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Status of Redfish Stock in Divisions 3LN

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ABSTRACT

Estimates of abundance and biomass of the commercial red-
fish stock, as given by trawl-acoustic surveys during
1983-1990, are presented. Numbers, biomass and fishing
mortality coefficients, estimated from VPA, are used
to evaluate the total allowable catch (TAC) for 1992
for different exploitation rates.

The 1990 trawl-acoustic survey estimated the total abun-
dance of redfish at 139.3 mill.fish and biomass at 39.6
thou.t.

Redfish stock, as calculated by VPA, has been classified
as average, with numbers amounting to 944.8 mill.fish
and biomass to 184.2 thou.t.

INTRODUCTION

During 1974 to 1985 the fishing for refish in Divs.3LN
was at a fairly steady level. The harvest varied from
12 to 24 thou.t and was below the TAC. The exploitation
rate was noted to grow since 1986 and the 1988 catch -
71 thou.t - was 2.8 times larger than the TAC (25 thou.t).
Preliminary catch data indicated its decline since 1988, although
in 1988 too it 1.8 times still exceeded the TAC level.

Soviet and Canadian research surveys provided evidence
indicating a reduction of numbers and biomass of red-
fish in the aforesaid areas. It is a matter of further
investigation whether it is a consequence of intensive
fishing or a reflection of population biological con-
dition.

A goal of the paper is to give unbiased estimates of the
stock size and TAC through mathematical methods on the
basis of biological data.

MATERIAL AND METHODS

Numbers and biomass of the commercial stock of redfish

are calculated through VPA. Age compositions in catches
for recent years have been revised in view of up-dated
international catch statistics. Values of redfish catch
in Divs. 3LN have been borrowed from ICNAF/NAFO Statis-
tical Bulletins and NAFO Circular Letters (90/76, 90/79,
90/87). Since forecasting is accoplished in lack of in-
ternational data on vessel type and fishing effort, for
each year fishing efforts are fitted to that of USSR
standard BMRT (large-refrigerator-trawler).

To estimate the stock size natural mortality coefficients
by age have been used as well as constant coefficients
equal to 0.1 for all age groups. The present paper pre-
sents estimates of the stock size, derived with the
account of only differentiated natural mortality coef-
ficients.

Of 13 VPA tuning methods to find start fishing mortality
coefficients the Laurec method was selected, in which
correlation coeffcients at age between fishing mortali-
ty and effort were maximum. Partial recruitment coeffi-
cients were derived through Rivard method (Rivard, 1980).

Three options of the forecast of stock size and TAC for
1992 are suggested: under cautious exploitation,

intensity of fishing of the 1990 level and at the level
of MSY.

The trawl-acoustic survey was accomplished by the RV"Per-
sey-III" in April-May 1990, stratified-random technique
was employed(Doubleday, 1981). Acoustic survey technique
was used as described in Mamylov (1987).

RESULTS

In Divs. 3LN the redfish were, as usually, distributed
over a continental slope. Catch was composed of indivi-
duals 9-43 cm (Fig.1) in length at age 2-24. 21-30 cm
fish prevailed. Large fish over 25 cm in length, largest
size 30-33 cm, predominated deeper 500 m. In general,
fish smaller than 30 cm accounted for about 90%. On the
Grand Bank, especially in Div. 3N, redfish smaller than
23 cm consituted more than a half of the catch.

The trawl survey estimated the redfish stock in Divs. 3LN
to be below the 1989 level. Biomass decreased from 11.0
to 7.1 thou.t and numbers from 44.5 to 23.1 mill.fish as
against previous year (Table 1). Estimates of the stock
size of redfish in Divs. 3LN,provided by the trawl-acous-
tic survey, were found to be at record low for the recent
5 years. A reduction was especially drastic in Div.3N,
where the numbers were estimated at 58.4 mill.fish and

biomass 9.8 thou.t, i.e. 80% in number and 84% by weight below the long-term mean.

Canadian trawl surveys in Div. 3L in 1986 and 1990 showed a reduction of biomass from 29.8 to 12.5 thou.t (Pover & Atkinson, 1990).

In connection with a drop of numbers and biomass of red-fish in Divs. 3LN growth of its stock in Div. 3O should be mentioned. Numbers of redfish in this division in-creased in 1990 to 1540.7 mill. fish against 464.9 mill. in 1989 and biomass from 75.1 to 297.8 thou.t (Table 2). In our opinion this growth is associated with the redis-tribution of fish from Div. 3N.

