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Redfish in Div. 30

by

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Abstract

Reported catches have ranged from 8,000 tons to 13,000 tons since 1985. The USSR is the predominant fleet. Canada has taken less than 200 tons since 1982. There are insufficient research vessel data to evaluate stock status. Standardized commercial catch rate (t/hour) appears to be stable since 1986. There is no analysis applicable at present to determine where the current TAC (14,000 tons, 1991-1993) stands in relation to an appropriate target.

Résumé

Les prises déclarées se sont échelonnées entre 8 000 et 13 000 tonnes depuis 1985. L'U.R.S.S. est la flotte dominante. Les prises canadiennes sont inférieures à 200 t depuis 1982. Les données d'évaluation des navires scientifiques sont insuffisantes pour estimer l'état du stock. Le taux de prises commerciales normalisé (t/h) apparaît stable depuis 1986. Aucune analyse ne permet pour le moment de déterminer si le TPA actuel (14 000 t pour 1991-1993) correspond à un objectif adéquat.

DESCRIPTION OF THE FISHERY

Since 1959 nominal catches have been in the range of 5,000 to 20,000 t. Since the implementation of the 200-mile fisheries jurisdictional zone in 1977, reported catches have been between a low of about 7,000 t in 1978 to a high of 18,000 t in 1979 (Table 1a).

The Soviet Union predominates in this fishery as it generally takes its share (about 50%) of the total foreign allocation, which constitutes about 2/3 of the Total Allowable Catch (TAC). Canada has the remainder of the quota but has generally taken less than 3 % of its allotment since 1982. In 1987 South Korea entered this fishery reporting catches to NAFO of about 2,000 t for 1987 and 1988. Preliminary statistics for 1989 and 1990 indicate a drop of about 2,500 t from the 1988 catch of 11,000 t. Surveillance estimates available from the Nfld. region (Table 1b) estimate actual catches in 1987 and 1988 were about 25,000 and 30,000 t respectively, at least double the reported catches, due essentially to increased activity of non-members of NAFO who do not report their catches.

The fishery has occurred primarily in the second and third quarters of the year since 1983 (Table 2). The prominent means of capture from the mid-1970s to the early 1980s was the bottom otter trawl (Table 3), but since 1984 there has been an increase in the use of the midwater trawl.

The fishery was first under TAC regulation in 1974 when a 16,000 t TAC was imposed. It was raised in 1978 to 20,000 t and maintained through 1987 (with the exception of 1980 when it was increased to 21,900 t for reasons unknown). In 1988 it was lowered to 14,000 t and has been at that level ever since.

DATA

Catch and weight at age

Commercial length frequencies (Figs. 1a and b) available from the 1990 fishery were combined by the method of Gavaris and Gavaris (1983), as outlined in Fig. 2, and then converted into numbers at age using a single age/length key for the year (Table 4).

The length-weight relationships used were:

$$WT\ (males) = 0.01659\ Forklength^{2.9548}$$

$$WT\ (females) = 0.013272\ Forklength^{3.0210}$$

Additional information recorded with the length frequencies indicate fishing occurred generally in the 300-550m depth range. Modal lengths between 22 and 25 cm were common among the

frequencies, corresponding to the 1979-81 year classes.

Catch at age was also constructed for 1989, as outlined in Fig. 3, by the method described above. The otoliths used to construct the age/length key came from Canadian research surveys conducted in the spring of that year. The 1979-81 year classes were also most represented in the 1989 catch (Table 5). A series of four years of catch and weight at age is now available for this stock (Tables 6-7).

Commercial catch rates

Catch and effort data for 1959 to 1988 were extracted from ICNAF/NAFO Statistical Bulletins and were combined with provisional 1989 NAFO data and 1990 Atlantic region data compiled by various DFO regional statistics branches. In addition to this, observer data from the Nfld. region were utilized, but only where the observer monitored the information. This latter information was aggregated on a trip by trip basis. Initially selected from this database were observations where redfish comprised more than 50% of the total catch and were therefore considered to be redfish directed.

These data were analysed with a multiplicative model (Gavaris 1980) to derive a standardized catch rate series. Effects included in the model were a combination country-gear-tonnage class category type (CGT), NAFO division, month, and a category type representing the amount of bycatch associated with each observation. For this effect five groups were arbitrarily established : (>50% <=60%), (>60% <=70%), (>70% <=80%), (>80% <=90%) and (>90%) where each group corresponds to the percentage of redfish relative to the total catch associated with each observation. In the usual manner, catch or effort data of less than 10 units were eliminated prior to analysis in addition to any categories with less than five samples except in the year category type.

The model utilizing effort measured in hours fished explained 65% of the variability in the catch rates (Table 8). All category types are significant. Even though the year category type is significant, there are only two years that have significantly different coefficients from the reference (1967 and 1990). Estimated coefficients from the regression show catch rates are generally highest in the May-August period. Residual plots (Fig. 4) did not signal that the model was inappropriate.

The standardized catch rate index (Table 9, Fig. 5) shows much interannual variability from 1959 to 1978. In 1979 there was a dramatic increase in the rate followed by a general decline to 1986. A period of stability occured until 1989. In 1990 the catch rate increased dramatically to the highest rate on record. Although preliminary, the data for 1990 indicate that this high rate was only experienced by tonnage class 7 USSR OTB vessels fishing in the

June to September period. Large fluctuations from year to year, primarily in the pre-1980 period are not considered reflective of the dynamics of such a long lived species as redfish.

Research vessel surveys

Stratified random groundfish surveys have been conducted in the spring in Div. 3O since 1973. These surveys generally only cover strata less than 200 fathoms (367 m) and are considered of little value in deriving an index of abundance because they do not survey sufficiently deep enough with regard to the distribution of redfish. However, information on size distribution may be useful to give some indication of recruitment. There was also a fall survey in 1990 that covered strata down to 300 fathoms (550 m).

Length frequencies represented as numbers per thousand (Figs. 6-9) indicate there have been two pulses of recruitment that could be followed for a few consecutive years during the period covered by the spring surveys. One of these in 1975 (the 1972 or 1973 year classes) and another in 1981 (the 1978 or 1979 year classes). It is interesting to compare the length distributions from spring and fall of 1990. Both surveys were conducted by the CSS Wilfred Templeman. The spring survey shows a single mode in the distribution while the fall shows a bimodal distribution. The derived length distribution from the fall survey, conducted in Nov.-Dec., combined for males and females shows a resemblance to lengths sampled by observers in November from the USSR OTB fleet (see Fig. 1a).

ESTIMATION OF STOCK PARAMETERS

Production model

While there was an indication of a declining trend since 1980 in the tons/hour standardized there was not enough contrast in the index for general production models to be appropriate.

Total mortality

Paloheimo Z's calculated for 1987-1989 averaged on ages 9-16 ranged from .029 to .163 using cpue at age with standardized effort measured in hours. There were some negative values over the ages in each year and overall these estimates were not considered useful.

PROGNOSIS

There is no analysis applicable to determine where the current TAC stands in relation to an appropriate reference level. The catch rate index in the mid to late 1980s appears stable. A substantial increase is suggested in 1990 but this could be simply an artifact of incomplete statistics. There is no basis to suggest a deviation from the current multi-year plan.

REFERENCES

Gavaris, S. 1980. Use of a multiplicative model to estimate catch rate and effort from commercial data. Can. J. Fish. Aquat. Sci. 37:2272-2275.

