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Assessment of the Stock of Beaked Redfish in the
Grand Bank Area (Divisions 3L and 3N)

by

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Abstract

Stock assessment and feasible catch of beaked redfish in the area of the Grand Bank of Newfoundland (3LN) are given on the basis of fishery analysis and results of total trawl surveys obtained by means of the VPA and Beverton and Holt's methods. The instantaneous fishing mortality rate of beaked redfish at which the maximum feasible catch may be taken is estimated.

Introduction

Redfish are rather important for the Soviet and foreign trawl fishing in the area of the Grand Bank of Newfoundland (3LN). Beaked redfish (Sebastodes mentella Travin), the most numerous and frequently occurring species, make up 90-95% of redfish in the catches.

The Soviet trawl fishing for redfish in the area of the Grand Bank of Newfoundland has started since 1956. The record catch of 45,000 tons was taken in 1959, then the catches decreased (Table 1). Fishery was carried out most successfully from 1971 to 1973. The significant decrease of catches because of change of fishery regulations in the Northwest Atlantic was registered in 1977-1978. Nowadays mainly the USSR and Canada are fishing for redfish in Div. 3LN.

Beaked redfish have a prolonged life cycle, multiage structure of populations, late maturation and a long period of larvae spawning (Nikolskaya, 1967, 1969).

It was found that redfish stock (Kopytov Bank, Rosengarten and Flemish Cap Banks), having been influenced by intensive fishery for a long time, was to a great extent depleted, and it caused the decrease of fishing productivity (Travin, 1957; Sorkin, Shafran, 1959; Zakharov, Konstantinov, 1970; Chekhova, 1980). The restoration period was very long. In this connection it is necessary to estimate beaked redfish stock in Div. 3LN, and allowable catch.

Materials and methods

Stock assessment and feasible catch were determined by the VPA and Beverton and Holt's (1969) methods. Statistics of international fishery (Stat. Bull. ICNAF, 1969-1979) and PINRO biological statistics (Tables 2 and 3) were the basis for calculations.

As a result of data processing (Table 3) the following equations of growth for males and females, respectively, were obtained:

$$l_t = 99 (1 - e^{-0.17(t+11.56)}),$$
$$l_t = 55 (1 - e^{-0.067(t+1.45)}).$$

In connection with the fact that growth rates of males and females of beaked redfish in Div. 3LN are different, in order to make more accurate estimation of the stock and feasible catch, calculations were made for each sex separately, and then were united for the whole fishing stock.

While constructing the curves of relation of feasible catch per recruit $\frac{Y_w}{R}$ and fishing mortality F rate (fig.1) the

following values of parameters for males and females were accepted:

$$M=0.10, t_0=4, t_1=6, t_2=23,$$

where M is the instantaneous rate of natural mortality.

t_p is the age at which fish first appear in the fishing area.

t_f' is the age at which fish enter fishing stage.

t_f is the maximum age.

The curves of feasible catch of males and females have their maximum in $F=0.30$ and $F=0.20$ with $\frac{Y}{R}W = 200$ g and $\frac{Y}{R}W = 170$ g, respectively.

To apply the VPA method total mortality rates Z at the last year of life (at the age of 23) for each year class were calculated as natural logarithms of relation of mean abundance in a catch per trawling hour at the age of 23 and the mean abundance of this year class in a catch per trawling hour at the age of 24.

Fishing mortality rates F at the last year of life of each year class were obtained by subtracting the accepted value $M=0.10$ from the calculated values of Z.

The results of stock assessment and estimation of the fishing mortality rates for males and females of beaked redfish in the area of the Grand Bank of Newfoundland by the VPA method are given in Tables 4 - 6.

Mean abundance of males and females (recruits) at the age of 5 is $100,592 \cdot 10^3$ and $35,195 \cdot 10^3$ spec., respectively, and feasible catch per recruit is 200 g and 170 g. Based on these data feasible catch of beaked redfish will be 26,000 tons. It is seen from Table 2 that the mean catch of beaked redfish for the 1968-1970 period was about 22,000 tons, which is 1.2 times as low as feasible catch.

Conclusions

The analysis of fishery and the results of total trawl surveys of 1971-1978 testify to general increase of beaked redfish abundance in Div. 3LN at the expense of entering of some abundant year classes to fishery. Calculations show that total allowable catch may be 26,000 tons with the present state of beaked redfish stock in Div. 3LN.

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Table 1. Redfish catch taken by all countries (tons) in the area
of the Grand Bank of Newfoundland, Divisions 3LN.

Year	3LN
1958	21069
1959	44585
1960	28010
1961	23175
1962	21434
1963	21097
1964	8104
1965	13493
1966	16974
1967	26270
1968	17613
1969	24637
1970	14388
1971	34353
1972	28933
1973	33297
1974	22286
1975	17871
1976	20512
1977	16516
1978	12000

Table 2. Total catch (tons), total number of caught redfish (thou. spec.) of different age and total number of trawling hours (bottom trawling) during fishing for beaked redfish in Div. 3LN.

