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Estimation of the Stock Status and TAC for Redfish *Sebastes marinus* in Div. 3LN for 1991

by

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ABSTRACT

The redfish exploitable stock abundance and biomass estimated from the 1983-89 surveys data are presented in the paper. The VPA method was used to calculate abundance, biomass and fishing mortality coefficients by age groups during 1968-1989. The TAC was assessed for 1991 with various catch rate.

The redfish stock in Divs. 3LN is evaluated to be at the mean level: the redfish biomass estimated by the VPA method with regard for differentiated natural mortality coefficients (M) amounted to 194.7 x 10^3t, and to 187.2 x 10^3t with M = 0.1, for all age groups.

INTRODUCTION

The North-West Atlantic redfish is one of the most important commercial fish. The fish stock was estimated, recently, by the trawl-acoustic surveys and mathemathical calculations.

Spacious biological material, the basis for estimates of age composition, year-class strength and other characteristics of population, is collected during the regular surveys, which are of great importance for stocks investigations and rational fishery management.

The main purpose of the paper is to obtain the most unbiased redfish stock and TAC estimates. Two ways of calculations were applied: with regard for and without natural mortality coefficients (M) differentiated by age groups, i.e. with the constant M = 0.1.

MATERIAL AND METHODS

The VPA method was used to estimate the redfish exploitable stock abundance and biomass from the 1968-89 data. Table 1 presents qu-

antitative composition of catches by age-groups and years of fishery.

The data on redfish international catch in Divs. 3LN in 1989 come from NAFO Circular Letter (89/62). Initial data for 1987-88 were substituted in connection with the total international catch refine ments given both in NAFO statistical papers (NAFO SCS Doc.89/21) and Canadian scientific papers (Atkinson and Power, 1989). Fishing efforts per each year are given for a standard Soviet vessel of BMRT-type.

Obtaining of reliable results is hampered by annual correction of international catch statistics. NAFO SCS Doc.89/54 indicates that the data since 1986 have been preliminary yet. We suppose, the catch statistics for 1989 in Divs. 3LN raises doubts. The Soviet catch of the redfish is at the quota level year in year out. The cause of total international catch variability recently is, most of all, a different fishery intensity of the EEC countries (Fig.1).

11 set-up methods were applied for calculation of the initial fishing mortality coefficients during the stock estimate by the VPA method (Pope and Shepperd, 1983). The calculations were made using both differentiated by ages and constant coefficients of natural mortality. Differentiated by ages coefficients of natural mortality come from the paper (Efimov et al., 1986). Maximum values of correlation coefficients between fishing mortality and effort served the ground for choosing this or that method.

Prediction of the stock status and the TAC estimate for 1991 was made at the various exploitation levels: at precautious level ($F_{0.1}$), at the 1989 level, and at the MSY level (F_{msy}).

The choice of fishing mortality coefficient for fishery regulation (TAC) was caused by the following: if actual values of F were significantly lower, than F_{msy}, the predicted catch rate was equal to F_{msy}, otherwise, the value of $F_{0.1}$ served as the predicted one.

The trawl survey was conducted by RV "Persey-III" by the stratified-random method in March-July 1989 (Doubleday, 1981) and the acoustic survey was prosecuted by the methods adopted in PINRO (Mamylov, 1987).

RESULTS

Initial coefficients of fishing mortality were estimated by the Laurec method, which set correlation coefficients between effort and mortality within 0.64-0.74 for main commercial groups aged 7--19. The redfish abundance estimate with regard for coefficients

of natural mortality differentiated by age amounted to 1151.7 x x 10^6spec. in 1989, the biomass - to 194.7 x 10^3t (Tables 2,3) and, with the constant M = 0.1, - to 1157.1 x 10^6spec. and 187.2 x x 10^3t, respectively (Tables 4,5).

The results from sampling hauls together with data from fishery vessels indicate that the bulk of catches consisted of fish 21-28 cm long (Fig.2) at age 7-10 from the 1979-1982 year-classes. A good recruitment by the 3-4 - year-olds from the 1985-86 year-classes was observed in Subarea 3.

The total abundance of the redfish in Div. 3LN calculated using the data from the trawl-acoustic survey in 1989 was 145.1 x 10^6 spec. and the biomass - 40.2 x 10^3t. The results obtained from the trawl survey in 1989 were the lowest for 1983-89 (Fig.3), and, in our opinion, they don't reflect the actual stock status of the redfish. Underestimation of fish in Divs. 3LN is explained by a rough bottom relief and scattered distribution of the redfish over the area inhabited. Primarily, it is due to the redfish migrations between Divs. 3N and 3O, when the hydrological conditions in the area vary.

CONCLUSIONS

The redfish biomass in Divs. 3LN in 1991 is supposed to be at the level of 300 x 10^3t (Tables 6,7). Since the actual coefficients of fishing mortality are close to F_{msy} and higher for some age groups (Tables 8,9), the catch rate for 1991 has been chosen at the level of $F_{0.1}$= 0.131. The TAC will be 22 x 10^3t with regard for the natural mortality coefficient values differentiated by age.

The stock estimate is lower with the constant values of natural mortality coefficient. Considering that natural mortality increases depending on age, the use of constant coefficients of natural mortality is unjustified.

