Some analyses of data for redfish off the south coast of Newfoundland (NAFO Div. 3P/4V)

by

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Abstract

The nominal catch increased slightly from about 9300 t in 1988 to just under 10,000 t in 1989. Although the catch by Nfld. vessels was down from 1988, that of Maritimes vessels was up considerably, particularly in Subdiv. 3Pn. About 50 % of the total landings from Subdiv. 3Pn were taken in April and May, whereas fishing was relatively steady in 3Ps throughout the year. Contouring analyses of acoustic research survey data from 1989 supported last year's conclusion that distribution of redfish is continuous across the channel area of 3P/4V and separation of stocks along NAFO boundaries is not appropriate. Acoustic estimates of biomass in the Div. 3P area for 1988 and 1989 were about 225,000 t, considerably higher than trawling estimates used in 1989 as the basis for a TAC of 10,000 t. Because of these differences, as well as questions concerning the appropriateness of applying relationships between general production analysis and summer trawl estimates to trawling surveys made in the winter, CAFSAC concluded that the rational for a TAC of 10,000 t could not be substantiated. Instead, it is not possible to provide advice concerning an appropriate catch level at this time.

RÉSUMÉ

Les prises nominales ont augmenté légèrement : elles sont passées d'environ 9 300 t en 1988 à juste un peu moins de 10 000 t en 1989. Bien que les prises des navires de Terre-Neuve aient diminué par rapport à 1988, celles des navires des Maritimes ont augmenté considérablement, surtout dans la sous-division 3Pn. Dans cette sous-division, la pêche pratiquée en avril et en mai a donné lieu à environ la moitié des débarquements totaux, tandis que dans la sous-division 3Ps, la pêche a été relativement stable durant toute l'année. Une analyse de délimitation réalisée à partir des données des relevées acoustiques de recherche de 1989 vient appuyer la même conclusion que l'an dernier, à savoir que la distribution du sébaste atlantique est continue d'un bout à l'autre dans la région du chenal dans les divisions 3P/4V et que la séparation des stocks le long des limites de l'OPANO n'est pas appropriée. Les évaluations à partir des relevés acoustiques de la biomasse dans la division 3P pour 1988 et 1989 étaient d'environ 225 000 t, ce qui est beaucoup plus que les évaluations établies à partir des données de chalutage utilisées en 1989 et qui ont servi à établir un TPA de 10 000 t. A cause de ces différences et à cause des doutes quant au bien-fondé d'appliquer les relations entre l'analyse de production générale et les évaluations du chalutage d'été aux relevés par chalutage réalisés en hiver, le CSCPCA a conclu qu'on ne pouvait démontrer le bien-fondé d'un TPA de 10 000 t. Il conclut plutôt que pour le moment il n'est pas possible d'émettre un avis sur le niveau approprié des prises.

Introduction

Nominal catches from Div. 3P have ranged between about 3,600 t (1985) and 37,000 t (1970) (Table 1, Fig. 1). The majority of the catch was taken in Subdiv. 3Ps during the mid-60's to late-70's, a period corresponding to that when the largest overall catches were taken. Catches from Subdiv. 3Ps have been below 4,000 t since 1982.

Catches by Maritime vessels increased dramatically beginning in 1986, and most of the increased effort was concentrated in Subdiv. 3Pn (Table 2). During the 1980's, Newfoundland vessels took approximately equal amounts from both subdivisions.

Landings from Subdiv. 3Pn ranged between about 2,000-4,000 t over the history of the fishery but increased in 1988 and 1989 due to increased effort in the area during the first half of the year (Table 3a). Landings from Subdiv. 3Ps are usually spread more evenly throughout the year (Table 3b).

In both subdivisions, most of the catch is taken by bottom trawls, although substantial amounts are caught in Subdiv. 3Ps using gillnets and long lines (Table 4). In recent years, most of the catch from Subdiv. 3Pn has been taken with midwater trawls.

Materials and Methods

i) Commercial Catch and Effort

Catch and effort data for the 1959-1986 period were extracted from ICNAF/NAFO Statistical Bulletins in the usual manner. They were combined with preliminary data from NAFO for 1987 and 1988, and preliminary data from Canada for 1989. As in the past, only catches where redfish comprised >50% of the total were used. An additional category type, redfish catch as percent total catch (still using only catches where redfish comprised >50% of the total), was included again this year. In 1989, CAFSAC recommended that the impact of the inclusion of this new category be investigated. As such, multiplicative analyses (Gavaris 1980) were carried out for Div. 3P both with, and without this category, and the results compared.

Since the issue of an appropriate 'stock' definition for redfish in the 3P, 4RST, 4V areas has not been resolved, the use of catch rates as an index of stock abundance is still not considered appropriate.

ii) Commercial Catch-at-age

A total of 9 commercial length frequencies were available from the fishery in 1989 (Fig. 2). These were combined (Table 5) to derive estimates of the numbers caught-at-age as well as the mean lengths and weights-at-age (Gavaris and Gavaris 1983). The weight/length relationships used to calculate the mean weight-at-age are:

$$WT_{males} = 0.01659\ FL^{2.9548}$$

$$WT_{females} = 0.01372\ FL^{3.0210}$$

iii) Research Trawling Surveys

Stratified random trawling surveys have been conducted in Div. 3P by the Newfoundland Region since 1973. The most recent survey was conducted if Feb., 1990. In the past, the multiplicative model has been used to estimate mean values (numbers and weights) for missing strata (eg. Atkinson and Power, MS 1989), but prior to 1980, Subdiv. 3Pn was not surveyed and the estimates for these strata changed considerably from one year to the next. In 1989, CAFSAC examined estimated biomass for

1980 onwards only. Because of these, the multiplicative analyses were carried out this year including only survey data from 1980 to the present.

iv) Research Acoustic Surveys

Acoustic surveys for redfish were started in Div. 3P in 1986. Because of technical difficulties, the results for the first two years were not considered usable for assessment purposes. In 1989, the survey coverage was expanded to include all of the channel in the 3P/4V area. For both surveys, all depths >200 m were covered.

Acoustic data were collected using a custom hydroacoustic data acquisition system (HYDAS) (Stevens, 1986). Included in the system is a 49 kHz SIMRAD EK400 sounder and a 5 kw transmitter. Sampling is at a rate of 15 kHz with data being stored to 9 track tape for subsequent analyses.

The transducer is mounted in a torpedo shaped 'towed body', with total weight of about 150 kg. It is typically towed off the starboard side of the vessel at a depth of about 100 m. Sampling begins at a time corresponding to a depth of 5 m below the transducer face. During the surveys, RMS (root mean square) voltage levels are squared, averaged over 1 m depth intervals, then accumulated over 10 min. time intervals.

Prior to final analysis, the data were examined visually using a custom data editor, HYED (HYDAS editing system), to eliminate any echoes not considered to be fish. These included winch noise (during slacking/retrieval of cable), occasional whale noise, and shadowing which occurs with rapid depth changes.

The density for each cubic metre (λ) at any given depth (R) is then calculated as:

$$\lambda = V_R^2 \left(\frac{1}{r_x^2 \, p_o^2 \, \bar{b}_2 \, (\frac{\bar{\sigma}}{4\pi}) \, c\pi \, TG_o^2} \right)$$

where:

- V_R^2 is the average RMS voltage at depth R
- r_x is the receiving sensitivity of the transducer
- p_o is the RMS pressure level
- $\bar{b}_2$ is the average beam pattern factor
- $(\frac{\bar{\sigma}}{4\pi})$ is the target strength
- c is the speed of sound in sea water
- T is the pulse length of the sound pulse
- G_o^2 is the fixed gain of the echo sounder system

Estimated densities per cubic metre for each of the 1 metre depth layers to the bottom (all analyses were done using a 1 m bottom offset) were then summed to provide an estimate of the density per square metre of surface area. All of these calculations are presently done on an HP 1000.

The survey area (Div. 3P) was divided into blocks prior to the 1988 survey (Fig. 3a). The selection of blocks was based on general redfish distribution as determined from examination of the distribution of trawl catches of redfish during the 1980's. Transects within each block were of equal length and followed a zig-zag pattern. In 1989, these blocks were modified somewhat (Fig. 3b), both to

accommodate the expanded area of coverage, and to allow for implementation of the parallel transect strategy recommended by CAFSAC (O'Boyle and Atkinson, 1989).

Atkinson (1982) reported use of a target strength (TS) of -33 dB/kg for redfish surveys in the Northwest Atlantic. Since that time, others (pers. comm. R. Keiser, Pacific Biological Station, and D. Miller, Northwest Atlantic Fisheries Centre) have selected a TS of -34 dB/kg for Pacific ocean perch and capelin respectively, and data from Hylen *et al.* (1989) indicated a TS for redfish of about -33.5 dB/kg. For analysis of the 1988 and 1989 data, a TS of -34 dB/kg was used.

During the acoustic surveys, limited time was available for trawling. Fishing sets (bottom trawl) were made both were fish concentrations were located, and in areas where few or no fish were seen. Midwater trawling was also carried out, but these sets were unsuccessful due to technical problems. Generally, the number of fishing sets was inadequate to determine reasonably either the species mix or the population structure of redfish (Fig. 4). Examination of the trawling results for the two years however, did indicate that in depths below about 300 m, redfish constituted almost 100% of the catches (Table 6). In instances when they did not, the main by-catch was black dogfish, a species without a swim bladder and hence a relatively low acoustic echo.

Because of the above observation, the data were analysed under three different scenarios. First, analysis was carried out assuming 100% of the insonified targets were redfish. Secondly, it was assumed that in depths between 200 and 300 m (100 to 200 m below the towed body since it was towed at an approximate depth of 100 m below the surface) only 50% of the targets were redfish. Last, it was assumed that none of the targets between 200 and 300 m were redfish. This last scenario results in the most conservative estimate.

Biomass estimates were obtained for both years following the procedures outlined by O'Boyle and Atkinson (1989), although strictly speaking this is not correct (biased variance but unbiased mean) for the zig-zag pattern used in 1988. Estimates of biomass for divisions 3P and 4V combined and separate were obtained from the 1989 survey.

Results and Discussion

i) Commercial Catch and Effort

The results of the multiplicative analyses for Div. 3P alone, with and without the additional percent category (Tables 7 and 8, Figure 5, 6 and 7), indicate that addition of this category does not alter the trend in the catch rates over time. Instead, an extra 6% of the variation in the data is explained, and the standardized catch rates are almost identical, not even being different by a scaling factor. This is not surprising given that over 70% of the data have redfish as >90% of the total catch. Because the addition of the percent category did not alter the catch rate trends, but only improved the relationships, subsequent analyses were carried out including this category. As noted above, these indices are not considered representative of trends in stock status.

ii) Commercial Catch-at-age

The estimated catch-at-age in 1989 (Table 9) indicates that fish aged 9-14 dominated in the catch, with other peaks at ages 18 and 20. The catch- and weight-at-age matrices from 1973 are shown in Table 10.

iii) Research Trawling Surveys

The results of the stratified random surveys from 1980 to 1990 (Table 11, Fig. 8) suggest an increasing trend in biomass since about 1984. Stratified mean numbers at length from the 1990 survey are shown in Fig. 9.

iv) Research Acoustic Surveys

Calibration parameters for the two surveys are listed in Table 12. Distribution of the densities from the acoustic surveys in both years (Fig. 10 and 11) gives support to the premise that Div. 3P and 4V redfish should not be managed separately, as it is obvious that densities are continuous across the boundary between the two. The detailed results of these surveys (Tables 13 - 15) indicate that the coefficients of variation associated with the 1989 survey are very small. It must be remembered however, that these C.V.'s pertain to survey design only (same as STRAP), and one transect is analogous to a fishing tow. There was considerable within transect variation as illustrated in the examples in Table 16.

The resultant biomass estimates can be summarized as follows:

Area/Year	Assume 100 %	Assume 50 %	Assume 0%
3P, 1988	221,192	207,892	194,591
3P, 1989	270,306	249,834	229,361
3P4V, 1989	389,688	360,557	332,739
4V, 1989	119,382	110,723	103,738

In Div. 3P in 1988 and 1989, 88 and 85% of the biomass respectively was found in depths > 300 m, while in 1989, 85% of the estimated 3P4V biomass was found > 300 m. These observations are not surprising given that the area with depths of 200 - 300 m is relatively small compared to that of deeper waters.

We feel that the assumption of 50% of the biomass in 200 - 300 m being redfish is reasonable, and thus the estimated biomass of redfish in Div. 3P in 1988 and 1989 is about 225,000 t. This estimate is about double that from the trawl surveys for the same two years. A higher estimate from the acoustic surveys is not unexpected because not only is the catchability of the trawl no longer a factor, but also because acoustics accounts for fish distributed in the area above the trawl opening.

In 1988, a reference catch of 10,000 t was obtained by applying an arbitrary exploitation rate of 15 % (approximating $F_{0.1}$) to the mean trawlable biomass estimated from surveys conducted from 1980-1989. This was considered reasonable since for Div. 4RST redfish there was a one-to-one relationship between trawlable biomass as estimated from surveys, and exploitable biomass from a non-equilibrium general production model.

Further considerations have cast doubts on this approach. It appears that the biomass of redfish in the area has been gradually increasing in the 1980's and therefore using the 10 year average from surveys may not be appropriate. The comparisons between survey results and results from production analysis in Div. 4RST were made using the results of summer surveys, whereas trawl surveys in Div. 3P are conducted in the winter. Changes in fish distribution in the water column from one time of the year to another would invalidate the comparisons. The Div. 3P commercial fishery that takes place at about the same time as the trawl survey is primarily prosecuted with midwater trawl. This suggests that the fishery is carried out on a portion of the stock not surveyed by bottom trawl, and that significant amounts of redfish are up in the water column at this time of year. Finally, the considerable differences in estimates from trawling and acoustics suggest that the rationale is inappropriate.

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Table 1: Summary of nominal catches (t) of redfish in Division 3P.

Year	3Pn	3Ps	Total	TAC
1959	9	3,774	3,783	
1960	14	9,211	9,225	
1961	1,060	8,340	9,400	
1962	2,132	11,306	13,438	
1963	2,597	11,150	13,747	
1964	4,688	9,119	13,807	
1965	8,802	9,931	18,733	
1966	4,325	16,543	20,868	
1967	4,526	28,465	32,991	
1968	2,642	11,242	13,884	
1969	3,324	28,727	32,051	
1970	3,689	33,581	37,270	
1971	966	26,534	27,500	
1972	639	25,398	26,037	
1973	3,654	14,714	18,368	
1974	4,264	17,894	22,158	25,000
1975	8,100	20,150	28,250	25,000
1976	5,932	13,235	19,167	18,000
1977	2,485	14,678	17,163	18,000
1978	3,042	12,203	15,245	18,000
1979	3,160	6,459	9,619	16,000
1980	2,372	5,192	7,564	18,000
1981	4,256	4,685	8,941	18,000
1982	3,820	2,090	5,910	18,000
1983	2,929	2,996	5,925	18,000
1984	2,396	2,005	4,401	18,000
1985	1,788	1,854	3,642	18,000
1986	3,498	3,651	7,149	18,000
1987*	4,582	2,169	6,751	18,000
1988*	6,963	2,296	9,259	15,000
1989*	7,259	2,733	9,992	15,000
1990				10,000

* Provisional.

Table 2a: Nominal catches (t) of redfish in Division 3Pn by country and year.

