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Diurnal variation in availability of different sizes of redfish (Sebastes mentella)

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Introduction

In recent years attention has been increasingly focussed on the different types of bias which may effect the use of catch per unit of effort in providing efficient indices of abundance of different fish stocks. One of the aspects which may generate such bias is concerned with changes in the vulnerability of the fish to the fishing gear. This vulnerability is a function of the fishing gear (in the broadest sense) and of the behaviour of the species of fish. The latter, which reveals itself both in the intrinsic behaviour pattern of the fish species in relation to the environment and in its behaviour towards the fishing gear, is likely to change with respect to time, and these changes may give rise to cyclical changes in availability, and to changes in availability related to the physiology of the fish and particularly the ageing process. The latter may be manifested in different degrees of availability for different sexes and size groups.

Cyclical changes in availability of different fish stocks have been the subject of many investigations and correlations between fish abundance and different cyclically varying factors are numerous (Gulland, 1955, provides a general discussion and more recently the ICES symposium on "The Measurement of Abundance of Fish Stocks" has served to direct attention to some of these). One of the most widespread of these cyclical changes in availability is that associated with the diurnal change between daylight and darkness. Although diurnal variations in catches have been reported for most of the major marine commercial fish species as caught by many different fishing gears, data on diurnal variation of the different size groups making up the catch is not so frequently documented.

Diurnal variations in the catches of Sebastes are well known to every redfish fisherman and these may on some occasions and at some localities be so extreme as to necessitate a switch to another target species or even a complete cessation of fishing activities during the hours of darkness when the redfish are generally least available to the otter-trawl gear.

The phenomenon has been documented for redfish by the following authors: Steele (1957), Konstantinov and Scherbino (1958), Templeman (1959), Von Seydlitz (1962), and Beamish (1966).

Materials and Methods

The results presented here could perhaps be regarded as part of a fortuitous bonus arising from two cruises of the research vessel "A.T. Cameron" in which the purpose was to compare the selectivity of No. 41 otter trawl manila nets having different mesh characteristics. The main characteristics of the 4 nets used (B, C, D, & E) are summarized in Table I.

During these two cruises, three different experiments were undertaken. In each experiment fishing was carried out at a single location, and was continued with one set every three hours over a period of several days. The position was maintained constant by use of a Decca Navigator Track Plotter to ensure that the ships track did not deviate from the narrow corridor used during all the sets of the experiment.

The period of the 24 hour day was divided into 8, 3 hour time periods and care was taken to ensure all sets (of one hour duration) occurred within these time periods. It is convenient to label or code each time period and this has been done according to the scheme below:

Time period

1	00.00 hrs to 02.59 hrs
2	03.00 hrs to 05.59 hrs
3	06.00 hrs to 08.59 hrs
4	09.00 hrs to 11.59 hrs
5	12.00 hrs to 14.59 hrs
6	15.00 hrs to 17.59 hrs
7	18.00 hrs to 20.59 hrs
8	21.00 hrs to 23.59 hrs

The plan of the experiment was such that in a block of 32 sets each net should have been used once in each time period. While this condition was enforced during Experiments II and III, in Experiment I occasional damage to the gear necessitated some modifications and this resulted in each net being used twice in each time period during the 64 sets which comprised the experiment.

The dates and locations (all Eastern edge of the Grand Bank) of the Experiments are summarized below.

Expt No.	Dates (1961)	No. of Sets	Lat. °N	Long. °W	Depth (fm.)
I	11 July to 21 July	64	46° 39'	47° 21'	185-170
II	30 July to 3 Aug.	32	46° 58'	47° 26'	170-180
III	4 Aug. to 8 Aug.	32	47° 11' to 47° 08'	47° 25'	170-185

For each set the catches of redfish were separated and the quantity of fish taken measured in baskets. When catches were small the total catch was weighed in baskets before being measured. Large catches were sampled by a random process of selection with the sampled baskets being weighed and measured and the sample weight and frequency subsequently multiplied to the total catch.

Redfish measurements were all of fork length (from the anterior tip of the lower jaw with the mouth closed to the most distal portion of the median caudal rays) made to the nearest cm, however, for most of the subsequent analysis these lengths were later combined into 2 cm groups. All redfish were sexed by internal examination of the gonads. Examination during the measuring operation revealed only 4 marinus redfish in the total of 31,352 fish measured during Experiment I, 7 out of 24,247 and 11 out of 17,438 in Experiments II and III respectively.

With fishing continuing at the one position for a protracted period of time a marked decrease in availability of redfish could be noted from the start to the end of each experiment. Although considerable variation exists with the different nets used during the different time periods, the trend was clear and was sufficient to allow estimates of the initial population to be made by a method similar to that described by DeLury (1951) (Method I).

The model is of a closed system and it is assumed that there is no exchange of fish with the area outside the system for the duration of the experiment and that there is no mortality acting apart from that due to the removal of fish by the fishing gear.

N_o = Number of fish present in the closed system before the start of the experiment.