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Table 1 Age composition of the redfish catches in Divs. 3LN, spec. ($\times 10^{-3}$)

Age, years	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
5	2.24	4.79	2.77	7.62	9.35	5.21	3.04	11.08	25.46	5.91	10.17	5.61
6	2.64	4.29	2.80	8.77	13.62	10.93	5.08	11.53	24.56	22.16	38.68	20.93
7	2.44	3.63	2.49	6.91	11.33	10.74	5.35	9.34	14.94	40.52	61.20	27.24
8	3.16	5.40	3.57	8.25	11.95	11.65	6.70	12.17	26.93	45.60	41.58	13.65
9	2.61	4.01	3.43	7.97	10.96	9.41	5.81	8.89	17.63	35.00	15.82	3.47
10	2.67	3.44	4.30	7.53	9.04	9.27	6.57	7.39	14.32	30.03	11.02	1.79
11	1.42	2.24	3.02	4.12	5.16	3.59	3.50	2.82	5.82	14.81	5.39	1.13
12	1.87	2.00	3.54	4.09	2.17	2.49	2.79	2.19	5.68	11.40	4.54	1.26
13	1.52	1.40	2.92	2.64	1.02	1.10	1.39	1.15	5.95	10.05	5.28	0.64
14	1.19	0.91	1.91	1.49	0.53	0.59	0.74	0.74	3.55	7.38	3.12	0.42
15	1.12	0.80	1.45	1.30	0.38	0.34	0.51	0.79	1.38	4.92	1.85	0.25
16	0.61	0.61	0.78	0.80	0.23	0.21	0.31	0.55	0.88	3.76	1.48	0.16
17	0.26	0.42	0.46	0.52	0.09	0.09	0.14	0.37	0.65	2.77	1.05	0.13
18	0.34	0.53	0.50	0.55	0.10	0.06	0.16	0.40	0.61	1.60	0.68	0.11
19	0.32	0.39	0.37	0.49	0.05	0.01	0.08	0.28	0.41	0.89	0.48	0.03
20	1.25	0.96	1.14	1.41	0.08	0.03	0.11	0.42	0.32	0.88	0.72	0.09
21	0.30	0.21	0.22	0.31	0.02	0.02	0.02	0.13	0.20	0.37	0.47	0.04
22	0.39	0.25	0.32	0.42	0.02	0.02	0.00	0.03	0.16	0.13	0.44	0.02
23	0.18	0.13	0.15	0.22	0.02	0.02	0.00	0.01	0.06	0.07	0.26	0.01
	27.0	36.4	36.2	65.4	74.1	65.8	42.3	70.3	149.5	238.3	204.3	77.0

Table 2 Redfish abundance estimated by the VPA method with regard for coefficients of natural mortality differentiated by age, spec. ($\times 10^{-6}$)

Age, years	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
5	86.23	89.78	96.72	110.90	122.35	128.48	126.28	173.49	258.06	464.29	400.85	284.59
6	63.68	75.89	76.69	84.88	93.10	101.82	111.30	111.37	146.45	209.32	414.48	353.03
7	45.07	55.97	65.93	68.10	69.93	72.88	83.50	97.87	91.74	111.63	171.96	345.49
8	30.25	40.08	49.18	59.68	57.43	54.88	58.22	73.45	83.11	71.91	65.90	102.70
9	23.51	25.97	33.22	43.75	49.26	43.48	41.32	49.38	58.65	53.50	24.55	22.72
10	20.85	20.25	21.25	28.86	34.61	37.01	32.93	34.38	39.16	39.57	17.53	8.29
11	16.07	17.79	16.44	16.58	20.83	24.98	27.10	25.77	26.39	24.22	9.12	6.28
12	15.22	14.30	15.38	13.28	12.31	17.48	21.16	23.35	22.71	20.33	9.26	3.68
13	15.15	13.07	12.04	11.58	8.97	9.91	14.67	17.97	20.72	16.64	8.66	4.58
14	9.55	13.21	11.31	8.81	8.64	7.71	8.54	12.87	16.31	14.25	6.27	3.21
15	9.06	8.00	11.80	8.99	7.08	7.78	6.83	7.48	11.64	12.19	6.48	2.97
16	4.96	7.36	6.69	9.60	7.12	6.15	6.92	5.87	6.21	9.52	6.63	4.26
17	6.20	3.87	6.02	5.26	7.85	6.16	5.31	5.90	4.74	4.73	4.98	4.54
18	8.66	5.09	2.94	4.75	4.05	6.67	5.23	4.44	4.73	3.48	1.54	3.32
19	4.51	6.72	3.65	1.94	3.36	3.19	5.35	4.09	3.24	3.29	1.40	0.94
20	6.05	3.13	4.73	2.44	1.04	2.50	2.40	3.98	2.85	2.09	1.72	0.65
21	4.03	3.15	1.37	2.33	0.56	0.65	1.70	1.57	2.40	1.71	0.73	0.60
22	2.80	2.24	1.77	0.68	1.19	0.33	0.38	1.03	0.86	1.32	0.76	0.11
23	1.42	1.22	1.02	0.71	0.08	0.62	0.16	0.20	0.53	0.35	0.57	0.11
	373.3	407.1	438.1	483.1	509.7	532.7	559.3	654.5	800.5	1064.3	1153.4	1151.7