Country	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987*	1988*	1989*
Canada (M)+	743	37	30	108	311	540	860	391	2,063	3,031	3,689	5,887
Canada (N)	2,266	2,676	2,154	3,749	3,508	2,385	1,536	1,187	1,356	1,490	3,218	1,372
Canada (Q)	-	384	165	387	-	-	-	-	75	48	56	-
France (M)	1	1	-	11	-	-	-	-	2	-	-	-
France (SP)	32	62	23	1	1	-	-	-	2	13	-	-
France	-	-	-	-	-	4	-	-	-	-	-	-
TOTAL	3,042	3,160	2,372	4,256	3,820	2,929	2,396	1,578	3,498	4,582	6,963	7,259

* Provisional.

\+ Maritimes and Quebec were combined prior to 1979.

Table 2b: Nominal catches (t) of redfish in Division 3Ps by country and year.

Country	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987*	1988*	1989*
Canada (M)+	2,592	970	360	391	515	670	396	313	606	421	770	984
Canada (N)	9,282	5,119	4,609	4,123	1,553	2,316	1,608	1,429	2,915	1,645	1,417	1,749
Canada (Q)	-	248	-	-	-	-	-	-	88	-	-	-
France (M)	14	21	112	124	5	-	-	12	-	67	95	-
France (SP)	315	101	111	47	17	-	-	-	42	36	14	-
France	-	-	-	-	-	10	1	-	-	-	-	-
TOTAL	12,203	6,459	5,192	4,685	2,090	2,996	2,005	1,754	3,651	2,169	2,296	2,733

* Provisional.

\+ Maritimes and Quebec were combined prior to 1979.

Table 3a: Nominal catches (t) of redfish in Division 3Pn by month and year.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1978	6	339	674	38	10	77	160	549	392	55	491	251	3,042
1979	17	142	598	354	74	92	210	168	167	372	570	396	3,160
1980	5	38	279	193	12	155	388	196	173	192	360	381	2,372
1981	9	432	100	315	117	160	969	540	498	753	272	91	4,256
1982	-	1	39	13	10	153	502	288	923	652	959	280	3,820
1983	21	63	30	207	1	217	294	622	791	144	356	183	2,929
1984	3	534	223	119	57	87	305	258	173	435	130	72	2,396
1985	66	18	13	101	3	131	272	527	206	135	122	194	1,788
1986	-	99	243	1,337	861	69	169	94	84	188	282	72	3,498
1987*	381	735	1,924	137	57	77	97	242	74	13	45	800	4,582
1988*	48	1,060	2,420	2,132	809	132	40	123	73	36	71	19	6,963
1989*	156	481	796	2,524	1,094	488	45	153	726	683	24	89	7,259

* Provisional

Table 3b: Nominal catches (t) of redfish in Division 3Ps by month and year.

Year	Jan.	Feb.	Mar.	Apr.	May	Jun.	Jul.	Aug.	Sep.	Oct.	Nov.	Dec.	Total
1978	31	301	899	396	148	903	1,625	2,029	1,892	2,178	1,066	735	12,203
1979	30	53	459	881	140	886	951	1,005	690	587	618	159	6,459
1980	6	72	347	469	174	257	978	1,130	706	335	339	379	5,192
1981	21	537	763	157	217	897	465	937	134	150	224	183	4,685
1982	4	5	27	127	154	133	220	580	193	398	205	44	2,090
1983	8	11	25	28	82	61	133	462	667	957	168	394	2,996
1984	9	126	179	39	114	470	804	141	40	37	22	24	2,005
1985	32	27	102	50	126	127	361	413	367	150	63	36	1,854
1986	13	37	685	282	499	432	754	213	343	111	186	96	3,651
1987*	41	94	110	139	172	268	439	244	189	92	74	307	2,169
1988*	74	498	206	126	133	177	110	179	200	95	125	373	2,296
1989*	260	161	354	355	113	232	239	374	500	76	40	29	2,733

* Provisional

Table 4: Breakdown of catches by gear type for redfish in Div. 3P.

	3Ps					3Pn					
Year	Bottom Trawl	MW Trawl	Gillnets	LL	Misc.	Bottom Trawl	MW Trawl	Gillnets	LL	Misc.	Totals
1976	9,096	3,461	409	169	100	1,904	3,971	3	25	29	19,167
1977	13,232	978	196	224	48	1,865	579	-	19	22	17,163
1978	10,107	1,455	385	220	36	2,234	787	-	15	6	15,245
1979	5,505	547	235	156	16	2,342	787	-	13	18	9,619
1980	4,645	143	244	139	21	2,072	287	-	10	3	7,564
1981	3,990	65	323	166	141	3,862	387	-	5	2	8,941
1982	1,777	-	219	76	18	3,817	-	1	1	1	5,910
1983	2,630	-	262	89	15	2,911	-	2	13	3	5,925
1984	1,730	-	139	134	2	2,380	-	1	9	6	4,401
1985	1,533	-	177	121	23	1,772	-	2	14	-	3,642
1986	2,920	152	432	135	12	3,191	305	-	2	-	7,149
1987	1,311	35	627	151	45	1,804	2,765	-	5	8	6,751
1988	1,367	408	393	124	4	2,140	4,813	1	8	1	9,259
1989	855	319	465	100	10	769	603	-	-	-	3,121 a

a Newfoundland only

Table 5: Process followed to derive estimates of the numbers of redfish caught at age in Div. 3P in 1989.

Frequency	Weight		Frequency	Weight		Frequency	Weight		Frequency	Weight		
			PortApr3PnCMMWT	1,734	--	3PnCM	5,887					
			PortMay3PnCMMWT	741			685	--	3Pn89	7,259		
PortApr3PnCNMWT	61	--	Apr3PnCNMWT	181	--	3PnCN	9,149					
SeaApr3PnCNMWT	63											
											--	LF3P89
PortMay3PnCNMWT				336								
PortApr3PsCNMWT	148	--	3PsCNMWT				685					
SeaApr3PsCNMWT	82							--	3Ps89	2,733		
			PortSept3PsCNOT	356	--	3PsCNOT	1,471					
			PortOct3PsCNOT	16								

Table 6: Percent redfish taken during fishing sets in different depth ranges in Div. 3P during acoustic surveys in 1986-1989.

Depth Range (m)	Percent Redfish
201-250	78
251-300	93
301-350	99
>350	99

Table 7: Regression of the multiplicative model for catch and effort for redfish in NAFO Div. 3P.

A. including percent category.

MULTIPLE R..... 0.769
MULTIPLE R SQUARED..... 0.592

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	3.235E2	3.235E2	
REGRESSION	73	3.240E2	4.439E0	30.275
CGT	27	1.665E2	6.165E0	42.047
Month	11	1.519E1	1.381E0	9.419
Subdiv.	1	3.510E0	3.510E0	23.938
Percent	4	3.415E1	8.539E0	58.234
Year	30	8.571E1	2.857E0	19.485
RESIDUALS	1523	2.233E2	1.466E-1	
TOTAL	1597	8.709E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	3114	INTERCEPT	-0.328	0.125	1597
2	7				
3	37				
4	95				
5	59				
1	2114	1	0.143	0.045	96
	2124	2	0.288	0.160	6
	2125	3	0.620	0.071	35
	2154	4	0.308	0.068	39
	2155	5	0.890	0.070	36
	3124	6	0.071	0.045	100
	3125	7	0.240	0.033	222
	3144	8	0.377	0.078	29
	3154	9	0.374	0.064	45
	3155	10	0.811	0.059	54
	9114	11	-0.265	0.068	38
	9125	12	0.236	0.070	36
	11115	13	0.338	0.151	7
	11116	14	0.611	0.151	7
	11126	15	0.726	0.134	9
	11127	16	0.982	0.178	5
	14127	17	1.136	0.087	24
	16127	18	0.319	0.161	6
	20114	19	-0.563	0.075	32
	20127	20	1.507	0.080	27
	20157	21	1.599	0.135	9
	27114	22	0.250	0.073	34
	27124	23	0.455	0.076	30
	27125	24	0.544	0.055	72
	27154	25	0.871	0.136	9
	27155	26	0.653	0.089	25
	28154	27	0.438	0.117	12
2	1	28	0.129	0.056	71
	2	29	0.244	0.052	97
	3	30	0.140	0.048	125
	4	31	0.047	0.048	112
	5	32	-0.004	0.051	87
	6	33	0.097	0.043	144
	8	34	-0.055	0.040	182
	9	35	-0.071	0.041	167

Table 7a: Continued.

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
	11	37	-0.153	0.043	146
	12	38	-0.084	0.046	123
3	36	39	0.105	0.021	629
4	55	40	-0.656	0.067	39
	65	41	-0.574	0.051	73
	75	42	-0.351	0.038	138
	85	43	-0.197	0.031	229
5	60	44	-0.221	0.153	17
	61	45	-0.301	0.149	20
	62	46	-0.240	0.142	28
	63	47	-0.032	0.133	52
	64	48	-0.016	0.144	25
	65	49	0.190	0.142	28
	66	50	0.265	0.136	41
	67	51	0.190	0.136	50
	68	52	0.151	0.136	42
	69	53	0.026	0.134	54
	70	54	0.022	0.132	63
	71	55	-0.190	0.133	61
	72	56	-0.174	0.133	61
	73	57	-0.265	0.131	79
	74	58	-0.433	0.131	86
	75	59	-0.440	0.130	92
	76	60	-0.674	0.131	85
	77	61	-0.561	0.130	80
	78	62	-0.539	0.130	78
	79	63	-0.643	0.131	81
	80	64	-0.461	0.133	58
	81	65	-0.592	0.135	48
	82	66	-0.471	0.139	39
	83	67	-0.311	0.141	35
	84	68	-0.512	0.148	24
	85	69	-0.593	0.136	50
	86	70	-0.406	0.135	51
	87	71	-0.261	0.137	45
	88	72	-0.426	0.134	64
	89	73	0.064	0.139	50

Table 7: Continued.

B. excluding percent category.

MULTIPLE R..... 0.728
MULTIPLE R SQUARED..... 0.530

ANALYSIS OF VARIANCE

SOURCE OF VARIATION	DF	SUMS OF SQUARES	MEAN SQUARES	F-VALUE
INTERCEPT	1	3.235E2	3.235E2	
REGRESSION	69	2.899E2	4.201E0	24.918
CGT	27	1.638E2	6.066E0	35.976
Month	11	1.045E1	9.500E-1	5.635
Subdiv.	1	7.485E0	7.485E0	44.394
Year	30	9.186E1	3.062E0	18.161
RESIDUALS	1527	2.575E2	1.686E-1	
TOTAL	1597	8.709E2		

REGRESSION COEFFICIENTS

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
1	3114	INTERCEPT	-0.424	0.134	1597
2	7				
3	37				
5	59				
1	2114	1	0.140	0.048	96
	2124	2	0.217	0.171	6
	2125	3	0.492	0.075	35
	2154	4	0.400	0.072	39
	2155	5	0.935	0.074	36
	3124	6	0.086	0.048	100
	3125	7	0.230	0.036	222
	3144	8	0.444	0.084	29
	3154	9	0.501	0.067	45
	3155	10	0.894	0.063	54
	9114	11	-0.412	0.072	38
	9125	12	0.189	0.075	36
	11115	13	0.292	0.162	7
	11116	14	0.640	0.162	7
	11126	15	0.790	0.144	9
	11127	16	0.923	0.190	5
	14127	17	0.873	0.091	24
	16127	18	0.407	0.172	6
	20114	19	-0.514	0.080	32
	20127	20	1.365	0.085	27
	20157	21	1.713	0.144	9
	27114	22	0.193	0.079	34
	27124	23	0.448	0.081	30
	27125	24	0.543	0.058	72
	27154	25	0.941	0.146	9
	27155	26	0.756	0.095	25
	28154	27	0.577	0.124	12
2	1	28	-0.000	0.059	71
	2	29	0.017	0.053	97
	3	30	-0.070	0.049	125
	4	31	-0.097	0.050	112
	5	32	-0.135	0.054	87
	6	33	0.084	0.046	144
	8	34	-0.067	0.043	182
	9	35	-0.090	0.044	167

Table 7b: Continued.

CATEGORY	CODE	VARIABLE	COEFFICIENT	STD. ERROR	NO. OBS.
	11	37	-0.207	0.046	146
	12	38	-0.180	0.049	123
3	36	39	0.151	0.023	629
5	60	40	-0.134	0.164	17
	61	41	-0.265	0.160	20
	62	42	-0.164	0.152	28
	63	43	0.048	0.142	52
	64	44	0.012	0.154	25
	65	45	0.239	0.152	28
	66	46	0.325	0.146	41
	67	47	0.234	0.146	50
	68	48	0.176	0.146	42
	69	49	0.094	0.143	54
	70	50	0.025	0.141	63
	71	51	-0.122	0.143	61
	72	52	-0.182	0.142	61
	73	53	-0.216	0.140	79
	74	54	-0.386	0.140	86
	75	55	-0.357	0.139	92
	76	56	-0.593	0.140	85
	77	57	-0.530	0.140	80
	78	58	-0.535	0.140	78
	79	59	-0.657	0.140	81
	80	60	-0.455	0.143	58
	81	61	-0.598	0.144	48
	82	62	-0.388	0.148	39
	83	63	-0.215	0.151	35
	84	64	-0.397	0.158	24
	85	65	-0.519	0.145	50
	86	66	-0.333	0.145	51
	87	67	-0.222	0.147	45
	88	68	-0.316	0.143	64
	89	69	0.194	0.148	50

Table 8: Standardized CPUE and effort for redfish in Div. 3P from multiplicative analyses.

A. including percent category

STANDARDS USED VARIABLES: Can(MQ)OTB4 Sept. 3Ps 95%

PREDICTED CATCH RATE

	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
59	-0.2555	0.0169	0.826	0.107	3783	4577
60	-0.4762	0.0102	0.665	0.067	9225	13872
61	-0.5569	0.0088	0.614	0.057	9400	15312
62	-0.4958	0.0075	0.653	0.056	13438	20579
63	-0.2870	0.0053	0.805	0.059	13747	17067
64	-0.2716	0.0085	0.817	0.075	13807	16906
65	-0.0656	0.0081	1.004	0.090	18733	18664
66	0.0098	0.0058	1.084	0.082	20868	19259
67	-0.0657	0.0060	1.005	0.077	32991	32838
68	-0.1043	0.0061	0.967	0.075	13884	14364
69	-0.2291	0.0055	0.853	0.063	32051	37554
70	-0.2340	0.0050	0.849	0.060	37270	43874
71	-0.4456	0.0054	0.687	0.050	27500	40010
72	-0.4299	0.0052	0.698	0.050	26037	37288
73	-0.5203	0.0045	0.638	0.043	18368	28783
74	-0.6889	0.0046	0.539	0.036	22158	41100
75	-0.6957	0.0040	0.536	0.034	28250	52740
76	-0.9298	0.0044	0.424	0.028	19167	45234
77	-0.8160	0.0043	0.475	0.031	17163	36147
78	-0.7950	0.0044	0.485	0.032	15245	31438
79	-0.8985	0.0049	0.437	0.030	9619	22006
80	-0.7169	0.0055	0.524	0.039	7564	14435
81	-0.8480	0.0060	0.459	0.036	8941	19458
82	-0.7269	0.0068	0.518	0.043	5910	11400
83	-0.5669	0.0073	0.608	0.052	5926	9743
84	-0.7680	0.0096	0.497	0.049	4401	8858
85	-0.8490	0.0060	0.459	0.036	3642	7934
86	-0.6616	0.0060	0.554	0.043	6986	12618
87	-0.5166	0.0065	0.640	0.052	7149	11173
88	-0.6810	0.0055	0.543	0.040	9259	17048
89	-0.1920	0.0066	0.885	0.072	9992	11288

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.079

Table 8: Continued.

