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The Stock Complex of Redfish in NAFO Divisions 3KLNOPs

by

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Introduction

At the June, 1985 meeting of the Scientific Council of NAFO, it was noted that the variability in the catch rate series for Divisions 3LN combined might be partially due to changes in availability of the fish with time due to seasonal and/or yearly migrations (NAFO Redbook 1985, p. 62). Data collected by scientists from the USSR showed that frequencies from Div. 3L resembled those from Div. 3K while those from Div. 3N were more similar to those from Div. 3O.

In light of these, and the suggestion that Div. 3N was an area of mixing, scientists were encouraged to examine their databases in order to clarify these issues (NAFO Redbook 1985, p. 62). This paper reviews the history of the present stock delineations, examines data available from the Canadian and NAFO databases and reviews some of the recent literature in order to examine the relationships of redfish in Divisions 3K, 3L, 3N, 3O and Subdivision 3Ps.

History of the Stocks

In 1961, Mead and Sinderman suggested that, for assessment purposes, three stocks of redfish could be defined in the Northwest Atlantic. These were: Div. 3M, Subarea (SA) 2 + Div. 3K and 3L, and Div. 3O + 3P + SA 4 and 5. They noted that the latter two stocks intermingled in Div. 3N but pointed out that the situation in this area was not clear. Travin et al. (1962) concluded that, on the basis of morphometric and parasite differences, SA 3 could be divided into a northern stock (Div. 3K + northern 3L), a Flemish Cap (3M) stock, and a south Newfoundland (Div. 3N, 3O and 3P) stock. They also determined that intermingling occurred in Div. 3N and the southern part of 3L. Based on the distribution of larvae, Bainbridge and Cooper (1971) concluded that three stocks as defined by Mead and Sinderman above existed in the Northwest Atlantic.

Assessment of the various redfish stocks began in the mid 1970's. Parsons and Parsons (1975) separated the redfish of Div. 3O and 3P based on differences in growth rates in the two areas observed by Sandeman (1969). They also separated redfish from the northern and eastern Grand Bank area (Div. 3L and 3N) from those in Div. 3O and 3P based on the conclusions of Mead and Sinderman (1961) and Bainbridge and Cooper (1971) above. They combined the data from Div. 3L and 3N since there was not adequate evidence to indicate that they were separate stocks. Thus their paper dealt with the assessment of three 'stocks'; Div. 3LN, Div. 3O and Div. 3P.

Later, Parsons, Pinhorn and Parsons (1976) presented assessments of two other 'stocks'; SA 2 + Div. 3K and Div. 3M. The separation of Div. 3M was not difficult as all previous studies had indicated that redfish on Flemish Cap constitute a self-contained stock. The authors stated that the relationship of redfish in Div. 3L to those in the more northern areas was uncertain. They also pointed out that Div. 3L had previously been combined with Div. 3N for assessment purposes. The authors treated the redfish in SA 2 + Div. 3K as a unit stock based on "current ICNAF practice". The origin of this "current ICNAF

practice" is obscure. The separation of redfish, for assessment purposes, along the boundaries described above (SA 2 + Div. 3K, Div. 3M, Div. 3LN, Div. 3O and Div. 3P) has continued to the present.

Nikolskaya (1981) concluded that S. mentella of Div. 3L differed from those of Div. 3NO based on growth rates, maximum age and dominant sizes and ages. He stated that separate assessments should be carried out on redfish of the northeastern slope of the Grand Bank (Div. 3L) and the southern slopes of the Grand Bank (Div. 3NO).

Methods and Results

Research frequencies of beaked redfish (S. mentella and S. fasciatus) from Canadian research cruises to Div. 3K (fall), 3L, 3N, 3O (spring) and 3P (spring) for the years 1978-1985 were grouped by depth range (151-250m, 251-350m, 351-450m, 451-550m and >550m) and the results from each year plotted. The results (Fig. 1-7) indicate that there are not consistent, clear cut differences in the frequencies between Divisions. The similarities, as determined subjectively, are summarized in Table 1. It is obvious that a wide range of similarities and differences exist. Data were not available for 1983.

Catch and effort data broken out by Division were extracted from ICNAF/NAFO statistics for the period 1959-1984 and combined with preliminary Canadian data for 1985. These were input into a multiplicative model (Gavaris 1980) to derive a standardized catch rate series for each Division separately. The criteria for selection of data are the same as used by Atkinson and Power (MS 1986). The catch rate series were then standardized to their respective means and plotted in pairs. There is no catch rate available for Div. 3O in 1968 so the plotted value represents the mean of 1967 and 1969. The results (Fig. 8) indicate firstly, that something happened in Div. 3K, 3L and 3N in 1974. Catch rates dropped significantly in Div. 3L but increased just as significantly in Div. 3K and 3N at the same time. This might suggest a mass migration of fish from Div. 3L into Div. 3K and 3N although a reason for this possible movement is not known.

A comparison of catch rates in Div. 3K and 3L indicates that annual variability is greater in Div. 3L but trends with time are only present in Div. 3K. Catch rates in Div. 3Ps are different from those in Div. 3O. The meaning of the trends in rates when comparing Div. 3L, 3N and 3O is less clear. In some years, the trends are in opposite directions (eg. 1959-1967 for Div. 3L and 3N, 1968-1975 for Div. 3N and 3O), but during other periods, the trends are in the same direction (eg. 1978-1985 for Div. 3L and 3N and for Div. 3N and 3O).

Discussion

An examination of both research frequencies and catch rates suggests that the redfish in Div. 3O are different from those in Div. 3Ps and it is appropriate to manage these as separate entities. The original justification for separation of Div. 3O and 3P - differing growth rates, is interesting but not necessarily valid. Sandeman (1969) found that redfish in Div. 3P had faster growth rates than those in Div. 3O and this fact was noted by Parsons and Parsons (1975) when justifying the separate assessment of the redfish in these two Divisions. Sandeman also found that in Div. 2J, the redfish in deeper water had faster growth rates than those in shallower water. According to Ni (1982) the deeper waters of Div. 2J contain S. mentella while a mixture of S. mentella and S. fasciatus reside in shallower waters. These two sets of findings would imply that S. fasciatus has a slower growth rate than S. mentella. A comparison of the distribution with depth of the two species in Div. 3O and 3P as determined by Ni (1982) and the depths from which Sandeman's (1969) samples were taken (82-210m in Div. 3O and 220-330m in Div. 3P) would lead to the conclusion that the Div. 3O sample was S. fasciatus while the Div. 3P sample contained a mixture of the two species. It could then be predicted that the redfish sample from Div. 3O would exhibit a slower growth rate than the sample from Div. 3P.

The situation with the other Divisions is less clear. Catch rates in Div. 3K and 3L do not show opposing trends over most of the period (except 1973-1975). The fluctuations in catch rates in Div. 3L and 3N and Div. 3N and 3O may indicate movement of fish between Divisions but this is unclear. The research frequencies reveal similarities between Div. 3K and 3L and Div. 3N and 3O at times, but there are also occasions when frequencies from Div. 3L most

closely resemble those from 3N. There were insufficient data to enable any season-by-season comparisons, but the surveys to Div. 3L and 3NO are all conducted in the spring so similarities/differences are not due to any seasonal migrations.

Templeman and Squires (1960) found differing levels of Sphyrion lumpi infestation in the different Divisions. Based on external examination, their data indicated a close similarity between redfish in Div. 3K and 3L (low infestation) while the redfish in Div. 3N were more heavily infested. Infestation was less again along the southwest slope of the Grand Bank (Div. 3O). Internal examination suggested that redfish in the southern 2/3's of Div. 3L were different from those in both Div. 3K and 3N (ie. they had 'zero' infestation). The differences between Div. 3N and 3O were again apparent.

Bourgeois and Ni (1984) determined, from an examination of parasites, that the beaked redfish of Div. 2H, 2J, 3K and 3L likely form a separate stock. Their database did not allow a comparison of redfish in Div. 3L, 3N and 3O.

Ni and Sandeman (1984) found that the size of maturity of beaked redfish in Div. 3L is closer to that of the beaked redfish in Div. 3K than those in Div. 3N. The size at maturity in Div. 3N was closer to that in Div. 3O.

Conclusions

The results presented do not give a clear indication of the relationships between redfish in the different Divisions examined. It is most probable that the picture is confounded by the existence of more than one species (S. mentella and S. fasciatus) as described by Ni (1982) and results from combined data may give a different picture than data separated by species. Given however, that at present, management is based on a species mix, it is worthwhile to examine the data in a mixed state in an attempt to determine the best possible management units.

The data indicate that the redfish of Div. 3O and 3P should be managed as separate units. The available data indicate considerable similarity between the redfish in Div. 3K and those in Div. 3L. It may therefore be appropriate to change the management unit to SA 2 + Div. 3KL. The position of redfish in Div. 3N is not clear. The frequencies indicate similarities with both Div. 3L and 3O depending on the year and depth. The catch rates suggest that on occasion, there is movement of redfish between Div. 3N and 3L and Div. 3N and 3O. These apparent movements are not predictable however, and are therefore probably not the result of any inherent biological trait. Rather, they may represent a response to some environmental factor. Mead and Sinderman (1961) noted that the situation in Div. 3N was unclear. This same situation exists today. It may be an area of mixing as suggested by Mead and Sinderman (1961) or it may be a separate unit as suggested by the work of Templeman and Squires (1960). Further work is necessary to clarify this.

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Table 1: Summary of similarities and differences in redfish frequencies as determined from Canadian research cruises to Div. 3K, 3L, 3N, 3O and 3Ps, 1978-1986.