Table 3 Redfish biomass estimated by the VPA method with regard for coefficients differentiated by age, ($\times 10^3$)

Age, years	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
5	11.21	16.16	12.09	20.96	19.82	18.89	17.68	21.69	30.97	41.32	35.68	27.04
6	14.46	16.62	16.64	19.27	21.13	22.60	24.93	20.60	20.21	28.26	47.25	50.13
7	11.18	13.21	16.09	16.68	17.13	16.98	20.54	23.49	18.07	16.74	25.11	60.81
8	9.20	11.54	12.49	17.19	18.66	17.40	14.85	19.83	21.28	15.03	12.78	22.70
9	7.95	8.91	10.90	14.79	17.53	15.39	14.96	15.55	17.48	14.55	6.43	6.70
10	8.13	8.26	7.42	12.44	13.78	15.25	13.10	14.20	14.88	12.84	5.68	2.98
11	6.97	7.70	7.01	7.49	9.21	10.79	12.44	11.39	11.48	9.40	3.54	2.69
12	7.97	6.89	7.97	7.04	6.49	8.22	11.32	11.79	11.47	9.13	4.23	1.76
13	9.53	7.57	6.79	7.09	5.49	5.28	8.25	10.24	11.94	8.57	4.54	2.52
14	6.49	8.93	7.17	5.83	5.75	4.82	5.85	8.41	10.60	8.71	3.76	2.04
15	6.68	5.81	8.54	6.90	5.07	5.58	4.94	5.46	8.49	8.31	4.42	2.15
16	4.09	5.85	5.38	8.04	5.65	4.85	5.05	4.82	4.97	7.13	4.95	3.46
17	5.68	3.32	4.99	4.63	6.81	5.10	4.38	5.17	4.07	3.83	4.02	3.94
18	8.16	4.98	2.82	4.39	3.78	6.01	4.72	3.96	4.33	3.04	1.40	3.34
19	4.55	6.62	3.80	2.06	3.42	3.10	5.01	4.05	3.23	3.11	1.38	0.71
20	6.56	3.22	4.89	2.71	1.14	2.67	2.42	4.10	3.00	2.25	1.86	0.76
21	4.74	3.54	1.60	2.72	0.66	0.74	1.91	1.68	2.70	1.94	0.85	0.73
22	3.34	2.66	2.06	0.80	1.42	0.39	0.45	1.20	1.03	1.55	0.94	0.14
23	1.73	1.46	1.23	0.89	0.10	0.74	0.19	0.25	0.65	0.43	0.73	0.15
	138.6	143.3	139.9	161.0	163.1	164.8	173.0	187.9	200.8	196.2	169.5	194.7

Table 4 Redfish abundance estimated by the VPA method with regard for constant coefficient of natural mortality by age, spec. ($\times 10^{-6}$)

Age, years	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
5	82.92	87.94	95.15	109.23	121.42	127.45	125.54	172.44	256.42	463.35	396.74	294.90
6	59.78	72.90	75.02	83.46	91.60	100.98	110.37	110.70	145.50	207.83	413.64	352.74
7	41.45	52.37	63.17	66.56	68.62	71.49	82.73	97.01	91.13	110.75	170.59	351.48
8	29.48	36.67	45.79	57.08	55.98	53.65	56.92	72.72	82.30	71.34	65.08	354.38
9	22.53	25.23	29.95	40.50	46.76	42.08	40.14	48.12	57.95	52.71	24.00	242.66
10	19.40	19.29	20.53	25.68	31.45	34.58	31.58	33.23	37.94	38.89	16.77	8.05
11	16.13	16.37	15.50	15.87	17.72	21.88	24.72	24.45	25.26	23.03	8.46	5.78
12	14.45	14.36	13.98	12.35	11.81	14.40	18.09	21.00	21.40	19.22	8.08	5.13
13	13.35	12.31	12.10	10.20	8.06	9.23	11.65	14.97	18.42	15.36	7.57	3.54
14	8.45	11.46	10.57	8.86	7.30	6.82	7.87	9.93	13.39	12.02	5.03	3.21
15	7.02	6.95	10.12	8.28	7.05	6.49	5.98	6.84	8.82	9.39	4.33	1.81
16	4.04	5.46	5.71	8.03	6.46	6.20	5.72	5.08	5.62	6.90	4.02	1.25
17	5.44	3.04	4.31	4.38	6.44	5.58	5.36	4.83	4.03	4.20	2.64	1.16
18	5.76	4.43	2.23	3.29	3.29	5.46	4.72	4.48	3.81	2.87	1.08	1.24
19	5.11	4.36	3.11	1.36	2.17	2.57	4.37	3.68	3.27	2.54	0.91	0.26
20	4.46	3.58	2.95	2.03	0.61	1.60	1.93	3.24	2.54	2.12	1.16	0.25
21	2.20	2.06	1.69	1.11	0.30	0.35	1.08	1.25	1.89	1.49	0.75	0.19
22	1.49	1.12	1.10	0.87	0.45	0.17	0.20	0.65	0.66	1.00	0.63	0.09
23	0.67	0.52	0.42	0.36	0.18	0.22	0.08	0.11	0.33	0.24	0.41	0.03
	344.1	380.4	413.4	459.5	487.5	511.2	539.0	634.7	780.7	1045.2	1131.9	1157.1