Gavaris, S., and C. A. Gavaris. 1983. Estimation of catch at age and its variance for groundfish stocks in the Newfoundland region, p. 178-182. In W. G. Doubleday and D. Rivard [ed.]. Sampling commercial catches of marine fish and invertebrates. Can. Spec. Publ. Fish. Aquat. Sci. 66.

Table 1a. Nominal catches (t) of redfish in Division 3Ø by country and year.

Country	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989[a]	1990[a]	1991
Canada (M)[b]	381	1,557	565	417	47	4	29	48	5	24	5	18	26	-
Canada (N)	1,460	4,847	976	2,160	444	3	138	56	136	159	176	9	128	-
France (M)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France (SP)	-	-	-	-	-	-	-	-	-	-	-	-	-	-
France	-	-	-	-	-	2	-	-	-	-	-	-	-	-
Japan	3	2	-	-	496	1	1,258	661	1,162	1,074	1,606	1,724	1,405	-
Portugal	-	134	59	-	5	-	-	-	-	-	22	12	-	-
Romania	-	664	-	-	-	-	-	-	-	-	-	-	-	-
Spain	1	8	-	-	-	-	25	630	45	26	4	-	-	-
USSR	4,647	8,008	14,219	8,659	8,717	5,670	7,262	5,905	6,099	7,152	4,921	4,517	3,870	-
Cuba	368	2,517	1,487	1,368	1,651	1,460	1,316	806	3,006	2,859	2,753	2,138	2,745	-
USA	-	-	-	-	-	-	-	104	2	-	-	-	-	-
Korea(S)	-	-	-	-	-	-	-	-	-	1,726	1,805	-	-	-
EEC	-	-	-	-	-	-	-	-	-	-	-	-	436	-
Total	6,860	17,737	17,306	12,604	11,360	7,140	10,028	8,210	10,455	13,020	11,292	8,418	8,610	-
TAC	20,000	20,000	21,900	20,000	20,000	20,000	20,000	20,000	20,000	20,000	14,000	14,000	14,000	14,000

[a]Provisional.
[b]Maritimes and Quebec were combined prior to 1979.

Table 1b. Surveillance estimates of redfish caught in Div. 30 from 1983 to 1990.

COUNTRY	1983		1984		1985		1986		1987	
	EST	REP	EST	REP	EST	REP	EST	REP	EST	REP
Cuba	1694	1460	1327	1316	710	806	1555	3006	3624	2859
Japan	--	--	1242	1258	660	661	1172	1162	2220	1074
Portugal	--	--	658	--	4630	--	600	--	233	--
Spain	--	--	15	25	226	630	70	45	55	26
USSR	2459	5670	13546	7262	5847	5905	4500	6099	9104	7152
Panama	--	--	--	--	375	--	--	--	10371	--
Caymen I.	--	--	--	--	--	--	--	--	800	--
St. Vinc.	--	--	--	--	--	--	--	--	--	--
S. Korea	--	--	--	--	--	--	--	--	--	--

countries who are not members of NAFO and fish in the regulatory area

COUNTRY	1988		1990	
	EST	REP	EST	REP
Cuba	4500	2753	3400	2745
Japan	1600	1606	1400	1405
Portugal	--	--	--	--
Spain	--	--	--	--
USSR	13160	4921	6600	3870
Panama	12000	--	--	--
Caymen I.	500	--	--	--
St. Vinc.	1000	--	--	--
S. Korea	--	1805	2700	--

EST=Estimated
REP=Reported
Estimates were not available for 1989

Table 2. Nominal catches (t) of redfish in Division 3Ø by month and year.

Year	Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1978	48	102	1,478	1,326	1,216	930	656	353	433	155	158	5	6,860
1979	35	844	2,464	2,072	87	1,997	739	692	1,235	1,320	3,594	2,658	17,737
1980	612	1,250	856	3,698	1,145	858	143	2,395	1,860	149	986	3,354	17,306
1981	991	3,735	1,444	1,601	621	1,467	773	584	510	873	5	-	12,604
1982	-	1	1,121	1,258	545	652	4,555	2,245	661	233	89	-	11,360
1983	254	355	2,904	1,227	71	156	576	938	319	1	73	266	7,140
1984	219	155	2	32	85	257	446	3,210	2,799	1,882	435	506	10,028
1985	1,522	-	453	239	118	252	227	1,710	1,486	350	35	1,817	8,210[a]
1986	707	-	427	593	69	710	3,491	3,712	58	1	319	368	10,455
1987	102	40	1,052	37	1,010	757	2,001	4,142	429	344	1,326	1,780	13,020
1988	15	1	493	684	915	1	1,755	3,922	1,286	1,057	915	248	11,292
1989[a]	-	13	15	2	662	1,185	1,143	3,305	2,090	-	-	3	8,418
1990[a]	-	-	72	31	1,131	2,470	1,294	1,008	941	817	614	210	8,610[b]

[a]Includes 1 t caught by USA in unknown month.
[b]Includes 22 t caught by EEC in unknown month.
[c]Provisional.

Table 3. Breakdown of catches by gear type for redfish in NAFO Div. 3Ø.

	Div. 3Ø				
Year	Bottom trawl	MW trawl	Gillnets	Misc	Total
1976	12,270	3,078	-	-	15,348
1977	10,427	423	-	-	10,850
1978	5,995	865	-	-	6,860
1979	15,670	2,067	-	-	17,737
1980	15,646	1,660	-	-	17,306
1981	9,991	2,613	-	-	12,604
1982	9,394	1,966	-	-	11,360
1983	5,217	1,923	-	-	7,140
1984	7,451	2,577	-	-	10,028
1985	4,431	3,778	-	1	8,210
1986	5,231	5,224	-	-	10,455
1987	8,601	4,419	-	-	13,020
1988	6,692	4,596	-	4	11,292
1989	4,388	4,030	-	-	8,418
1990					

Table 4 .Estimated numbers of redfish caught at age ('000) (including their average weight and length) from the commercial fishery in Division 30 in 1990.

	AVERAGE		CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
6	0.086	17.990	838	155.36	0.19
7	0.098	18.805	3366	251.01	0.07
8	0.141	21.260	2988	437.42	0.15
9	0.174	22.815	7233	734.30	0.10
10	0.193	23.611	9696	812.08	0.08
11	0.226	24.856	4959	590.80	0.12
12	0.247	25.669	3842	482.87	0.13
13	0.284	26.845	2266	294.54	0.13
14	0.310	27.599	1227	212.25	0.17
15	0.338	28.424	990	151.97	0.15
16	0.366	29.157	792	125.61	0.16
17	0.393	29.794	616	106.48	0.17
18	0.457	31.377	274	52.04	0.19
19	0.486	32.034	207	39.07	0.19
20	0.564	33.676	110	21.11	0.19
21	0.587	34.081	66	18.14	0.27
22	0.638	35.094	41	10.49	0.25
23	0.697	36.328	44	9.18	0.21
24	0.785	37.727	32	7.40	0.23
25	0.766	37.237	46	9.90	0.21
26	0.847	38.686	24	6.24	0.26
27	0.832	38.485	18	5.34	0.29
28	0.840	38.608	16	5.00	0.31
29	0.882	39.233	12	4.35	0.35
30	0.989	40.599	29	6.47	0.22

Table 5 .Estimated numbers of redfish caught at age ('000) (including their average weight and length) from the commercial fishery in Division 30 in 1989.