B. excluding percent category

STANDARDS USED VARIABLES: Can(MQ)OTB4 Sept. 3Ps

PREDICTED CATCH RATE

	LN TRANSFORM		RETRANSFORMED			
YEAR	MEAN	S.E.	MEAN	S.E.	CATCH	EFFORT
59	-0.3737	0.0193	0.742	0.103	3783	5101
60	-0.5079	0.0117	0.651	0.070	9225	14172
61	-0.6388	0.0101	0.572	0.057	9400	16447
62	-0.5373	0.0086	0.633	0.059	13438	21227
63	-0.3255	0.0061	0.783	0.061	13747	17549
64	-0.3618	0.0097	0.754	0.074	13807	18311
65	-0.1345	0.0092	0.947	0.091	18733	19787
66	-0.0488	0.0066	1.033	0.084	20868	20205
67	-0.1392	0.0068	0.943	0.078	32991	34971
68	-0.1976	0.0070	0.890	0.074	13884	15604
69	-0.2795	0.0063	0.820	0.065	32051	39079
70	-0.3490	0.0057	0.765	0.057	37270	48701
71	-0.4961	0.0061	0.660	0.052	27500	41637
72	-0.5558	0.0059	0.622	0.048	26037	41842
73	-0.5893	0.0051	0.602	0.043	18368	30510
74	-0.7598	0.0052	0.508	0.037	22158	43653
75	-0.7309	0.0045	0.523	0.035	28250	54047
76	-0.9667	0.0050	0.413	0.029	19167	46433
77	-0.9042	0.0049	0.439	0.031	17163	39057
78	-0.9090	0.0049	0.437	0.031	15245	34861
79	-1.0311	0.0054	0.387	0.028	9619	24859
80	-0.8287	0.0062	0.474	0.037	7564	15972
81	-0.9714	0.0068	0.410	0.034	8941	21783
82	-0.7617	0.0078	0.506	0.045	5910	11681
83	-0.5883	0.0084	0.602	0.055	5926	9850
84	-0.7704	0.0110	0.501	0.053	4401	8788
85	-0.8926	0.0069	0.444	0.037	3642	8201
86	-0.7066	0.0069	0.535	0.044	6986	13060
87	-0.5959	0.0074	0.597	0.051	7149	11968
88	-0.6898	0.0063	0.544	0.043	9259	17016
89	-0.1792	0.0076	0.906	0.079	9992	11029

AVERAGE C.V. FOR THE RETRANSFORMED MEAN: 0.085

Table 9: Estimates of catch-, weight- and length-at-age of redfish in Div. 3P in 1989.

	AVERAGE		CATCH		
AGE	WEIGHT	LENGTH	MEAN	STD. ERR.	C. V.
* 6	0.060	16.014	9	0.06	0.01
* 7	0.151	21.757	5	4.91	1.03
* 8	0.166	22.471	46	15.08	0.32
* 9	0.229	25.071	1320	208.07	0.16
10	0.249	25.742	1766	240.68	0.14
11	0.274	26.601	1936	268.37	0.14
12	0.291	27.161	1854	245.83	0.13
13	0.325	28.142	1300	198.86	0.15
14	0.366	29.266	1125	161.88	0.14
15	0.396	30.074	831	145.38	0.17
16	0.431	30.947	898	149.42	0.17
17	0.475	31.949	758	138.89	0.18
18	0.484	32.124	1143	172.13	0.15
19	0.570	33.778	959	165.54	0.17
20	0.548	33.409	1098	170.51	0.16
21	0.602	34.435	551	122.18	0.22
22	0.674	35.692	646	133.71	0.21
23	0.643	35.230	527	114.98	0.22
24	0.666	35.654	660	129.37	0.20
25	0.655	35.556	463	96.01	0.21
26	0.745	37.055	664	118.45	0.18
27	0.767	37.418	481	95.53	0.20
28	0.785	37.742	315	76.26	0.24
*29	0.856	38.818	322	68.28	0.21
*30	0.988	40.469	1465	116.69	0.08

* FOR THE AGES FLAGGED BY * THERE WAS AN AGE LENGTH KEY WITH ONLY ONE AGE DETERMINATION FOR SOME LENGTH. SINCE THE VARIANCE FORMULA HAS N-1 IN THE DENOMINATOR IT CANNOT BE EVALUATED FOR THIS LENGTH. CONSEQUENTLY THIS VARIANCE COMPONENT IS NOT INCLUDED IN THE VARIANCE FOR THE FLAGGED AGES. THIS IS GENERALLY NOT A SERIOUS PROBLEM SINCE IT OCCURS WHEN FEW FISH ARE CAUGHT AT THAT LENGTH.

Table 10a: Commercial catch-at-age of redfish in Div. 3P

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
6	13	102	393	39	262	1272	437	198	9	3	9	66
7	11	867	681	53	500	3939	1501	1014	230	12	12	338
8	16	1818	1832	249	508	6992	2687	1845	1751	85	9	366
9	8	1596	866	549	805	7014	2842	2469	2172	262	67	427
10	20	1481	477	365	850	4944	1597	2004	1905	280	216	1173
11	531	1774	1090	410	791	2240	891	1591	1518	679	267	2150
12	994	1356	611	478	989	1947	1014	1266	1396	959	465	1407
13	3046	3491	996	936	865	814	710	653	1499	1056	693	1197
14	6039	2964	1101	1058	1041	1031	706	833	717	1473	1101	964
15	9222	3075	2163	1013	1465	1104	493	601	585	1167	1225	755
16	5808	7425	3543	1698	808	881	446	325	434	1053	1301	793
17	7228	2517	8265	1063	1322	752	599	380	393	513	1081	657
18	1824	3809	5923	3927	1024	1014	545	320	343	361	1357	688
19	869	1030	11826	1793	2708	810	528	327	451	261	705	388
20	1138	1285	2957	5998	1518	1789	651	331	422	169	653	245
21	583	679	2278	1383	4745	494	1015	445	323	211	556	178
22	381	1507	2040	2256	2323	1458	672	840	576	232	394	138
23	400	2734	1724	1850	2442	988	1256	503	990	217	311	126
24	479	1367	775	1238	2069	1026	727	827	589	338	312	139
25	166	2081	1182	2145	1103	1001	1047	501	1153	440	311	153
26	2	1829	976	1525	630	640	687	509	777	644	251	310
27	2	2	674	821	403	505	451	248	733	432	495	113
28	2	2	2	544	313	322	343	298	508	460	289	142
29	2	2	2	2	294	178	206	178	419	383	306	56
30	1	1	1	1	1	1	1	1	1	1	1	1

	1985	1986	1987	1988	1989
6	1424	228	11	1	9
7	623	1173	270	25	5
8	342	1224	871	748	46
9	332	460	1542	2339	1320
10	48	296	744	1266	1766
11	84	344	356	671	1936
12	126	380	331	655	1854
13	147	335	407	459	1300
14	178	467	526	599	1125
15	512	619	784	591	831
16	911	1125	1097	1278	898
17	972	1049	1468	1899	758
18	864	1368	1082	1867	1143
19	415	1159	1148	1273	959
20	432	1346	897	704	1098
21	184	672	821	575	551
22	203	317	535	606	646
23	117	453	336	829	527
24	211	197	456	553	660
25	173	358	500	662	463
26	166	372	419	571	664
27	319	561	296	592	481
28	334	570	226	431	315
29	303	422	102	391	322
30	625	1348	535	849	1465

Table 10b: Commercial weight-at-age of redfish in Div. 3P

	1973	1974	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984
6	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.105	0.113	0.060	0.076	0.082
7	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.142	0.137	0.098	0.114	0.113
8	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.177	0.184	0.164	0.148
9	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.213	0.220	0.220	0.214	0.176
10	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.247	0.266	0.266	0.258	0.202
11	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.286	0.290	0.326	0.269	0.234
12	0.331	0.331	0.331	0.331	0.331	0.331	0.331	0.331	0.340	0.361	0.318	0.275
13	0.369	0.369	0.369	0.369	0.369	0.369	0.369	0.369	0.355	0.373	0.347	0.308
14	0.406	0.406	0.406	0.406	0.406	0.406	0.406	0.406	0.417	0.396	0.376	0.346
15	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.445	0.426	0.416	0.394	0.350
16	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.481	0.465	0.441	0.412	0.404
17	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.516	0.515	0.514	0.454	0.417
18	0.553	0.553	0.553	0.553	0.553	0.553	0.553	0.553	0.541	0.518	0.464	0.457
19	0.587	0.587	0.587	0.587	0.587	0.587	0.587	0.587	0.621	0.573	0.490	0.519
20	0.621	0.621	0.621	0.621	0.621	0.621	0.621	0.621	0.625	0.599	0.495	0.538
21	0.657	0.657	0.657	0.657	0.657	0.657	0.657	0.657	0.601	0.655	0.533	0.575
22	0.688	0.688	0.688	0.688	0.688	0.688	0.688	0.688	0.650	0.665	0.579	0.544
23	0.724	0.724	0.724	0.724	0.724	0.724	0.724	0.724	0.652	0.699	0.606	0.627
24	0.770	0.770	0.770	0.770	0.770	0.770	0.770	0.770	0.707	0.678	0.673	0.598
25	0.816	0.816	0.816	0.816	0.816	0.816	0.816	0.816	0.726	0.707	0.684	0.638
26	0.865	0.865	0.865	0.865	0.865	0.865	0.865	0.865	0.784	0.745	0.740	0.673
27	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.913	0.811	0.850	0.711	0.795
28	0.948	0.948	0.948	0.948	0.948	0.948	0.948	0.948	0.872	0.820	0.820	0.780
29	0.985	0.985	0.985	0.985	0.985	0.985	0.985	0.985	0.883	0.932	0.845	0.854
30	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000

	1985	1986	1987	1988	1989
6	0.066	0.071	0.069	0.070	0.060
7	0.088	0.095	0.112	0.127	0.151
8	0.145	0.125	0.157	0.198	0.166
9	0.183	0.209	0.198	0.230	0.229
10	0.231	0.249	0.228	0.258	0.249
11	0.232	0.276	0.282	0.290	0.274
12	0.243	0.287	0.302	0.314	0.291
13	0.273	0.328	0.324	0.339	0.325
14	0.287	0.371	0.348	0.338	0.366
15	0.376	0.398	0.377	0.388	0.396
16	0.420	0.433	0.427	0.449	0.431
17	0.476	0.471	0.464	0.473	0.475
18	0.472	0.536	0.496	0.531	0.484
19	0.513	0.544	0.545	0.555	0.570
20	0.553	0.581	0.566	0.604	0.548
21	0.574	0.650	0.548	0.564	0.602
22	0.602	0.739	0.584	0.578	0.674
23	0.534	0.689	0.670	0.641	0.643
24	0.632	0.786	0.665	0.719	0.666
25	0.648	0.696	0.722	0.667	0.655
26	0.657	0.719	0.749	0.737	0.745
27	0.686	0.730	0.850	0.793	0.767
28	0.713	0.765	0.781	0.889	0.785
29	0.764	0.800	0.817	0.873	0.856
30	1.000	1.000	1.000	1.000	1.000

Table 11: Mean weight (kg) of redfish caught per standard tow in Division 3P during Canadian research surveys, 1980-1990.

(numbers in brackets indicate number of sets; • indicates strata estimated using multiplicative model)

(Standards are stratum 309 and 1983)

Stratum	1980 ATC	1981 ATC	1982 ATC	1983 Needler	1984 Needler	1985 Templeman	1986 Templeman	1987 Templeman	1988 Templeman
302	3.24 •	5.34 •	2.41 •	11.40 (3)	2.38 •	2.95 •	14.75 (2)	10.25 (2)	8.40 (2)
303	84.21 (2)	178.67 (3)	73.72 •	383.25 (4)	72.80 •	87.35 •	87.00 (4)	184.17 (3)	100.17 (3)
304	601.22 (2)	42.75 (2)	97.94 •	2265.33 (3)	96.73 •	116.03 •	209.00 (2)	238.25 (2)	112.00 (2)
305	36.17 (3)	68.00 (5)	45.26 •	48.00 (6)	44.70 •	53.67 •	43.50 (1)	382.65 (2)	155.92 (6)
306	165.71 (2)	44.93 (3)	54.93 (3)	81.13 (4)	3.51 (2)	37.00 (2)	39.67 (3)	24.63 (4)	190.77 (4)
307	12.38 (2)	21.17 (3)	4.05 (4)	49.00 (4)	69.25 (2)	3.70 (3)	2.00 (3)	5.67 (3)	3.95 (4)
309	3908.91 (2)	264.50 (2)	42.50 (2)	101.92 (3)	12.25 (2)	85.33 (3)	69.25 (2)	127.00 (2)	86.17 (3)
310	35.64 (2)	17.50 (2)	529.11 (3)	34.67 (3)	4.75 (2)	95.83 (3)	43.00 (2)	4.00 (2)	46.17 (3)
311	0.00 (2)	1.50 (2)	0.17 (3)	0.00 (3)	4.00 (2)	1.97 (4)	0.00 (3)	0.00 (3)	0.05 (4)
313	15.55 (2)	29.00 (2)	158.50 (2)	44.33 (3)	3.50 (2)	89.50 (2)	93.75 (2)	20.25 (2)	31.00 (2)
316	51.30 (2)	21.00 (2)	36.50 (1)	55.88 (4)	9.75 (2)	12.83 (3)	10.50 (2)	40.50 (3)	24.33 (3)
317	3.40 (2)	0.25 (2)	1.07 (3)	110.70 (3)	31.25 (2)	0.00 (2)	0.00 (2)	0.00 (3)	0.20 (2)
318	94.89 (2)	80.21 •	148.50 (2)	88.50 (3)	21.25 (2)	47.13 •	149.75 (2)	671.00 (2)	13.00 (2)
319	0.79 (4)	46.00 (2)	3.86 (7)	4.79 (7)	2.90 (6)	0.00 (2)	1.45 (8)	1.19 (9)	13.82 (8)
705	62.65 (2)	49.50 (2)	317.00 (2)	4.33 (3)	13.50 (2)	29.50 (2)	90.50 (2)	102.25 (2)	65.00 (2)
706	26.33 (2)	17.00 (2)	42.25 (4)	11.50 (5)	8.50 (2)	60.13 (4)	45.88 (4)	35.10 (5)	114.35 (4)
707	38.82 (2)	59.58 •	29.45 •	80.83 (3)	96.75 (2)	34.95 •	61.50 (2)	69.50 (2)	153.25 (2)
708	15.43 (2)	74.45 •	36.87 •	358.75 (2)	40.50 (2)	43.73 •	73.25 (2)	101.75 (2)	156.00 (2)
709	0.38 •	0.88 •	0.19 •	0.10 (2)	1.75 (2)	0.31 •	0.00 (1)	5.70 (1)	2.16 •
710	1.31 •	2.33 •	0.91 •	2.27 (3)	0.50 (2)	5.25 (2)	53.50 (2)	2.54 •	68.63 (2)
711	15.66 (2)	13.50 (2)	5.40 (2)	28.21 (8)	16.10 (5)	31.27 (8)	119.11 (9)	52.71 (7)	84.71 (7)
712	40.18 (2)	112.00 (2)	15.00 (3)	49.50 (7)	30.19 •	27.97 (6)	70.78 (9)	77.63 (4)	68.00 (7)
713	10.44 (2)	41.33 (6)	8.25 (2)	16.86 (7)	24.40 •	41.19 (8)	45.10 (5)	110.13 (4)	651.84 (7)
714	41.09 (2)	32.69 (8)	30.08 (6)	49.85 (10)	34.70 •	31.00 (1)	58.60 (5)	48.38 (4)	312.92 (9)
715	472.84 (2)	183.84 (2)	11.40 (2)	12.50 (3)	22.00 (2)	1137.00 (1)	97.25 (2)	127.50 (2)	133.00 (2)
716	22.02 (2)	22.25 (4)	25.25 (2)	15.50 (4)	10.07 (3)	27.50 (5)	71.63 (4)	147.50 (3)	100.06 (5)
Mean	153.47	55.07	40.73	85.29	25.29	49.06	55.77	92.70	153.44
Total	122,634	44,002	32,544	68,154	20,204	39,200	44,562	74,073	122,607

Table 11: (cont.)