Table 5 Redfish biomass estimated by the VPA method with regard for constant coefficient of natural mortality by age, x 10^3

Age, years	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
5	10.78	15.83	11.89	20.65	19.67	18.73	17.58	21.55	30.77	41.24	35.31	28.02
6	13.57	15.96	16.28	18.94	20.79	22.42	24.72	20.48	20.08	28.06	47.15	50.09
7	10.28	12.36	15.41	16.31	16.81	16.66	20.35	23.28	17.95	16.61	24.91	61.86
8	8.96	10.56	11.63	16.44	18.19	17.01	14.51	19.63	21.07	14.91	12.62	23.07
9	7.61	8.65	9.82	13.69	16.65	14.90	14.53	15.16	17.27	14.34	6.29	6.68
10	7.57	7.87	7.17	11.07	12.52	14.25	12.57	13.72	14.42	12.64	5.43	2.90
11	7.00	7.09	6.60	7.17	7.83	9.45	11.35	10.81	10.99	8.93	3.28	2.48
12	7.57	6.92	7.24	6.54	6.12	6.77	9.68	10.60	10.81	8.63	3.69	1.50
13	8.40	7.13	6.82	6.24	4.93	4.92	6.55	8.53	10.61	7.91	3.96	1.95
14	5.75	7.75	6.70	5.87	4.86	4.26	5.39	6.50	8.71	7.34	3.01	1.41
15	5.18	5.05	7.33	6.36	5.11	4.65	4.33	4.99	6.44	6.40	2.96	1.30
16	3.33	4.34	4.59	6.73	5.13	4.90	4.18	4.17	4.49	5.16	3.00	1.83
17	4.98	2.61	3.58	3.85	5.59	4.62	4.42	4.23	3.46	3.39	2.13	1.87
18	5.42	4.34	2.14	3.03	3.07	4.92	4.27	3.99	3.48	2.51	0.99	1.25
19	5.15	4.30	3.24	1.45	2.21	2.50	4.09	3.65	3.26	2.40	0.90	0.28
20	4.84	3.69	3.05	2.26	0.67	1.71	1.95	3.34	2.67	2.27	1.25	0.30
21	2.59	2.31	1.97	1.30	0.35	0.40	1.22	1.34	2.13	1.70	0.87	0.23
22	1.77	1.33	1.28	1.02	0.53	0.20	0.24	0.76	0.79	1.18	0.78	0.12
23	0.82	0.63	0.51	0.45	0.21	0.26	0.09	0.13	0.40	0.30	0.52	0.05
	121.6	128.7	127.3	149.4	151.3	153.5	162.0	176.9	189.8	185.9	159.1	187.2

Table 6 Prediction of the redfish stock status and TAC (with regard for differentiated natural mortality coefficient)

T	M	F	1989 N spec. ($x10^{-6}$)	1990 N spec. ($x10^{-6}$)	1990 B t x 10^3	1991 Biomass, t x 10^3 $F_{0.1}$	1991 Biomass, t x 10^3 $F=F_{1989}$	1991 Biomass, t x 10^3 F_{msy}	1991 TAC, t x 10^3 $F_{0.1}$	1991 TAC, t x 10^3 $F=F_{1989}$	1991 TAC, t x 10^3 F_{msy}
5	0.100	0.0295	284.59	284.59	27.04	27.04	27.04	27.04	0.33	0.75	0.50
6	0.080	0.0638	353.03	250.02	35.50	36.10	35.50	35.86	0.94	2.11	1.42
7	0.060	0.0847	345.49	305.75	53.81	39.52	38.11	38.95	1.89	3.01	2.80
8	0.040	0.1456	102.70	298.94	66.07	60.51	58.47	58.92	6.26	7.77	9.05
9	0.030	0.1654	22.70	85.30	25.16	75.78	73.25	71.46	7.81	11.01	10.93
10	0.020	0.2466	8.29	13.67	6.72	26.66	25.26	25.18	3.24	5.47	4.52
11	0.010	0.1986	6.28	6.35	2.72	6.89	6.13	6.43	0.58	1.10	0.81
12	0.020	0.2159	3.68	5.10	2.44	2.75	2.46	2.62	0.21	0.47	0.30
13	0.030	0.1873	4.58	2.90	1.60	2.53	2.22	2.43	0.24	0.37	0.34
14	0.040	0.1447	3.21	3.69	2.35	1.62	1.49	1.54	0.12	0.20	0.16
15	0.070	0.1315	2.97	2.67	1.92	2.36	2.20	2.27	0.10	0.26	0.14
16	0.110	0.0934	4.26	2.43	1.98	1.94	1.77	1.89	0.08	0.15	0.12
17	0.150	0.0558	4.54	3.48	3.02	1.81	1.72	1.77	0.09	0.09	0.14
18	0.210	0.0591	3.32	3.70	3.72	2.84	2.85	2.76	0.15	0.15	0.23
19	0.280	0.0607	0.64	2.54	2.81	3.12	3.13	3.02	0.12	0.16	0.18
20	0.370	0.1739	0.65	0.46	0.54	2.16	2.13	2.11	0.11	0.29	0.16
21	0.490	0.0873	0.60	0.38	0.46	0.36	0.32	0.35	0.02	0.02	0.03
22	0.630	0.2974	0.11	0.34	0.44	0.28	0.27	0.27	0.02	0.05	0.02
23	0.800	0.1435	0.11	0.04	0.06	0.22	0.18	0.22	0.01	0.02	0.01
			1151.7	1277.3	238.3	294.5	284.5	285.1	22.3	33.4	31.9