	AVERAGE		CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
4	0.050	15.000	29	29.40	1.01
5	0.052	15.217	112	33.33	0.30
6	0.079	17.536	368	92.94	0.25
7	0.101	18.987	811	173.20	0.21
8	0.128	20.585	2618	342.40	0.13
9	0.160	22.163	7180	609.90	0.08
10	0.179	23.017	9170	688.04	0.08
11	0.200	23.872	6168	600.70	0.10
12	0.235	25.232	3275	402.00	0.12
13	0.258	26.001	2221	316.81	0.14
14	0.283	26.797	1482	244.95	0.17
15	0.323	28.016	1181	204.74	0.17
16	0.358	28.916	1521	227.96	0.15
17	0.381	29.515	1297	211.65	0.16
18	0.434	30.779	516	139.85	0.27
19	0.478	31.756	320	101.08	0.32
20	0.510	32.491	438	109.17	0.25
21	0.552	33.257	85	41.91	0.50
22	0.637	35.052	47	25.10	0.54
23	0.561	33.528	101	50.94	0.51
24	0.651	35.235	25	18.28	0.74
25	0.845	38.711	4	2.27	0.54
26	0.899	39.350	3	1.21	0.41
27	0.678	35.671	31	20.03	0.64
28	0.834	39.000	1	1.11	1.11
29	0.714	37.000	1	0.73	1.20
30	0.772	38.000		0.54	1.38

Table 6. Estimated numbers of redfish caught at age ('000) in Division 3O, 1987-1990.

	1987	1988	1989	1990
4	0	15	29	0
5	24	43	112	0
6	701	38	368	838
7	8388	666	811	3366
8	19818	8415	2618	2988
9	13754	15739	7180	7233
10	3751	7266	9170	9696
11	2852	3714	6168	4959
12	2862	2787	3275	3842
13	2849	2489	2221	2266
14	2210	1664	1482	1227
15	1908	2008	1181	990
16	1173	1864	1521	792
17	947	1251	1297	616
18	522	610	516	274
19	402	501	320	207
20	192	656	438	110
21	130	238	85	66
22	67	208	47	41
23	26	71	101	44
24	49	57	25	32
25	47	26	4	46
26	34	20	3	24
27	12	20	31	18
28	0	17	1	16
29	11	7	1	12

Table 7. Estimated weight at age (kg.) of redfish caught in Division 30 from 1987-1990.

	1987	1988	1989	1990
4	0.000	0.050	0.050	0.000
5	0.056	0.050	0.052	0.000
6	0.090	0.079	0.079	0.086
7	0.120	0.117	0.101	0.098
8	0.144	0.150	0.128	0.141
9	0.184	0.181	0.160	0.174
10	0.212	0.202	0.179	0.193
11	0.235	0.240	0.200	0.226
12	0.258	0.270	0.235	0.247
13	0.277	0.288	0.258	0.284
14	0.313	0.322	0.283	0.310
15	0.354	0.339	0.323	0.338
16	0.378	0.383	0.358	0.366
17	0.403	0.399	0.381	0.393
18	0.436	0.450	0.434	0.457
19	0.464	0.487	0.478	0.486
20	0.521	0.477	0.510	0.564
21	0.521	0.561	0.552	0.587
22	0.610	0.573	0.637	0.638
23	0.578	0.624	0.561	0.697
24	0.579	0.671	0.651	0.785
25	0.623	0.768	0.845	0.766
26	0.672	0.743	0.899	0.847
27	0.634	0.808	0.678	0.832
28	0.000	0.922	0.834	0.840
29	0.581	0.850	0.714	0.882

Table 8. Anova table and regression coefficients from a multiplicative analysis of catch rate data with effort measured in hours fished.

REGRESSION OF MULTIPLICATIVE MODEL

MULTIPLE R..... 0.809
MULTIPLE R SQUARED..... 0.654

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	2.643E1	2.643E1	
REGRESSION	62	1.546E2	2.494E0	12.741
TYPE 1	17	5.963E1	3.508E0	17.921
TYPE 2	11	9.593E0	8.721E-1	4.456
TYPE 3	4	1.350E1	3.375E0	17.243
TYPE 4	30	1.033E1	3.445E-1	1.760
RESIDUALS	418	8.182E1	1.957E-1	
TOTAL	481	2.629E2		

Table 8. (continued)

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	20127	INTERCEPT	0.909	0.152	481
2	8				
4	95				
5	59				
1	2114	1	-0.941	0.135	20
	2125	2	-0.788	0.124	18
	3114	3	-1.003	0.081	78
	3125	4	-1.009	0.100	31
	4127	5	0.011	0.119	19
	4157	6	-0.124	0.108	25
	9114	7	-1.617	0.216	6
	14125	8	-0.428	0.213	5
	14126	9	-0.420	0.123	18
	14127	10	-0.334	0.103	29
	16127	11	-0.702	0.215	6
	20114	12	-1.497	0.148	14
	20126	13	-0.930	0.215	5
	20157	14	-0.075	0.080	52
	25126	15	-0.500	0.172	9
	25127	16	-0.058	0.164	10
	27125	17	-0.646	0.152	10
2	1	18	-0.286	0.137	14
	2	19	-0.376	0.126	18
	3	20	-0.205	0.098	35
	4	21	-0.570	0.103	29
	5	22	-0.097	0.094	39
	6	23	0.012	0.092	43
	7	24	-0.005	0.077	70
	9	25	-0.140	0.083	57
	10	26	-0.167	0.091	43
	11	27	-0.306	0.099	33
	12	28	-0.275	0.103	32
4	55	29	-0.669	0.099	32
	65	30	-0.431	0.087	41
	75	31	-0.306	0.081	43
	85	32	-0.310	0.059	94
5	60	33	0.178	0.286	3
	61	34	0.258	0.232	6
	62	35	0.045	0.191	11
	63	36	0.144	0.185	13
	64	37	0.262	0.232	6
	65	38	-0.042	0.249	5
	66	39	0.213	0.356	2
	67	40	0.366	0.213	7
	69	41	-0.221	0.205	9
	70	42	-0.065	0.198	10
	71	43	0.211	0.183	14
	72	44	-0.137	0.172	17
	73	45	0.166	0.204	9
	74	46	-0.266	0.204	9
	75	47	-0.338	0.225	6
	76	48	0.081	0.163	23
	77	49	0.002	0.162	23
	78	50	-0.151	0.158	24
	79	51	0.308	0.157	29
	80	52	0.179	0.160	26
	81	53	0.201	0.163	24
	82	54	0.299	0.163	25
	83	55	0.191	0.174	17
	84	56	0.139	0.163	25
	85	57	0.084	0.168	22
	86	58	0.035	0.178	18
	87	59	0.176	0.162	33
	88	60	0.048	0.166	28
	89	61	0.046	0.182	16
	90	62	0.448	0.213	8

Table 9. Standardized catch rate series from a multiplicative analysis of catch rate data using effort measured in hours fished.