Year of fishery	Number of trawling hours	Sex	Total catch of the country	A G E , Y E A R S								
				5	6	7	8	9	10	II	12	13
1968	17084,6	males	8343	250	468	1160	1876	2417	3933	2238	1907	1663
		females	9270	196	316	445	816	732	1108	1120	1643	1222
1969	11295,7	males	7728	176	478	961	1418	1853	2490	2209	1809	1542
		females	15341	221	473	862	1327	1246	1639	1826	2747	2003
1970	6805,0	males	3617	1486	1763	1410	1461	2089	2162	779	377	176
		females	10771	1003	1457	1310	1959	1485	2162	2742	3723	3294
1971	17111,1	males	10687	2422	3265	1990	1141	1706	1708	1851	2701	1847
		females	23666	850	1556	1564	2278	856	994	857	1140	714
1972	14857,0	males	12085	553	1212	1091	1038	1457	3107	2859	2007	1949
		females	16848	424	1730	979	1462	1091	1398	1038	1582	972
1973	17586,1	males	14604	437	1470	2101	2554	3525	5486	3526	2524	1993
		females	18693	505	996	1464	2126	1862	2095	1559	2203	1297
1974	8881,5	males	11143	158	331	168	655	738	2127	3020	980	2283
		females	11143	158	248	243	571	242	163	488	1059	1058
1975	7881,7	males	8122	4395	3872	2347	2299	2896	1899	900	548	699
		females	9749	3321	3719	2844	4220	2649	2073	1000	950	623
1976	9214,3	males	7786	108	231	391	611	1075	3432	4643	3209	1618
		females	12726	93	254	487	928	1173	2299	2464	4076	3261
1977	7361,6	males	6702	9	372	125	240	439	1455	2440	1798	1283
		females	9814	17	64	116	209	306	640	811	2071	1912
1978	8603,6	males	3745	1266	1481	1133	1026	1279	1231	720	660	649
		females	8255	958	1431	1284	2101	1304	1422	879	1188	855

Table 2. (Continued)

Year of fishery :	A G E , Y E A R S								
	14	15	16	17	18	19	20	21	22
1968	1062 770	565 824	489 434	305 243	297 411	153 580	267 1802	91 542	30 504
1969	1150 1329	727 1322	665 664	400 400	400 708	171 1031	255 3027	8 827	16 879
1970	126 2088	51 1308	50 579	25 126	25 176	452 151	24 251	24 100	16 283
1971	569 1279	708 3694	1136 1563	570 426	709 994	427 1991	1138 5969	144 2700	24 1138
1972	1519 913	1034 1823	1278 911	913 485	973 853	668 1156	1217 4014	181 1035	122 1278
1973	1628 1164	1096 1795	1198 963	864 798	964 1065	602 1326	1166 3756	167 1028	67 1097
1974	2455 732	1712 1224	1792 489	978 245	896 406	325 570	569 2773	162 733	87 1142
1975	899 324	649 224	749 101	475 51	350 125	124 175	299 1199	33 174	80 374
1976	731 2015	298 1366	279 616	197 262	151 363	76 516	185 1341	13 432	6 299
1977	996 1470	642 1837	767 642	581 209	525 681	259 649	478 1203	3 715	15 329
1978	429 751	212 896	187 418	97 163	84 254	30 291	54 1188	12 285	6 375
									181

Table 3. Mean length and mass of beaked redfish in the area of the Grand Bank of Newfoundland, Div. 3LN.

A g	Mean length		Mean mass		A g	Mean length		Mean mass	
	(cm)	(g)	(cm)	(g)		(cm)	(g)	(cm)	(g)
e	males	females	males	females	e	males	females	males	females
4	23,0	18,0	160	110	I4	36,2	34,4	640	618
5	23,0	23,6	183	198	I5	36,9	36,6	708	703
6	24,2	24,6	222	234	I6	37,8	37,0	756	743
7	25,3	26,0	252	257	I7	38,9	39,4	802	847
8	26,1	26,3	262	285	I8	39,4	39,9	854	916
9	26,6	27,5	290	313	I9	40,2	41,0	917	1094
I0	28,8	28,8	352	356	I0	41,4	42,1	951	II70
II	31,3	30,1	424	393	II1	44,0	42,3	II00	I219
I2	32,7	31,9	496	461	I22	43,0	44,6	I000	I241
I3	34,6	33,1	573	539	I23	-	45,6	-	I237

Table 4. Instantaneous rates of fishing mortality of beaked redfish males (numerator) and females (denominator) in the area of the Grand Bank of Newfoundland, Div. 3LN.