Legend: T - age;
M - coefficients of natural mortality;
F - coefficients of fishing mortality;
N - abundance;
B - biomass

Table 7 Prediction of the redfish stock status and TAC (with regard for constant natural mortality coefficient)

T	M	F	1989 N spec. (x 10^{-6})	1990 N spec. (x 10^{-6})	1990 B t x 10^3	1991 Biomass, t x 10^3 $F_{0.1}$	1991 Biomass, t x 10^3 $F=F_{1989}$	1991 Biomass, t x 10^3 F_{msy}	1991 TAC, t x 10^3 $F_{0.1}$	1991 TAC, t x 10^3 $F=F_{1989}$	1991 TAC, t x 10^3 F_{msy}
5	0.100	0.0307	294.90	294.90	28.02	28.02	28.02	28.02	0.29	0.81	0.45
6	0.100	0.0645	352.74	258.77	36.74	36.74	36.74	37.26	0.85	2.19	1.28
7	0.100	0.0849	351.48	299.24	52.67	52.67	52.67	39.73	1.66	2.99	2.47
8	0.100	0.1476	104.38	292.14	64.56	64.56	64.56	55.93	5.10	7.19	7.42
9	0.100	0.1719	22.66	81.48	24.04	24.04	24.04	67.12	6.29	10.13	8.90
10	0.100	0.2661	8.05	17.26	6.21	6.21	6.21	22.85	2.62	4.98	3.69
11	0.100	0.2284	5.78	5.58	2.40	2.40	2.40	5.57	0.45	1.00	0.63
12	0.100	0.2698	3.13	4.16	1.99	1.99	1.99	2.13	0.16	0.43	0.23
13	0.100	0.2594	3.54	2.17	1.19	1.19	1.19	1.84	0.18	0.34	0.26
14	0.100	0.2242	2.21	2.47	1.57	1.57	1.57	1.07	0.09	0.18	0.13
15	0.100	0.2301	1.81	1.60	1.15	1.15	1.15	1.40	0.08	0.25	0.12
16	0.100	0.1836	2.25	1.30	1.06	1.06	1.06	1.07	0.07	0.15	0.10
17	0.100	0.1182	2.16	1.70	1.47	1.47	1.47	0.92	0.08	0.09	0.11
18	0.100	0.1572	1.24	1.73	1.75	1.75	1.75	1.35	0.12	0.19	0.18
19	0.100	0.1447	0.26	0.96	1.06	1.06	1.06	1.50	0.10	0.19	0.14
20	0.100	0.4519	0.25	0.20	0.24	0.24	0.24	0.92	0.08	0.31	0.12
21	0.100	0.2524	0.19	0.14	0.18	0.18	0.18	0.19	0.02	0.03	0.02
22	0.100	0.2709	0.09	0.13	0.17	0.17	0.17	0.15	0.02	0.03	0.03
23	0.100	0.3635	0.03	0.06	0.09	0.09	0.09	0.13	0.01	0.04	0.02
			1157.1	1266.0	226.5	226.5	226.5	269.1	18.3	31.5	26.3

Legend: T - age;
M - coefficients of natural mortality;
F - coefficients of fishing mortality;
N - abundance;
B - biomass

Table 8 Coefficients of fishing mortality estimated with regard for natural mortality coefficient differentiated by age

Age, years	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
5	0.0277	0.0576	0.0306	0.0749	0.0836	0.0436	0.0256	0.0694	0.1093	0.0135	0.0270	0.0295
6	0.0492	0.0607	0.0368	0.1137	0.1649	0.1184	0.0486	0.1139	0.1915	0.1166	0.1021	0.0638
7	0.0574	0.0692	0.0396	0.1104	0.1824	0.1646	0.0683	0.1035	0.1835	0.4670	0.4555	0.2847
8	0.1126	0.1477	0.0770	0.1520	0.2384	0.2437	0.1248	0.1850	0.4006	1.0346	1.0259	0.4456
9	0.1194	0.1706	0.1107	0.2044	0.2559	0.2479	0.1539	0.2018	0.3636	1.0859	1.0561	0.4654
10	0.1387	0.1882	0.2284	0.3058	0.3062	0.2915	0.2250	0.2445	0.4604	1.4472	1.0060	0.2466
11	0.0966	0.1352	0.2039	0.2875	0.1653	0.1561	0.1389	0.1164	0.2507	0.9518	0.8990	0.1986
12	0.1323	0.1521	0.2643	0.3720	0.1965	0.1555	0.1431	0.0994	0.2910	0.8338	0.6838	0.2159
13	0.1072	0.1148	0.2828	0.2630	0.1221	0.1197	0.1013	0.0670	0.3442	0.9455	0.7625	0.1873
14	0.1363	0.0727	0.1896	0.1898	0.0651	0.0809	0.0922	0.0604	0.2512	0.7486	0.7071	0.1447
15	0.1369	0.1086	0.1363	0.1628	0.0586	0.0469	0.0808	0.1156	0.1307	0.5396	0.3492	0.1315
16	0.1396	0.0921	0.1317	0.0917	0.0342	0.0372	0.0486	0.1040	0.1628	0.5371	0.2680	0.0934
17	0.0469	0.1245	0.0862	0.1118	0.0130	0.0151	0.0298	0.0706	0.1599	0.9749	0.2566	0.0558
18	0.0447	0.1236	0.2063	0.1365	0.0283	0.0097	0.0343	0.1054	0.1542	0.6998	0.6629	0.0594
19	0.0858	0.0697	0.1233	0.3432	0.0165	0.0054	0.0166	0.0824	0.1567	0.3681	0.4894	0.0607
20	0.2823	0.4512	0.3371	1.1022	0.0951	0.0135	0.0543	0.1355	0.1427	0.6763	0.6783	0.1739
21	0.0984	0.0895	0.2205	0.1824	0.0368	0.0395	0.0142	0.1112	0.1103	0.3139	1.4246	0.0873
22	0.2030	0.1595	0.2784	1.4837	0.0286	0.0848	0.0106	0.0346	0.2759	0.1989	1.3291	0.2976
23	0.2061	0.1623	0.2422	0.5670	0.5605	0.0481	0.0273	0.0972	0.1810	0.3542	0.9684	0.1435
6-17	0.0913	0.1072	0.1039	0.1707	0.1943	0.1745	0.1011	0.1374	0.2752	0.5937	0.3545	0.0893

