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Demersal Fish Committee

REPORT OF THE ICES 0-GROUP FLATFISH WORKING GROUP

Charlottenlund, 19-21 February 1979

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CONTENTS

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1. INTRODUCTION

The ICES O-Group Flatfish Working Group met in Charlottenlund 19-21 February 1979, following ICES resolution, C.Res.1978/2:5, as follows:

> "It was decided, that in view of the importance for stock assessment of information on O-group flatfish abundance in the main nursery areas,
>
> (a) a new Working Group should be formed to analyse O-group flatfish data for the North Sea. This Working Group which should be called "O-Group Flatfish Working Group" shall be convened by Mr J F de Veen and shall meet for 3 days in February 1979 in Copenhagen;
>
> (b) member countries should, whenever possible, extend the coverage of the existing sampling programme to include other plaice and sole nursery areas".

The following members participated:

D W Armstrong	UK (Scotland)
F A van Beek	Netherlands
W R Bowering	Canada
N Cloet	Belgium
Ms E Nielsen	Denmark
G Rauck	Germany (Fed.Rep.of)
J D Riley	UK (England)
J F de Veen (Chairman)	Netherlands.

2. REVIEW OF EXISTING O-GROUP PROGRAMMES IN THE NORTH SEA

2.1 On a national level O-group flatfish surveys have been carried out by Denmark in the Danish nurseries in the North Sea (1933-41, 1946-57) in the months June to October. Analysis of the results, mainly for O-group plaice, failed to show any significant relation to indices of year class strength derived from the fishery on adult plaice (Vedel Tåning, 1943; Ursin, 1958).

Another survey in the past was conducted in a local nursery in Bridlington Bay by England from 1950 to 1958 (Wimpenny, 1960). The results of this programme failed to show any connection with year class abundance in the adult plaice fishery.

2.2 In 1969 the Netherlands started a programme meant to show the relative importance of the various Dutch nurseries as useful information in relation to problems dealing with land reclamation, pollution, and so on, but also to assess the relative O- and 1-group abundance of flatfish and of juvenile brown shrimp. Two cruises per year are carried out, one in April-May, the other in September-October.

The sampling area was extended in 1970 by Belgium to include the Belgian nurseries; in 1970 to cover the German Waddensea by the

Federal Republic of Germany and in 1977 by France to extend the area into the continental side of the eastern Channel.

In the four countries a standard beam trawl is in use (see Figure 1, in Annex 1). It carries a groundrope with wooden bobbins and one tickler chain. Owing to a regrettable misunderstanding the tickler chain was never used in the German Waddensea. It is necessary to carry out comparative fishing experiments to be able to make corrections for this discrepancy in the German data, which will raise the level of e.g. 0- and 1-group sole catches substantially. The correction has still to be applied to the data in Annex 3.

The size of the beam trawl is 3 meter in the Dutch nurseries, in the Zeeland estuary and the Waddensea and in the German Waddensea, and 6 meter in the French, Belgian and Dutch coastal areas.

A drawback of the 'continental' programme is that it samples the 0-group plaice only partly. The very shallow area below 2-3 m, where a greater part of the 0-group plaice is concentrated when feeding, cannot be sampled adequately owing to the draught of the ships.

To fill in this gap the Netherlands started a programme sampling the fish, shrimp and benthos populations on the tidal flats in the Waddensea and the fish populations on the North Sea beaches in 1976.

A review of the 'continental' programme, including an analysis of the results in the Dutch nurseries, is given in Annex 1.

Annex 2 describes the Dutch tidal flat programme and Annex 4 describes the 0- and 1-group surveys in Belgium.

2.3 In England a programme comparable to the continental programme was initiated in 1970 but is continuous from 1973-. It was not designed exclusively to estimate 0-group flatfish abundance but it could be used for this purpose. One census per year is carried out, in September-October, in all nurseries on the east coast of England up to the Scottish border.

The English programme samples the 0-group plaice adequately by sampling the 0-2 m depth zone by push netting (Riley, 1971). The gear in use in depths over 2 m is a 2 m beam trawl with 3 tickler chains. The distance covered is measured by a measuring wheel attached to one of the beam trawl shoes.

The results of the surveys are reviewed by Riley (1977). Table 1 below gives the year class strength indices obtained so far for plaice and for sole and the 95% confidence limits.