PREDICTED CATCH RATE

YEAR	LN TRANSFORM MEAN	LN TRANSFORM S.E.	RETRANSFORMED MEAN	RETRANSFORMED S.E.	CATCH	EFFORT
1959	0.9091	0.0232	2.706	0.411	9268	3425
1960	1.0866	0.0758	3.148	0.851	5030	1598
1961	1.1675	0.0488	3.460	0.756	11394	3293
1962	0.9543	0.0297	2.822	0.483	7557	2678
1963	1.0532	0.0273	3.119	0.513	11807	3785
1964	1.1708	0.0469	3.474	0.744	20161	5803
1965	0.8671	0.0557	2.553	0.595	19791	7752
1966	1.1221	0.1170	3.195	1.063	15305	4790
1967	1.2751	0.0368	3.876	0.737	19037	4911
1969	0.6885	0.0314	2.162	0.381	15911	7361
1970	0.8445	0.0294	2.529	0.431	13221	5227
1971	1.1203	0.0229	3.343	0.504	19802	5923
1972	0.7719	0.0189	2.365	0.324	16117	6816
1973	1.0754	0.0275	3.189	0.526	8797	2759
1974	0.6429	0.0290	2.068	0.350	13124	6347
1975	0.5712	0.0416	1.913	0.387	15110	7900
1976	0.9900	0.0144	2.947	0.353	15348	5208
1977	0.9109	0.0158	2.721	0.341	10850	3987
1978	0.7581	0.0150	2.337	0.286	6860	2936
1979	1.2173	0.0141	3.700	0.439	17737	4794
1980	1.0883	0.0131	3.254	0.372	17306	5318
1981	1.1097	0.0141	3.323	0.394	12604	3793
1982	1.2079	0.0127	3.668	0.412	11360	3097
1983	1.0999	0.0170	3.285	0.427	7140	2173
1984	1.0479	0.0134	3.125	0.361	10028	3209
1985	0.9930	0.0155	2.955	0.367	8210	2779
1986	0.9444	0.0179	2.811	0.375	10455	3719
1987	1.0854	0.0131	3.245	0.371	13020	4013
1988	0.9571	0.0133	2.853	0.328	11292	3957
1989	0.9550	0.0186	2.840	0.386	8418	2964
1990	1.3575	0.0289	4.225	0.713	8610	2038

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.161

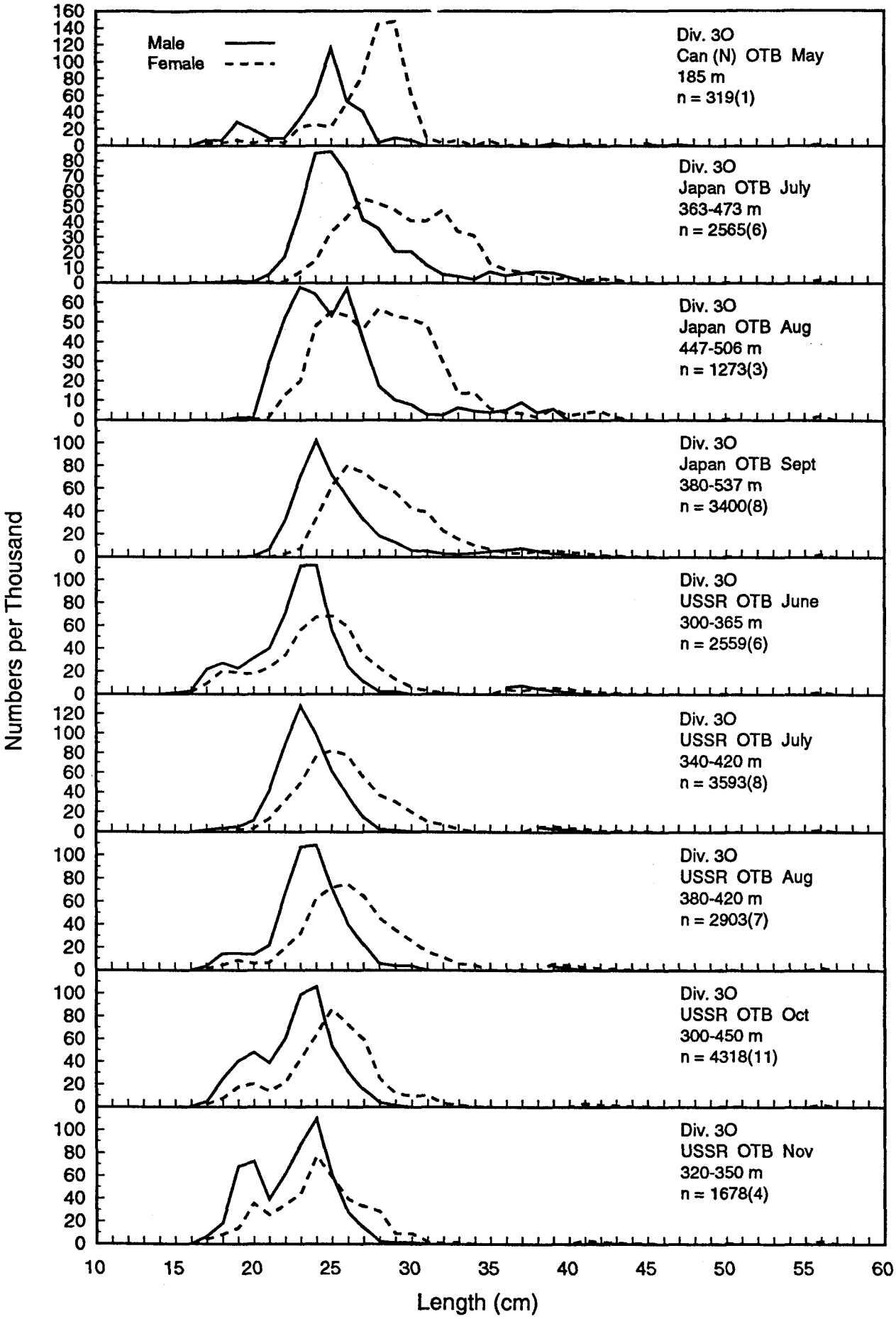


Figure 4: Commercial length frequencies from Div. 3O in 1990 (observer sampling).

