	2452	3164	4008	5556	5100	5527	4397	3338	3530	3091	3573	3674	3592	3940	
17	2889	1686	2487	1515	1564	2029	1960	1141	1003	1886	2677	3879	4889	4439	3409	2208	2120	2209	2411	2579	2399	2404	
18	2097	1004	832	1030	1076	1273	1547	909	384	729	1564	2269	2947	4315	2478	1776	1378	1439	1749	1696	1804	1635	
19	1348	657	392	464	691	841	916	648	235	203	526	1287	1949	2545	2025	984	1041	849	1064	1072	1095	1123	
20	870	370	190	180	236	527	606	405	152	90	111	372	1100	1666	1129	633	492	599	588	586	610	650	
21	718	202	104	60	72	157	384	273	101	66	41	55	278	930	616	277	350	236	366	231	299	331	
22	225	104	24	22	9	31	89	122	28	36	36	15	32	196	232	59	119	85	85	111	58	112	
23	45	34	1	2	2	2	10	31	10	0	13	17	7	9	59	8	6	23	8	12	27	16	

Table 7. Instantaneous rates of fishing mortality F of beaked redfish females in the Flemish Cap area.

Age, years	YEARS OF FISHERY																					
	1958	1959	1960	1961	1962	1963	1964	1965	1966	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
6	0.000	0.003	0.001	0.000	0.000	0.000	0.001	0.004	0.001	0.000	0.000	0.000	0.000	0.000	0.004	0.005	0.000	0.020	0.000	0.000	0.003	0.002
7	0.008	0.020	0.003	0.001	0.002	0.000	0.005	0.018	0.005	0.000	0.001	0.001	0.001	0.002	0.017	0.038	0.019	0.107	0.004	0.001	0.011	0.013
8	0.043	0.036	0.005	0.003	0.005	0.001	0.003	0.020	0.003	0.000	0.003	0.005	0.006	0.007	0.026	0.088	0.097	0.069	0.018	0.007	0.007	0.022
9	0.130	0.105	0.013	0.012	0.011	0.003	0.010	0.038	0.007	0.000	0.007	0.013	0.001	0.025	0.064	0.172	0.197	0.111	0.050	0.032	0.034	0.049
10	0.244	0.221	0.092	0.042	0.023	0.012	0.030	0.070	0.012	0.001	0.008	0.015	0.003	0.050	0.088	0.165	0.201	0.130	0.117	0.065	0.099	0.077
11	0.345	0.391	0.065	0.100	0.045	0.034	0.061	0.124	0.023	0.001	0.009	0.015	0.003	0.079	0.117	0.111	0.187	0.137	0.165	0.119	0.125	0.107
12	0.472	0.595	0.137	0.252	0.095	0.068	0.169	0.279	0.062	0.006	0.025	0.018	0.007	0.107	0.205	0.129	0.236	0.136	0.189	0.192	0.170	0.169
13	0.489	0.643	0.141	0.358	0.112	0.068	0.191	0.419	0.080	0.011	0.039	0.018	0.009	0.077	0.225	0.123	0.264	0.103	0.124	0.183	0.154	0.183
14	0.547	0.848	0.150	0.475	0.151	0.094	0.243	0.594	0.156	0.016	0.067	0.028	0.039	0.070	0.341	0.153	0.380	0.109	0.109	0.261	0.187	0.239
15	0.561	1.070	0.186	0.483	0.107	0.158	0.346	0.766	0.228	0.024	0.082	0.034	0.049	0.063	0.612	0.206	0.539	0.146	0.131	0.380	0.251	0.306
16	0.838	1.140	0.209	0.517	0.163	0.162	0.486	1.086	0.290	0.028	0.121	0.026	0.052	0.051	0.865	0.294	0.594	0.168	0.154	0.438	0.299	0.380
17	0.657	0.944	0.132	0.354	0.106	0.081	0.282	1.085	0.373	0.022	0.109	0.017	0.029	0.025	0.777	0.246	0.423	0.107	0.127	0.306	0.197	0.305
18	0.667	1.205	0.185	0.420	0.116	0.104	0.269	1.177	0.850	0.048	0.157	0.019	0.057	0.020	1.048	0.275	0.519	0.134	0.161	0.392	0.202	0.382
19	0.914	1.655	0.352	0.851	0.161	0.181	0.369	1.455	1.368	0.152	0.423	0.029	0.086	0.036	1.500	0.521	0.624	0.227	0.276	0.660	0.274	0.577
20	0.763	1.626	0.388	1.101	0.233	0.182	0.277	1.180	1.170	0.177	0.946	0.051	0.087	0.026	1.632	0.440	0.684	0.247	0.313	0.765	0.229	0.596
21	0.625	2.379	0.499	2.065	0.426	0.394	0.255	1.289	1.444	0.165	1.358	0.163	0.345	0.047	2.176	0.796	0.557	0.566	0.568	1.565	0.334	0.856
22	1.106	4.543	1.287	3.158	1.121	1.135	0.547	2.272	4.306	0.219	0.940	0.190	0.730	0.137	3.511	2.366	0.667	2.623	1.431	1.892	0.816	1.667
23	0.832	3.136	2.104	3.943	0.442	1.756	0.879	1.525	2.677	1.091	1.805	0.228	1.161	1.805	2.636	2.620	1.605	3.087	1.451	2.472	0.443	1.805