Stratum	1989 Templeman		1990 Templeman	
302	5.00	(2)	1.67	(3)
303	49.88	(4)	1,228.00	(3)
304	330.38	(2)	167.90	(2)
305	173.28	(6)	189.55	(4)
306	10.33	(3)	212.48	(3)
307	3.00	(3)	25.63	(3)
309	69.00	(2)	44.80	(2)
310	16.25	(2)	2.75	(2)
311	0.13	(3)	0.00	(3)
313	25.00	(2)	1.92	(2)
316	4.87	(3)	2.65	(2)
317	0.00	(2)	0.00	(2)
318	105.75	(2)	92.86	•
319	1.00	(8)	3.91	•
705	11.00	(2)	5.50	(2)
706	23.88	(4)	10.78	(4)
707	108.28	(2)	69.00	•
708	228.00	(2)	86.20	•
709	6.25	(2)	1.09	•
710	2.61	•	2.78	•
711	149.36	(7)	165.15	(3)
712	163.06	(8)	83.46	(5)
713	119.06	(8)	57.26	(7)
714	204.10	(10)	160.49	(7)
715	735.43	(2)	353.00	(2)
716	52.88	(4)	17.10	(5)
Mean	101.44		137.36	
Total	81,053		109,756	

Table 12: Calibration parameters for acoustic systems used for the 1988 and 1989 surveys in Div. 3P and 3P4V respectively.

Parameter	1988	1989
Source Level (dB)	125.20	124.20
Receive Sensitivity (dB)	-75.30	-72.50
Receiver Gain (dB)	79.50	79.93
Average Beam Angle (dB)	-29.42	-29.36
Pulse Length (millisec.)	0.60	0.60
Sampling Threshold (mV)	50.00	50.00
Target Strength (dB)	-34.00	-34.00

Table 13a: Estimates of stratum densities (kg/m^2) and total biomass for redfish in Div. 3P from 1988 acoustic data.
(Assume 100% redfish in <300 m)

BLOCK D

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	9.6423	46,300	1.00
2	8.7243	46,300	1.00
3	4.8710	46,300	1.00
4	14.0988	46,300	1.00
5			
6			
7			
8			

Weighted Mean (gm/m^2): 9.3341

BLOCK E

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	10.8330	55,189.6	1.00
2	15.5180	55,189.6	1.00
3	10.0643	55,189.6	1.00
4	12.0006	55,189.6	1.00
5	4.5017	55,189.6	1.00
6	3.9417	55,189.6	1.00
7	2.2569	55,189.6	1.00
8	12.3402	55,189.6	1.00

Weighted Mean (gm/m^2): 8.9321

BLOCK F

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	11.0536	58,338	1.00
2	7.2932	58,338	1.00
3	4.0346	58,338	1.00
4	27.9310	58,338	1.00
5	30.383	58,338	1.00
6	18.7898	58,338	1.00
7			
8			

Weighted Mean (gm/m^2): 16.5809

BLOCK G

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	12.1435	43,707.2	1.00
2	4.0154	43,707.2	1.00
3	11.5733	43,707.2	1.00
4	9.9272	43,707.2	1.00
5	15.3015	43,707.2	1.00
6	6.6743	43,707.2	1.00
7	6.4411	43,707.2	1.00
8			

Weighted Mean (gm/m^2): 9.4395

BLOCK H

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	7.4283	53,708	1.00
2	10.2139	53,708	1.00
3	13.8437	53,708	1.00
4	3.1289	53,708	1.00
5	5.5788	53,708	1.00
6	13.4705	53,708	1.00
7	4.8405	53,708	1.00
8	17.7735	53,708	1.00

Weighted Mean (gm/m^2): 9.5348

BLOCK I

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	38.7824	25,372.4	1.00
2	1.1611	25,372.4	1.00
3	3.6792	25,372.4	1.00
4	30.6575	25,372.4	1.00
5	1.8000	25,372.4	1.00
6	1.0133	25,372.4	1.00
7			
8			

Weighted Mean (gm/m^2): 12.8489

Table 13a: Continued

BLOCK J

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	0.5253	85,192	1.00
2	0.1667	85,192	1.00
3	1.5325	85,192	1.00
4	2.6460	85,192	1.00
5	4.0914	85,192	1.00
6			
7			
8			

Weighted Mean (gm/m^2) 1.7924

BLOCK K

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	2.3260	53,708	1.00
2	1.9916	53,708	1.00
3	1.7006	53,708	1.00

Weighted Mean (gm/m^2) 2.0061

Biomass estimates (tonnes)

Block	Mean Biomass (gm/m^2)	Area (m^2)	Biomass (t)
D	9.3341	4.1E+09	38,194
E	8.9321	4.9E+09	44,147
F	16.5809	4.4E+09	72,681
G	9.4395	2.0E+09	18,649
H	9.5348	2.8E+09	26,522
I	12.8489	9.6E+08	12,384
J	1.7924	3.3E+09	5,939
K	2.0061	1.3E+09	2,677

Total Biomass (t) 221,192

Table 13b: Estimates of stratum density (gm/m^2) and total biomass for redfish in Div. 3P from 1988 acoustic data.
(Assume 0% redfish in < 300 m)

BLOCK D

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	9.6423	46,300	1.00
2	8.7243	46,300	1.00
3	4.8710	46,300	1.00
4	14.0508	46,300	1.00
5			
6			
7			
8			

Weighted Mean (gm/m^2): 9.3221

BLOCK E

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	10.6259	55,189.6	1.00
2	15.4296	55,189.6	1.00
3	10.0643	55,189.6	1.00
4	11.3640	55,189.6	1.00
5	4.5017	55,189.6	1.00
6	3.7649	55,189.6	1.00
7	1.8011	55,189.6	1.00
8	12.3402	55,189.6	1.00

Weighted Mean (gm/m^2): 8.7365

BLOCK F

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	11.0536	58,338	1.00
2	7.2932	58,338	1.00
3	4.0346	58,338	1.00
4	27.9310	58,338	1.00
5	30.3830	58,338	1.00
6	18.7898	58,338	1.00
7			
8			

Weighted Mean (gm/m^2): 16.5809

BLOCK G

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	12.1435	43,707.2	1.00
2	3.8448	43,707.2	1.00
3	10.6893	43,707.2	1.00
4	9.9272	43,707.2	1.00
5	15.3015	43,707.2	1.00
6	6.6743	43,707.2	1.00
7	6.1468	43,707.2	1.00
8			

Weighted Mean (gm/m^2): 9.2468

BLOCK H

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	5.8669	53,708	1.00
2	8.8827	53,708	1.00
3	7.4746	53,708	1.00
4	0.0000	53,708	1.00
5	4.6978	53,708	1.00
6	10.2631	53,708	1.00
7	0.0000	53,708	1.00
8	15.7606	53,708	1.00

Weighted Mean (gm/m^2): 6.6182

BLOCK I

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	0.0000	25,372.4	1.00
2	0.0000	25,372.4	1.00
3	0.0000	25,372.4	1.00
4	0.6568	25,372.4	1.00
5	0.0000	25,372.4	1.00
6	0.0000	25,372.4	1.00
7			
8			

Weighted Mean (gm/m^2): 0.1095

Table 13b: Continued.

BLOCK J

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	0.1598	85,192	1.00
2	0.1667	85,192	1.00
3	0.6148	85,192	1.00
4	1.1291	85,192	1.00
5	0.5000	85,192	1.00
6			
7			
8			

Weighted Mean (gm/m^2) 0.5141

BLOCK K

Transect	Mean Density (gm/m^2)	Transect Length (m)	Weighting Factor
1	1.8176	53,708	1.00
2	1.5442	53,708	1.00
3	1.3583	53,708	1.00

Weighted Mean (gm/m^2) 1.5734

Biomass estimates (tonnes)

Block	Mean Biomass (gm/m^2)	Area (m^2)	Biomass (t)
D	9.3221	4.1E+09	38,145
E	8.7365	4.9E+09	43,180
F	16.5809	4.4E+09	72,681
G	9.2468	2.0E+09	18,268
H	6.6182	2.8E+09	18,410
I	0.1095	9.6E+08	106
J	0.5141	3.3E+09	1,703
K	1.5734	1.3E+09	2,099

Total Biomass (t) 194,591

Table 14a: Estimates of stratum density (kg/m^2) and biomass (t) of redfish in Div. 3P4V from 1989 acoustic data.
(Assume 100% redfish in <300 m)

BLOCK B

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0038	61.0	1.01
2	0.0046	62.0	1.02
3	0.0049	60.0	0.99
4	0.0044	60.0	0.99
5	0.0031	60.0	0.99
6	0.0034	61.0	1.01

Weighted Mean (kg/m^2): 0.0040

Variance: 8.75E-08

BLOCK C

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0063	58.0	1.01
2	0.0087	58.0	1.01
3	0.0059	59.0	1.02
4	0.0067	58.0	1.01
5	0.0061	55.0	0.95
6			

Weighted Mean (kg/m^2): 0.0067

Variance: 2.74E-07

BLOCK D

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0197	51.0	1.00
2	0.0180	51.0	1.00
3	0.0268	50.0	0.98
4	0.0163	51.0	1.00
5	0.0061	51.0	1.00
6	0.0074	51.0	1.00
7			

Weighted Mean (kg/m^2): 0.0157

Variance: 1.01E-05

BLOCK E

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0058	54.5	1.02
2	0.0070	52.5	0.98
3	0.0102	52.0	0.98
4	0.0185	53.0	0.99
5	0.0054	55.0	1.03
6	0.0028	53.0	0.99
7			

Weighted Mean (kg/m^2): 0.0083

Variance: 5.12E-06

BLOCK F (BURGEO)

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0275	75.0	1.87
2	0.0104	46.5	1.16
3	0.0033	40.0	0.99
4	0.0017	36.5	0.91
5	0.0033	34.0	0.85
6	0.0034	26.0	0.65
7	0.0016	23.5	0.58

Weighted Mean (kg/m^2): 0.0106

Variance: 2.85E-05

Table 14a: Continued.

Block	Mean Density (kg/m^2)	Area (m^2)	Biomass (t)
B	0.0040	1.07E+10	43,019
C	0.0067	8.89E+09	59,891
D	0.0157	8.66E+09	135,761
E	0.0083	9.30E+09	76,886
F	0.0106	7.01E+09	74,131

Total Biomass (t)	389,688
Total Variance	2.63E+15
C.V.	13.2%

Table 14b: Estimates of stratum density (kg/m^2) and total biomass (t) of redfish in Div. 3P4V from 1989 acoustic data.
(Assume 0% redfish in <300 m)

BLOCK B

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0030	61.0	1.01
2	0.0043	62.0	1.02
3	0.0032	60.0	0.99
4	0.0036	60.0	0.99
5	0.0021	60.0	0.99
6	0.0033	61.0	1.01

Weighted Mean (kg/m^2): 0.0032

Variance: 8.72E-08

BLOCK C

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0061	58.0	1.01
2	0.0068	58.0	1.01
3	0.0056	59.0	1.02
4	0.0063	58.0	1.01
5	0.0051	55.0	0.95
6			

Weighted Mean (kg/m^2): 0.0060

Variance: 7.74E-08

BLOCK D

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0195	51.0	1.00
2	0.0173	51.0	1.00
3	0.0266	50.0	0.98
4	0.0157	51.0	1.00
5	0.0052	51.0	1.00
6	0.0068	51.0	1.00
7			

Weighted Mean (kg/m^2): 0.0151

Variance: 1.06E-05

BLOCK E

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0055	54.5	1.02
2	0.0066	52.5	0.98
3	0.0101	52.0	0.98
4	0.0184	53.0	0.99
5	0.0050	55.0	1.03
6	0.0024	53.0	0.99
7			

Weighted Mean (kg/m^2): 0.0080

Variance: 5.31E-06

BLOCK F (BURGEO)

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0190	75.0	1.87
2	0.0009	46.5	1.16
3	0.0001	40.0	0.99
4	0.0005	36.5	0.91
5	0.0011	34.0	0.85
6	0.0008	26.0	0.65
7	0.0012	23.5	0.58

Weighted Mean (kg/m^2): 0.0056

Variance: 1.74E-05

Table 14b: Continued.

Block	Mean Density (kg/m^2)	Area (m^2)	Biomass (t)
B	0.0032	1.07E+10	34,868
C	0.0060	8.89E+09	53,208
D	0.0151	8.66E+09	131,167
E	0.0080	9.30E+09	74,154
F	0.0056	7.01E+09	39,342
Total Biomass (t)			332,739
Total Variance			2.13E+15
C.V.			13.9%

Table 15a: Estimates of stratum density (kg/m^2) and total biomass (t) of redfish in Div. 3P from 1989 acoustic data.
(Assume 100% redfish in <300 m)

BLOCK B

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0019	61.0	1.01
2	0.0030	62.0	1.02
3	0.0017	60.0	0.99
4	0.0017	60.0	0.99
5	0.0021	60.0	0.99
6	0.0013	61.0	1.01

Weighted Mean (kg/m^2): 0.0019

Variance: 5.59E-08

BLOCK C

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0034	58.0	1.01
2	0.0046	58.0	1.01
3	0.0036	59.0	1.02
4	0.0035	58.0	1.01
5	0.0041	55.0	0.95
6			

Weighted Mean (kg/m^2): 0.0038

Variance: 4.45E-08

BLOCK D

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0106	51.0	1.00
2	0.0135	51.0	1.00
3	0.0200	50.0	0.98
4	0.0150	51.0	1.00
5	0.0026	51.0	1.00
6	0.0045	51.0	1.00
7			

Weighted Mean (kg/m^2): 0.0110

Variance: 7.17E-06

BLOCK E

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0026	54.5	1.02
2	0.0063	52.5	0.98
3	0.0056	52.0	0.98
4	0.0114	53.0	0.99
5	0.0025	55.0	1.03
6	0.0013	53.0	0.99
7			

Weighted Mean (kg/m^2): 0.0049

Variance: 2.30E-06

BLOCK F (BURGEO)

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0275	75.0	1.87
2	0.0104	46.5	1.16
3	0.0033	40.0	0.99
4	0.0017	36.5	0.91
5	0.0033	34.0	0.85
6	0.0034	26.0	0.65
7	0.0016	23.5	0.58

Weighted Mean (kg/m^2): 0.0106

Variance: 2.85E-05

Table 15a: Continued.