Figure	3K-3L	3L-3N	3N-3O	3O-3Ps
1a	X		X	
1b		X		
1c		X		
1d	X			
2a	X		X	
2b			X	
2c		X		
2d		X		
2e				
3a		X		
3b				X
3c		X		
3d				
3e		X		
4a	X		X	
4b	X		X	
4c	X		X	
4d				
5a		X		
5b				
6a	X			
6b	X		X	
6c				
7a	X			
7b				

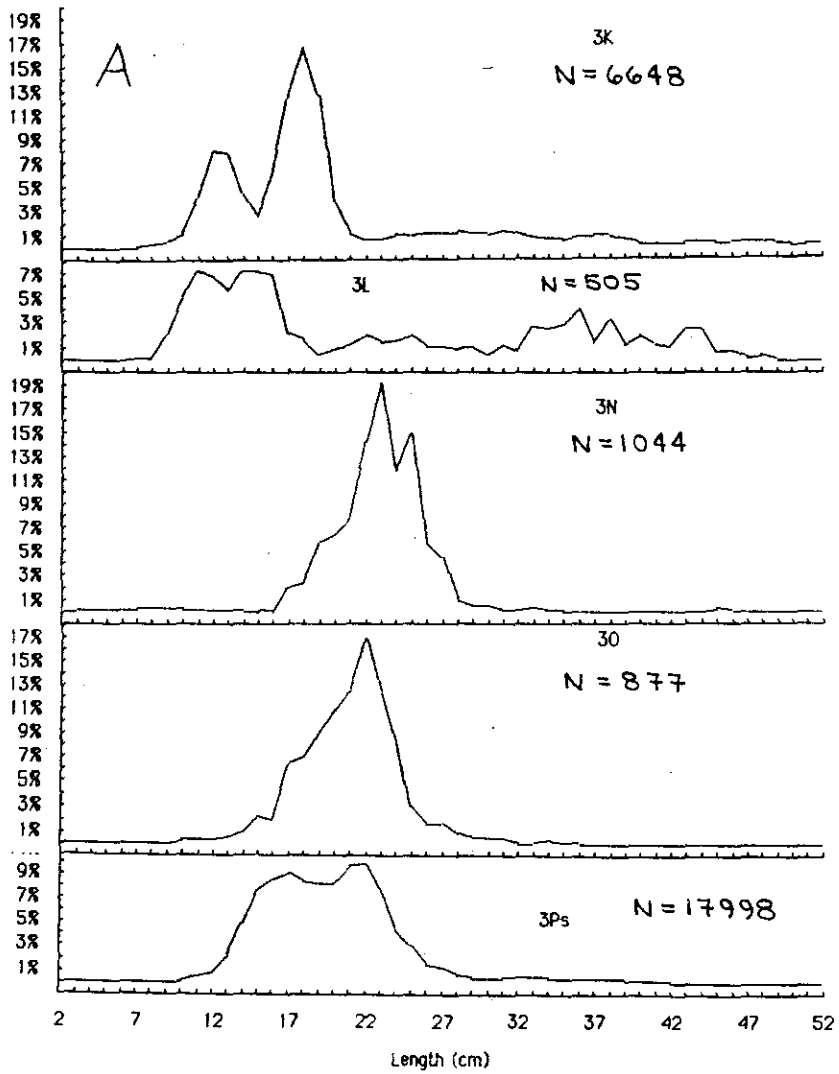


Fig. 1a: Length frequencies of redfish by Division from Canadian research cruises, 1978 (151-250m).

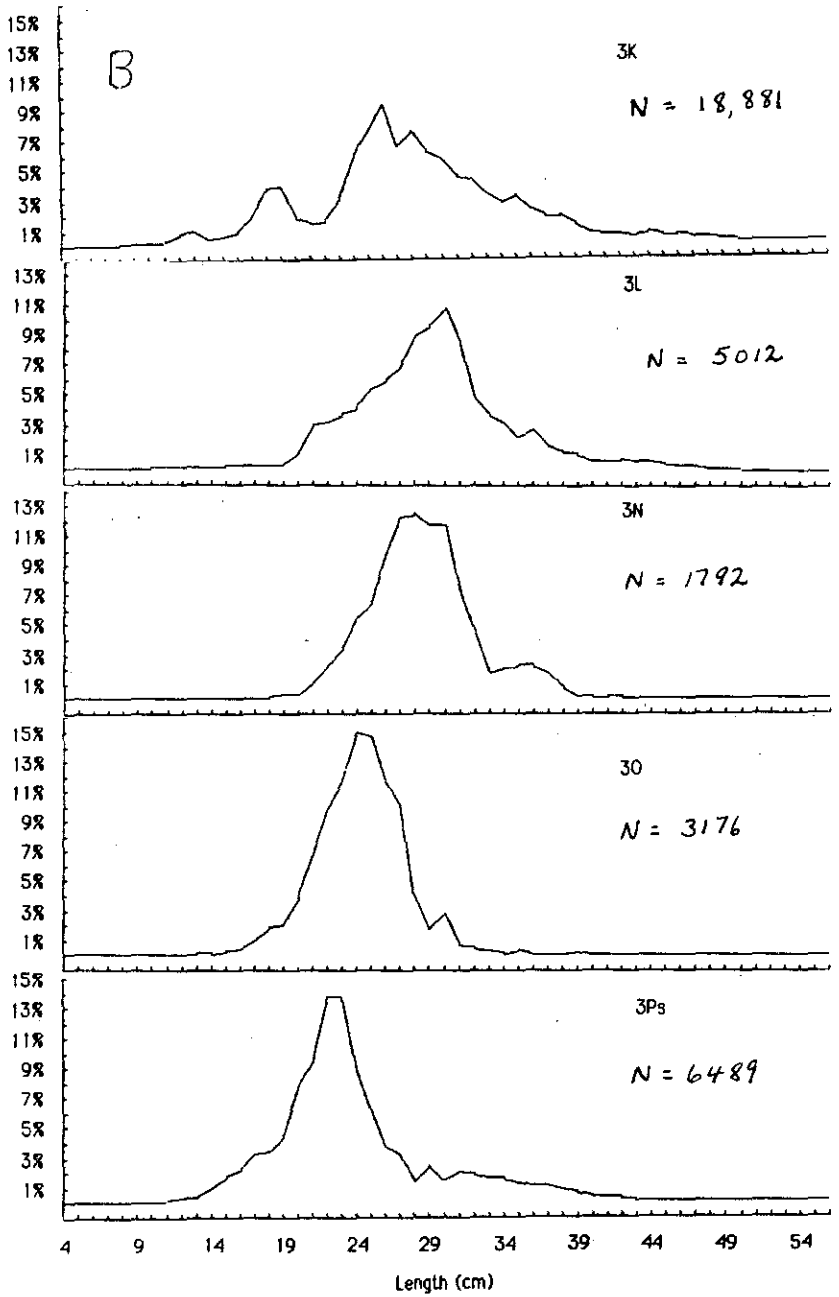
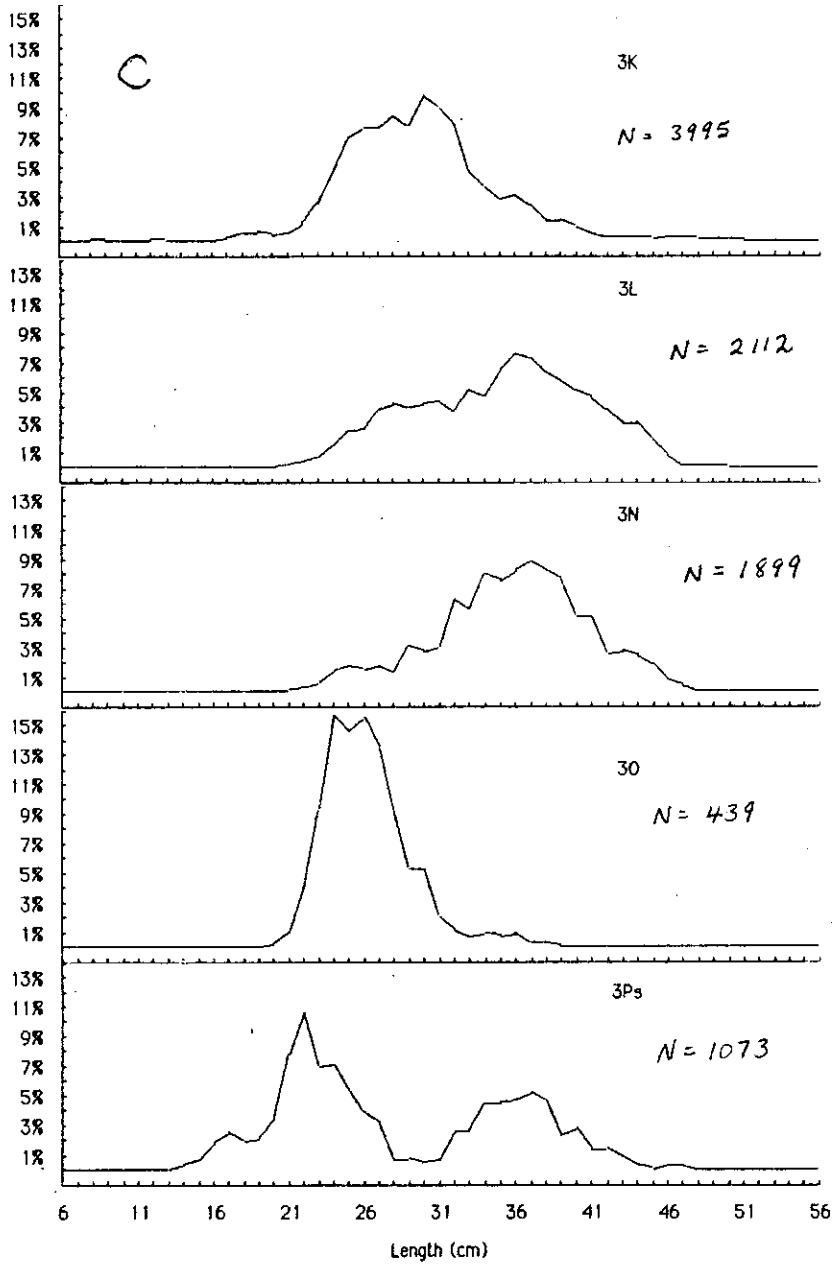


Fig. 1b: Length frequencies of redfish by Division from Canadian research cruises, 1978 (251-350m).



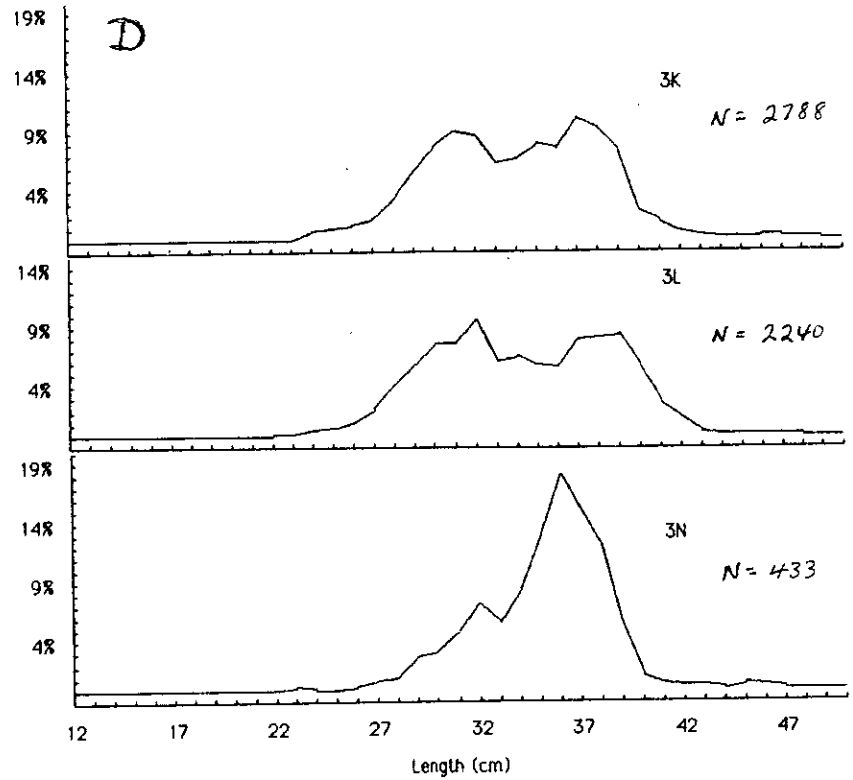


Fig. 1c: Length frequencies of redfish by Division from Canadian research cruises, 1978 (351-450m).