Table 1. 0-group population indices, English east coast. Sept.-Oct.

Year	PLAICE			SOLE		
	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%
1973	29.1	38.7	51.9	8.1	10.8	14.2
1974	26.8	46.8	83.0	9.5	18.3	35.6
1975	12.8	19.0	28.4	17.2	27.0	42.6
1976	32.2	42.9	57.4	28.6	41.9	61.6
1977	23.4	32.2	43.7	13.9	20.5	29.6
1978	18.7	25.2	34.6	16.3	22.9	32.8

2.4 Recently a comparison has been made between the English and the continental beam trawl. The results of this are discussed in Annex 3.

3. OBJECTIVES OF THE CURRENT RESEARCH VESSEL SURVEYS

The surveys described in the previous section had two major objectives:

1) Provision of data for various national bodies on the relative importance of the nursery areas in relation to problems arising from e.g. reclamation of land, oil spillage, pollution, etc.

2) Estimation of indices of year class strength which can be used by Assessment Working Groups to evaluate the number of young fish which will recruit to the fishery in future years.

The Group felt that the first objective is being achieved but that there are a number of problems associated with the second objective. The rest of this report will, therefore, be concerned with a description of these problems and proposal for how they might be overcome.

4. REQUIREMENTS FOR ASSESSMENT PURPOSES

In evaluating a total allowable catch for any species of fish it is highly desirable that an accurate assessment is available of the number of young fish which will recruit to the fishery in the year for which the TAC is being set.

In order that this can be done, it is necessary that some functional relationship can be clearly defined between an index of year class strength (obtained from research vessel surveys) at some age below that at which recruitment to the fishery occurs and the estimated number of fish in the sea at the age of recruitment. At present, the number of fish in the sea at the age of recruitment to the fishery is most conveniently obtained from the results of a virtual population analysis.

5. PROBLEMS IN PREDICTION OF NUMBERS OF FISH IN THE SEA USING RESEARCH VESSEL/VPA CORRELATIONS

A regression analysis of Dutch data on catch per 1 000 m^2 of 0- and 1-group sole and plaice respectively versus appropriate VPA estimates of numbers of fish in the sea at the age of recruitment is shown in Annex 1. In addition, in Annex 3 it is shown that indices for sole and plaice year classes of 1973, 1974 and 1975 were obtainable from existing data by combining continental and English surveys.

The major problem at present is that, with the exception of a reasonably good correlation ($r = 0.64$, see Annex 1, Table 6) between indices of abundance of 1-group sole obtained from Dutch research vessel cruises and VPA estimates of the number of sole in the sea at age 2, no significant correlations have been demonstrated between research vessel results and VPA results.

Assuming that VPA estimates of the number of fish in the sea at the age of recruitment to the fishery are reasonably correct, the Group felt that the major reasons for this lack of correlation were as follows:

1) Data obtained from Dutch research vessel surveys allow the estimation of a correlation based on 9 data points. The general lack of significant correlations is thought to be due to two factors. Firstly, the VPA on North Sea sole and plaice can only be carried out on the total North Sea stocks of these species since it is not possible to collect landings data in such a way that an age distribution of the landings from each sub-stock in each year can be derived. Secondly, it is known from previous research that recruitment to some nursery areas (and hence to some sub-stocks) might be low in some areas and high in other areas within a given year. Dutch research vessel surveys do not and cannot cover the total North Sea nursery area. If, therefore, an attempt is made to obtain an index of recruitment to the total North Sea stock from data collected from only a limited part of the total nursery area, there is no a priori reason to believe that such an estimate will be valid. It is therefore not surprising that, in general, no correlation can be demonstrated between total North Sea VPA results and Dutch research vessel results.

2) The combination of English and Dutch results as described in Annex 3 produces data from which it is possible to evaluate a correlation based on only three points. It is, therefore, unlikely that any significant correlation would be expected in this case, Furthermore, the combination of English and Dutch data does not fulfil the requirement that the total nursery area should be sampled in order to obtain a valid index of recruitment.

It should be stressed, however, that there is no guarantee that VPA estimates of numbers in the sea at the age of recruitment to the fishery are correct. If large errors are in fact present in these estimates then, taken in conjunction with the factors just mentioned, the likelihood of obtaining a significant correlation between VPA and research vessel results will be further diminished.