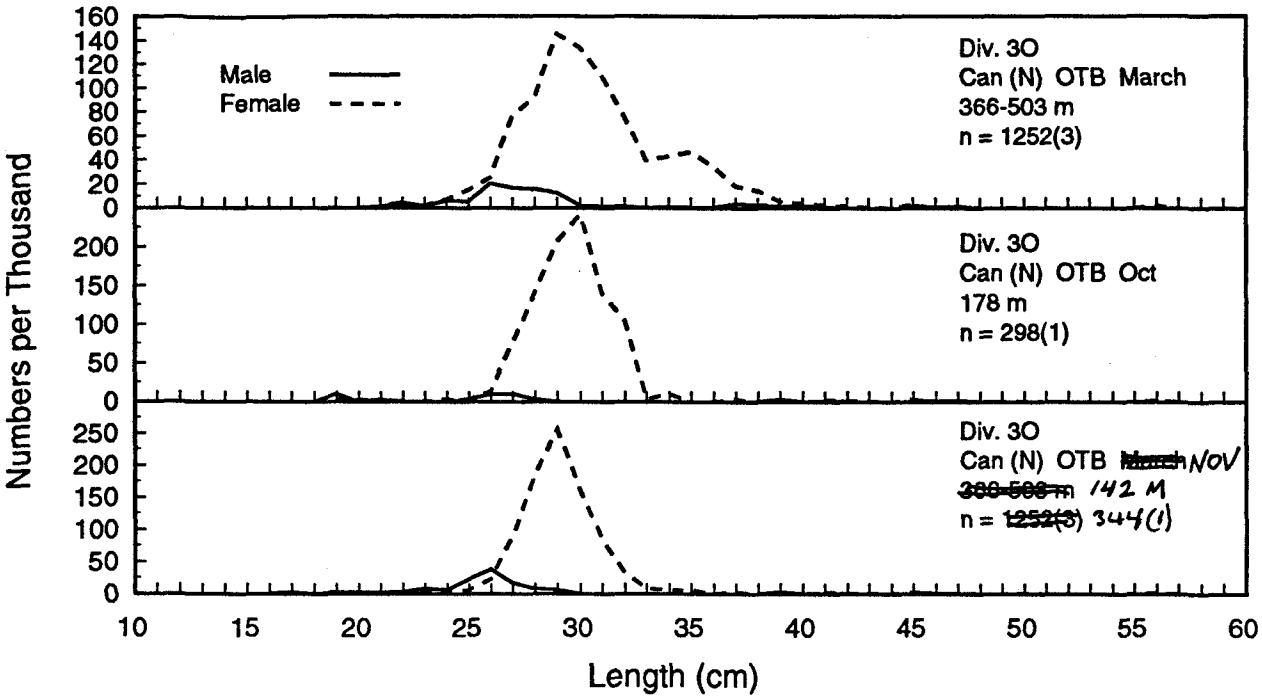


Figure 1b Commercial length frequencies from Div. 3O in 1990 (port sampling).

OTB/Q1/CAN(N)/MAR - 44	OTB/Q1 - 72	
OTB/Q2/CAN(N)/MAY - 4 OTB/Q2/USSR /JUN - 770	OTB/Q2 - 3632	
OTB/Q3/JPN /JUL - 276 OTB/Q3/USSR /JUL - 965 OTB/Q3/JPN /AUG - 188 OTB/Q3/USSR /AUG - 781 OTB/Q3/JPN /SEP - 783	OTB/Q3 - 3243	LF3Ø - 8610
OTB/Q4/CAN(N)/OCT - 10 OTB/Q4/USSR /OCT - 649 OTB/Q4/CAN(N)/NOV - 6 OTB/Q4/USSR /NOV - 530	OTB/Q4 - 1641	

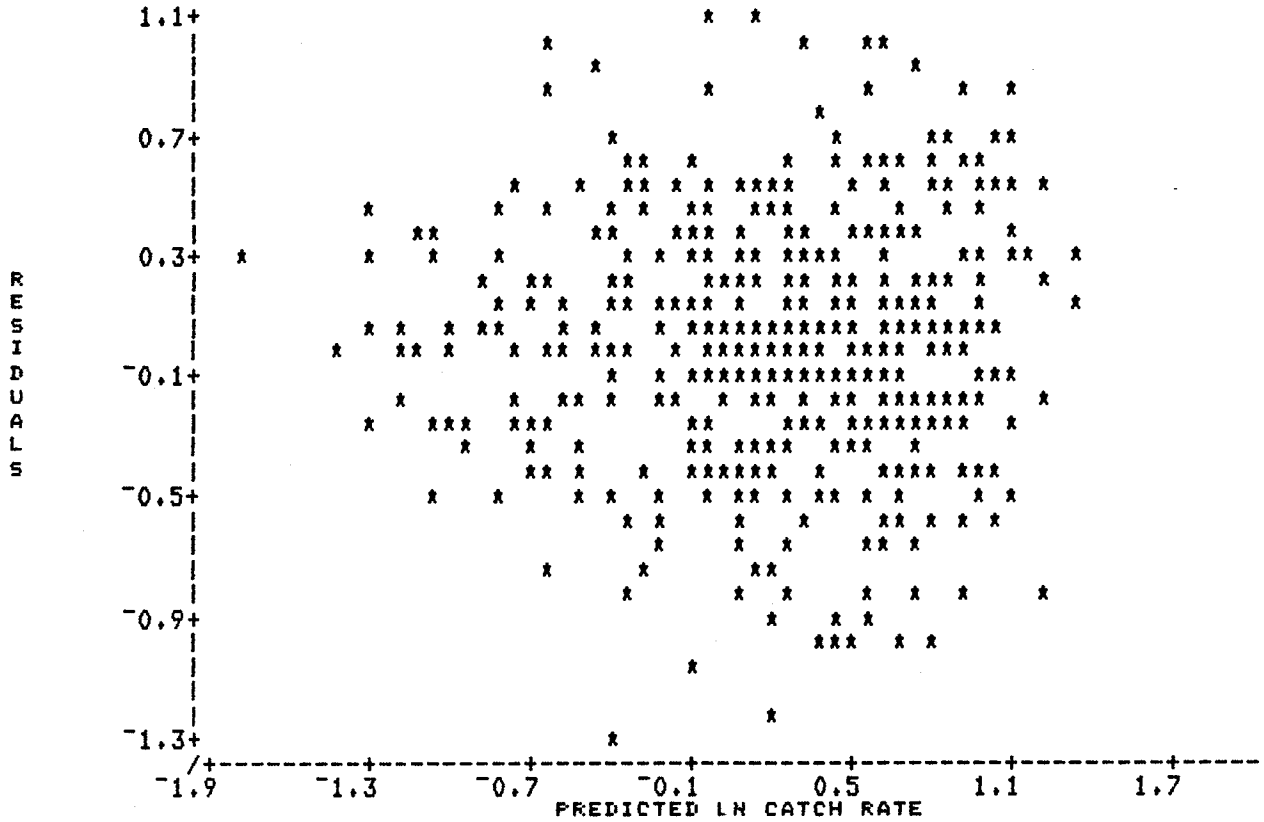
Legend: OTB = bottom otter trawl
Q = quarter of year
JPN = Japan
Can(N) = Newfoundland
USSR = Soviet Union

Fig. 2. Commercial frequencies available and the process of combining these with appropriate weightings to derive the estimated numbers of redfish caught at age in Div. 3Ø in 1990.

OTB/Q2/USSR/JUN - 615	OTB/Q2 - 1280	
		LF3Ø - 8418
OTB/Q3/JPN /JUL - 99 OTB/Q3/JPN /AUG - 646 OTB/Q3/JPN /SEP - 979 OTB/Q3/USSR/AUG - 404 OTB/Q3/USSR/SEP - 528	OTB/Q3 - 3077	

Legend: OTB = bottom otter trawl
Q = quarter of year
JPN = Japan
USSR = Soviet Union

Fig. 3. Commercial frequencies available and the process of combining these with appropriate weightings to derive the estimated numbers of redfish caught at age in Div. 3Ø in 1989.