N_t = Number of fish remaining in the system after (t) sets

C_t = Number of fish removed during set t.

$$N_t = N_o - \sum_1^t C_t \qquad (1)$$

The otter trawl sets were all of one hour duration and the usual assumption is made that the number of fish caught in a given set is proportional to the number of fish present before the start of that set

$$C_t = K\,N_{t-1} \qquad (2)$$

where K is the constant of proportionality. Combining the above equations we have

$$C_t = KN_o - K\sum_1^{t-1} C_t \qquad (3)$$

A plot of C_t against $\sum_{1}^{t-1} C_t$ should thus be a straight line and a least squares fit should allow estimates of both K and N_o. The value of K can be considered as the average proportion of fish present taken during each set. The actual value of K in each set will fluctuate quite widely depending on the particular net in use and the time period when the set in question was made.

This method of estimating (N_o) was used in the two smaller experiments each of which consisted of 32 sets. For the other experiment (I) the procedure was modified (Method II). In this experiment a total of 64 sets was made and each net was used twice in each time perio. Also, although the nets were not used either so each net was used an equal number of times or so that each time period was fished an equal number of times within each period of 16 sets, this was nearly so. Thus variations due to either the net or to the time period will likely be averaged out within each successive block of 16 sets. If this is so then for the block of first 16 sets the relationship (2) above can be written

$$\sum_{t=1}^{t=16} C_t = K \sum_{t=0}^{t=15} N_t$$

and similarily for the second and subsequent blocks using the requisite values of (t) for the block in question. As before (K) is a constant which represents the average proportion of fish caught under average conditions of availability to an average net.

Under these conditions when the summed catch of the sets in each block is proportional to the summed total fish present before each set, it is evident that the instantaneous decrease of the population is proportional to the number present or

$$\frac{dN}{dt} = -qN$$

which yields on integration

$$N_t = N_o e^{-qt} \qquad (4)$$

where (N_t) represents the number of fish remaining after (t) sets have removed from the initial population of (N_o) fish. Thus from equations (1) and (4) we have

$$N_o - \sum_{1}^{t} C = N_o e^{-qt}$$

whence

$$\sum_{1}^{t} C = N_o (1-e^{-qt})$$

by substituting (t + 1) for (t) in the above equation and subtracting the resulting equation from it, the following may be obtained (analagous to the Ford-Walford transformation).

$$\sum_{1}^{t+1} C_t = N_o(1-e^{-q}) + \sum_{1}^{t} C_t e^{-q} \qquad (5)$$

with (N_o) and (q) constants a straight line will be obtained from which estimates of these values may be obtained. As we have seen, the value of (q) is not constant but varies according to the time of day and the net used, however by using blocks of 16 sets the variations can be averaged out or at least minimized. The equation (5) above becomes in this case

$$\sum_{R=2}^{R=4} C_R = N_o(1-e^{-q}) + \sum_{R=1}^{R=3} C_R e^{-q}$$

where $C_1 = \sum_{t=1}^{t=16} C_t, \; C_2 = \sum_{t=17}^{t=32} C_t, \; C_3 = \sum_{t=33}^{t=48} C_t, \; C_4 = \sum_{t=49}^{t=64} C_t$

and estimates of (q) and (N_o) determined from the least squares fit to a three point line.

Both of the two methods described above yield estimates of the initial population of redfish present within the assumed closed system prior to the start of each experiment. With estimates of the number of fish of different sizes present at the start of each experiment it is immediately possible to obtain estimates of the proportion of the total fish present that were taken during each set and to compare the amounts of fish of different sizes caught at different time periods and by the different nets.

Results

For the purpose of this analysis the redfish were grouped in two centimeter groups and estimates of N_o obtained for each of these length groups for each sex and each experiment. As has been stated previously, two methods have been used to derive the estimates of N_o and Fig. 1 shows the two methods as applied to the 36 and 37 cm males from experiment I. N_o as computed here by least squares fits to each line using method I was: 5550 fish; and by method II the value of 6060 fish was obtained.

With a total of 128 sets in the complete series of experiments, each net was fished in each time period four times and thus four different values of the proportion of the total fish of each size group caught are available for each combination of net and time period. It is convenient to label these proportions and they are called here availability factors. It was apparent from even a cursory examination of these availability factors that the catchability of the redfish in these experiments varied with size and that greater proportions of the smaller redfish were being caught than of the larger.

The size distribution of the estimated redfish population before and after these experiments is shown in Fig. 2. This figure while it does not show any clear difference in catchability between large fish and small fish or between the sexes, it does show the size distribution of the population being examined.

When the percentage of fish caught of the total present before the start of fishing is examined for each different length group (Fig. 3) it is at once apparent that these percentages were greater for the small fish taken during these experiments than they were for large fish. This is all the more striking when one considers that included in these results are the catches of large meshed nets D and E, which can be expected to catch very few of the smaller fish in any case. Indeed, when the proportion of fish caught in each size group at each time period are examined for each net separately (Fig. 4), it is clear that for the smaller meshed nets B and C the availability factors of the smaller fish were considerably larger than those of the bigger fish. In Fig. 3 there are indications that the behaviour of the two sexes does not differ very much, and analysis of variance confirms there were no differences between the availability factors of males and females of a given size group (Table III). Thus it is valid to combine the sexes as has been done in Fig. 4.