6. OTHER POSSIBLE SOURCES OF INFORMATION

Data obtained on the by-catch of 0-group plaice by German shrimp vessels have been shown to be highly correlated with VPA estimates of year class strength for the years 1954-68 (Rauck and Zijlstra, 1978). Unfortunately, changes in the gear and landing practices used by the German shrimp fleet have made it difficult to continue this data series. At present, work is proceeding in Germany (Fed.Rep.of) based on samples taken regularly from specific vessels in the hope that a useful data series can be established. It will, however, require a number of years of data collection before their usefulness can be evaluated.

There also exists a programme to estimate the abundance of 0- and 1-group plaice which occur in the intertidal zone of the Dutch Waddensea. This programme is described in Annex 2. At present the main objective of the programme is not to provide estimates of year class strength, but it may be possible in future years to combine results from this programme with corresponding results from the research vessel programmes previously described.

7. PROPOSALS FOR IMPROVING INDICES OF YEAR CLASS STRENGTH

The Group felt that, in view of the fact that VPA results for sole and plaice can be based only on the total North Sea stock, meaningful research vessel indices of pre-recruit year class strength can be collected only if the total nursery areas of plaice and sole are regularly and systematically sampled.

At present, sampling is not carried out or is carried out only intermittently off the Danish, German and Scottish coasts. The Group recommends that sampling programmes of the type already in existence in other areas should be started as soon as possible in these areas. Obviously, existing sampling programmes should be continued.

The Group further recommends that this programme should be carried out at least in September-October and should be continued for at least 10 years to obtain adequate data for comparison with VPA and other results.

8. PROPOSALS ON TECHNICAL IMPROVEMENTS

There are differences in the methods employed in the English sampling programme and those used in the combined Dutch, Belgian and German programme. The principal difference is that the English sampling system is stratified by depth while the other programme is not. However, both sampling systems can be used to produce indices of the number of 0- and 1-group plaice and sole per 1 000 m^2 and hence differences in sampling methods are not thought to be of first order importance.

The Group felt that all beam trawls used in the surveys should be fitted with the Lowestoft design of wheel for measuring the distance towed since this should give more reliable results than those obtained from navigational aids.

It was also thought that more intensive sampling in shallow water would be desirable on the part of the Belgian, Dutch, German and Danish participants, while the English programme should attempt to intensify sampling in the deeper depth zones.

A paper by Mr H Becker was presented to the Group (Annex 5). The paper describes a method of determining the number of hauls to be made at each station to achieve a predesignated coefficient of variation. While in principal this objective is very desirable, it was felt that to achieve the objective would probably result in a great increase in the number of hauls. At the present level of manpower and research vessel availability, this would not be possible.

9. DESIRABILITY OF CORRELATING SURVEYS IN AREAS OTHER THAN THE NORTH SEA

English tagging experiments on juvenile plaice on eastern Channel nursery areas indicate that many of the juvenile plaice tagged in that area are subsequently recovered from the North Sea. It is likely, therefore, that recruitment levels to the North Sea stocks are influenced by levels of recruitment to the eastern Channel nursery areas. French scientists are currently operating a sampling programme for 0- and 1-group flatfish on nursery areas in the southern shore of the Channel and it would be desirable to supplement this work with surveys on the northern shore.

The Irish Sea and Bristol Channel Working Group sets TACs on Irish Sea and Bristol Channel plaice and sole for which no prediction of recruitment is possible at present. Surveys on 0- and 1-group plaice and sole are currently being carried out by Ireland in the western part of the Irish Sea. Data of these surveys were not available to the Group, but the usefulness of the results should be evaluated as soon as possible.

0- and 1-group flatfish surveys should be initiated in the Bristol Channel and the eastern part of the Irish Sea.

REFERENCES

RAUCK, G and J J Zijlstra, 1978. On the nursery aspects of the Waddensea for commercial fish species and possible long-term changes. Rapp. p.-v. Réun. Cons.int.Explor.Mer, 172:266-275.

RILEY, J D, 1971. The Riley push net in: Methods for the study of marine benthos. Ed. by N A Holme and A D McIntyre. Blackwell Sci.Publ. Oxford and Edinb. (I.B.P. Handbook, No.16):286-288.