Table 3 shows matrix of mean weight by age for 1968-1990, used to estimate the commercial stock of redfish and to forecast its stock size and TAC for 1992. Table 4 presents numbers of fish caught in different age groups of the commercial stock. Table 5 gives correlation coef-ficients between fishing mortality and effort (F - E) by age as well as coefficients of partial recruitment (PR). In 1990 the abundance of redfish in Divs. 3LN, with account for differentiated M, was estimated at 944.8 mill. fish and biomass at 184.2 thou.t. Forecasts of stock size and TAC for 1991 and 1992 are prepared, provided that mean weights and recruitment are at the level of terminal year. Then the stock of redfish in Divs. 3LN will be 215.19 thou.t in 1991 and 240.0 thou.t in 1992 (Table 6). To calculate the catch, which may be expected in 1992, three levels of exploitation of the commercial stock were used: $F_{0.1} = 0.12$, $F_{MSY} = 0.34$, $F = F_{1990} = 0.21$. We believe it more acceptable to have cautious exploi-tation in 1992, when the TAC is 16.5 thou.t.

Estimation of the redfish stock size by using the VPA is based on fairly steady commercial data, therefore estimates obtained do not exhibit considerable varia-tion. Results provided by trawl-acoustic surveys are influenced by many factors: condition of water masses, biological cycle of fish under study, time of surveying etc. This causes discrepancies between estimates from VPA and trawl-acoustic survey.

CONCLUSIONS

Estimates suggested by the VPA show that the stock of redfish in Divs. 3LN is at the average level. Bearing in mind, that research surveys of recent years have indicated a reduction of its numbers and biomass, cau-tious fishing is more acceptable in 1992 with the TAC of 16.5 thou.t.

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Table 1. Estimates provided by the trawl-acoustic survey for redfish in Divs. 3LN for 1983-1990

Year	Trawl survey Numbers, fish x 10^{-6}	Trawl survey Biomass, thou.t	Acoustic survey Numbers, fish x 10^{-6}	Acoustic survey Biomass thou.t	Total Numbers, fish x 10^{-6}	Total Biomass, thou.t
1983	428,9	125,0				
1984	720,3	199,4				
1985	245,1	85,9				
1986	133,4	46,8				
1987	182,1	60,8				
1988	167,3	40,0	654,9	118,1	822,2	158,1
1989	44,7	10,9	100,5	18,3	145,2	29,2
1990	23,1	7,1	116,2	32,5	139,3	39,6

Table 2. Estimates provided by the trawl-acoustic survey for redfish in Div. 3O in 1983-1990.

Year	Trawl survey Numbers, fish x 10^{-6}	Trawl survey Biomass, thou.t	Acoustic survey Numbers, fish x 10^{-6}	Acoustic survey Biomass, thou.t	Total Numbers, fish x 10^{-6}	Total Biomass, thou.t
1983	1187,8	127,0				
1984	763,8	108,7				
1985	1232,4	129,0				
1986	750,7	109,4				
1987	99,4	19,2				
1988	348,8	34,5	1576,1	170,1	1954,9	204,6
1989	170,6	27,9	294,3	47,2	464,9	75,1
1990	537,8	98,6	1002,9	199,2	1540,7	297,8

Table 3. Mean weight of redfish (g) by age in Divs. 3LN.

Age, years	YEAR											
	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
5	109	120	175	188	201	168	174	122	178	142	130	180
6	178	225	228	255	213	232	200	229	237	190	227	219
7	236	225	256	270	267	238	240	242	254	244	248	236
8	294	270	301	308	300	319	252	243	318	276	304	288
9	318	302	304	338	357	329	340	296	284	348	338	343
10	338	365	326	372	397	394	359	384	340	386	390	408
11	376	394	430	422	448	436	423	444	428	429	434	433
12	462	454	512	517	534	542	475	481	529	534	524	482
13	535	512	568	580	604	614	637	528	539	604	629	579
14	563	604	622	670	694	695	694	685	616	638	680	676
15	678	695	738	688	714	734	786	724	733	741	738	726
16	744	758	795	769	827	833	838	808	810	832	824	794
17	810	801	866	838	867	886	880	898	830	876	916	858
18	838	876	892	930	935	900	907	895	968	989	942	978
19	867	908	916	1039	1050	1024	935	928	932	1044	1009	986
20	930	954	999	1054	1072	1084	1066	970	1016	1137	1084	1030
21	1061	1045	1173	1112	1138	1130	1105	1072	1084	1182	1175	1124
22	1116	1138	1133	1203	1192	1183	1184	1126	1146	1191	1191	1188
23	1258	1230	1203	1223	1234	1220	1228	1234	1232	1220	1219	1201