Table 8. Instantaneous mortality rates of beaked redfish in the Flemish Cap area.

year of fishery	Instantaneous mortality rates			
	males		females	
	total	fishing	total	fishing
1958	0.389	0.290	0.386	0.287
1959	0.492	0.394	0.424	0.325
1960	0.186	0.086	0.154	0.054
1961	0.225	0.125	0.222	0.122
1962	0.183	0.084	0.146	0.046
1963	0.171	0.071	0.138	0.038
1964	0.221	0.121	0.200	0.100
1965	0.382	0.284	0.312	0.213
1966	0.160	0.060	0.151	0.051
1967	0.105	0.005	0.105	0.005
1968	0.141	0.041	0.125	0.025
1969	0.118	0.018	0.113	0.013
1970	0.123	0.023	0.112	0.012
1971	0.146	0.046	0.135	0.035
1972	0.268	0.169	0.263	0.164
1973	0.253	0.153	0.225	0.125
1974	0.376	0.276	0.287	0.187
1975	0.225	0.125	0.217	0.117
1976	0.249	0.149	0.195	0.095
1977	0.206	0.106	0.202	0.102
1978	0.166	0.067	0.168	0.068
1979	0.163	0.064	0.170	0.070

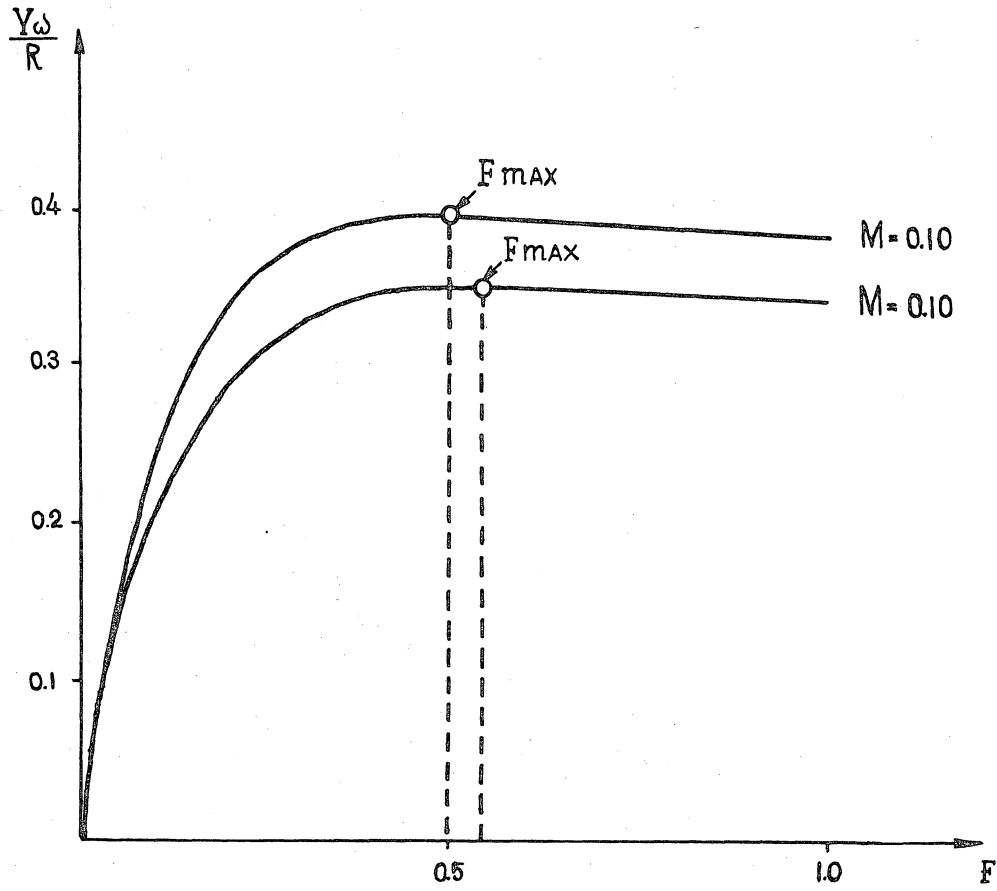


Fig. 1. Relation of feasible catch of males (the curve below) and females (the curve above) of beaked redfish and fishing mortality coefficient.