RILEY, J D, 1977. On the evaluation of the English east coast 0-group flatfish year class measurements 1973-1976. ICES, Doc. C.M.1977/F:25, 5 pp. (mimeo.).

RILEY, J D, D J SYMONDS and L WOOLNER, 1979. On the factors influencing the distribution of 0-group demersal fish in coastal waters. ICES/ELH Symp. on the Early Life History of Fish/DA:1, 10 pp. (mimeo.).

URSIN, E, 1958. The strength of individual year classes of plaice in the Danish Waddensea. Medd.Danmarks Fisk.- og Havunders., Ny Serie, 11(20):3-14.

VEDEL TÅNING, Å, 1943. Fluctuation in the number of 0-group plaice fished in the Waddensea. ICES, Annls.biol., 1:135-137.

WIMPENNY, R S, 1960. Young plaice hauls off the English east coast. Fish.Invest.Lond., Ser.2, 23 (1), 20 pp.

ANNEX 1

THE BELGIAN-DUTCH-GERMAN PRE-RECRUIT SURVEYS FOR O- AND I-GROUP FLATFISH AND JUVENILE BROWN SHRIMP

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In 1969, the Netherlands Institute for Fisheries Research initiated a programme to assess the relative importance of the various Dutch nurseries for juvenile flatfish, roundfish and brown shrimp. The institutes of Belgium and the Federal Republic of Germany soon joined the programme and for a number of years the University of Kiel, Federal Republic of Germany, also participated.

A standard gear was chosen consisting of a 3-meter beam trawl, mesh size 2.5 cm, with a bobbin groundrope and one tickler chain for the smaller ships in the estuaries and the Waddensea, and a 6-meter beam trawl of the same rigging for the ships working in the coastal area (Figure 1, page 17).

The standard fishing procedure was to fish with the tide at a speed of 1.5 knots and for 15 minutes. In each small area three hauls were intended, one as deep and one as shallow as possible, and one at intermediate depth.

The location of the stations is not random but determined by the existence of channels between the tidal flats. Figure 2(page 18) gives an example of the stations in use by the Belgian-Dutch-German Group.

Two cruises per year were planned, one in spring (April-May) and one in autumn (September-October). Next to the first objective, the estimation of year class strength of O- and 1-group fish became important.

It is quite possible that the standard gear chosen at the beginning of the surveys is far from optimal for the purpose. In 1969, there was a direct need to start the programme and no time was available to first spend some years to develop a very efficient gear.

The efficiency of the standard gear has been tested, and although this may not be very large, the data can still be used for our purpose. We may refrain from estimating the actual number of recruits; an index of the relative abundance too is useful for predicting future recruitment strength.

Once chosen, a standard gear should not be altered regularly, or even once, to avoid invalidating the possibility of comparison of the strength of successive year classes.

Results of the Pre-Recruit Surveys 1969-1978

The resulting numbers per 1 000 m^2 for plaice and sole <13 cm (0-group) and 13-19 cm (mainly 1-group) for the Sub-areas given in Figure 3 (page 19) for the Dutch nurseries in the Waddensea, Zeeland estuary, and coastal area, are given in Tables 1 - 4 (pages 11-14) for the spring and the autumn cruises for each year during the period 1969-78. Average numbers are given per cruise for the Waddensea, Zeeland estuary and coastal area as a whole, and the bottom line gives the averages for the total Dutch nursery weighted for the total areas of the three nurseries.

These data will be used in another section when doing regression analysis of the pre-recruit estimates with VPA data.

Another use of the data has been to calculate the average density over the years in the various Sub-areas, and the results are shown in Figures 4 (plaice <13 cm), 5 (plaice 13-19 cm), 6 (sole <13 cm) and 7 (sole 13-19 cm) on pages 20-23.

There is one big drawback in our fishing methods. Owing to the depth of the research vessels, it is not possible to fish in very shallow water. It is known (Kuipers, 1973) that 0- and 1-group plaice only remain in deeper parts during low tide when the tidal flats are dry. As soon as the water level rises and the flats become submerged, most of the young plaice enter the flats and feed on worms in shallow water. For that reason, our data on 0- and 1-group plaice are underestimates, because fishing is not only restricted to low tide.