Block	Mean Density (kg/m^2)	Area (m^2)	Biomass (t)
B	0.0019	1.07E+10	20,918
C	0.0038	8.89E+09	34,065
D	0.0110	8.66E+09	95,292
E	0.0049	9.30E+09	45,900
F	0.0106	7.01E+09	74,131

Total Biomass (t)	270,306
Total Variance	2.14E+15
C.V.	17.1%

Table 15b: Estimates of transect density (kg/^m) and total biomass (t) for redfish in Div. 3P from 1989 acoustic data.
(Assume 0% redfish in <300 m)

BLOCK B

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0019	61.0	1.01
2	0.0030	62.0	1.02
3	0.0010	60.0	0.99
4	0.0013	60.0	0.99
5	0.0012	60.0	0.99
6	0.0013	61.0	1.01

Weighted Mean (kg/m^2): 0.0016

Variance: 9.18E-08

BLOCK C

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0034	58.0	1.01
2	0.0046	58.0	1.01
3	0.0036	59.0	1.02
4	0.0035	58.0	1.01
5	0.0040	55.0	0.95
6			

Weighted Mean (kg/m^2): .0.0038

Variance: 4.30E-08

BLOCK D

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0105	51.0	1.00
2	0.0134	51.0	1.00
3	0.0199	50.0	0.98
4	0.0148	51.0	1.00
5	0.0025	51.0	1.00
6	0.0043	51.0	1.00
7			

Weighted Mean (kg/m^2): 0.0109

Variance: 7.15E-06

BLOCK E

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0025	54.5	1.02
2	0.0063	52.5	0.98
3	0.0055	52.0	0.98
4	0.0113	53.0	0.99
5	0.0025	55.0	1.03
6	0.0009	53.0	0.99
7			

Weighted Mean (kg/m^2): 0.0048

Variance: 2.36E-06

BLOCK F (BURGEO)

Transect	Mean Density (kg/m^2)	Transect Length (m)	Weighting Factor
1	0.0190	75.0	1.87
2	0.0009	46.5	1.16
3	0.0001	40.0	0.99
4	0.0005	36.5	0.91
5	0.0011	34.0	0.85
6	0.0008	26.0	0.65
7	0.0012	23.5	0.58

Weighted Mean (kg/m^2): 0.0056

Variance: 1.74E-05

Table 15b: Continued.

Block	Mean Density (kg/m^2)	Area (m^2)	Biomass (t)
B	0.0016	1.07E+10	17,507
C	0.0038	8.89E+09	33,918
D	0.0109	8.66E+09	94,078
E	0.0048	9.30E+09	44,516
F	0.0056	7.01E+09	39,342
Total Biomass (t)			229,361
Total Variance			1.61E+15
C.V.			17.5%

Table 16: Sample statistics (arithmetic) from the 10 min. interval transect densities accumulated during the 1989 acoustics survey in Div. 3P4V.

The following results are for: TRANSECT$ = C1

Total observations: 44

	DENSITY
N of cases	44
Minimum	0.5489
Maximum	20.0117
Range	19.4628
Mean	6.3074
Variance	17.4811
Standard dev	4.1810
Std. error	0.6303
Skewness	1.0582
Kurtosis	1.2462
Sum	277.5248

The following results are for: TRANSECT$ = C2

Total observations: 43

	DENSITY
N of cases	43
Minimum	0.4627
Maximum	65.1840
Range	64.7213
Mean	8.7473
Variance	122.8202
Standard dev	11.0824
Std. error	1.6901
Skewness	3.5578
Kurtosis	14.3850
Sum	376.1341

The following results are for: TRANSECT$ = C3

Total observations: 46

	DENSITY
N of cases	46
Minimum	0.8349
Maximum	24.9493
Range	24.1144
Mean	5.8700
Variance	26.9200
Standard dev	5.1885
Std. error	0.7650
Skewness	1.6953
Kurtosis	3.0068
Sum	270.0199

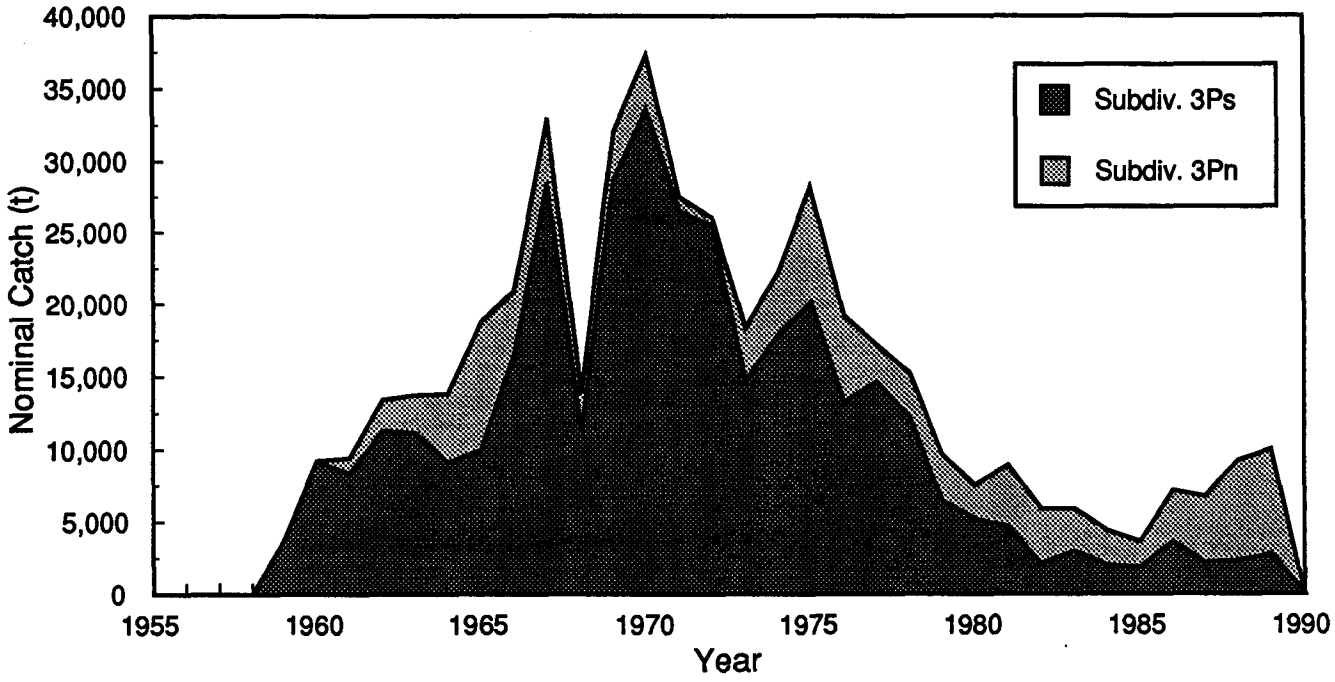


Fig. 1: Nominal catches of redfish in Div. 3P, 1959-1989 (1987-1989 are provisional).

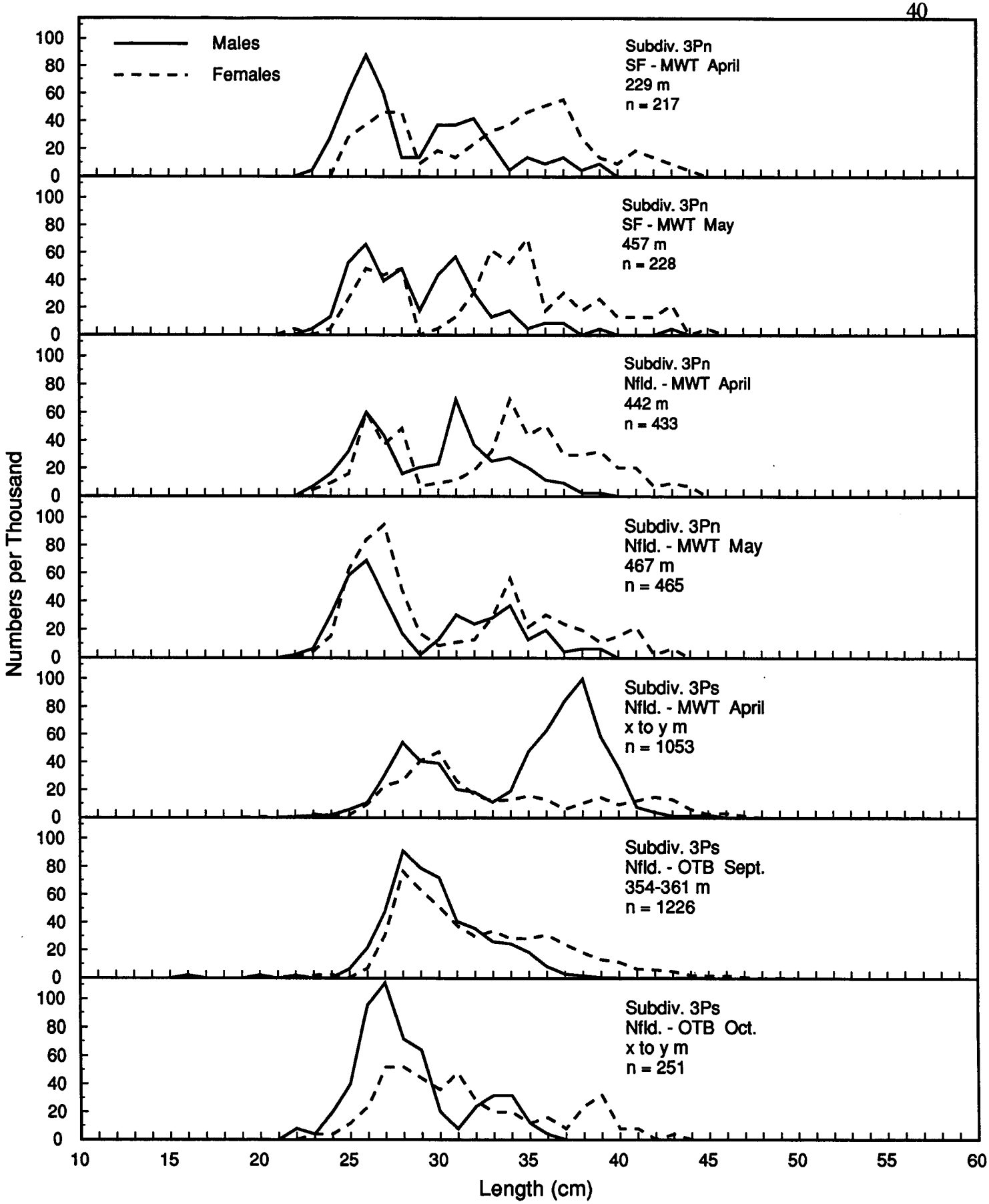


Fig. 2a: Length frequencies from the commercial redfish fishery in Div. 3P in 1989 (port sampling).

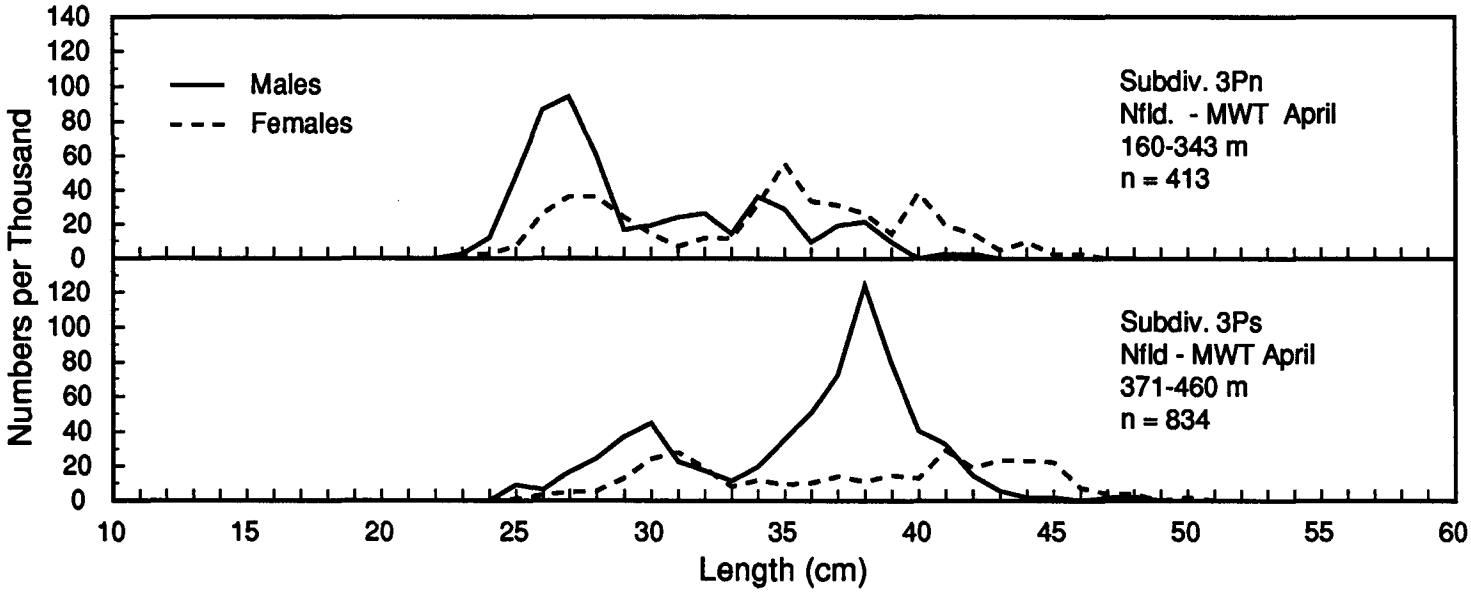


Fig. 2b: Length frequencies from the commercial redfish fishery in Div. 3P in 1989 (sea sampling).

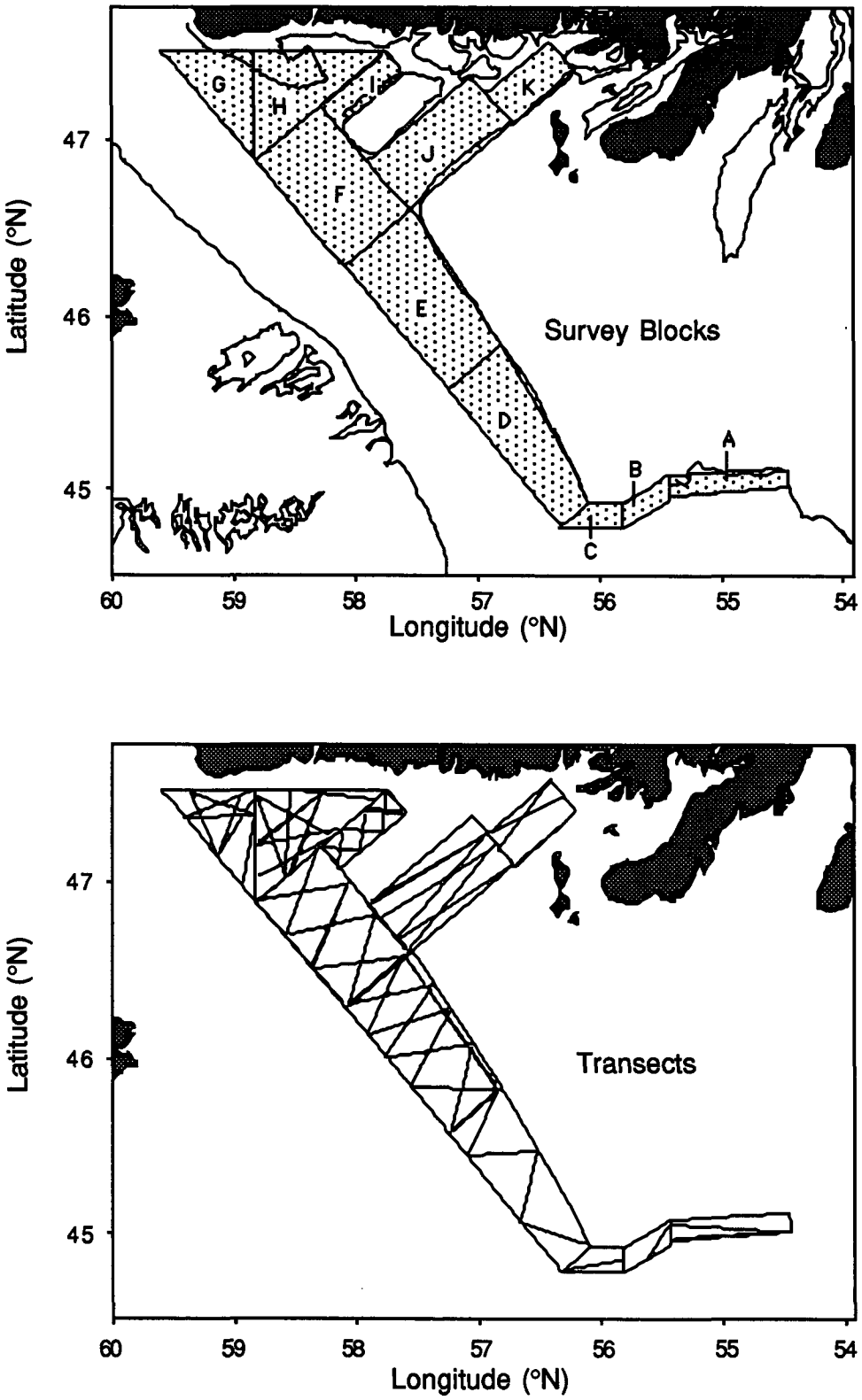


Fig. 3a: Survey blocks and transects surveyed during 1988 redfish acoustic survey.