Table 9 Coefficients of fishing mortality estimated with regard for constant natural mortality coefficient by age

Age, years	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989
5	0.0288	0.0589	0.0311	0.0761	0.0843	0.0439	0.0258	0.0699	0.1101	0.0135	0.0273	0.0307
6	0.0525	0.0632	0.0396	0.1157	0.1678	0.1194	0.0490	0.1146	0.1929	0.1175	0.1023	0.0645
7	0.0626	0.0741	0.0414	0.1131	0.1862	0.1680	0.0689	0.1044	0.1848	0.4717	0.4602	0.0849
8	0.1157	0.1626	0.0829	0.1595	0.2453	0.2501	0.1278	0.1870	0.4054	1.0493	1.0487	0.1476
9	0.1250	0.1761	0.1236	0.2228	0.2716	0.2573	0.1588	0.2077	0.3689	1.1154	1.1001	0.1719
10	0.1499	0.1986	0.2374	0.3510	0.3428	0.3156	0.2358	0.2542	0.4793	1.5055	1.0874	0.2661
11	0.1062	0.1478	0.2177	0.3025	0.1974	0.1803	0.1533	0.1231	0.2635	1.0378	1.0204	0.2284
12	0.1399	0.1514	0.2951	0.4065	0.2096	0.1921	0.1696	0.1112	0.3119	0.9123	0.8384	0.2698
13	0.1226	0.1222	0.2842	0.3044	0.1369	0.1291	0.1293	0.0810	0.3970	1.0860	1.2272	0.2594
14	0.1554	0.0843	0.2041	0.1884	0.0775	0.0919	0.1003	0.0789	0.3153	0.9798	0.9985	0.2242
15	0.1804	0.1261	0.1608	0.1779	0.0582	0.0564	0.0928	0.1271	0.1762	0.7781	0.5790	0.2301
16	0.1742	0.1262	0.1561	0.1106	0.0378	0.0369	0.0591	0.1213	0.1816	0.8490	0.4890	0.1836
17	0.0537	0.1610	0.1224	0.1358	0.0158	0.0167	0.0296	0.0869	0.1909	1.2040	0.5539	0.1182
18	0.0680	0.1432	0.2816	0.2037	0.0350	0.0118	0.0380	0.1044	0.1953	0.9369	1.1436	0.1572
19	0.0754	0.1094	0.1459	0.5296	0.0256	0.0067	0.0204	0.0920	0.1551	0.5062	0.8909	0.1447
20	0.4038	0.3823	0.6068	1.5602	0.1684	0.0211	0.0677	0.1690	0.1615	0.6656	1.2705	0.4519
21	0.1875	0.1401	0.1761	0.4256	0.0708	0.0739	0.0224	0.1416	0.1421	0.3673	1.3640	0.2524
22	0.4187	0.3459	0.4896	0.9613	0.0784	0.1726	0.0202	0.0554	0.3724	0.2688	1.9801	0.2209
23	0.4863	0.4219	0.7012	1.6463	0.2265	0.1408	0.0592	0.1951	0.3091	0.5456	1.7866	0.3635
6-17	0.0986	0.1152	0.1111	0.1813	0.2053	0.1833	0.1057	0.1428	0.2854	0.6245	0.3689	0.0913