Fig. 1d: Length frequencies of redfish by Division from Canadian research cruises, 1978 (>550m).

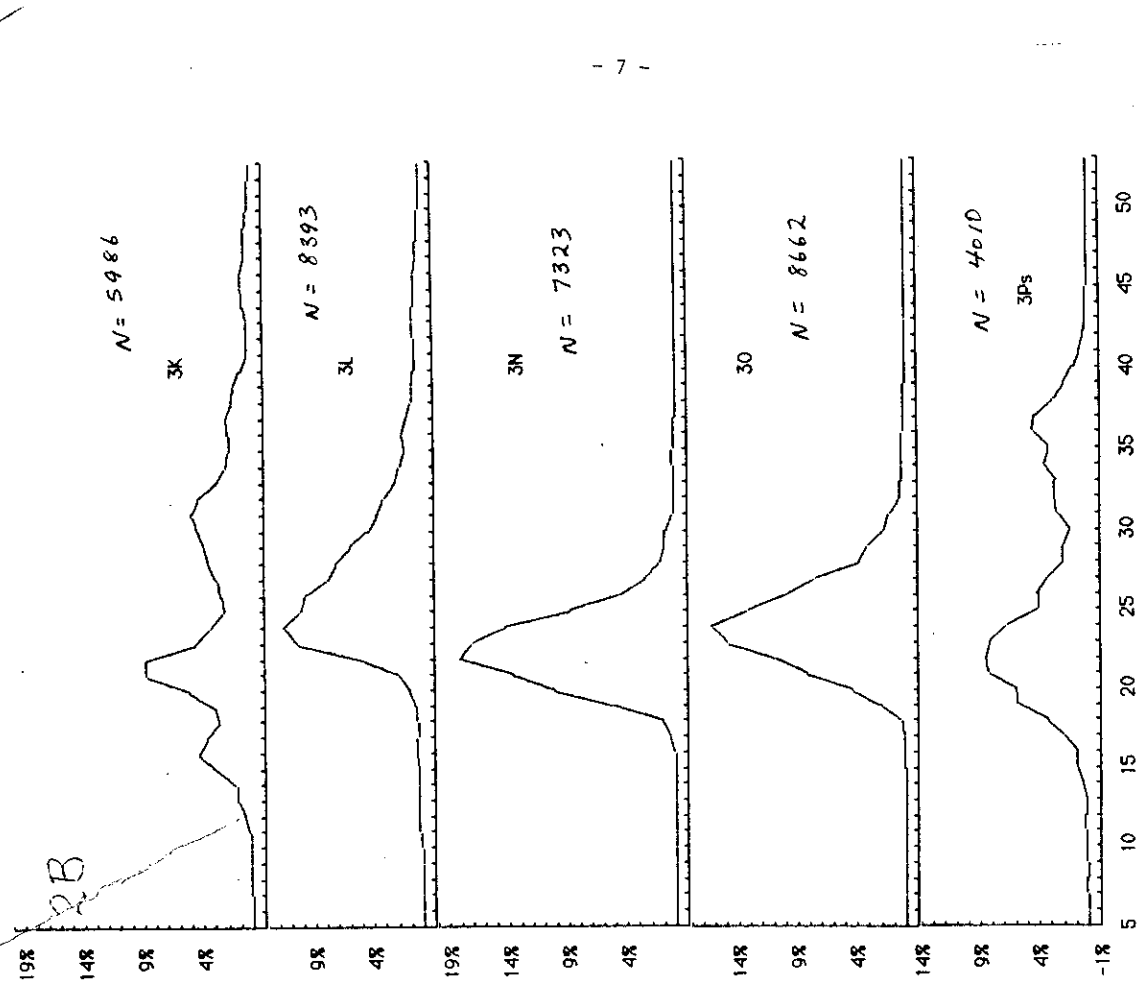
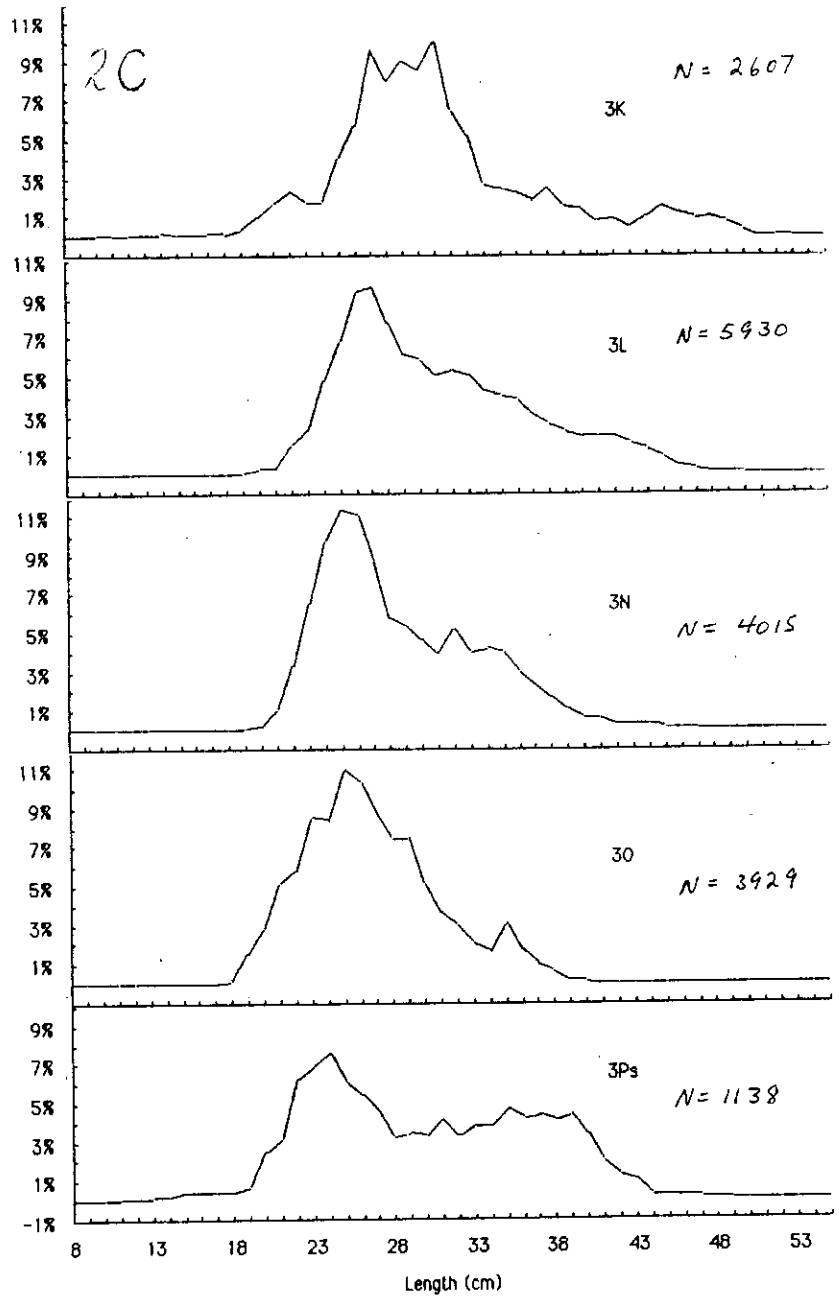


Fig. 2a: Length frequencies of redfish by Division from Canadian research cruises, 1979 (151-250m).

Fig. 2b: Length frequencies of redfish by Division from Canadian research cruises, 1979 (251-350m).



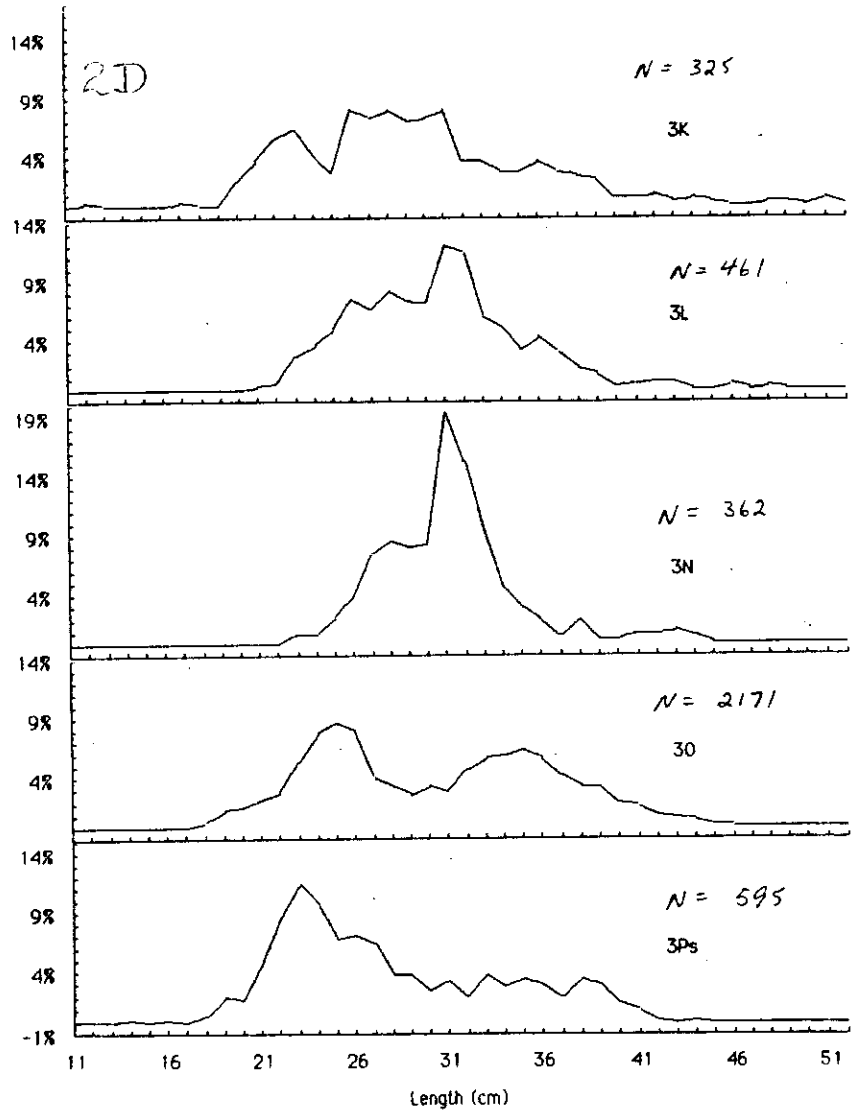


Fig. 2c: Length frequencies of redfish by Division from Canadian research cruises, 1979 (351-450m).