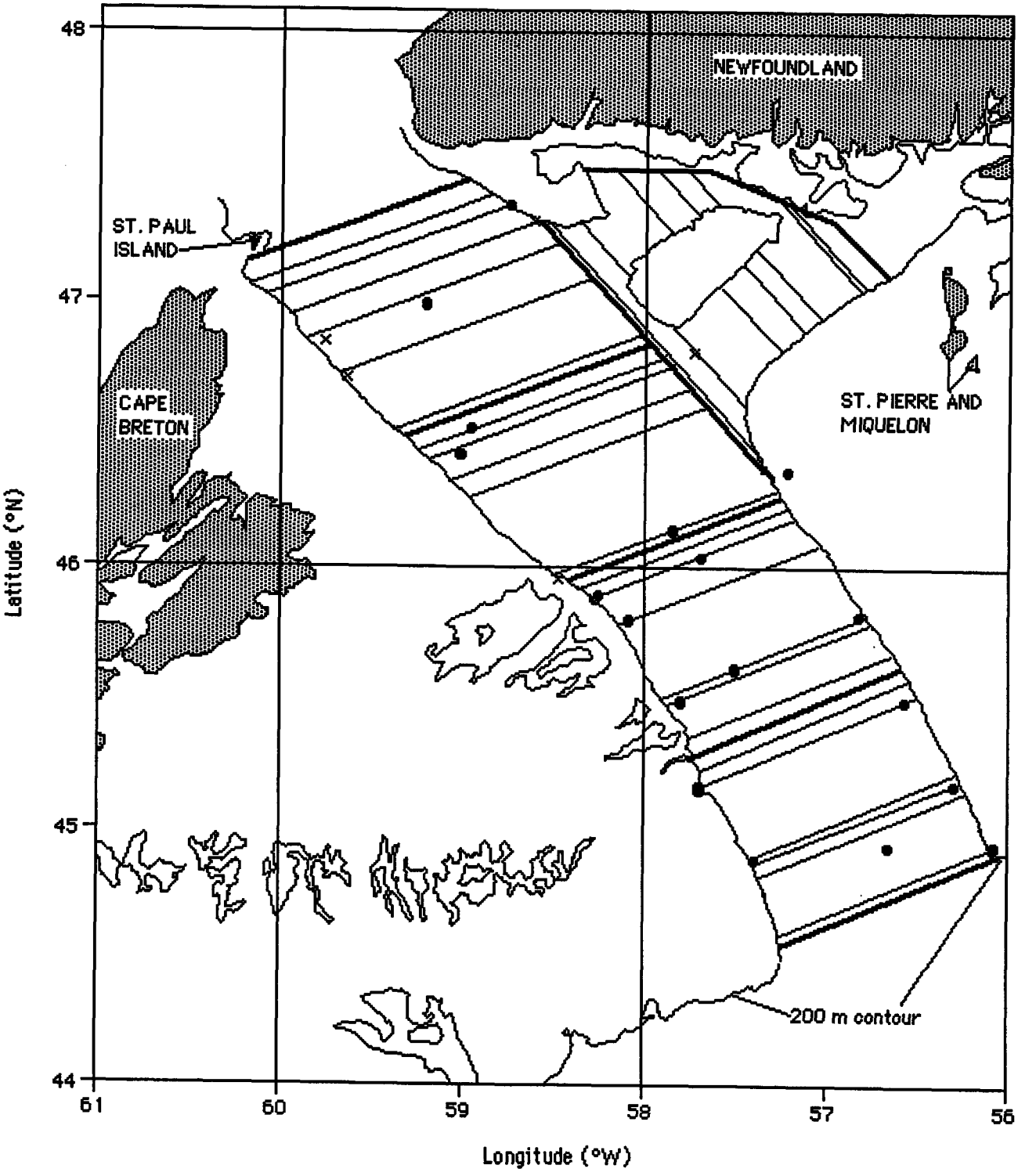


Fig. 3b: Survey blocks and transects used during redfish acoustic survey in 1989.

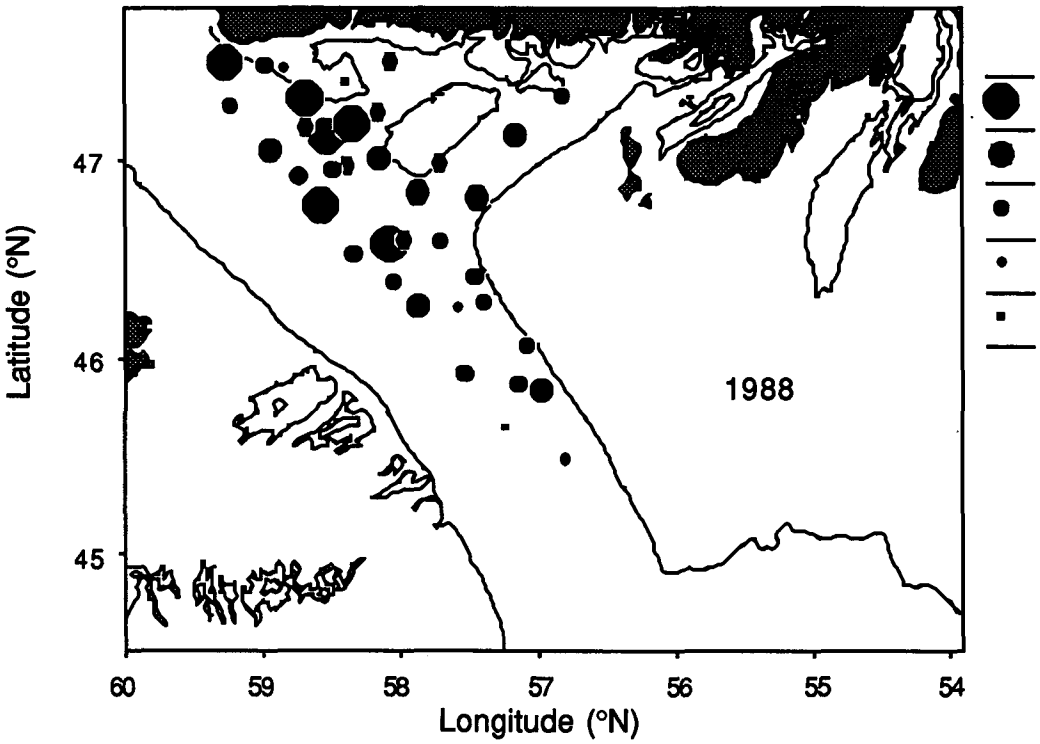


Fig. 4a: Location of fishing sets and redfish catches during redfish acoustic survey in 1988.

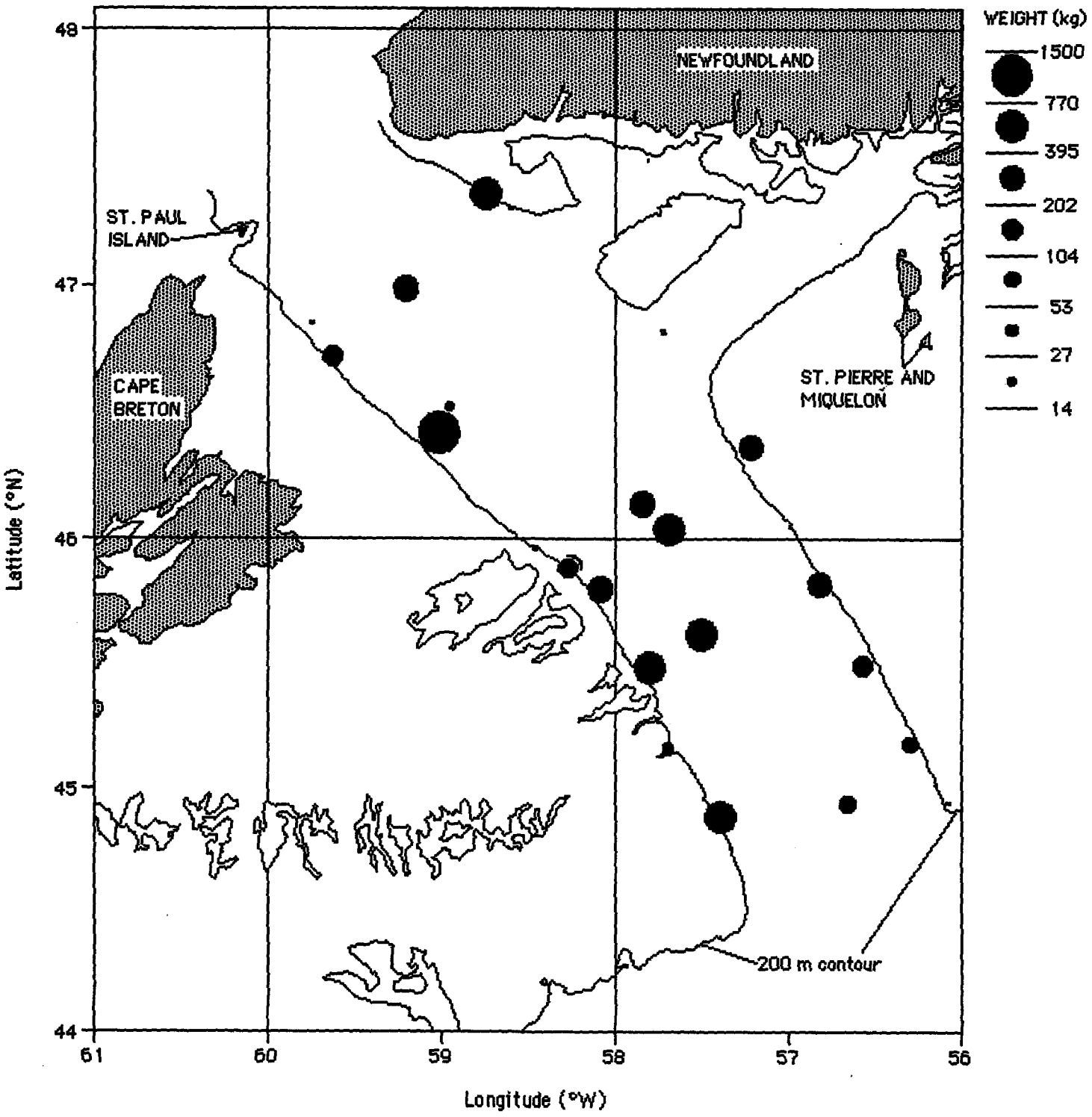
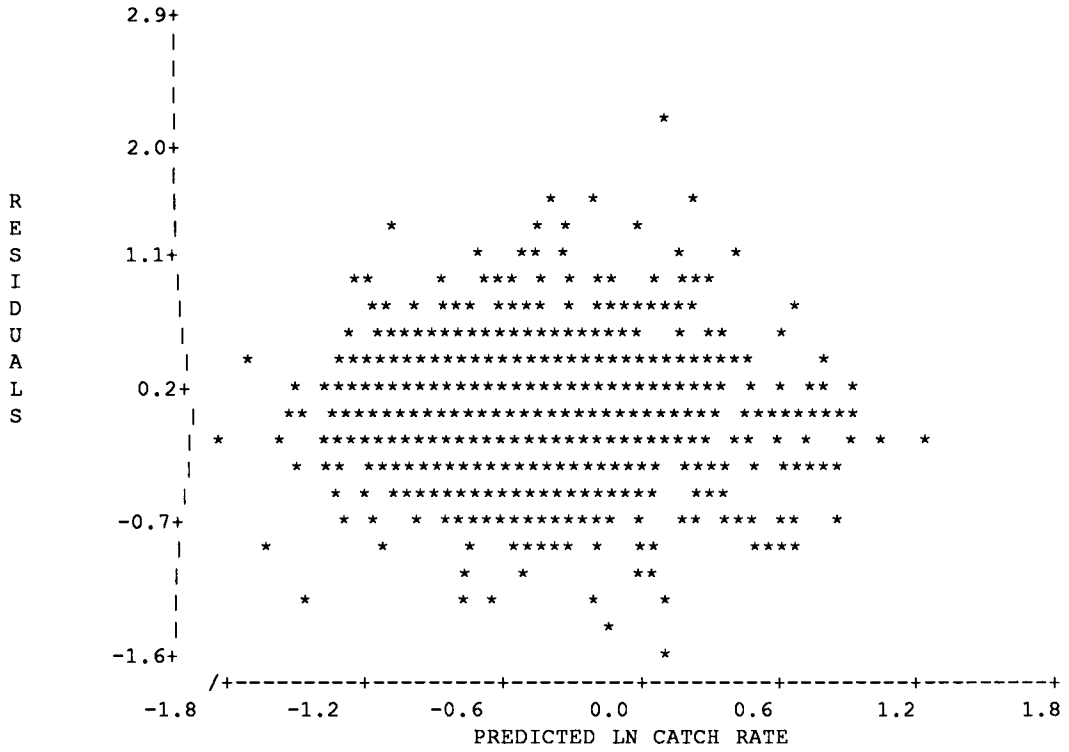


Fig. 4b: Location of fishing sets and catches of redfish during the 1989 acoustic survey.