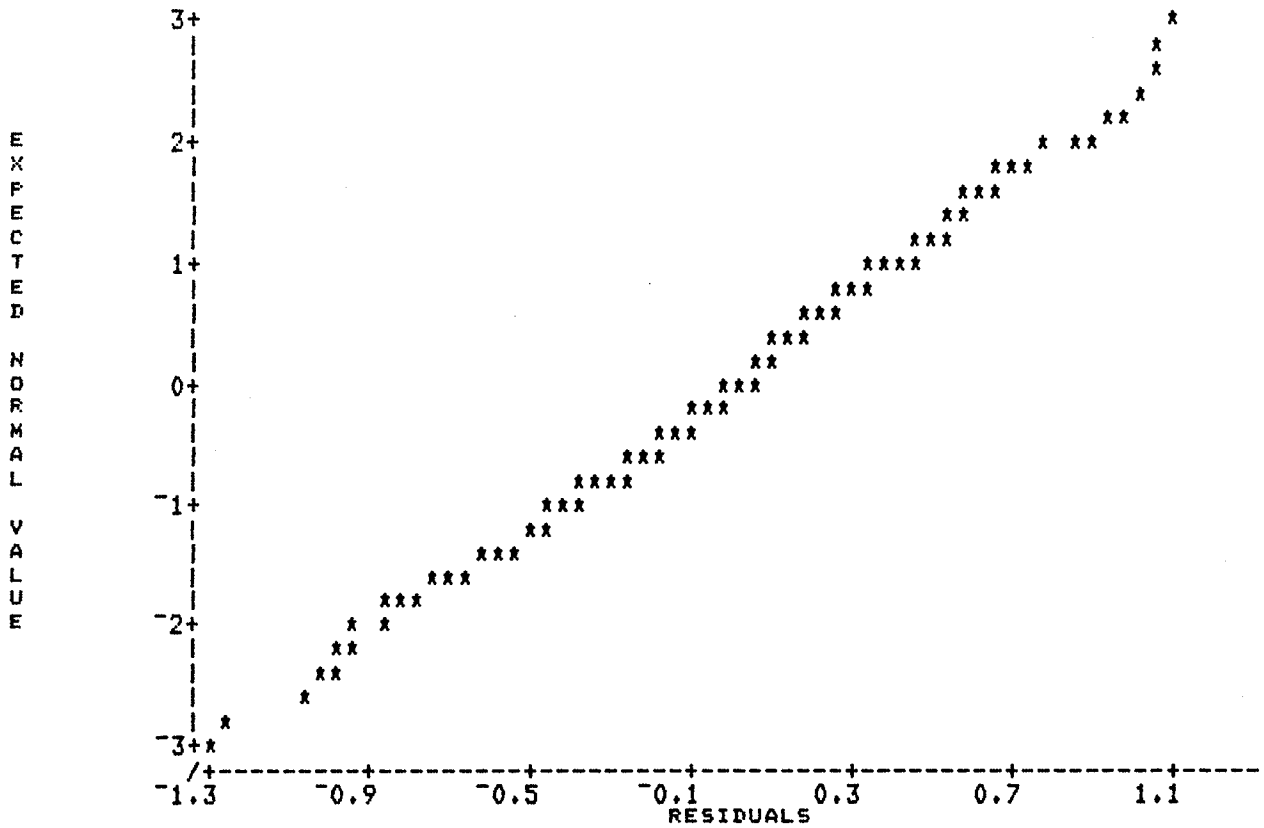


Fig. 4. Residual plots from a multiplicative analysis of catch rate data with effort measured in hours fished.

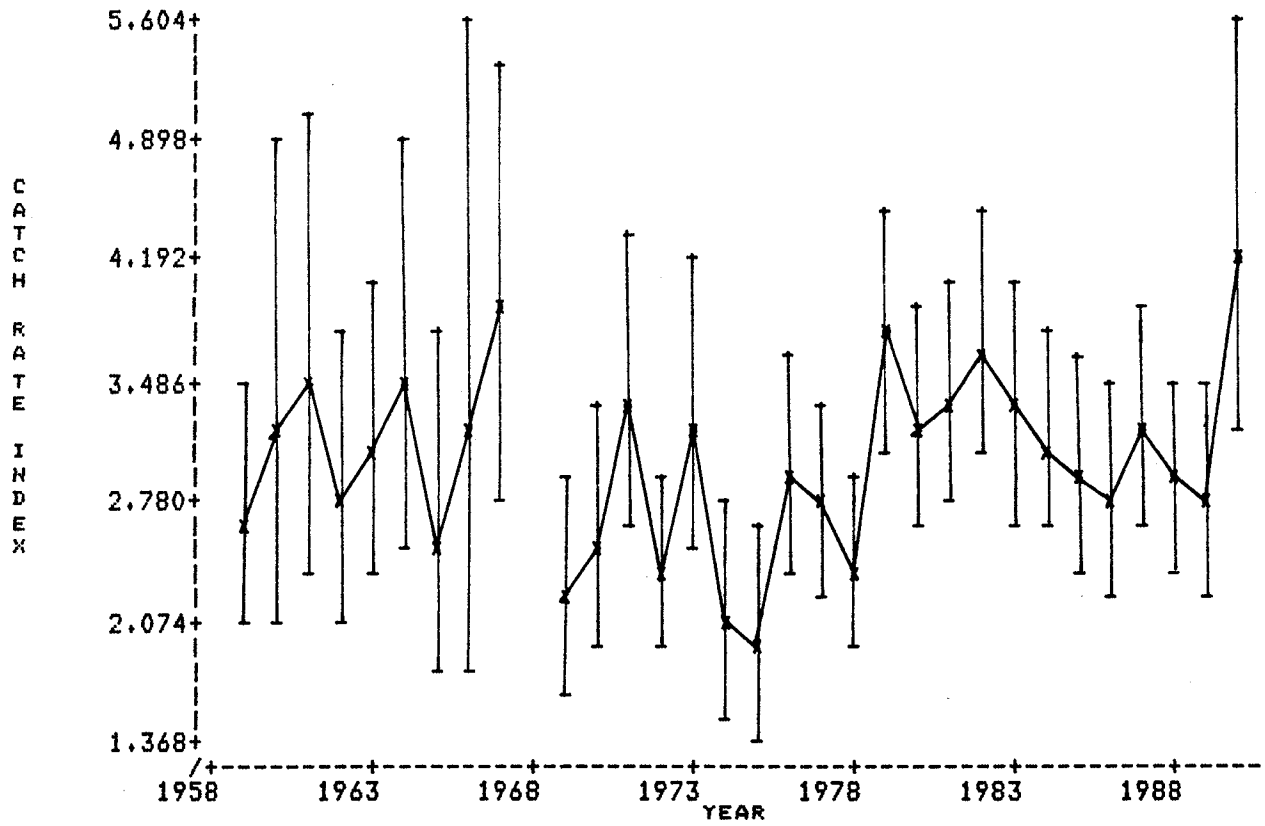


Fig. 5. Standardized catch rate series from a multiplicative analysis of catch rate data with effort measured in hours fished.