Fig. 2d: Length frequencies of redfish by Division from Canadian research cruises, 1979 (451-550m).

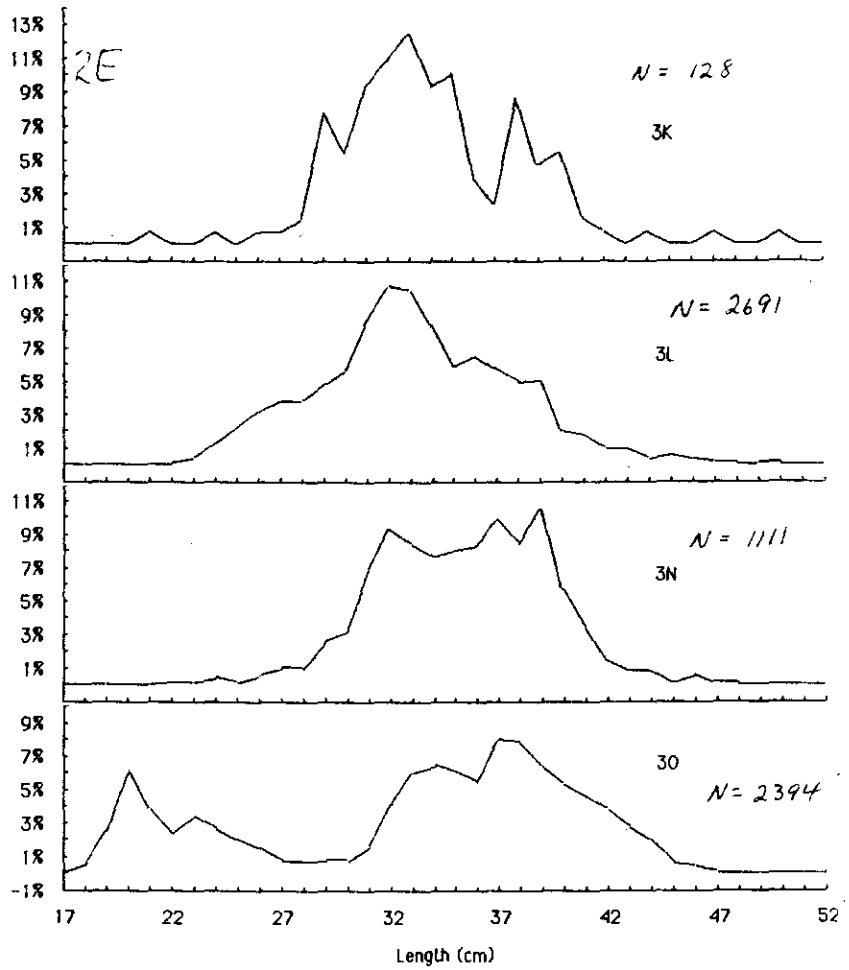


Fig. 2e: Length frequencies of redfish by Division from Canadian research cruises, 1979 (>550m).

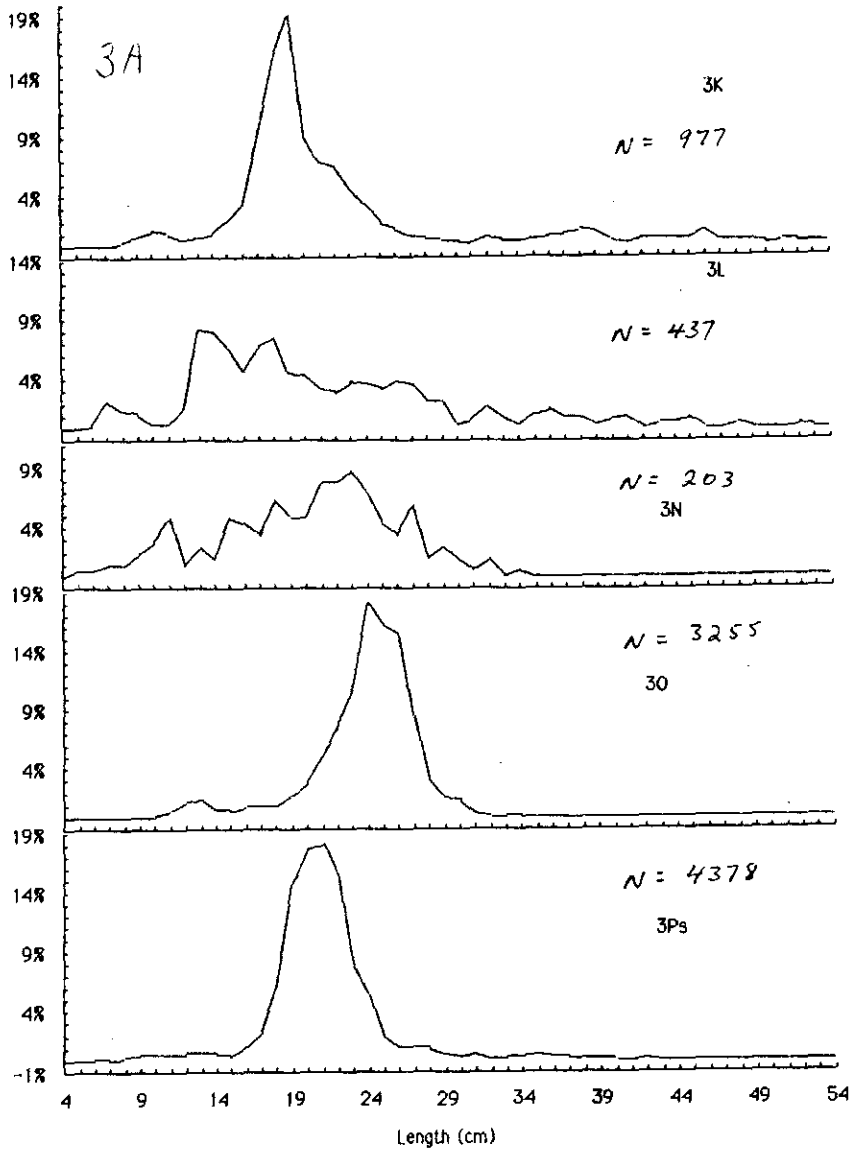


Fig. 3a: Length frequencies of redfish by Division from Canadian research cruises, 1980 (151-250m).

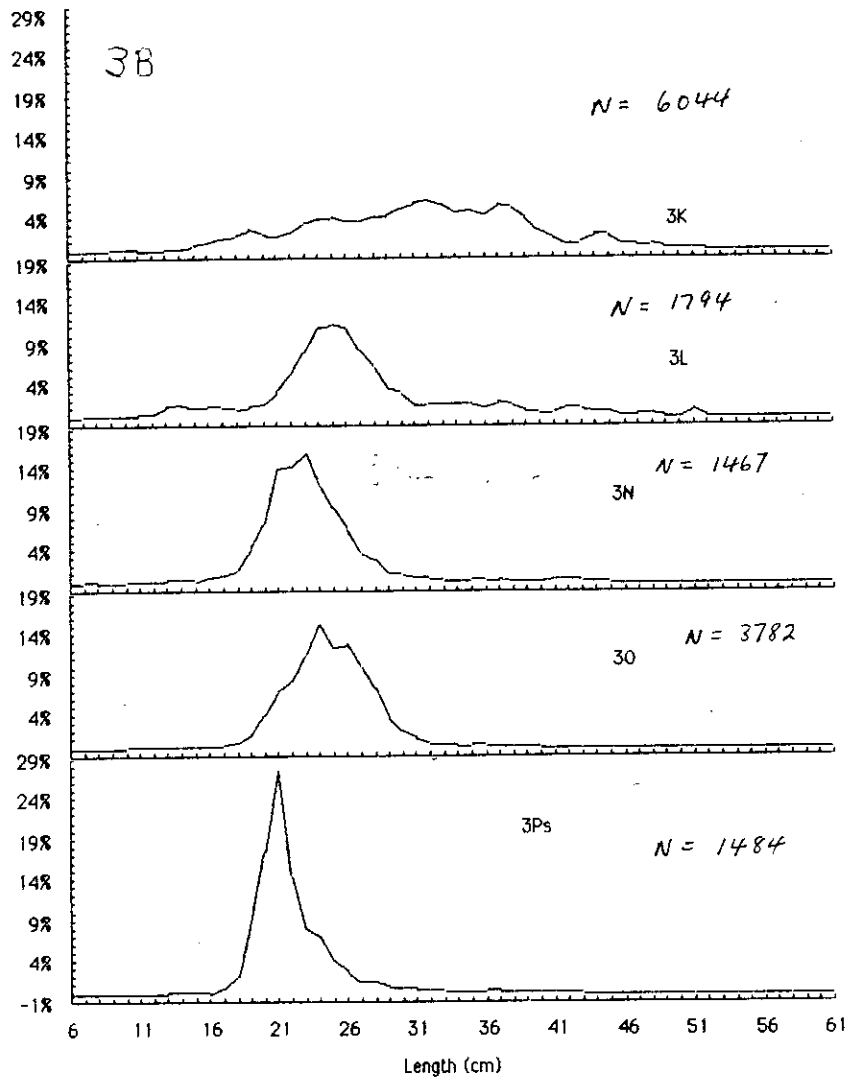


Fig. 3b: Length frequencies of redfish by Division from Canadian research cruises, 1980 (251-350m).