In order to examine the relative importance of the different time periods and different nets in affecting the availability, a series of analyses of variance were computed. These so-called availability factors are actually ratios and this suggests that the requirements of homogeneity of variance and additivity might better be met by applying a suitable transformation to the data. Preliminary analyses in which the inverse sine transformation was applied (the availability factors transformed to the angle whose sine is the square root of each factor) indicated a more normal-like frequency distribution of the data and tests on part of the data revealed an improvement in additivity (Tukey, 1949), and in the main analyses that followed the data were all transformed using this transformation.

In the first series of analyses of variance the data for each sex and length group were examined with respect to differences between nets and time periods. It was evident from this analysis (Table II) that interaction between the two sources of variation was negligible and that, apart from the single instance of the 20 and 21 cm males group, the difference between time periods was always highly significant. With regard to differences between nets, both for males and females at the length group of 36 and 37 cm and for sizes above this, the action of the nets could be considered similar and only on sizes smaller than this could differences between nets be considered real.

In the second series of analyses of variance differences between sexes and time periods were examined for each length group and net. Following the conclusion above that interaction was negligible, the assumption was made that here also interaction would likely be negligible and in this series of analyses (as also in the ones that follow) mean values of the transformed data were used. It is evident (Table III) that differences between time periods are significant while those between sexes in general are not. In spite of this and because it is customary to separate the sexes for biological reasons, the sexes were treated separately in the next stage of the analysis when the proportion of fish of each sex and length group caught by one net were examined against that taken by each other net at each time period.

It is customary when comparing the selectivity of different nets to compare the results of comparative fishing by selection ogives of the different nets being tested. In doing this it is usually assumed that the small meshed net provides a sample of the total population and the catches of the large meshed nets are expressed as percentages of this small meshed net at corresponding length groups. With estimates on hand of the average proportion of total fish present (availability factors), it is possible to compare these proportions in a like manner and derive selection ogives and the other statistics pertaining to them. This has been done in Fig. 5 and included in this figure are the results of the analyses of variance summarized in Table IV which indicate where differences between the nets may be considered significant or not.

Probably the most significant result from these experiments is to be found in the results obtained when all time periods are combined and the availability factors of the length groups examined for each net. The experiments were designed to compensate for differences between time periods just to allow such a combination of time periods in order to effect a comparison between the nets independently of the variation due to diurnal movements. The results of this analysis are shown in Fig. 6.

The different proportions of fish caught by the different nets can very easily be seen, and whereas for the larger fish the four nets caught the same proportion of fish present (males about 2.0%, and females about 3.0 - 4.0%) at the smaller lengths the fish were much more available to the nets which could catch them with the small mesh net B (2.0 inches mesh size internal, wet after use) catching about 7% of the available fish of 24-25 cm in length and net C (3.4 inch mesh size internal, wet after use) about 5.5% of the available fish.

Discussion

The results examined above are all based on one important assumption namely that the system was a closed one and that during the experiment the only removal of fish was by the fishing operation itself. While it might be quite realistic to assume the normal processes of natural mortality to be negligible during the relatively short period of the experiment, it is much more difficult to believe that there would be no migration of fish from the area which is being stirred up by repeated sets of the otter trawl. Furthermore even though the fish may not actually leave the area, it is quite conceivable that they could become less available to the net because they remained away from the bottom and did not foray to the less attractive disturbed area close to the bottom; in this case the effect would be the same as leaving the area.

It is important to examine what effects emigration might have on the results obtained during these experiments. If emigration takes place so that a constant proportion (P) of the total fish present become permanently unavilable to the net the basic equation (3) above can be altered with the incorporation of an additional term to account for this steady removal of fish by a means other than the fishing operation itself.

$$N_t = N_o - \sum_{1}^{t} C_t - p\sum_{o}^{t-1} N_t$$

and substituting as before this reduces to

$$C_t = KN_o - (K + p) \sum_{1}^{t-1} C_t$$

which of course is similar to the equation used except that the slope is increased by the amount p, and being unable to separate K and p we have no means of estimating N_o.

An examination of the values obtained for the slopes (K + p) in the two experiments in which this method was used for estimating N_o showed that there was no obvious correlation between either the slope and the intercept or between the slope and the length groups in three of the four possibilities examined. (In the males for one experiment an inverse correlation was evident between the slope and the length groups). With the assumption of no emigration we have considered the slope (K + p) = (K) and if the value of p is positive and significantly different from zero we will obtain estimates of N_o which are too small and hence the individual estimates of the availability factor for each net and time period will be too large. To negate the results shown here, p would have to be different for each length group being considerably greater for the larger fish and not so great for the smaller fish.

The whole analysis would have been much simplified had only a single net been used in the course of the experiments. With one of the sources of variability removed there should be much less scatter of data points and better estimates of N_o should result. The method appears to be suitable for general application provided the condition of a closed system or controlled migration is satisfied and provided the density of fish is such that continuous fishing will cause a marked diminution in the catches.

Within the limitations of the model, these experiments have yielded two general results. The first allows 50% selection lengths and selection factors to be obtained. These net selection parameters obtained using the availability factors show satisfactorily close agreement with those obtained by the usual methods (Table V). Furthermore, as is usual in redfish selection experiments, the selection lengths of the females were higher than those of the males for the same net.