Age, years	YEAR										
	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
5	125	189	162	147	140	125	120	89	89	95	109
6	217	227	227	222	224	185	138	135	114	142	159
7	244	245	245	233	246	240	197	150	146	176	194
8	254	288	325	317	255	270	256	209	194	221	243
9	328	338	356	354	362	315	298	272	262	295	306
10	349	431	398	412	398	413	380	325	324	360	373
11	426	452	442	432	459	442	435	388	388	429	428
12	518	530	527	470	535	505	505	449	457	478	491
13	564	612	612	533	562	570	576	515	524	550	562
14	634	662	666	625	685	654	650	611	599	637	659
15	724	768	725	717	724	730	730	682	682	718	730
16	803	838	794	789	730	820	800	749	747	813	797
17	830	880	868	828	825	875	858	809	806	868	854
18	960	923	934	902	904	892	914	874	914	1007	932
19	1011	1063	1017	972	936	990	997	945	984	1107	996
20	1033	1111	1099	1068	1010	1030	1053	1074	1080	1179	1070
21	1166	1165	1178	1136	1124	1072	1126	1140	1152	1214	1161
22	1166	1181	1191	1191	1170	1172	1195	1180	1228	1298	1218
23	1205	1246	1196	1196	1196	1220	1220	1238	1275	1352	1278

Table 4. Age composition of redfish in catches from Divs.3LN, indiv. (x10^{-6})

Age, years	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978	1979
5	0.45	0.40	2.49	3.27	0.98	0.94	0.32	7.72	0.22	0.03	2.24	4.79
6	0.78	0.95	3.22	4.82	1.94	2.47	0.58	7.59	0.53	0.11	2.94	4.29
7	1.60	1.82	2.72	3.55	2.07	3.56	0.41	5.19	0.95	0.24	2.44	3.63
8	2.69	2.74	3.42	3.42	2.50	4.68	1.23	6.52	1.67	0.45	3.16	5.40
9	3.15	3.10	3.57	2.56	2.55	5.39	0.98	5.54	2.43	0.75	2.61	4.01
10	5.04	4.13	4.32	2.70	4.50	7.58	2.29	3.97	6.22	2.09	2.67	3.44
11	3.36	4.03	3.52	2.71	3.90	5.08	3.51	1.90	7.71	3.25	1.62	2.24
12	3.55	4.56	4.10	3.84	3.59	4.73	2.04	1.50	7.91	3.87	1.87	2.00
13	2.88	3.54	3.47	2.56	2.92	3.29	3.34	1.32	5.29	3.20	1.52	1.40
14	1.83	2.48	2.21	1.85	2.43	2.79	3.19	1.22	2.98	2.47	1.19	0.91
15	1.39	2.05	1.36	4.40	2.86	2.89	2.94	0.87	1.81	2.48	1.12	0.80
16	0.92	1.33	0.64	2.70	2.19	2.16	2.28	0.85	0.97	1.41	0.61	0.61
17	0.55	0.80	0.15	1.00	1.40	1.66	1.22	0.53	0.49	0.79	0.26	0.42
18	0.71	1.11	0.20	1.70	1.83	2.03	1.30	0.47	0.56	1.21	0.34	0.53
19	0.73	1.20	0.15	2.42	1.82	1.93	0.89	0.30	0.64	0.91	0.32	0.39
20	2.07	3.28	0.27	7.11	5.23	4.92	3.34	1.50	0.16	1.68	1.25	0.96
21	0.63	0.83	0.10	2.84	1.22	1.20	0.89	0.21	0.48	0.72	0.30	0.21
22	0.53	0.89	0.00	1.14	1.40	1.16	1.22	0.49	0.33	0.34	0.39	0.25
23	0.27	0.44	0.03	0.43	0.73	0.73	0.82	0.50	0.19	0.16	0.18	0.13