Table 5. Mean annual stock (thou. spec.) of beaked redfish by age groups ($M = 0.10$) in Div. 3LN.

Table 6. Mean annual stock (tons) of beaked redfish by age groups ($M = 0.10$) in Div. 3IN.

Age	YEARS OF FISHERY										
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
5	12599	172021	11655	10012	7633	8368	8485	10859	11257	12219	14038
6	12531	13474	188216	11819	10286	7853	8855	8195	10868	12077	12824
7	12544	12307	13134	192248	11119	9704	7555	8152	7249	10818	11786
8	11630	11629	11327	12000	180515	9931	8852	6447	7184	7033	10193
9	12343	10777	10688	10441	11113	50906	9128	7810	5210	6830	6535
10	13547	11882	10200	10299	9812	9966	9430	8806	6347	4730	6555
11	12872	12299	10916	9315	9405	8210	8201	8918	6867	4845	4128
12	14141	11825	11197	9884	8406	7962	7160	7604	7196	4874	4025
13	12071	13023	10376	10075	8599	7004	6241	6674	6229	4970	3793
14	11700	10803	11720	9138	8828	7090	5170	5117	5627	4307	3966
15	13081	10633	9751	9656	7683	7177	5220	4019	4253	3897	3573
16	14800	11579	9278	7869	7003	5601	4997	3769	3228	2952	2817
17	14455	14297	11150	8726	6349	5564	4322	4082	3338	2583	2434
18	8547	13394	13523	10038	7275	4692	4151	3551	3562	2469	2101
19	7513	8189	13435	12845	8842	5851	3620	3761	3236	3062	1988
20	3438	4789	7142	8078	7905	4388	2400	2116	2519	1707	1736
21	1578	1728	2882	4726	3676	4413	1500	803	1026	1175	728
22	935	349	981	1787	1961	1958	2445	589	419	476	454
23	177	188	20	422	458	470	523	260	161	100	116
Σ	190502	345186	357591	349378	316868	167108	108255	101532	95776	91223	93490

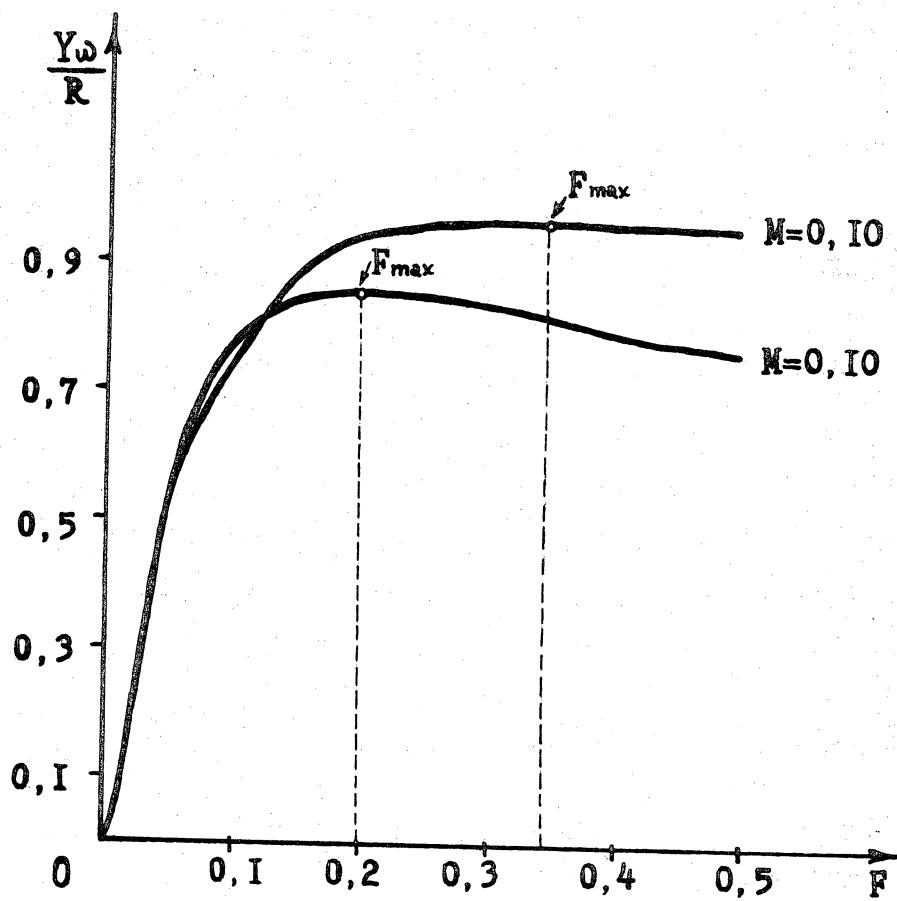


Fig.1. Relation of beaked redfish feasible catch and fishing mortality rate.