The second and far more significant result is the very great difference in availability of the small and large redfish to the net. The principle that small fish are more easily caught than the larger fish (provided the mesh size is large enough to retain them) is common and expected. However, that a net can catch the smaller commercial sized fish between two and three times more effectively than the same net or indeed larger meshed nets, can catch the larger fish creates a situation in which a differential fishing mortality rate with size might present an additional complicating factor in our attempts at managing the fishery and assessing the likely effects of mesh size regulation.

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References

Beamish, F.W.H. 1966. Vertical migration by demersal fish in the Northwest Atlantic. J. Fish. Res. Bd. Canada, 23(1): 109-139.

Gulland, J.A. 1955. Estimation of growth and mortality in commercial fish populations. Fish. Invest., Ser. 2, 18 (9).

Konstantinov, K.G., and M.N. Scherbino. 1958. [Diurnal vertical migrations of redfish]. Rybn. Khozy., 39(10): 11-13.

Steele, D.H. 1957. The redfish (Sebastes marinus L.) in the Western Gulf of St. Lawrence. J. Fish. Res. Bd. Canada, 14(6): 899-924.

Templeman, W. 1959. Redfish distribution in the North Atlantic. Bull. Fish. Res. Bd. Canada, No. 120, 173 p.

1963. Otter trawl covered codend and alternate haul mesh selection experiments on Redfish, Haddock, Cod, American plaice and Witch flounder: girth measurements of Haddock, Cod and Redfish and meshing of Redfish in the Newfoundland area. ICNAF Spec. Publ., No. 5: 201-217.

Tukey, J.W. 1949. One degree of freedom for non-additivity. Biometrics 5(3): 232-249.

Seydlitz, H. Von. 1962. Untersuchungen über die Tagesperiodizität des rotbarsches, _Sebastes marinus_, auf Grund von Fanganalysen. Kurze Mitteilungen, Institut für Fischereibiologie, Universitat Hamburg, No. 12, p 27-35.

DeLury, D.B. 1951. On the planning of Experiments for the estimation of fish populations. Jour. Fish. Res. Bd. Canada, 8(4): 281-307.

Table I. General specifications of manila nets used during experiments.

	Net B				Net C				Net D				Net E			
	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)	(a)	(b)	(c)	(d)
Upper Wing	10/75	85	5	100/3									10/70	78	5½	100/3
Lower Wing	33/45	130	5	100/3									30/42	120	5½	100/3
Square	220/170	30	5	100/3		As Net B				As Net B			202/156	27	5½	100/3
Belly	170/170	20	5	100/3										35	5½	100/3
													156/38			
	170/60	70	5-3¼	100/3		20	5	100/3		20	5	100/3		35	5½	75/4
					170/42				170/38							
						42	4½	75/4		38	5	75/4				
Lengthening piece	60/60	105	3¼	75/4	42/42	75	4 5/8	50/4	38/38	66	5 1/8	50/4	38/38	60	5 5/8	50/4
Codend	60/60	90	3¼ (2.0)**	75/4*	42/42	58	5 1/8 (3.4)**	50/4*	38/38	52	5 3/4 (4.1)**	50/4*	38/38	48	6¼ (4.5)**	50/4*

(a) Number of meshes. Forward end/After end.

(b) Number of meshes long

(c) Dry manufacturers mesh size (between knot centres)

(d) Runnage/Ply of twine. All single twine except where noted below.

* Double twine

** Internal mesh size, wet after at least 5 sets (Westhoff gauge 10 lbs pressure).

Table II. Results of analyses of variance: differences between nets and time periods are here examined for each length group (sexes separate).

	Males			Females		
Length Group (cm)	Between Time Periods	Between Nets	Inter- action	Between Time Periods	Between Nets	Inter- action
20 & 21	N.S.	* *	N.S.	-	-	-
22 & 23	* *	* *	N.S.	* *	* *	N.S.
24 & 25	* *	* *	N.S.	* *	* *	N.S.
26 & 27	* *	* *	N.S.	* *	* *	N.S.
28 & 29	* *	* *	N.S.	* *	* *	N.S.
30 & 31	* *	* *	N.S.	* *	* *	N.S.
32 & 33	* *	* *	N.S.	* *	* *	N.S.
34 & 35	* *	* *	N.S.	* *	* *	N.S.
36 & 37	* *	N.S.	N.S.	* *	N.S.	N.S.
38 & 39	* *	N.S.	N.S.	* *	N.S.	N.S.
40 & 41	-	-	-	* *	N.S.	N.S.
42 & 43	-	-	-	* *	N.S.	N.S.

* * indicates significant difference at 0.01 probability level

* indicates significant difference at 0.05 probability level

N.S. indicates no significant difference

- indicates data not analyzed because of lack or paucity of data.

Table III. Results of analyses of variance: differences between sexes and time periods examined for each length group and net.

Length Group (cm)	Differences between sexes				Differences between Time periods			
	B	C	D	E	B	C	D	E
20 & 21	-	-	-	-	-	-	-	-
22 & 23	N.S.	N.S.	N.S.	N.S.	* *	* *	* *	N.S.
24 & 25	N.S.	* *	N.S.	N.S.	* *	* *	* *	* *
26 & 27	N.S.	N.S.	N.S.	N.S.	* *	* *	* *	*
28 & 29	N.S.	N.S.	N.S.	N.S.	* *	* *	* *	*
30 &31	N.S.	N.S.	N.S.	N.S.	*	* *	* *	* *
32 & 33	N.S.	N.S.	N.S.	N.S.	* *	* *	*	*
34 & 35	N.S.	N.S.	N.S.	N.S.	*	* *	* *	* *
36 & 37	N.S.	N.S.	N.S.	N.S.	N.S.	*	* *	*
38 & 39	*	* *	*	*	N.S.	N.S.	*	N.S.
40 & 41	-	-	-	-				
42 & 43	-	-	-	-				

* * indicates difference at 0.01 probability level

* indicates difference at 0.05 probability level

N.S. indicates no significant difference

\- indicates data not analyzed because of lack or paucity of data.