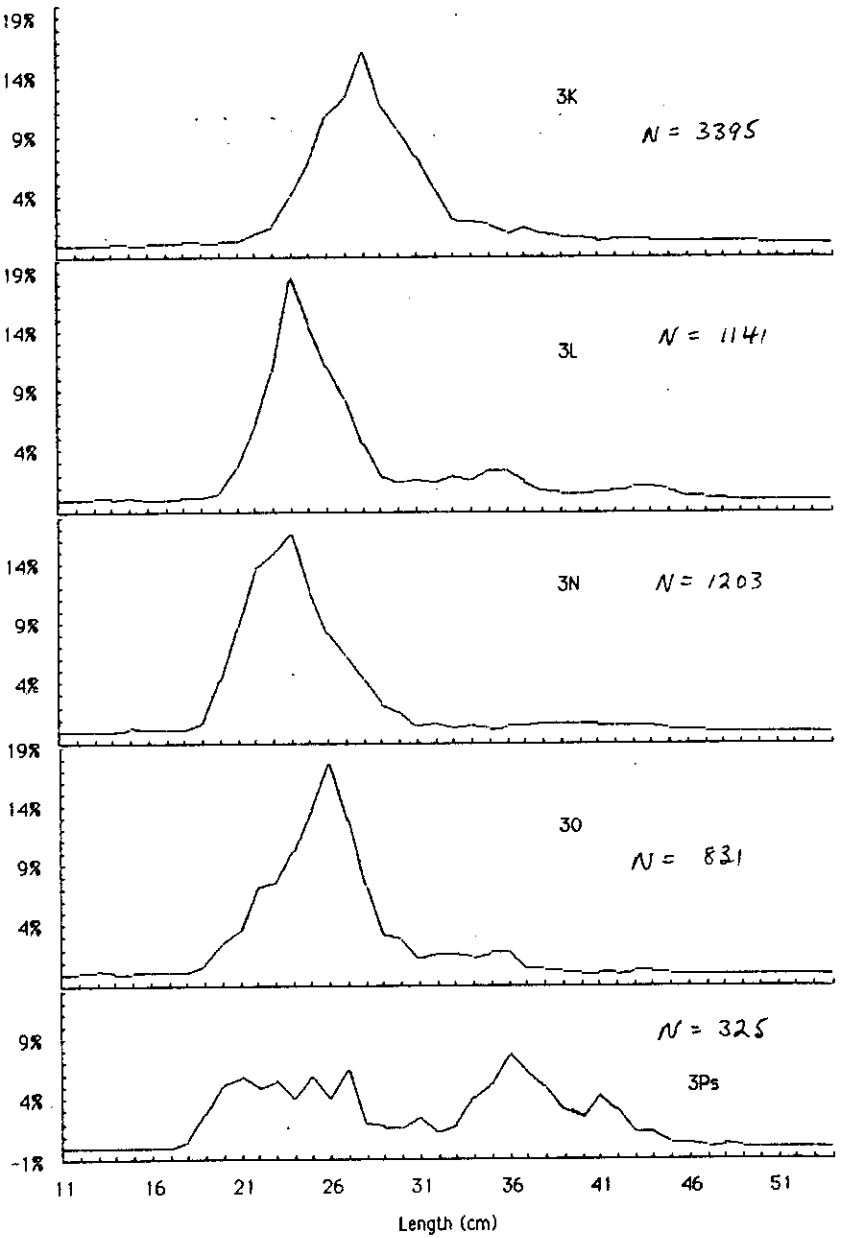


Fig. 3c: Length frequencies of redfish by Division from Canadian research cruises, 1980 (351-450m).

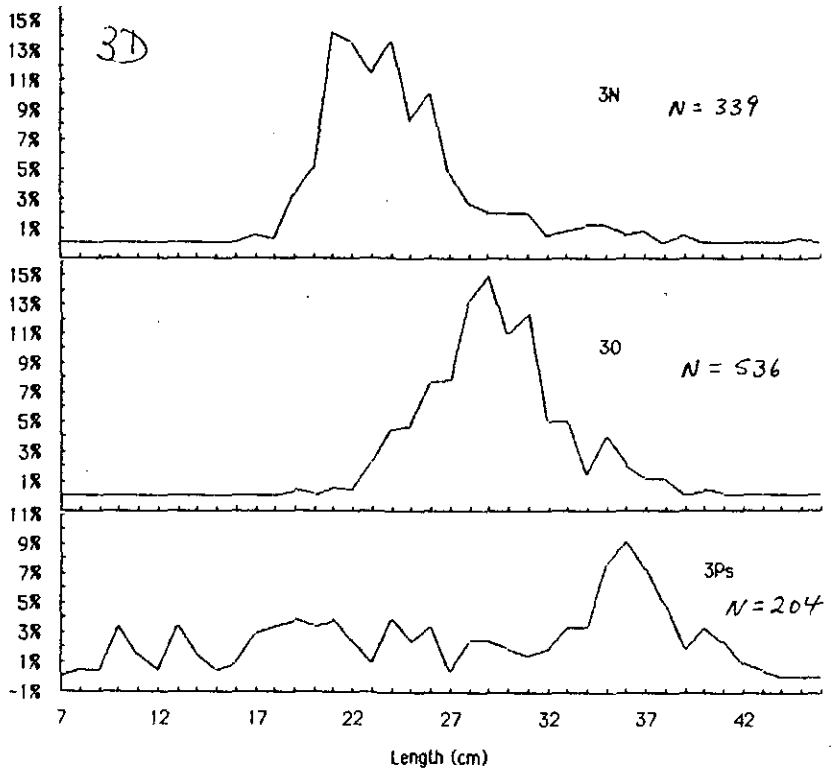


Fig. 3d: Length frequencies 5f redfish by Division from Canadian research cruises, 1980 (451-550m).

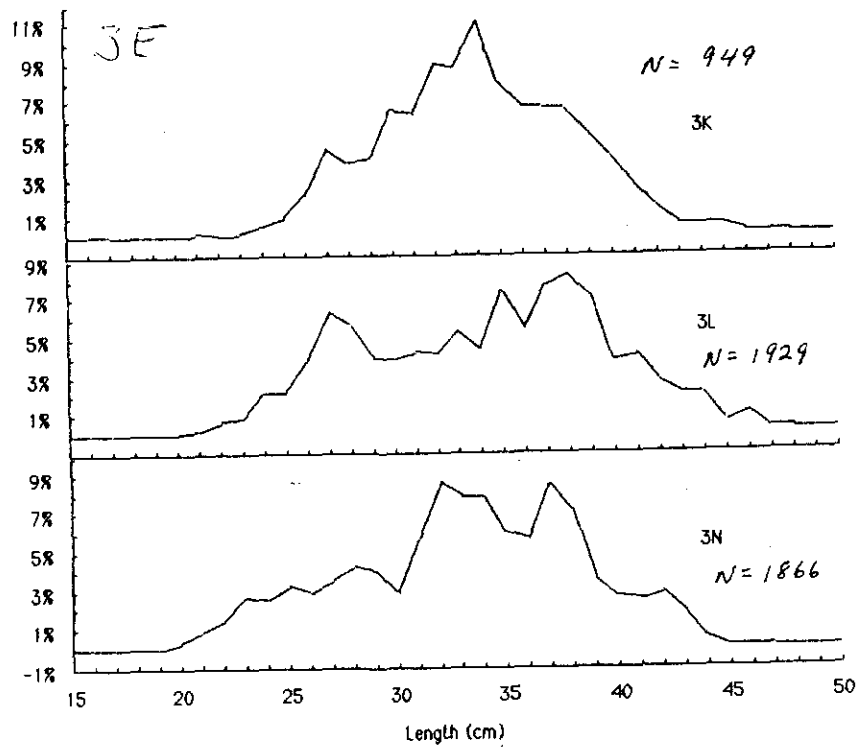


Fig. 3e: Length frequencies 5f redfish by Division from Canadian research cruises, 1980 (>550m).

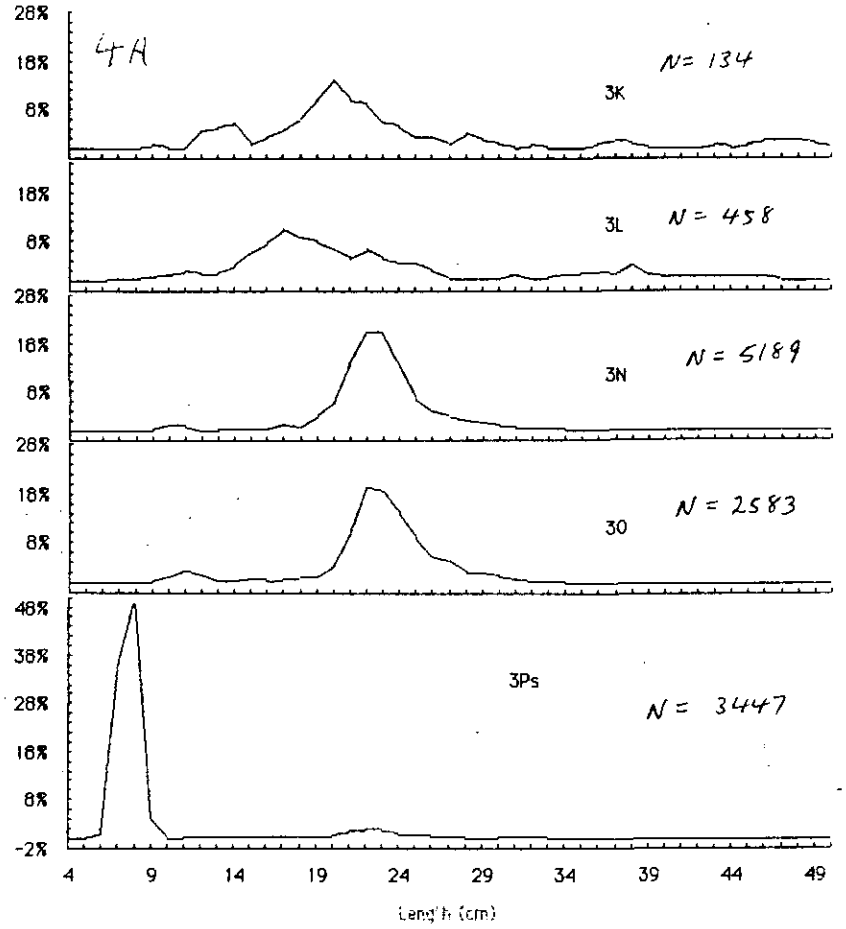


Fig. 4a: Length frequencies 5f redfish by Division from Canadian research cruises, 1981 (151-250m).