A. Including percent category.



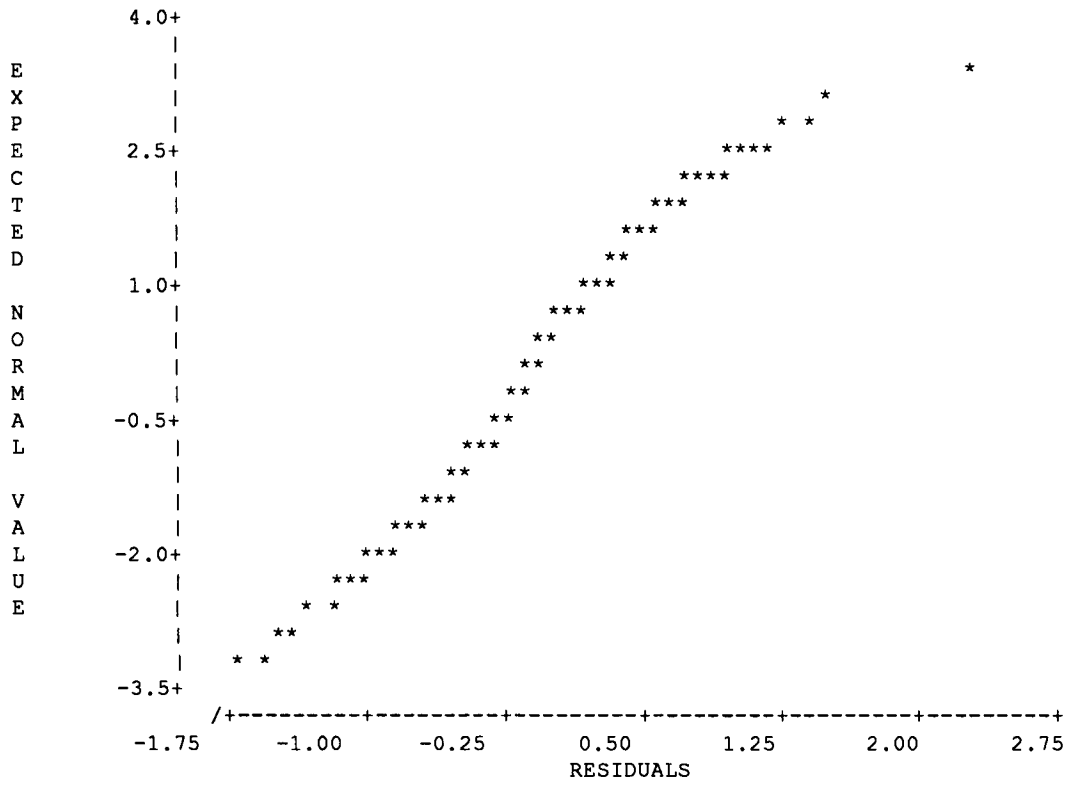
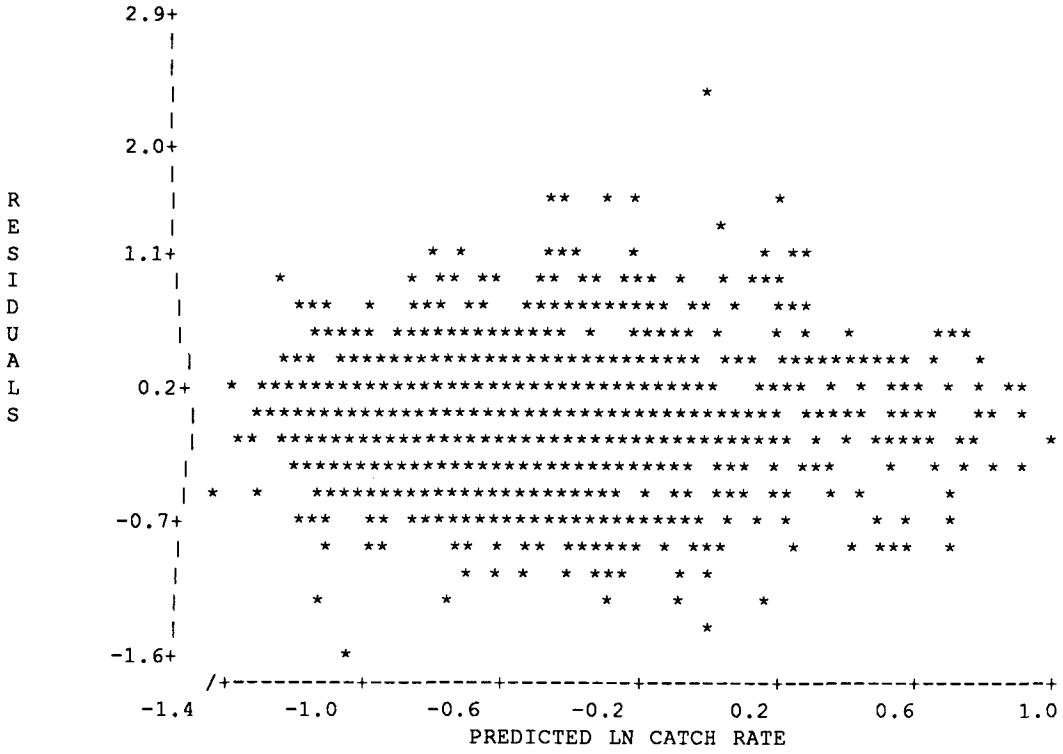


Fig. 5: Residual plots from the multiplicative model for redfish in Div. 3P (A.) including the percent category, and (B.) excluding the percent category.

B. Excluding the percent category



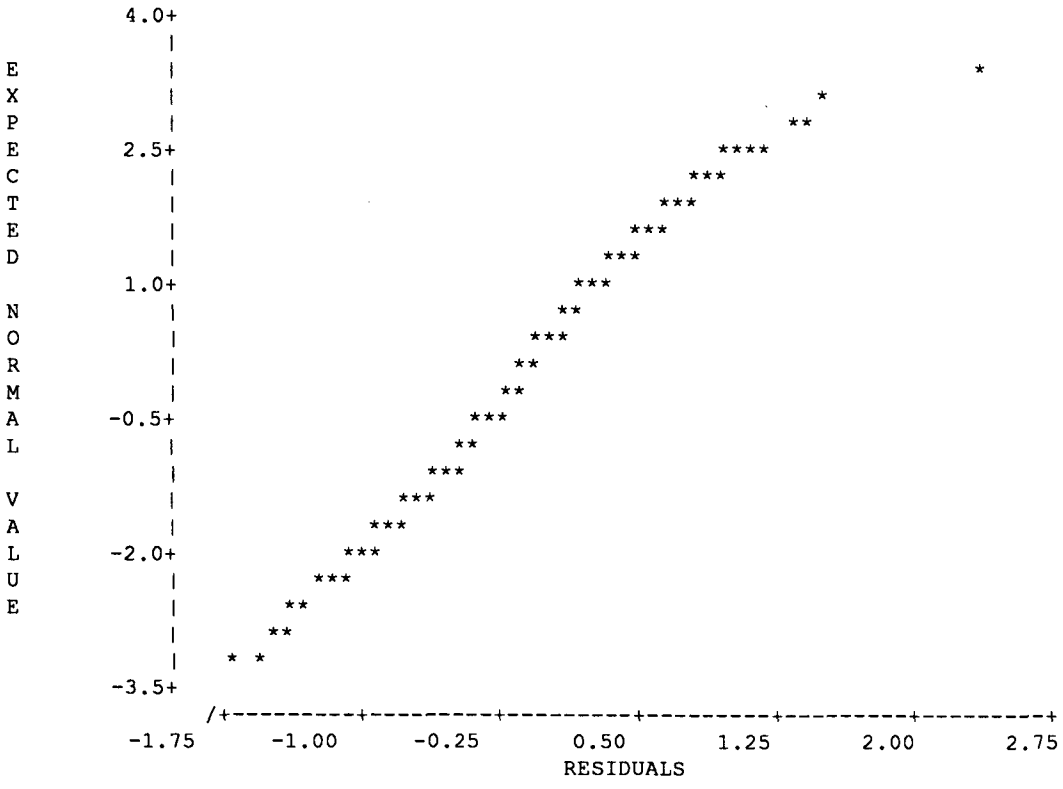
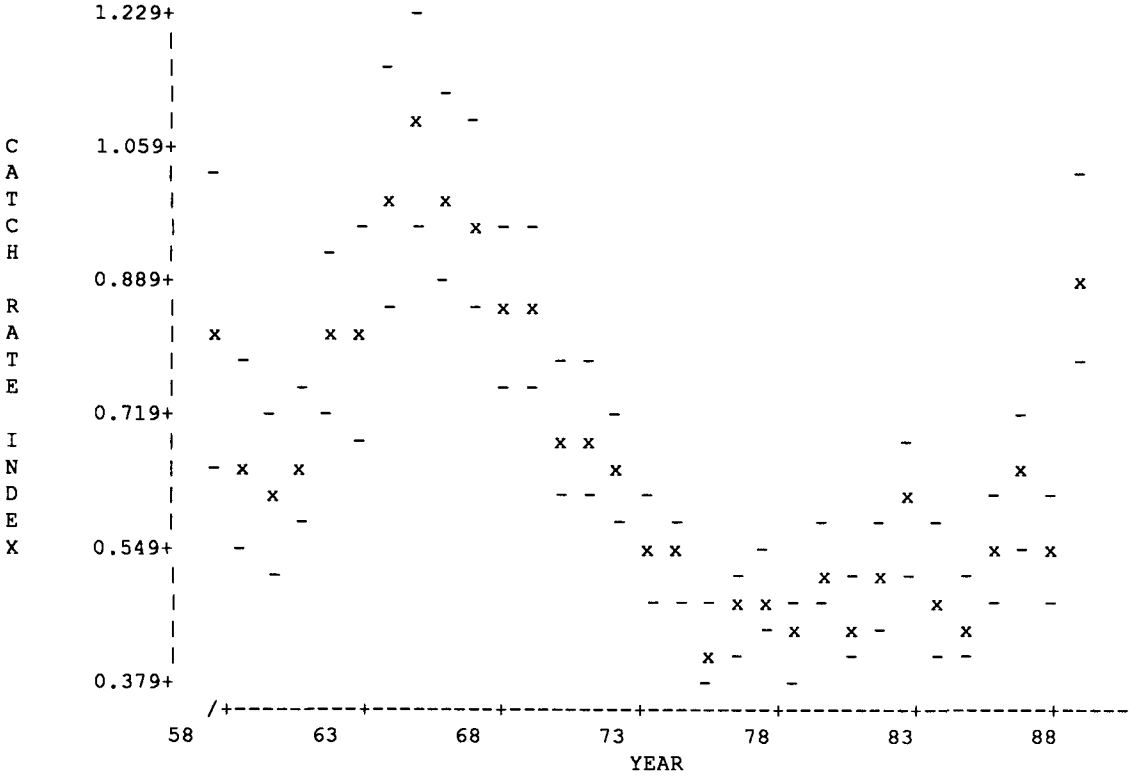


Fig. 5: Continued.

A. Including percent category.



B. Excluding percent category.

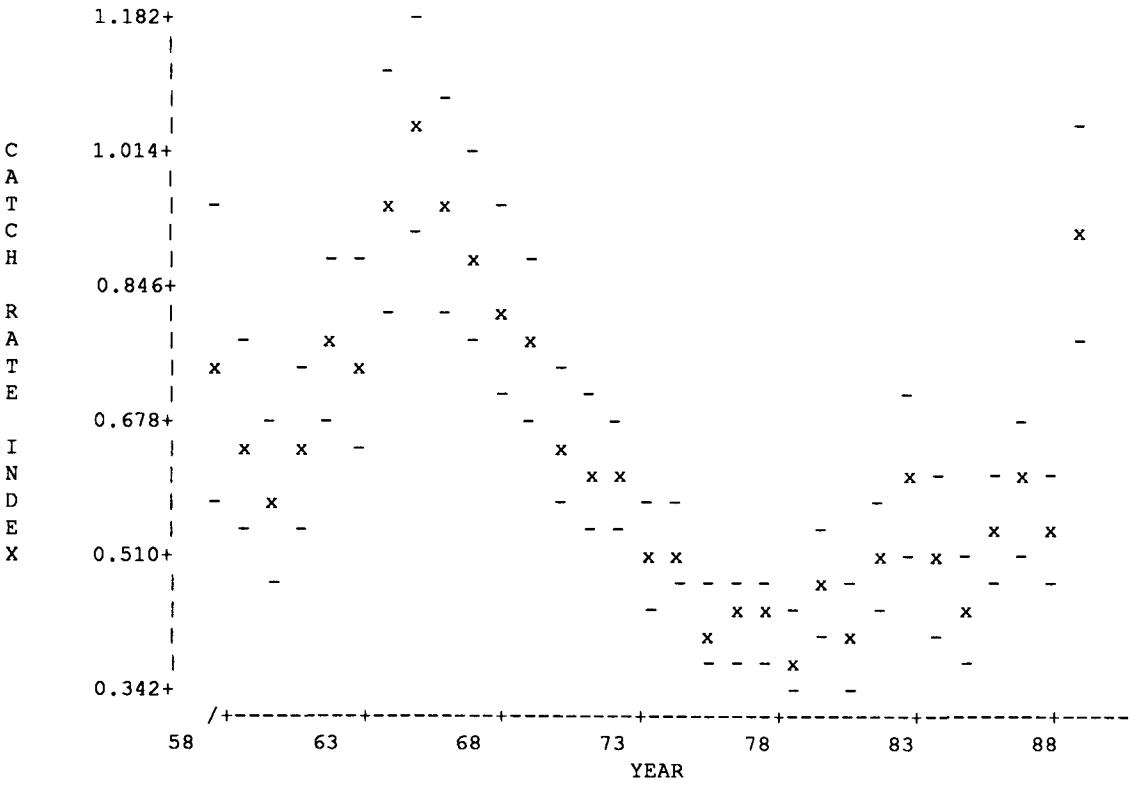


Fig. 6: Standardized catch rates (t/hr) for Div. 3P redfish (A.) including the percent category, and (B.) excluding the percent category.

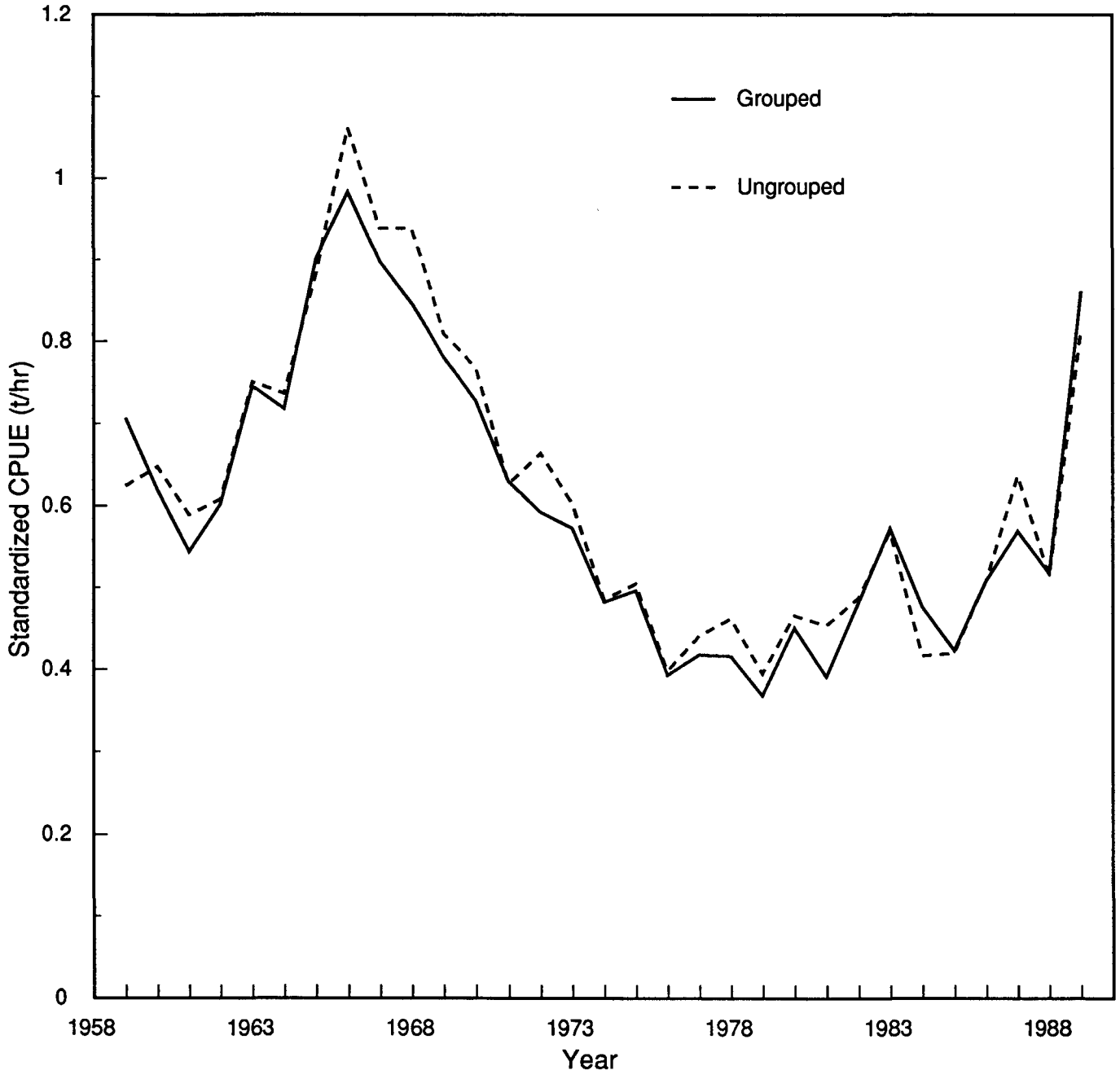


Fig. 7: Comparison of standardized CPUE (t/hr) for redfish in Div. 3P including and excluding the percent category in the multiplicative model.