Table IV. Results of analyses of variance between pairs of nets.

Length Group	Nets	♀ Nets C	♀ Nets D	♀ Nets E	♂ Nets C	♂ Nets D	♂ Nets E
22	B	N.S.	* *	* *	*	* *	* *
	C		* *	* *		* *	* *
	D			* *			*
24	B	*	* *	* *	* *	* *	* *
	C		* *	* *		* *	* *
	D			*			N.S.
26	B	N.S.	* *	* *	*	* *	* *
	C		* *	* *		* *	* *
	D			* *			*
28	B	N.S.	* *	* *	N.S.	* *	* *
	C		* *	* *		* *	* *
	D			* *			*
30	B	N.S.	*	* *	N.S.	* *	* *
	C		*	* *		* *	* *
	D			*			* *
32	B	N.S.	N.S.	* *	N.S.	N.S.	* *
	C		N.S.	* *		*	* *
	D			* *			* *
34	B	N.S.	N.S.	* *	N.S.	N.S.	* *
	C		N.S.	* *		N.S.	* *
	D			N.S.			* *
36	B	N.S.	N.S.	*	N.S.	N.S.	N.S.
	C		N.S.	*		N.S.	*
	D			N.S.			N.S.
38	B	N.S.	N.S.	N.S.	N.S.	N.S.	N.S.
	C		N.S.	N.S.		N.S.	N.S.
	D			N.S.			N.S.
40	B	N.S.	N.S.	N.S.			
	C		N.S.	N.S.			
	D			N.S.			
42	B	N.S.	N.S.	N.S.			
	C		N.S.	N.S.			
	D			N.S.			

* * Significant difference $(P < 0.01)$

* Significant difference $(0.05 > P > 0.01)$

N.S. No significant difference $(P < 0.05)$

Table V. Comparison of net selection parameters obtained by the usual method and from availability factors.

Net and Sex	Standard method		From availability factors	
	50% point (cm)	Selection factor	50% point (cm)	Selection factor
Net D ♂	30.0	2.88	29.7	2.86
Net D ♀	30.6	2.94	30.1	2.89
Net E ♂	33.4	2.93	33.0	2.93
Net E ♀	33.7	2.96	34.6	3.03