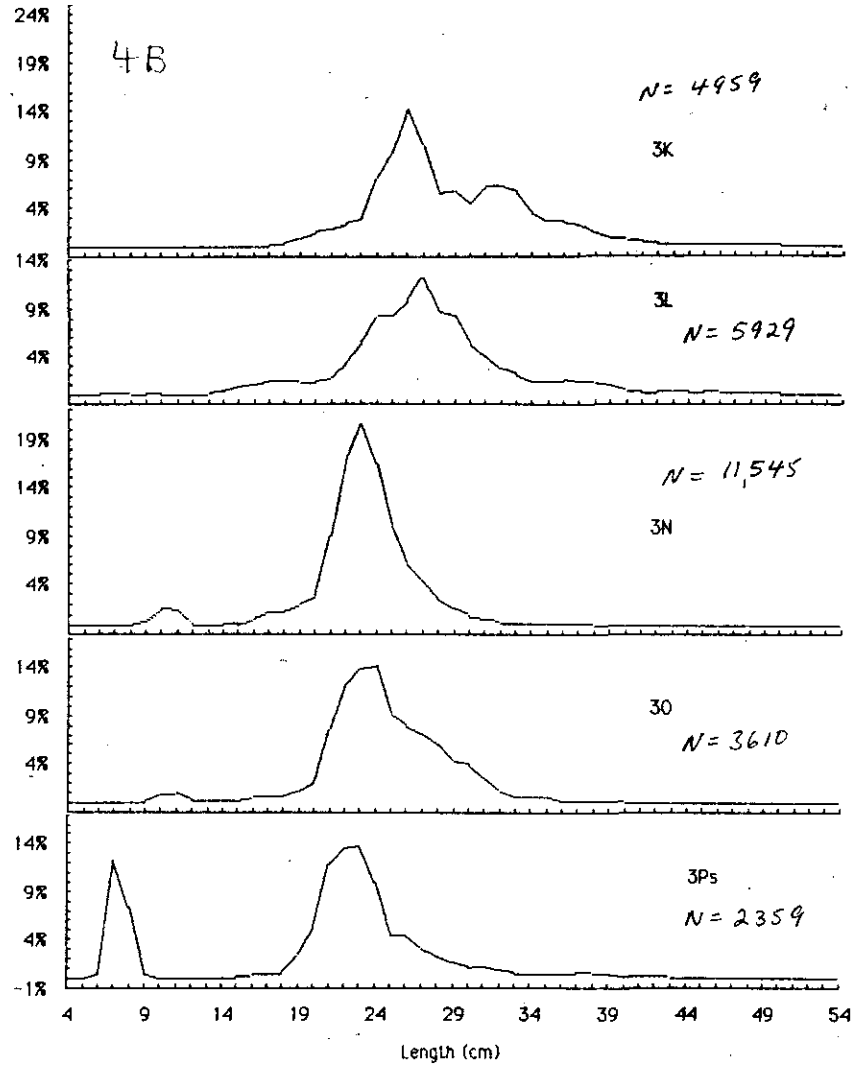


Fig. 4b: Length frequencies 5f redfish by Division from Canadian research cruises, 1981 (251-350m).

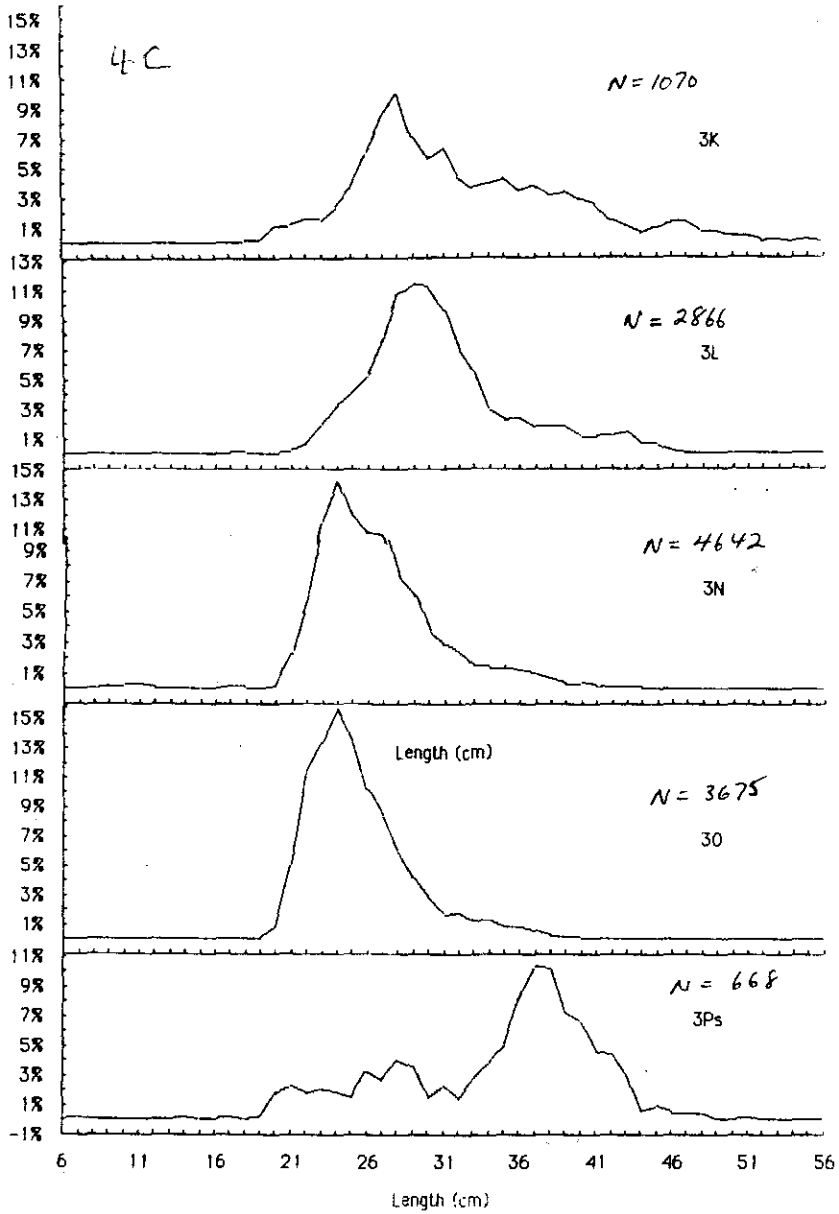


Fig. 4c: Length frequencies 5f redfish by Division from Canadian research cruises, 1981 (351-450m).

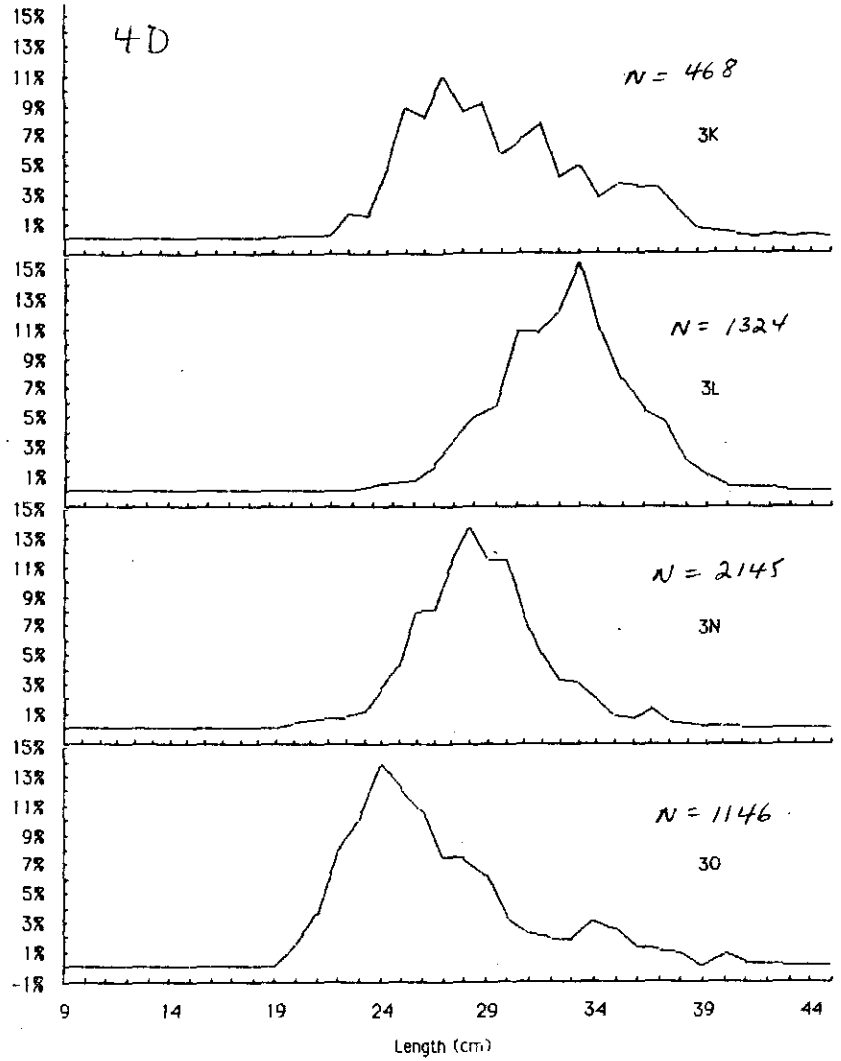


Fig. 4d: Length frequencies 5f redfish by Division from Canadian research cruises, 1981 (>550m).

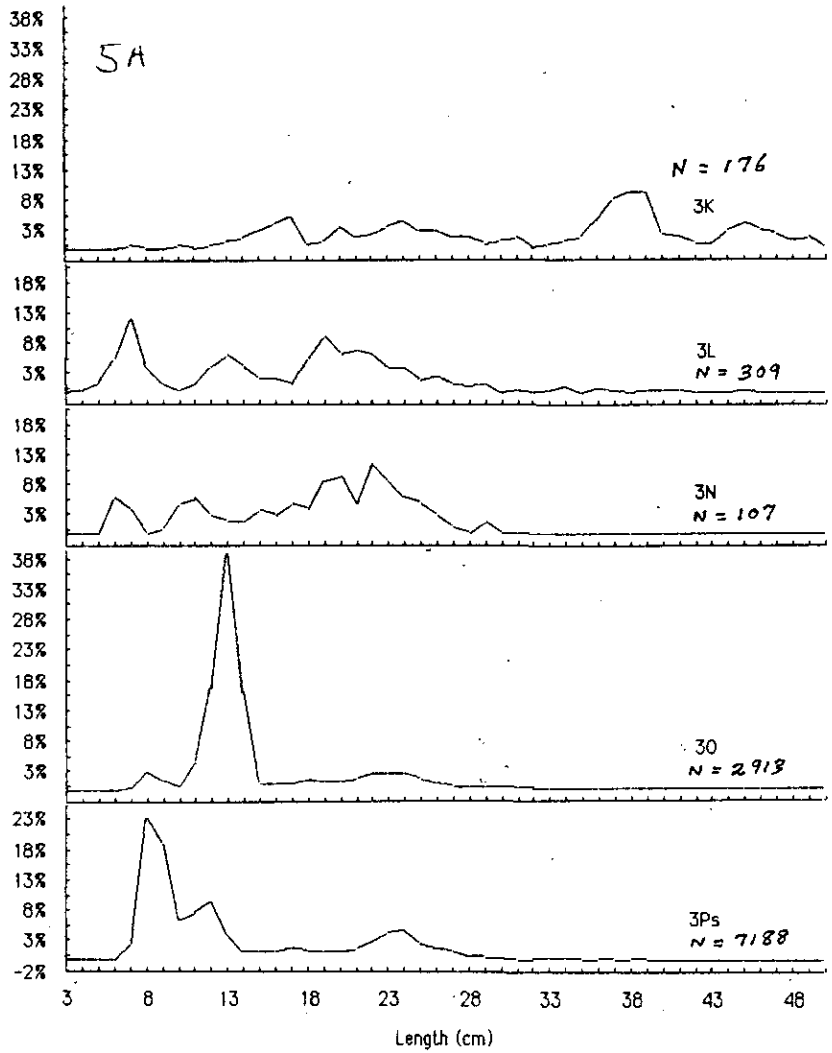


Fig. 5a: Length frequencies of redfish by Division from Canadian research cruises, 1982 (151-250m).