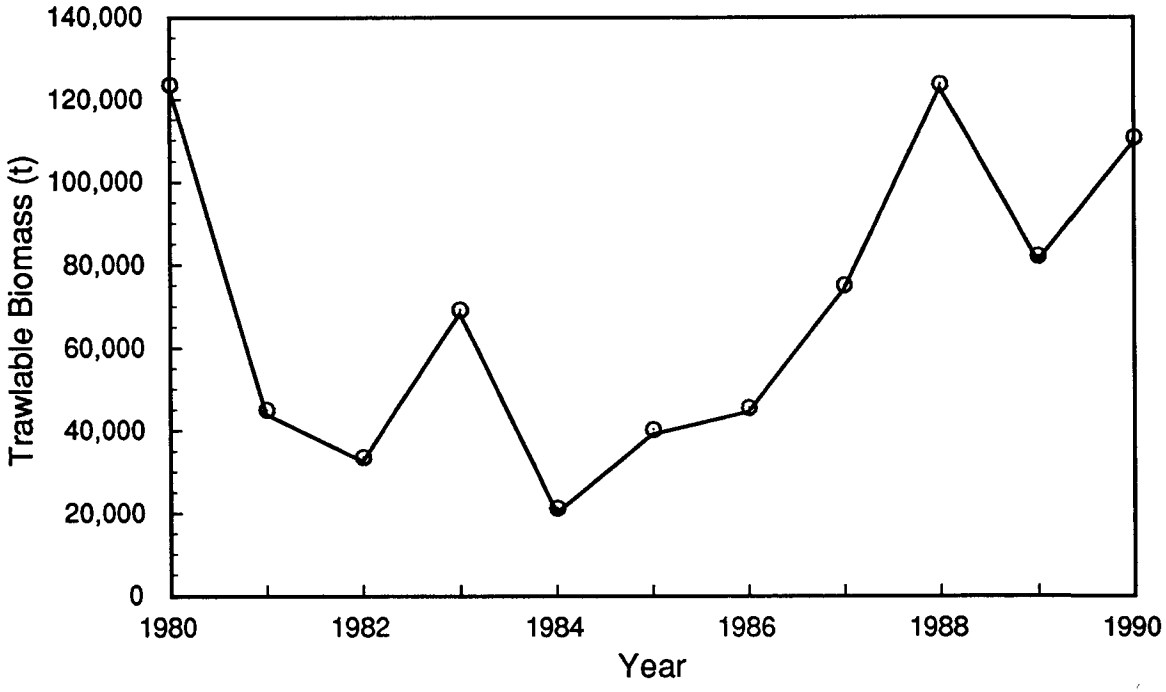


Fig. 8: Trawlable biomass (t) of redfish in Div. 3P from trawling surveys, 1980-1990.

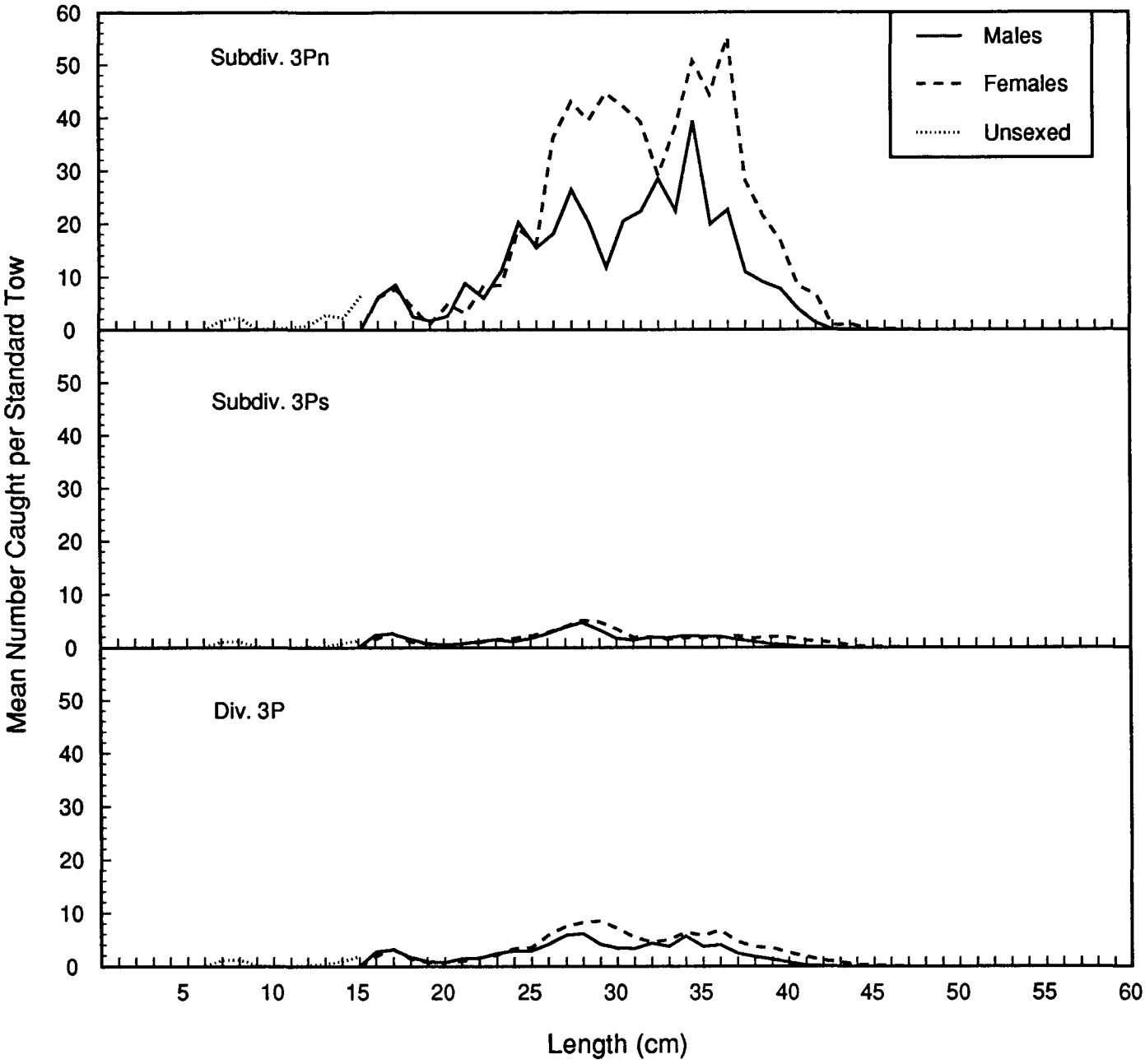


Fig. 9: Length frequencies of redfish caugth during the research survey in Div. 3P in 1990.

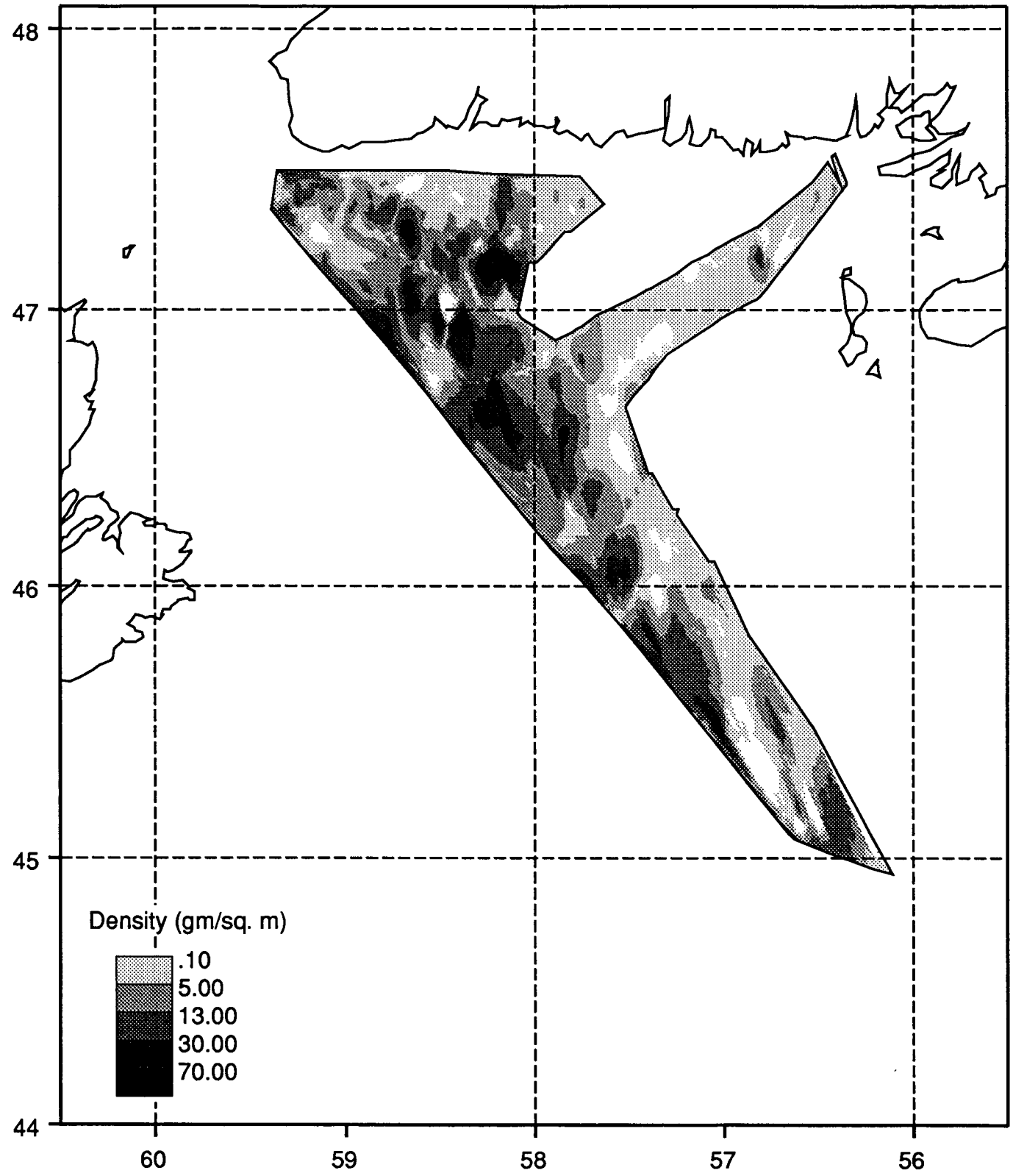


Fig. 10: Distribution of fish densities as determined from the 1988 acoustic survey in Div. 3P.

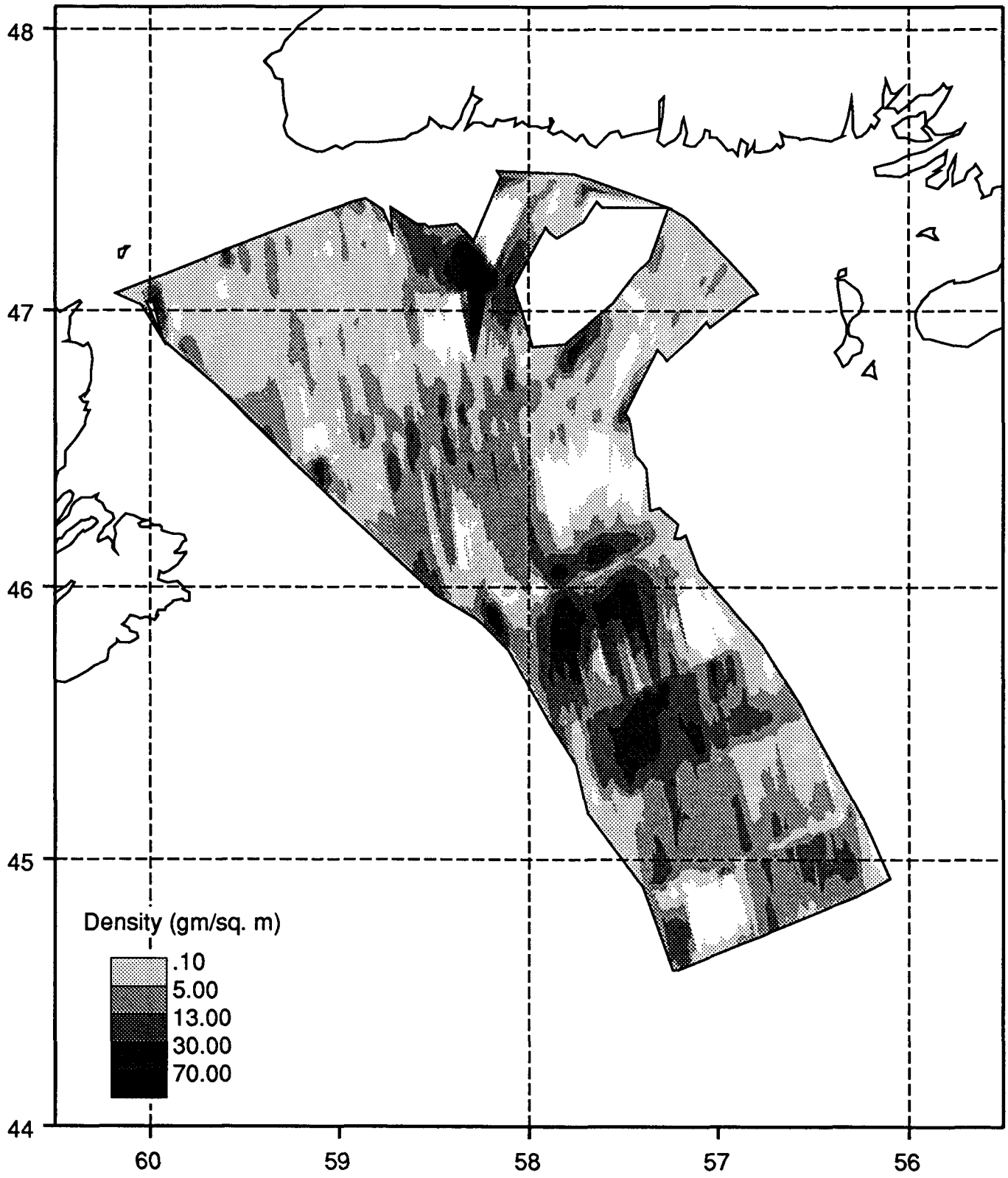


Fig. 11: Distribution of fish densities as determined from the 1989 acoustic survey in Div. 3P4V.