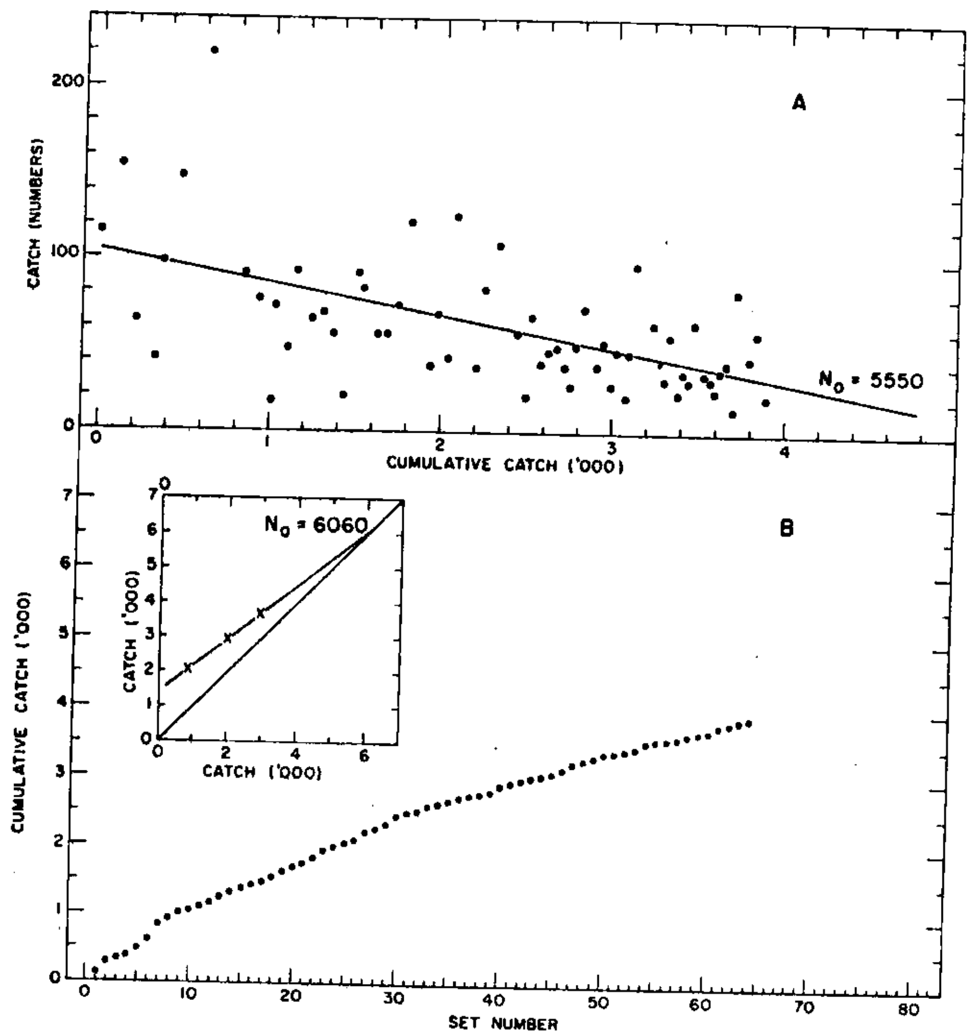

Fig. 1. Example of two methods used in deriving estimates of N_o.

(36 and 37 cm males)

A. Method I. Plot of numbers of fish caught in each set against cumulative catch in numbers before it.

B. Method II. Plot of Cumulative catch in numbers against time (set number). The inset shows the catch in numbers obtained in a block of 16 sets plotted against that obtained in the previous block of 16 sets.

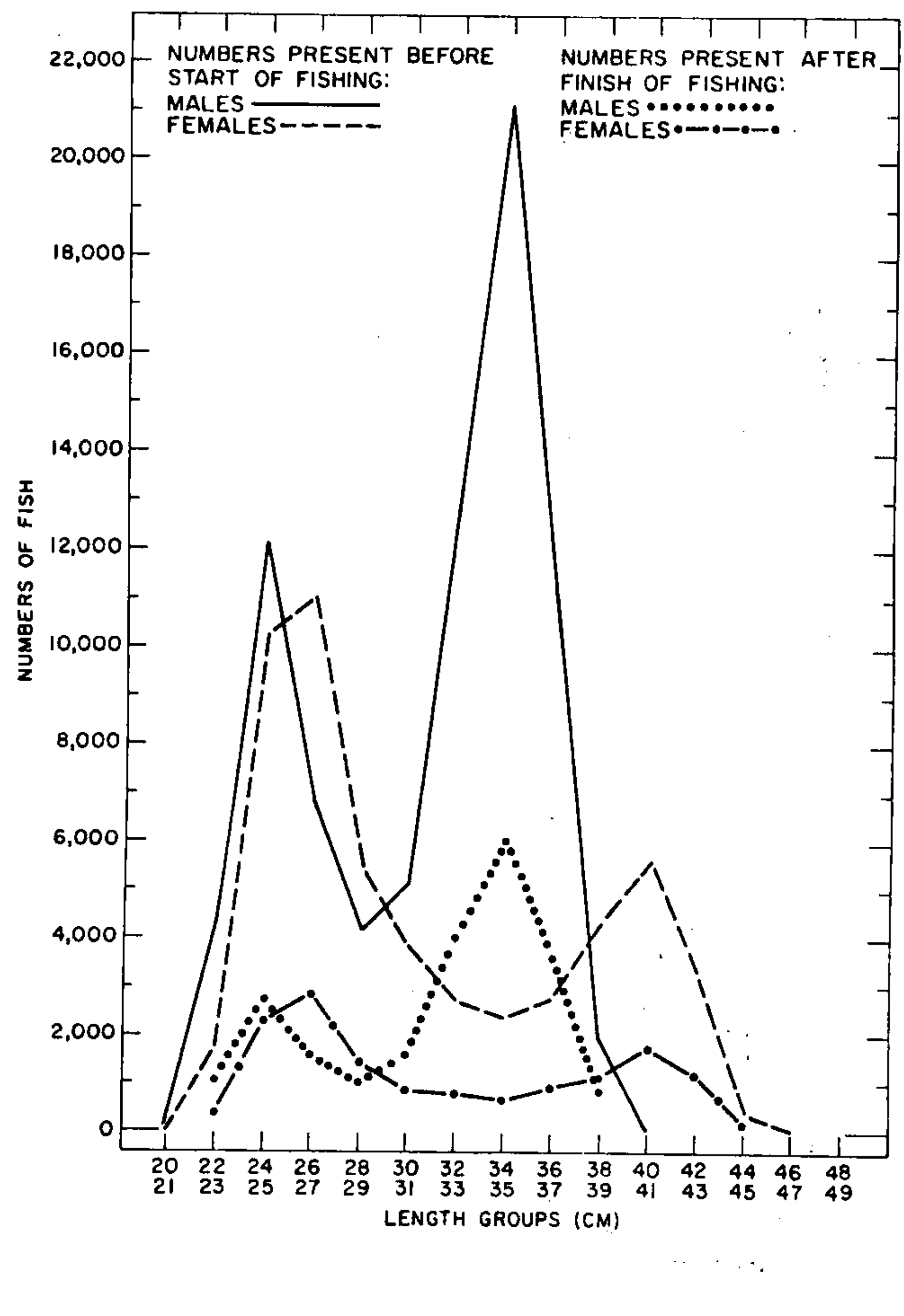

Fig. 2. Calculated numbers present at each length group before and after the experiment.