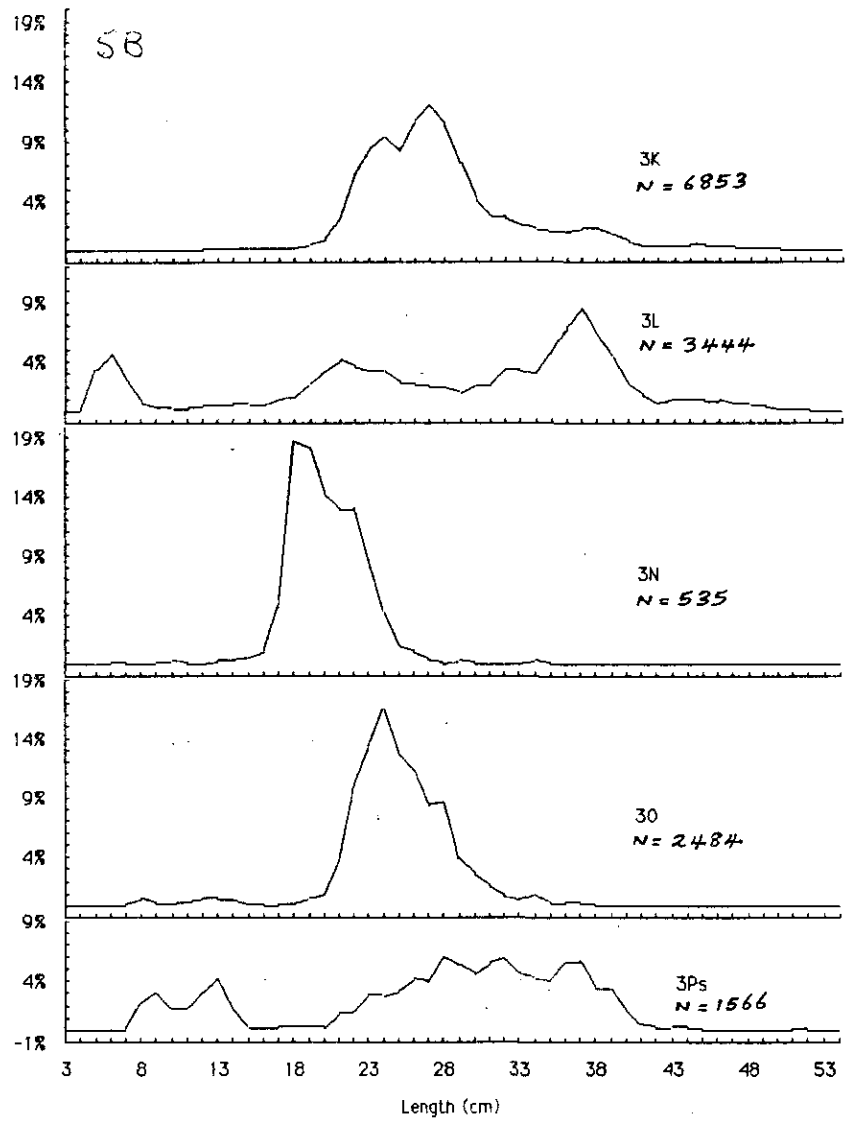


Fig. 5b: Length frequencies 5f redfish by Division from Canadian research cruises, 1982 (251-350m).

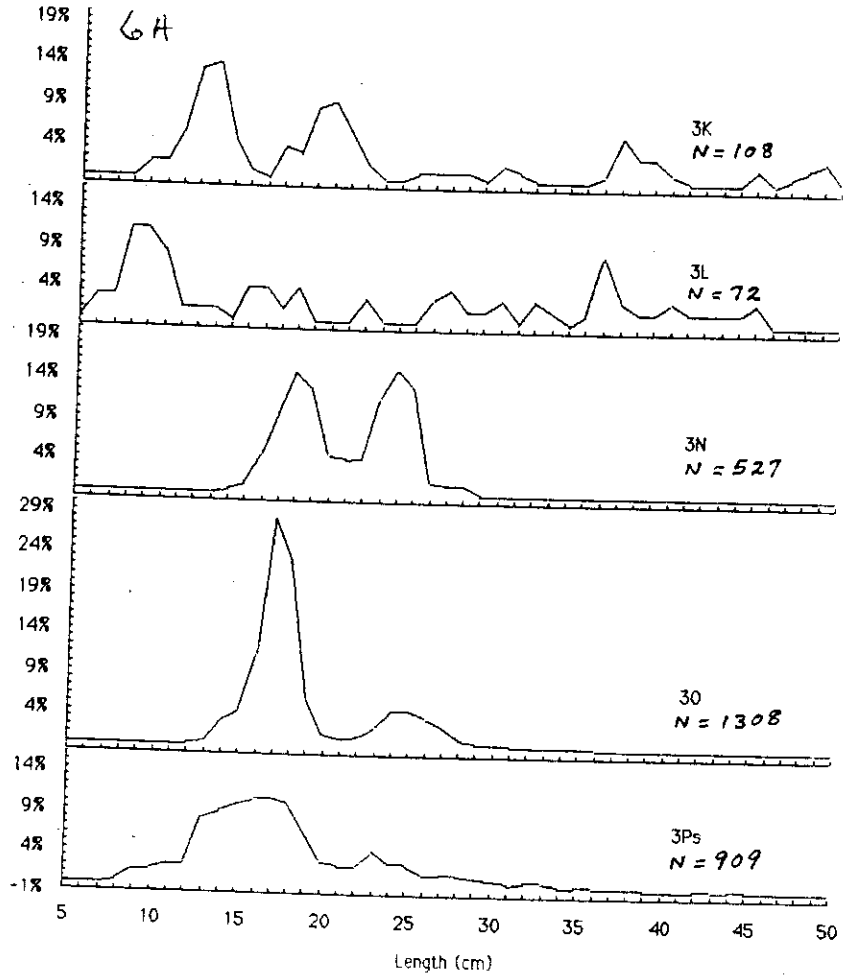


Fig. 6a: Length frequencies of redfish by Division from Canadian research cruises, 1984 (151-250m).

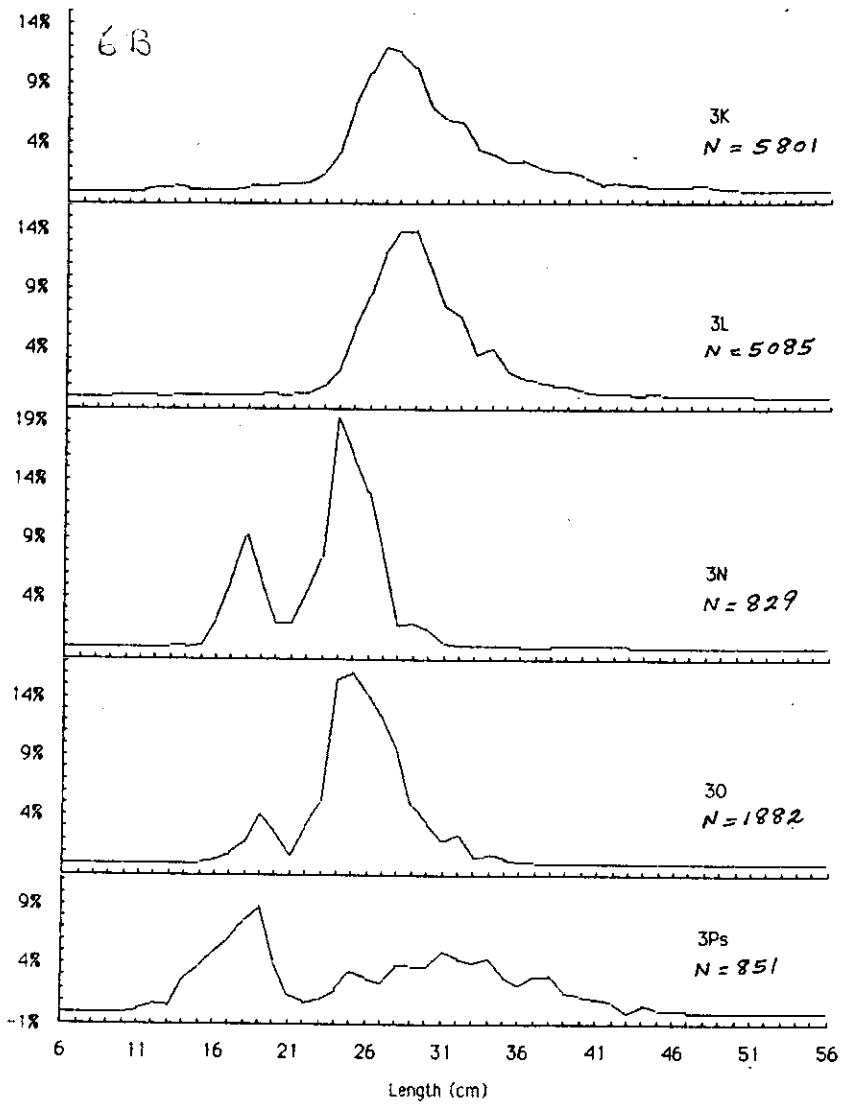


Fig. 6b: Length frequencies of redfish by Division from Canadian research cruises, 1984 (251-350m).

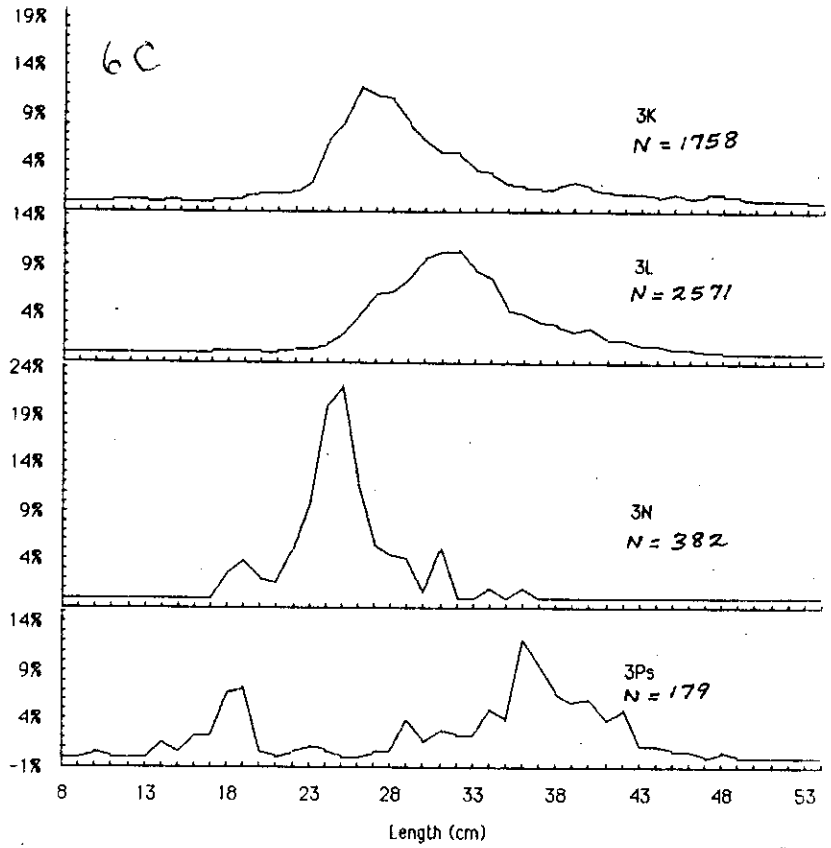


Fig. 6c: Length frequencies of redfish by Division from Canadian research cruises, 1984 (351-450m).