0- and 1-group sole do not enter the tidal flats with rising tide and stay in water depths which are covered by our research ships.

In spring 1976, a special programme was started to estimate the numbers of young plaice on the tidal flats in the Waddensea and in shallow water along the North Sea coast. The discussion paper by Mr Van Beek deals with the results of these studies (see Annex 2, page 24).

Analysis of Pre-recruit Strength in Sole and Plaice

In the analysis of our data in the preceding section, we are able to check the accuracy of these estimates if we dispose of unbiased estimates of the recruiting year classes to compare. Virtual population analysis can provide these estimates. The results of the comparison, however, can be influenced by:

1. Errors in the VPA estimates owing to uncertainties in the terminal F-values. The most recent year class will suffer most.

2. Unknown variations in natural mortality M in the 0- as well as in the 1-group.

3. Insufficient coverage of the essential nurseries; local variations in the nurseries in one year class do occur and will have a large effect. This effect can only be eliminated when all nurseries are sampled. A notorious example of the effect of incomplete coverage is the plaice 1972 year class, which was found to be below average in the Belgian and Dutch nurseries and in the Niedersachsen area. No information was available further north in the first year of the year class. On recruiting to the adult stock, the 1972 year class turned out to be very good, especially in the central and northern North Sea. The bulk of this year class must have grown up in the northern German and Danish nurseries, making good the poor appearance in the southern nurseries.

Regression Analysis of the Dutch 0- and 1-Group Data with VPA Estimates of Two-Year-Old Fish

Tables 5a and b (page 15) give the average density per year class for sole in the spring and autumn surveys, and the combined estimate per year class. In cases of only one estimate per year, this estimate was corrected for the ratio spring/autumn density derived from the year classes with two estimates per year.

Table 6 (page 15) gives the combined estimates per year class as natural logs of the 0- and 1-group and of the VPA 2-year-old sole.

Regression analysis shows that no correlation exists between the 0-group and the VPA estimate. A good correlation is found between the 1-group and the VPA estimate. There is hardly any correlation between the 0- and 1-group estimates.

The bottom row of Table 6 (page 15) gives the decline in natural logs of the 1-group compared with the 0-group. This decline is large and cannot be attributed solely to natural mortality.

The good correlation between the 1-group and the VPA estimates shows that the gear, in spite of its rather low efficiency for sole, works satisfactorily. The lack of any correlation in the 0-group must therefore be taken as a real phenomenon, may be reflecting large variations in natural mortality and other causes of decline (emigration, vertical migration) from year to year.

A peculiar fact is the very low variance in the VPA estimates (var. 0.272) as compared with the high variance in the 0-group (var. 1.075) and 1-group (var. 0.999) estimates.

Tables 7a and b (page 16) give the average density per year class for plaice calculated in the same way as sole.

Table 8 (page 16) gives the comparison with the VPA recruitment estimates. There is a rather good correlation of the 0-group estimates with the VPA recruit estimates, however, in a negative sense. Strange as it may seem, the Dutch 0-group data show opposite densities as found later in the adult stock. The 1-group still shows a negative correlation of about the same magnitude, and the 0- and 1-group estimates are positively related. If there is something inexplicable, it affects both the 0- and 1-groups. We mentioned the 1972 year class, which was also reported as poor on the tidal flat Balgzand by Kuipers working on very shallow water. If we omit the 1972 year class data from the regression, we still get a negative correlation between 0-group and VPA, and a lower negative correlation between 1-group and VPA. The failure to predict future recruitment through the Dutch pre-recruit data is not a unique case. Ursin, evaluating the Danish Waddensea material for prediction purposes, failed to show a clear relationship with recruitment to the North Sea stock, and to the VPA estimates provided by Bannister. Wimpenny, using abundance estimates of 1-group plaice from the English coast (Bridlington Bay), also failed to find any relationship with the VPA figures.