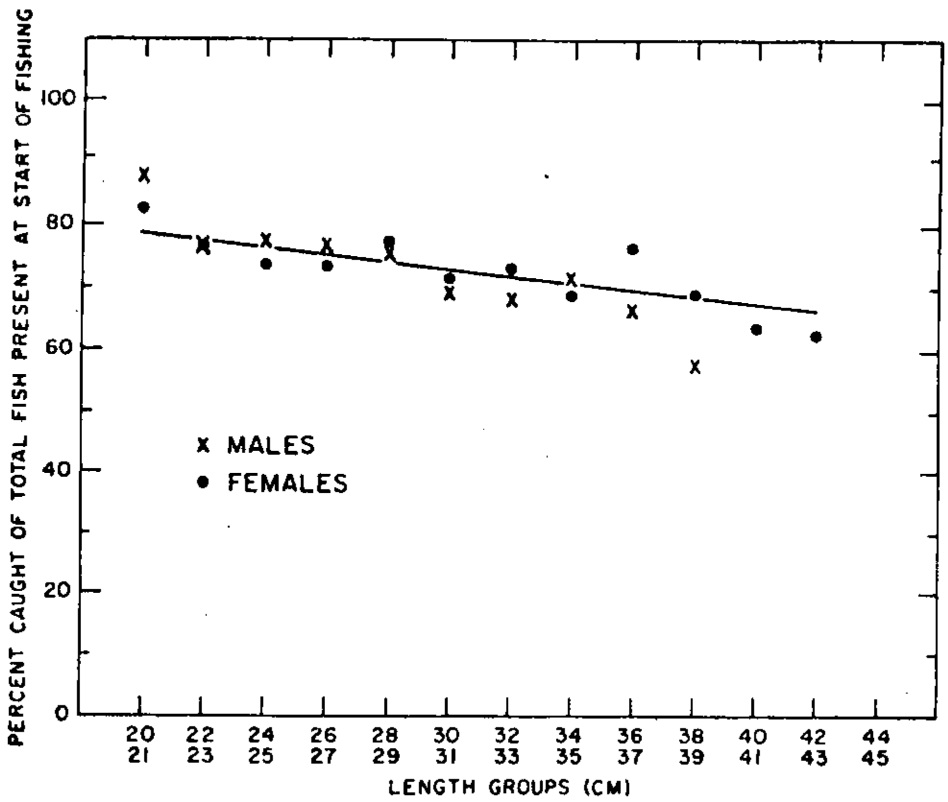

Fig. 3. Percentage of fish caught of the total calculated present before the start of fishing for each length group.

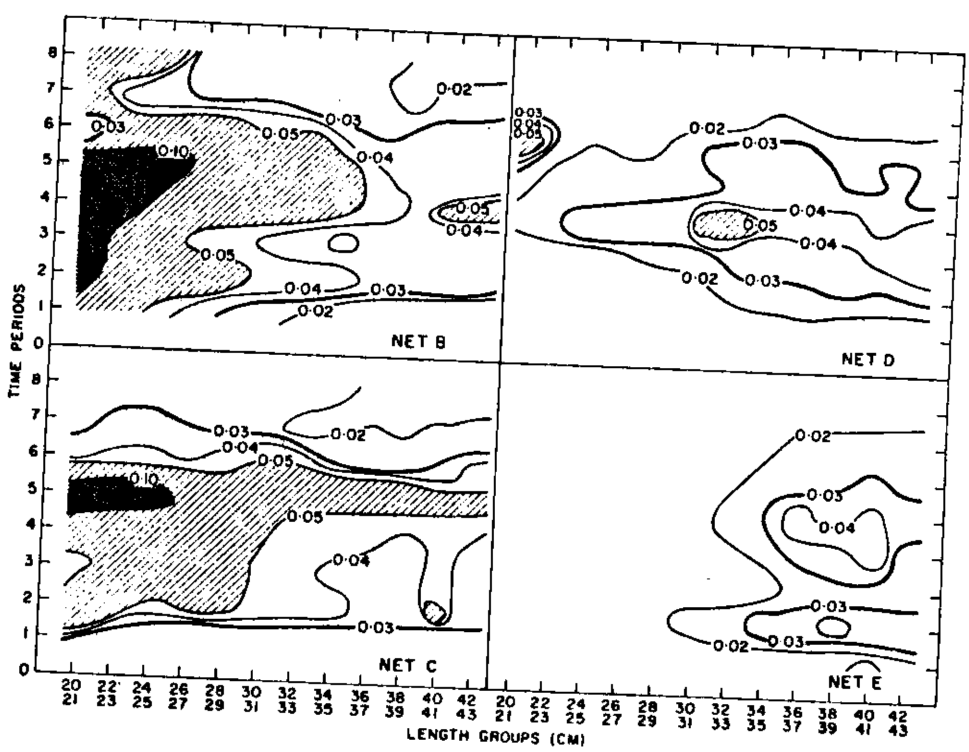

Fig. 4. Availability factor isopleth diagrams for the four nets used. In each diagram the mean availability factors for each length group and time period have been plotted, and isopleths drawn joining points at which the availability factors were the same.