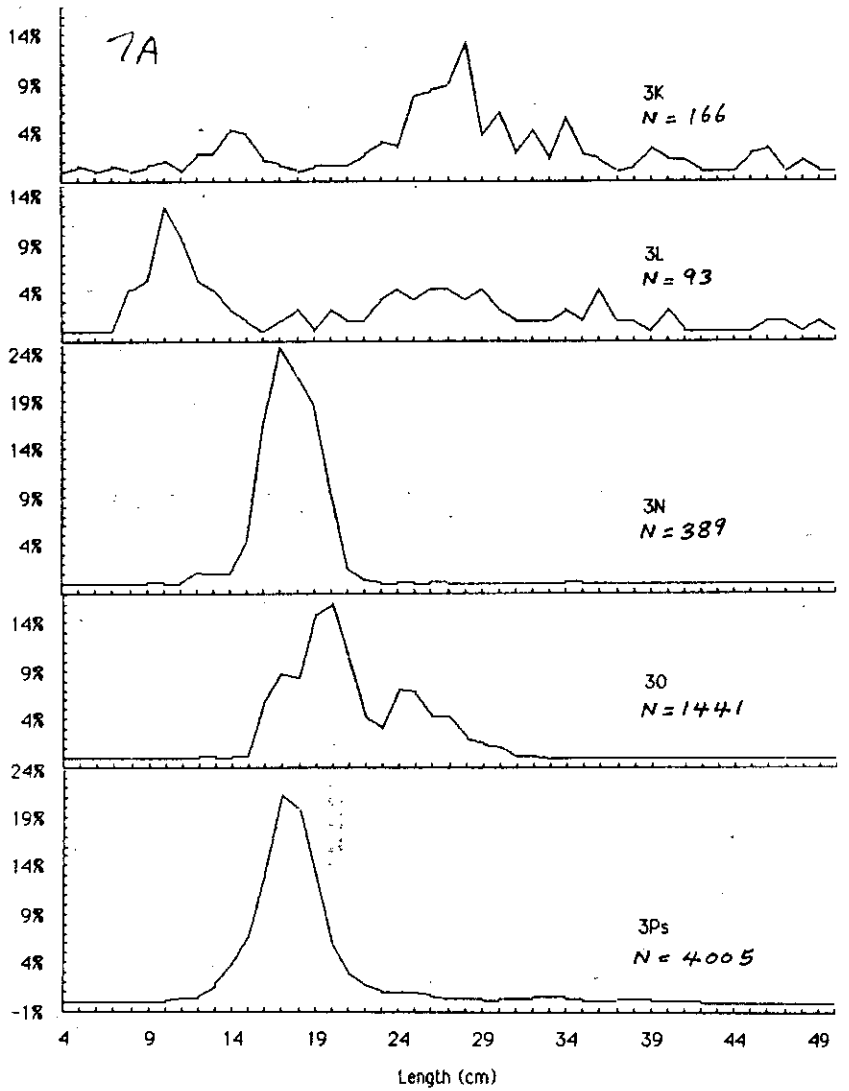


Fig. 7a: Length frequencies of redfish by Division from Canadian research cruises, 1985 (151-250m).

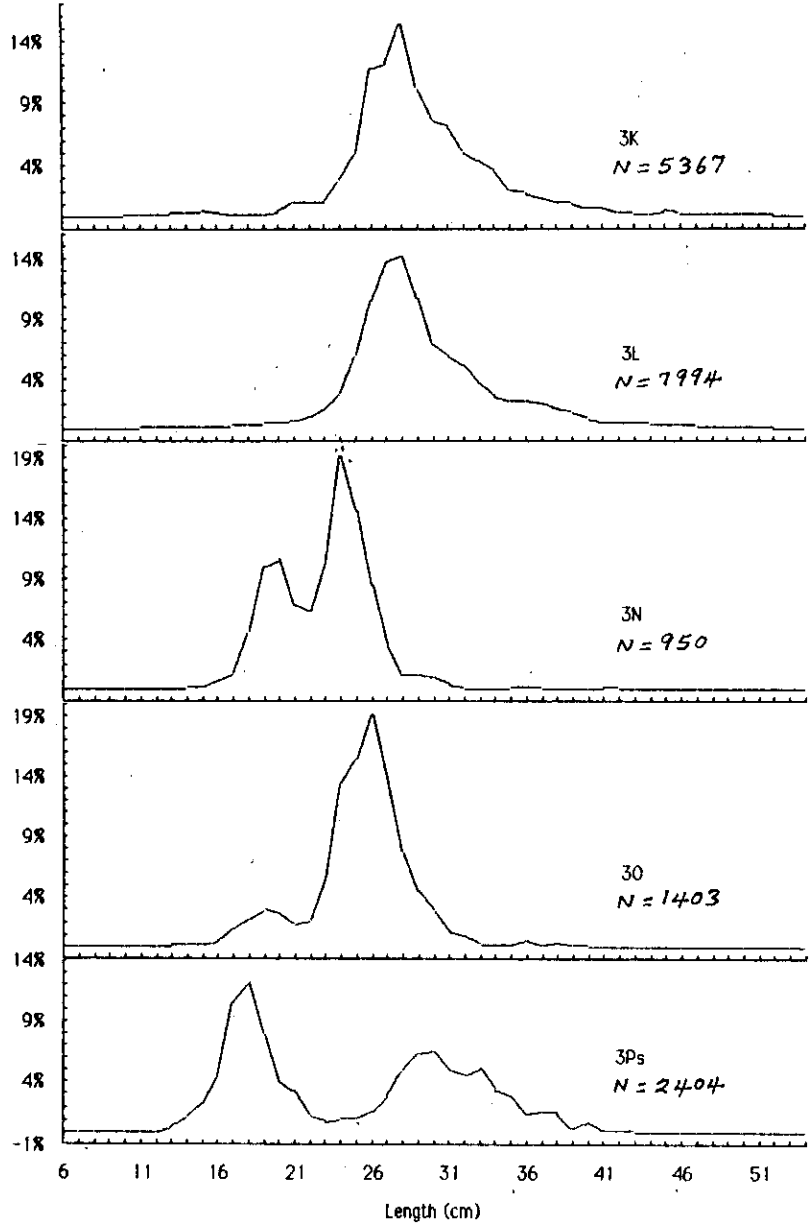


Fig. 7b: Length frequencies of redfish by Division from Canadian research cruises, 1985 (251-350m).

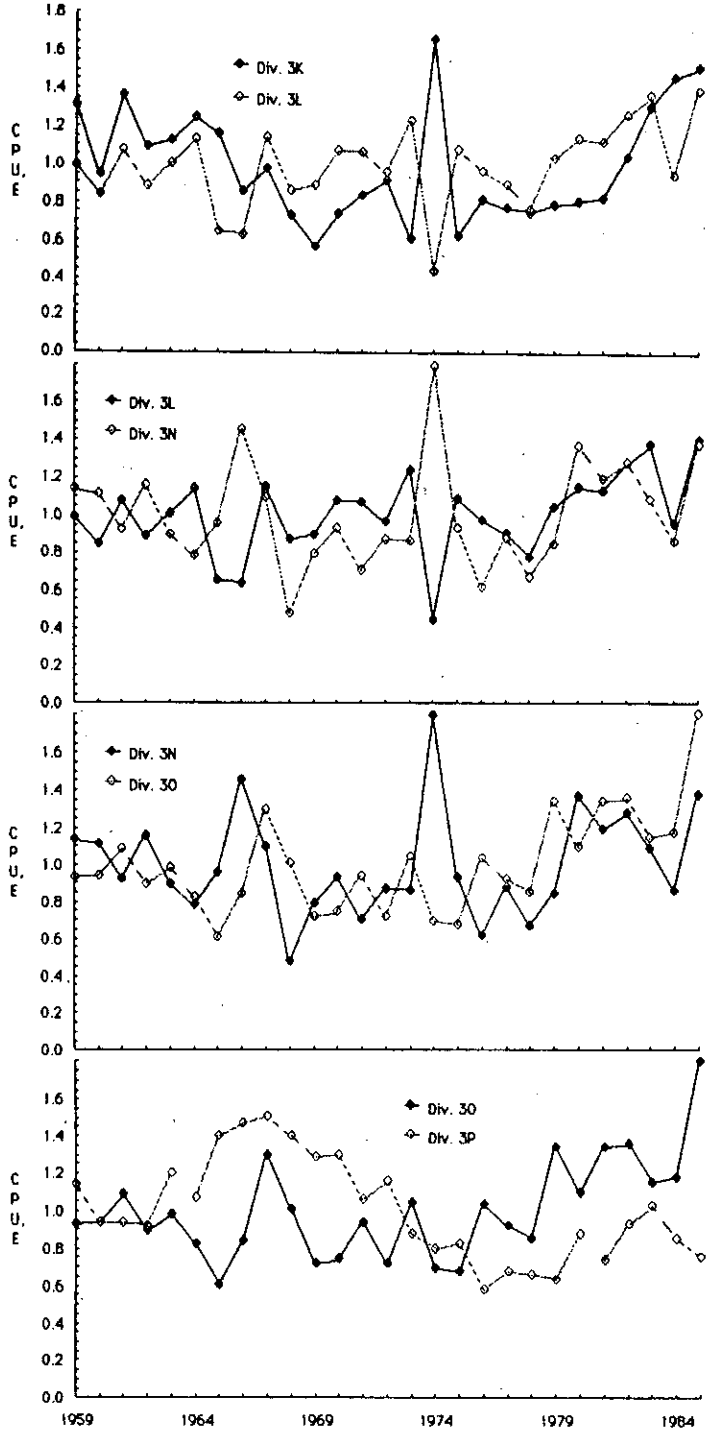


Fig. 8: Catch rates for redfish by Division as determined using a multiplicative model and standardized to their respective means, 1959-1985.