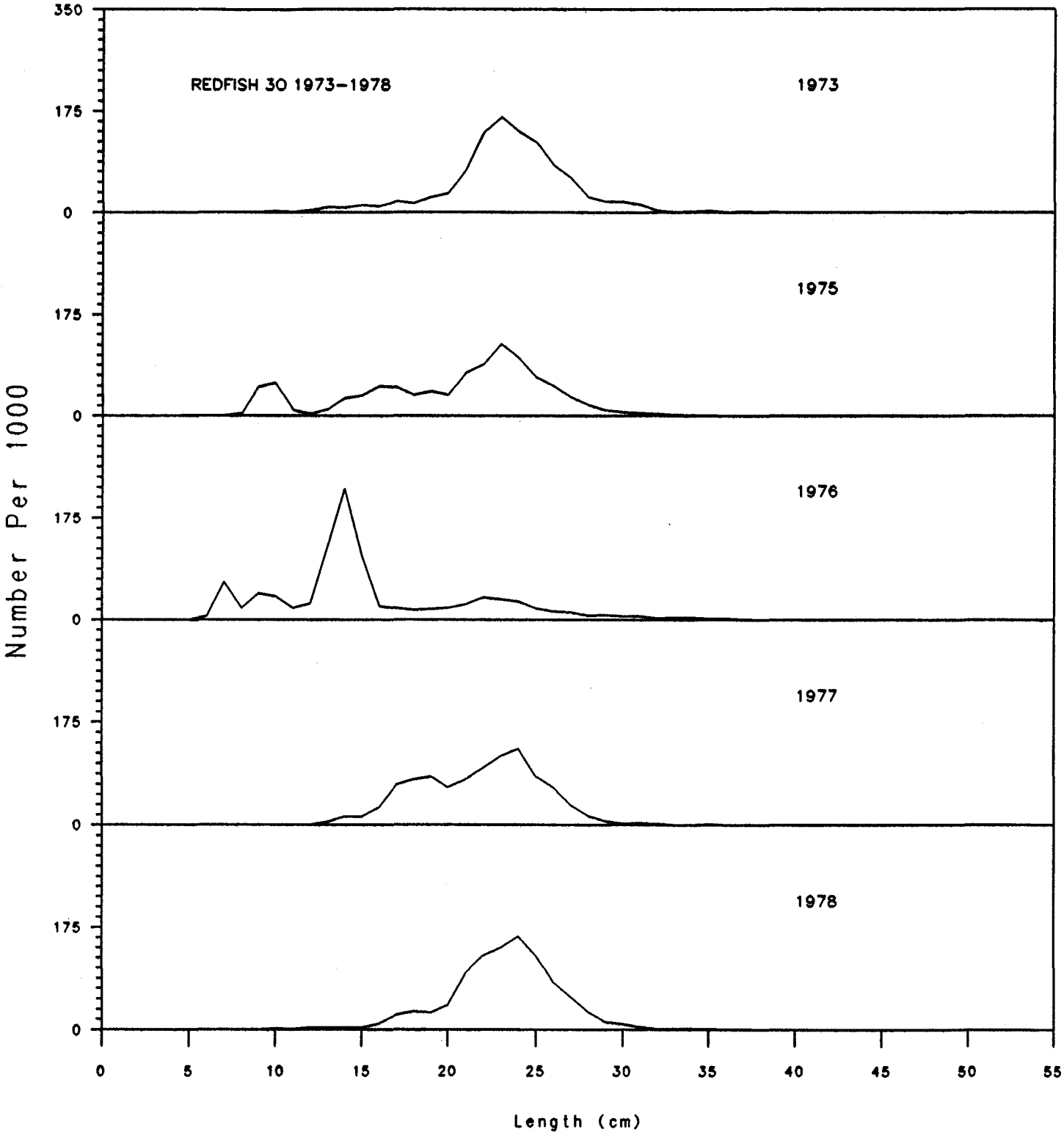


Figure 6. Redfish length distribution from stratified random research surveys conducted in the spring in Div. 30 for the years 1973-1978.

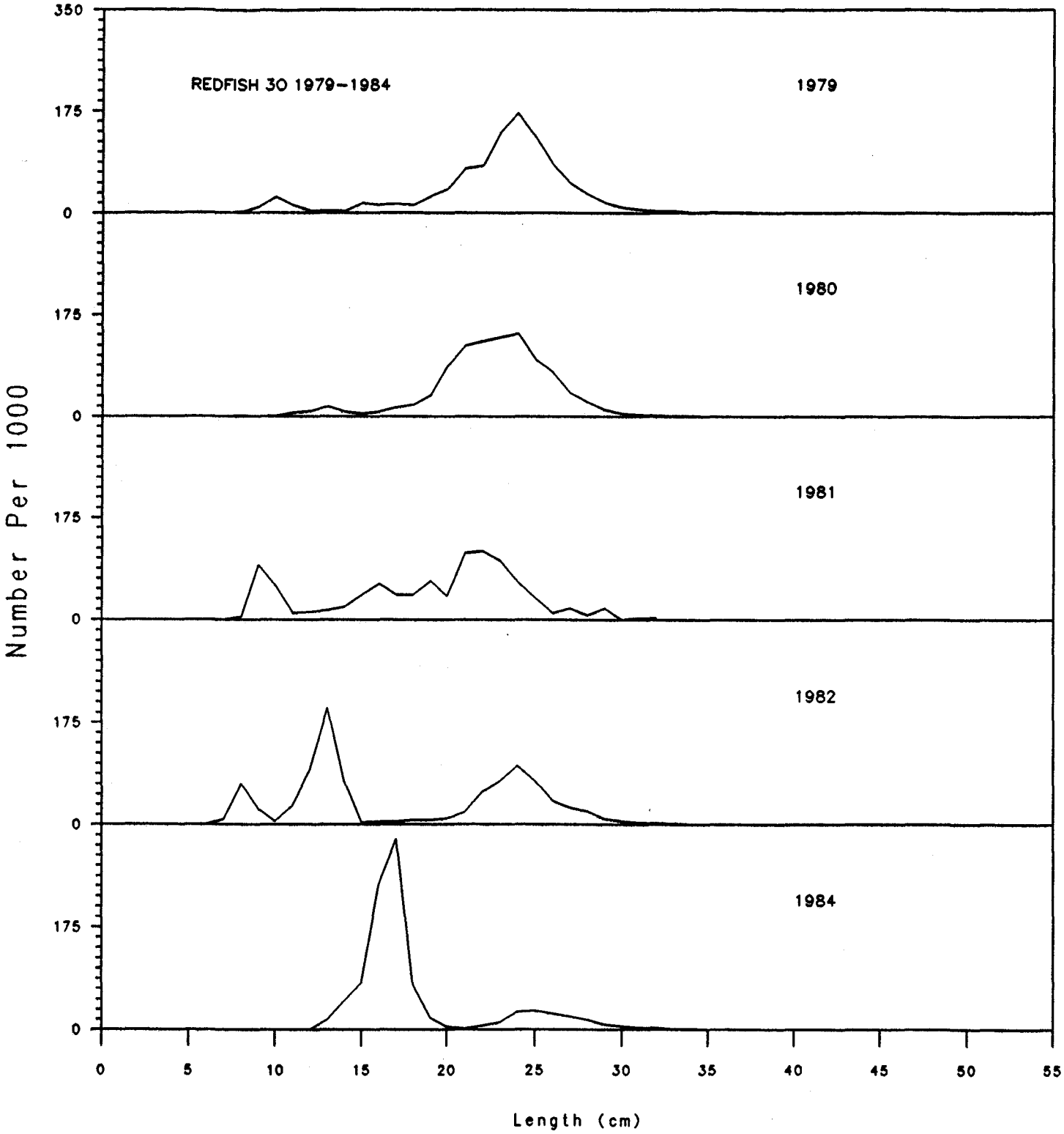


Figure 7. Redfish length distribution from stratified random research surveys conducted in the spring in Div. 30 for the years 1979-1984.