Age, years	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990
5	2.77	7.62	9.35	5.21	3.04	11.08	23.46	5.91	10.17	7.41	3.82
6	2.80	8.77	13.62	10.93	5.08	11.53	24.56	22.16	38.68	27.60	6.03
7	2.49	6.91	11.33	10.74	5.35	9.34	14.94	40.52	61.20	35.96	29.51
8	3.57	8.25	11.95	11.65	6.70	12.17	26.93	45.60	41.58	18.01	20.07
9	3.43	7.97	10.96	9.41	5.81	8.89	17.63	35.00	15.82	4.50	3.02
10	4.30	7.53	9.04	9.27	6.57	7.39	14.32	30.03	11.02	2.37	1.03
11	3.02	4.12	3.16	3.59	3.50	2.82	5.82	14.81	5.39	1.49	0.64
12	3.51	4.09	2.77	2.49	2.79	2.19	5.68	11.40	4.54	0.93	0.72
13	2.92	2.61	1.02	1.10	1.39	1.15	5.95	10.05	5.28	1.02	0.38
14	1.91	1.49	0.53	0.59	0.74	0.74	3.55	7.38	3.12	0.36	0.25
15	1.45	1.30	0.38	0.34	0.51	0.79	1.38	4.92	1.85	0.47	0.23
16	0.78	0.80	0.23	0.21	0.31	0.55	0.88	3.76	1.48	0.47	0.17
17	0.46	0.32	0.03	0.09	0.14	0.37	0.65	2.77	1.05	0.30	0.07
18	0.50	0.55	0.10	0.06	0.16	0.40	0.61	1.60	0.68	0.23	0.03
19	0.37	0.49	0.05	0.01	0.08	0.28	0.41	0.89	0.48	0.04	0.01
20	1.14	1.41	0.08	0.03	0.11	0.42	0.32	0.88	0.72	0.11	0.01
21	0.22	0.31	0.02	0.02	0.02	0.13	0.20	0.37	0.47	0.05	0.02
22	0.32	0.42	0.02	0.02	0.00	0.03	0.16	0.18	0.44	0.03	0.01
23	0.15	0.22	0.02	0.02	0.00	0.01	0.06	0.07	0.26	0.01	0.01

Table. 5 Coefficients of partial recruitment (PR)
and correlation between fishing mortality
and effort (F - E) by age

Age, years	5	6	7	8	9	10	11	12	13	14
PR	0,164	0,291	0,407	0,743	0,772	0,939	1,000	1,000	1,000	1,000
F - E	0,005	0,391	0,639	0,669	0,706	0,742	0,711	0,623	0,673	0,718

Age, years	15	16	17	18	19	20	21	22	23
PR	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000	1,000
F - E	0,704	0,747	0,762	0,601	0,488	0,478	0,480	0,433	0,475