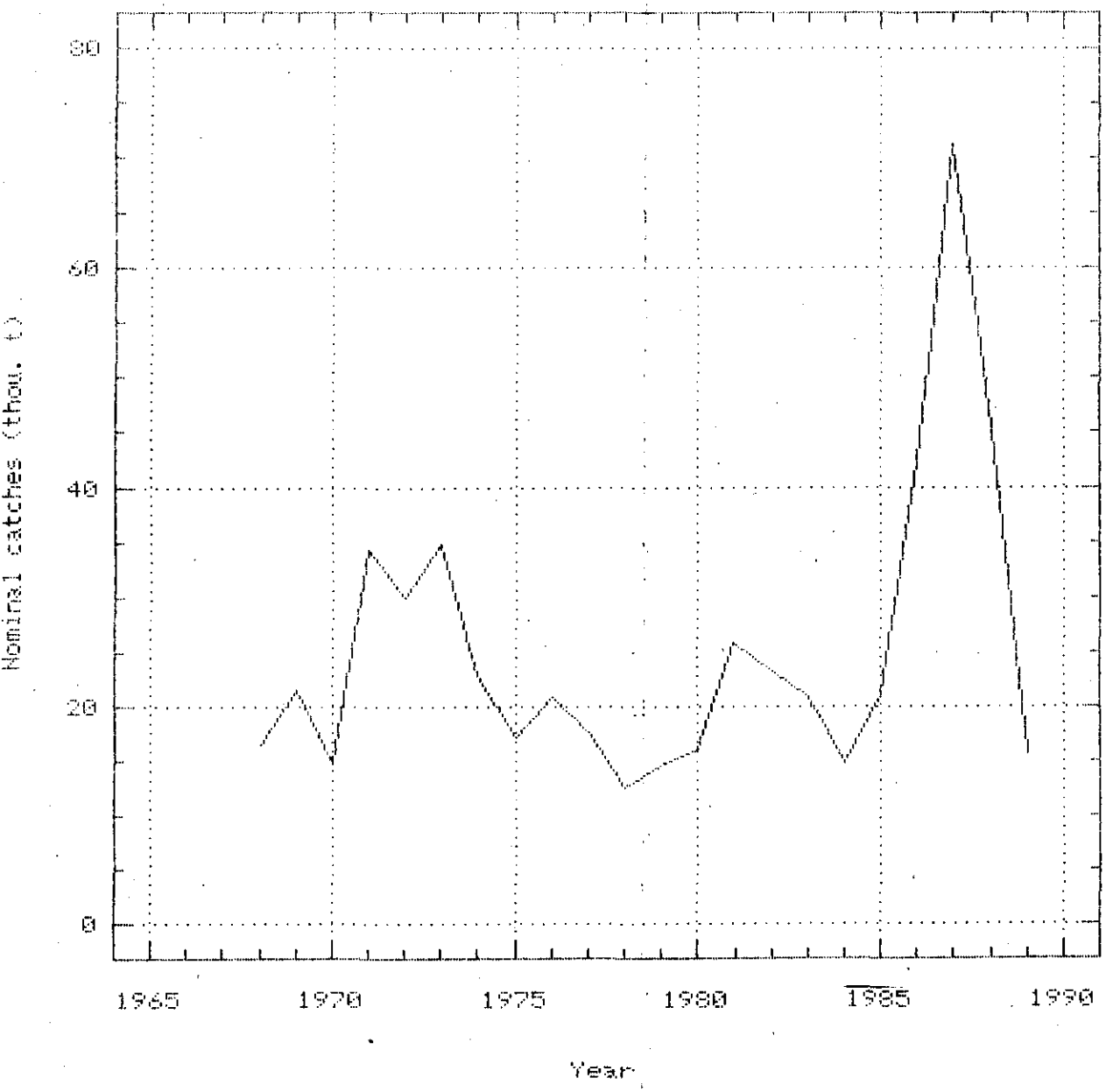

Fig. 1. Nominal catches of redfish in div.3LN(1986-89 are provisional)