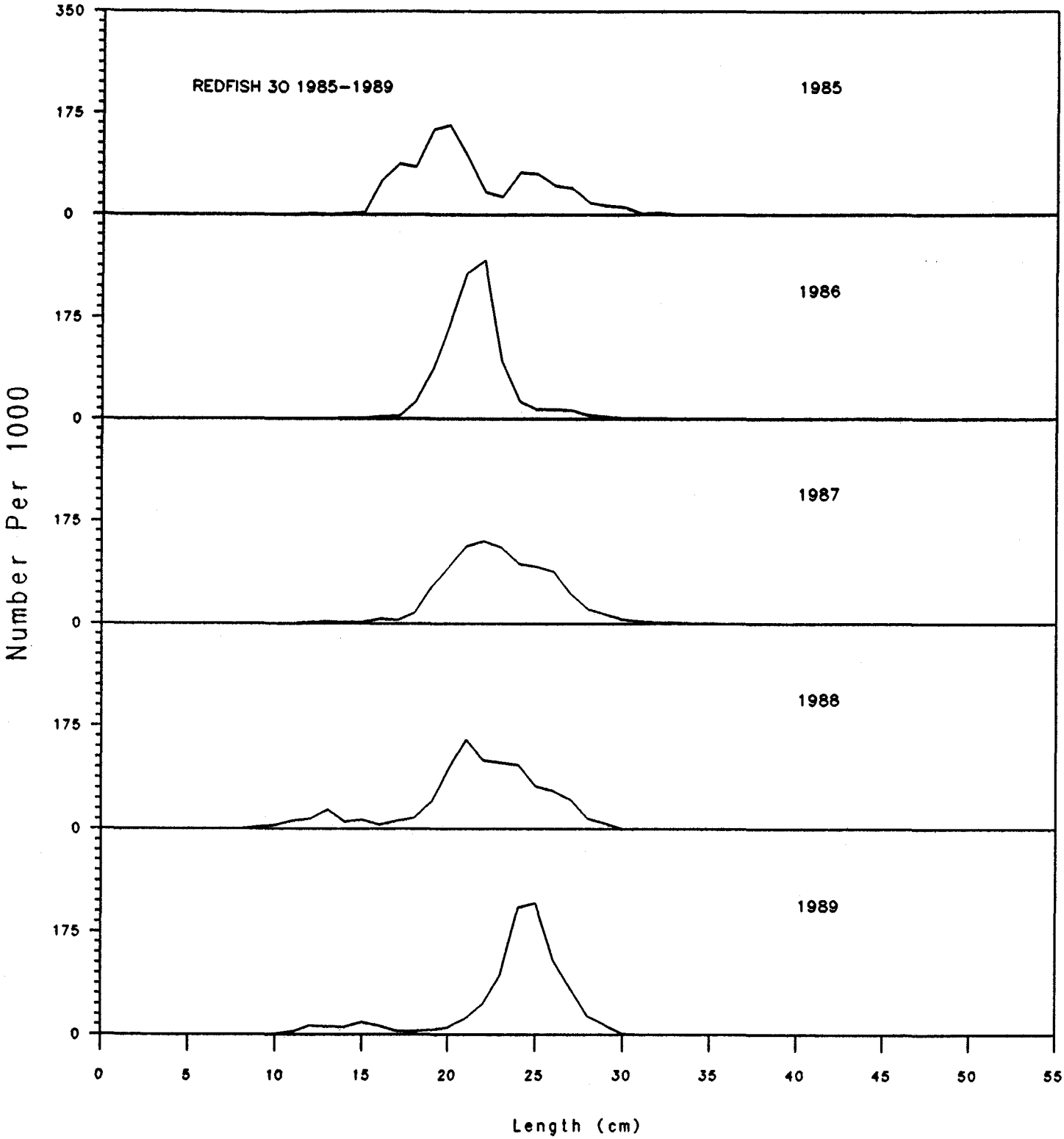


Figure 8. Redfish length distribution from stratified random research surveys conducted in the spring in Div. 30 for the years 1985-1989.

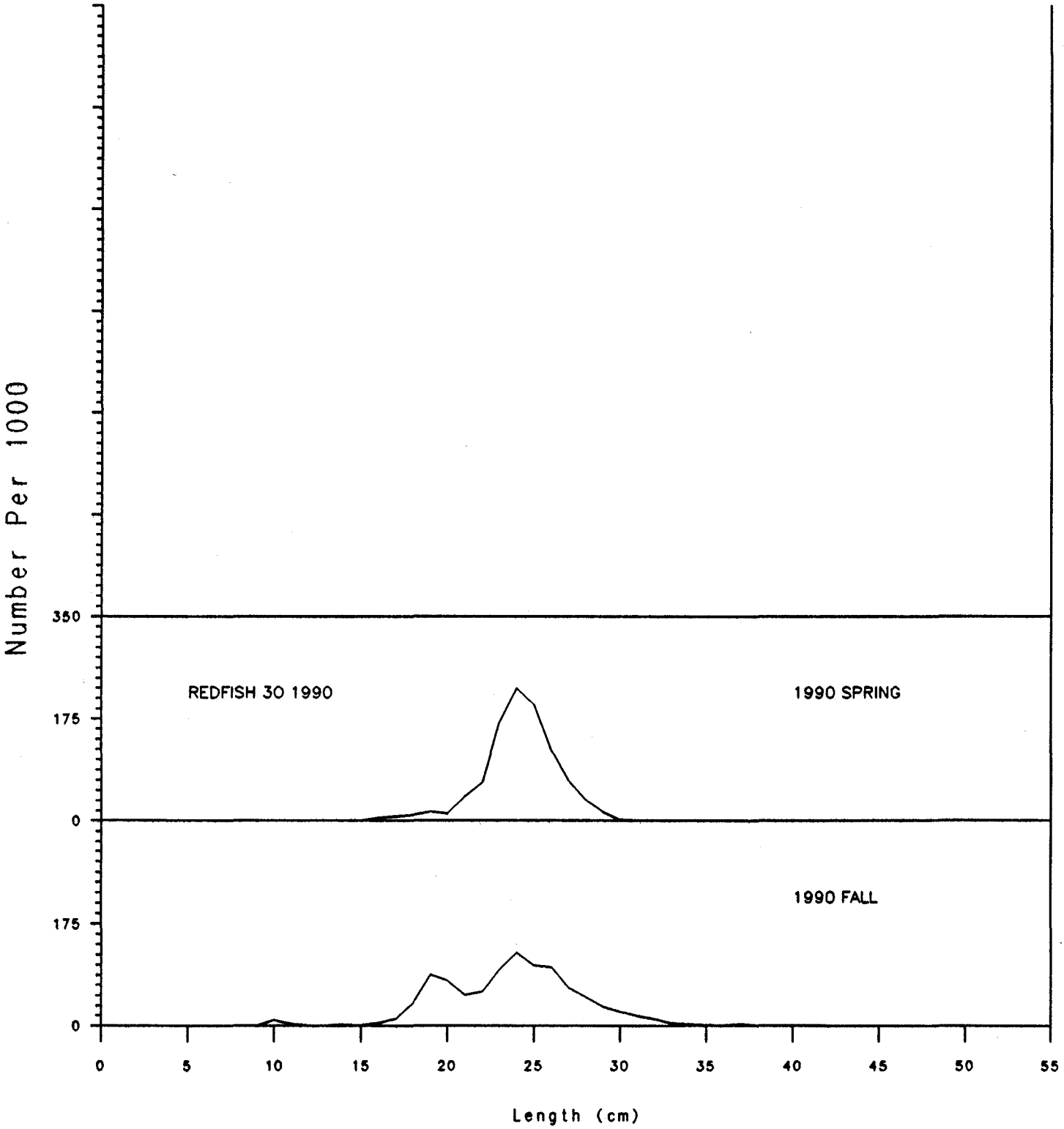


Figure 9. Redfish length distribution from stratified random research surveys conducted in the spring and fall in Div 30 in 1990.