Table 6. Forecast of redfish stock size and TAO in Divs. 3LN

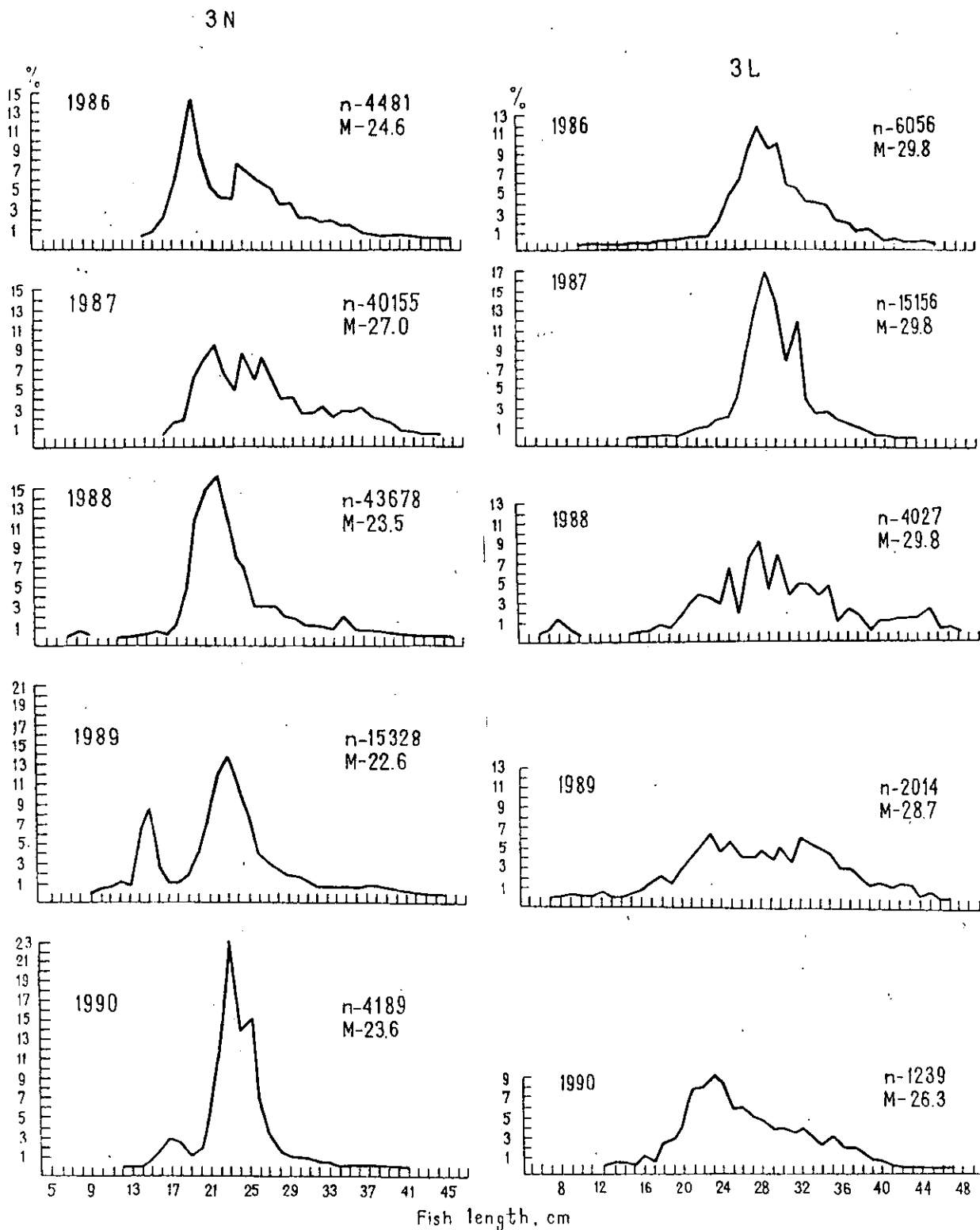| T	M	F	1990 N fish(x10^{-6})	1991 N fish(x10^{-6})	1991 B thou.t	1992 TAO, thou.t $F_{0.1}=0.12$	$F=F_{1990}=0.21$	$F_{MSY}=0.34$
5	0.1400	0.0203	172.57	172.57	18.811	0.292	0.508	0.815
6	0.1100	0.0532	125.61	146.47	23.289	0.658	1.138	1.813
7	0.0800	0.0766	430.28	106.82	20.723	0.994	1.712	2.708
8	0.0600	0.1428	168.30	368.87	89.634	1.689	2.869	4.452
9	0.0400	0.1500	22.74	139.04	42.546	7.424	12.591	19.497
10	0.0200	0.1836	5.59	18.88	7.043	4.230	7.124	10.924
11	0.0100	0.1223	4.16	4.45	1.905	0.443	0.755	1.179
12	0.0100	0.1352	4.33	3.48	1.709	0.142	0.241	0.375
13	0.0100	0.1276	2.56	3.57	2.005	0.118	0.202	0.314
14	0.0300	0.0984	2.11	2.15	1.416	0.110	0.189	0.297
15	0.0400	0.0886	2.14	1.80	1.316	0.067	0.115	0.181
16	0.0700	0.0860	2.11	1.83	1.460	0.059	0.101	0.159
17	0.1100	0.0850	1.38	1.80	1.541	0.060	0.103	0.163
18	0.1600	0.1145	0.48	1.17	1.091	0.081	0.139	0.217
19	0.2300	0.1316	0.37	0.38	0.380	0.057	0.098	0.152
20	0.3200	0.2100	0.01	0.28	0.297	0.028	0.046	0.071
21	0.4200	0.1315	0.01	0.01	0.008	0.011	0.019	0.030
22	0.5600	0.1429	0.01	0.01	0.011	0.000	0.000	0.001
23	0.7200	0.1533	0.01	0.01	0.008	0.000	0.001	0.001
			944.79	973.60	215.194	16.462	27.950	43.348

Fig. 1 Size composition of redfish in catches taken with
a small-meshed trawl in Divs. 3LN in 1986-1990.