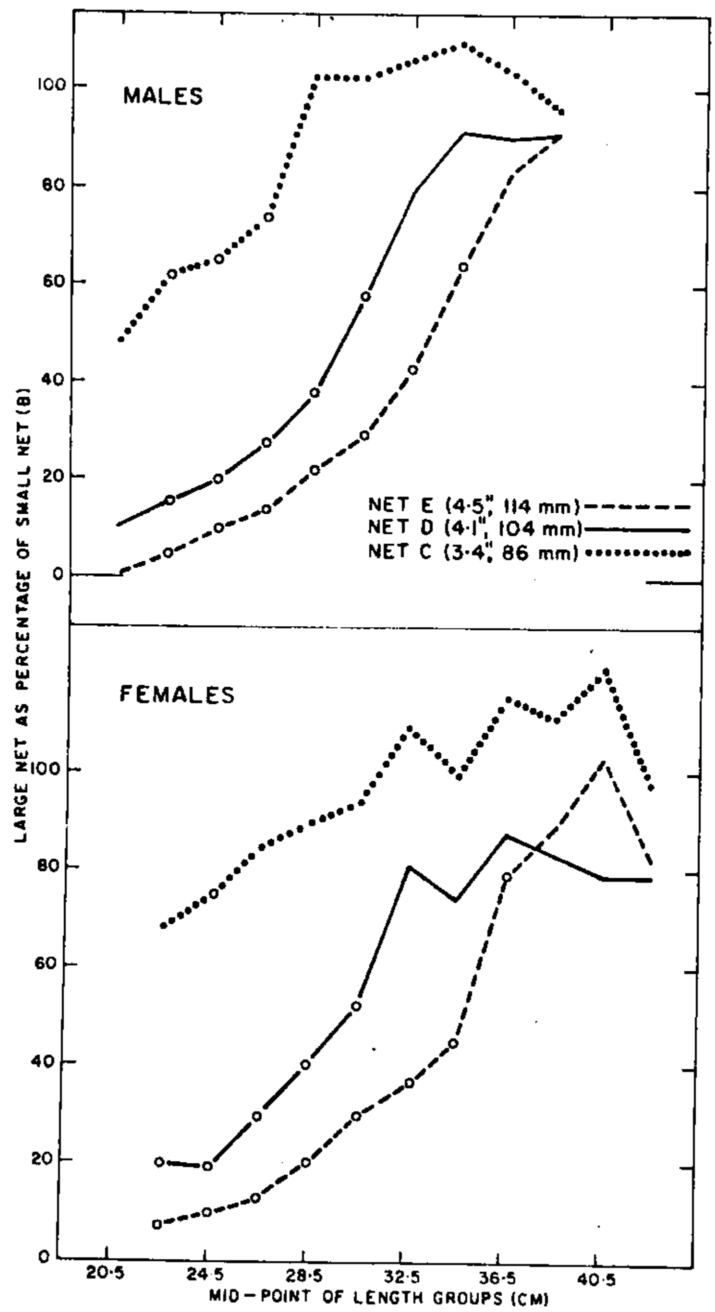

Fig. 5. Selection ogives obtained from availability factors. The points shown by open circles indicate that the large and small nets were significantly different ($P < 0.05$) at these points. Where no open circles are drawn the small and large net may be considered essentially the same.

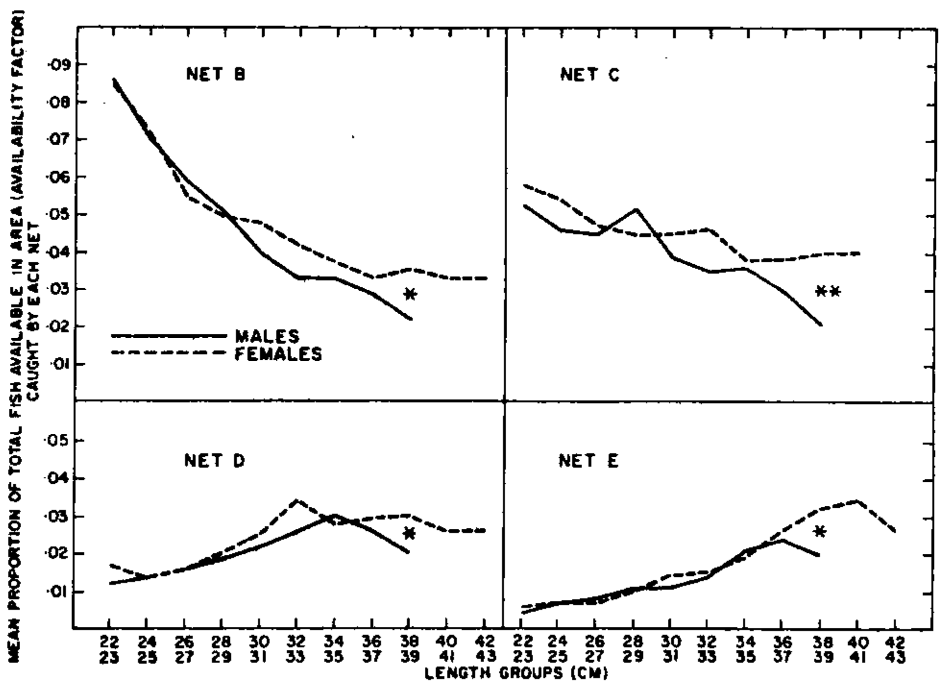

Fig. 6. Mean proportions of total fish in area (availability factor) obtained at each length group for each net.