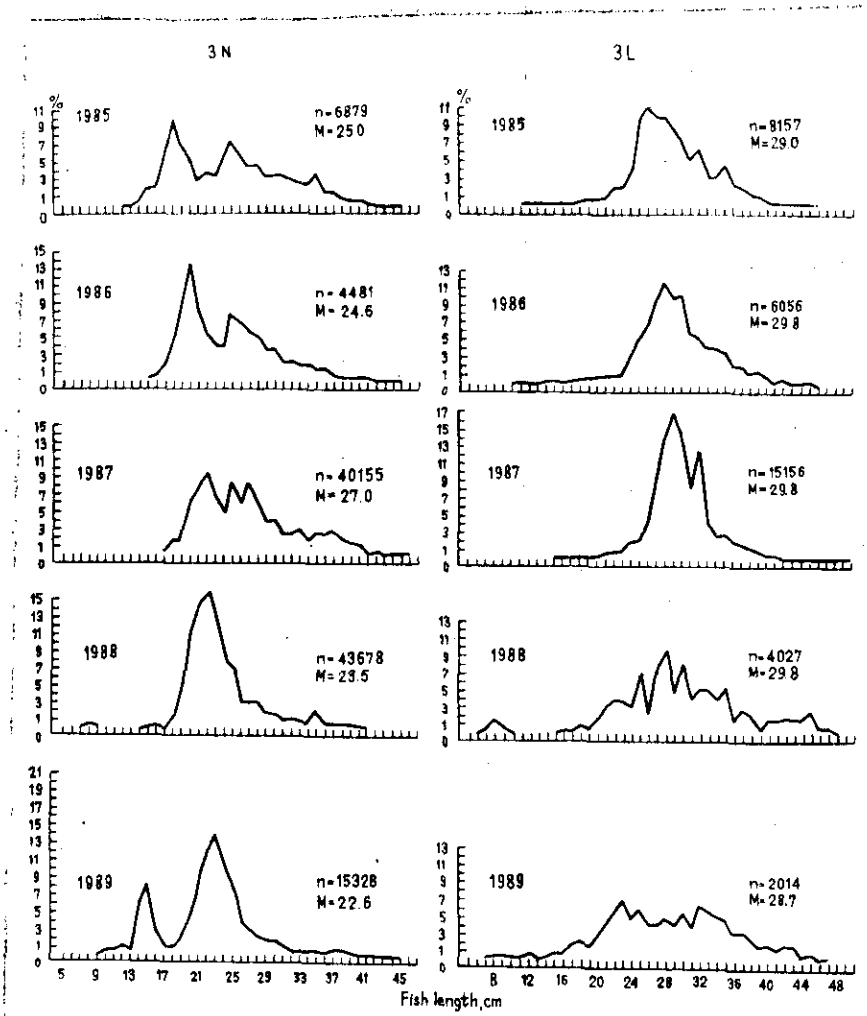

Fig.2 Redfish length composition from the catches by the small-meshed trawl in Div.3LN in 1985-89

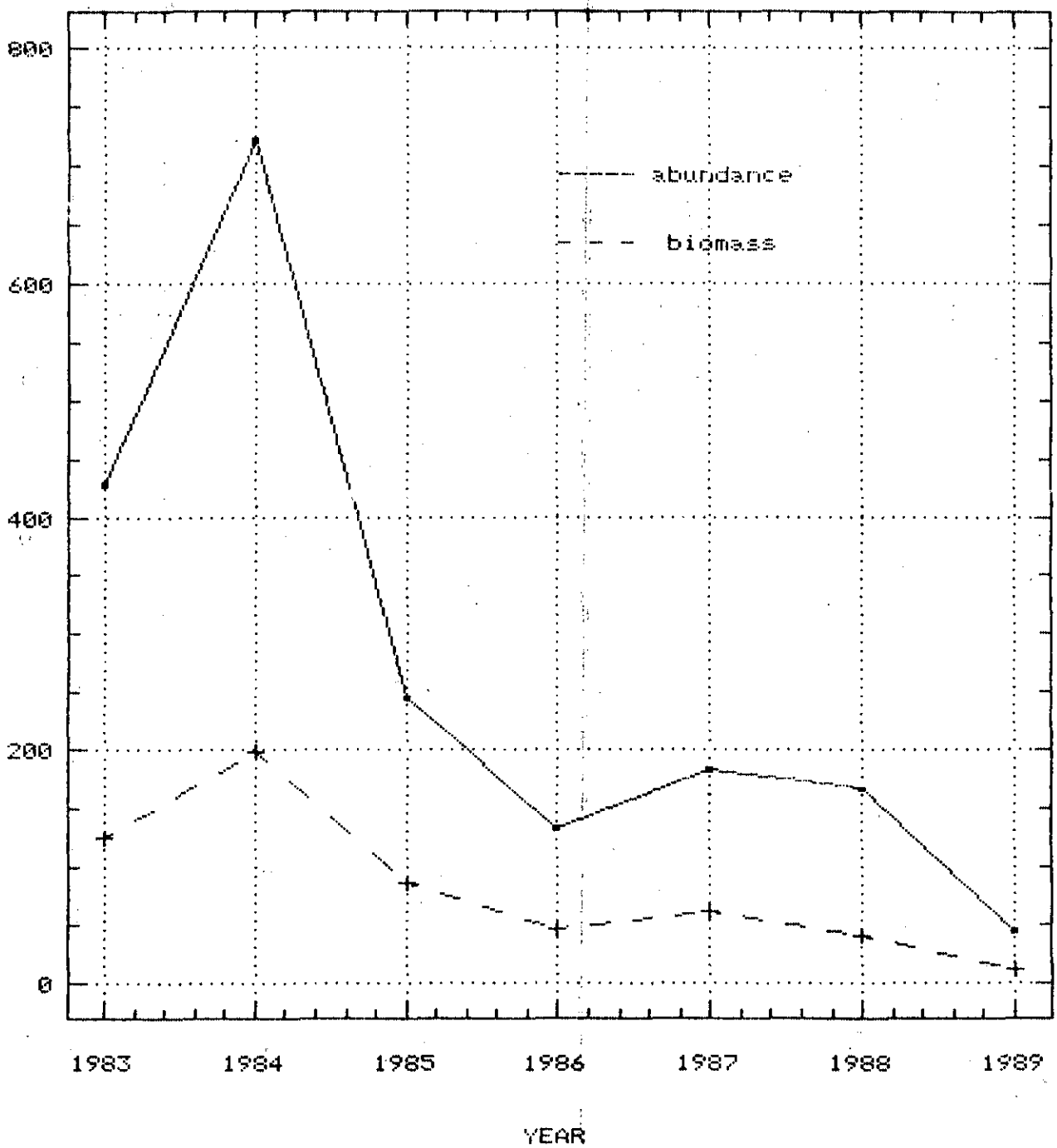

Fig.3. Abundance(mill.spec.) & biomass(thou.t) of redfish in Div.3LN based on trawl data