In my opinion, it is not the pre-recruit data which are wrong but the use of VPA figures of the total North Sea stock. It is a well-known fact that the North Sea stock consists of various sub-stocks each having its own nursery area. If it could be possible to split the total North Sea plaice catch into its sub-stock components, VPA per sub-stock could yield the necessary data on recruit strength to relate to, and, e.g., the Dutch data could be compared with the Southern Bight sub-stock, the English data with the Flamborough sub-stock, etc. Unfortunately, the sub-stocks mix during part of the year and the necessary split in the catches is nearly impossible to carry out. A discriminant function analysis could be of help but this involves an amount of extra sampling and biometrical measurements which at the moment is impossible. The only way out is to sample all nurseries and reach a 100% coverage by research ships.

The fact that only part of the 0- and 1-group plaice could be sampled cannot explain this strange reverse correlation completely. It is necessary to study in more detail the distribution of members of a year class among all nurseries. It is my view that incomplete coverage of the nurseries has also had an effect on the correlation.

Also for plaice, there is a very low variance in the VPA estimates (var. 0.126) as compared with the higher variances in the 0-group (var. 0.460) and in the 1-group (var. 0.376).

Annex 1, Table 1. Numbers of young plaice (< 13 cm) per 1 000 m^2 in the Dutch nurseries: Waddensea, Zeeland estuary and coastal area by Sub-areas for spring (April-May) and autumn (September-October) cruises in the period 1969-1978.

Sub-Area	1969		1970		1971		1972		1973		1974		1975		1976		1977		1978	
	Apr-May	Sep-Oct	Apr-May	Sep-Oct	August	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct
Waddensea																				
A	20.20	13.20	7.45	19.90	5.00	24.00	48.90	7.62	13.26	9.59	9.74	7.25	3.15	7.29	0.97	79.07	13.87	20.69	35.31	117.39
B	20.52	4.00	12.85	15.00	78.00	8.70	55.40	10.47	23.58	3.27	24.93	5.33	6.80	4.10	3.87	25.17	18.00	16.39	9.59	136.21
C	15.05	26.30	1.68	9.50	63.70	5.00	33.60	2.49	1.08	5.85	40.39	29.59	8.06	22.44	5.90	66.35	22.10	2.50	49.28	69.09
D	31.26	9.50	9.11	4.30	74.20	4.00	65.40	7.56	8.97	19.34	66.32	0.69	8.47	6.88	3.41	4.87	5.21	1.56	43.07	14.50
E	24.59	3.70	1.80	2.80	14.20	1.10	24.20	3.86	2.26	12.62	8.34	1.16	0.28	2.02	0.35	0.28	0	2.72	0.04	52.76
F	59.37	21.70	8.90	4.90	17.00	0.50	164.70	7.23	61.85	1.57	34.40	1.87	19.50	9.13	8.93	0.90	0.85	1.10	25.43	17.28
G	35.06	4.20	1.14	0.30	18.60	5.80	1.20	2.28	0.27	2.50	2.30	0	0.20	0.73	0.27	1.23	0.13	0.07	15.93	3.58
H	25.83	23.00	2.17	6.60	27.50	16.60	9.10	0.32	0.27	0.83	5.22	1.60	0.39	7.01	6.69	9.06	4.98	0.11	0.90	7.48
K		14.80	14.60	23.70	13.50	59.50	24.40	8.33	3.44	21.27	7.19	6.96	2.02	21.13	0.62	68.83	6.65	28.50	33.54	31.19
L			11.66	26.50	15.90	20.10	30.30	3.21	2.76	19.81	2.25	12.76	3.67	24.24	0.60	32.05	4.52	11.80	22.43	35.81
M			7.42	3.60	4.30	34.60	7.60	2.92	2.87	15.95	6.96	23.07	4.01	11.15	1.77	15.52	9.08	20.00	4.63	73.39
N			3.67		5.10	17.80	43.40	10.81	0.36	14.33	4.36	9.13	2.73	13.63	16.66	36.46	24.93	16.61	36.06	38.44
X			1.93	8.10	45.60	10.80	21.40	1.41	0.68	37.85	14.17			84.81	0.33	159.06		9.57		193.89
Average	28.99	13.38	8.87	10.65	28.08	16.48	42.35	5.59	10.08	10.58	17.70	8.28	4.94	16.50	3.87	38.37	9.19	10.12	23.02	60.85
Zeeland estuary																				
A	0.33	0.09	1.40	2.01	2.40	2.90	0.30	0.30	0.13	1.65	0.07	0.23	0	0.58	0.10	0.20	0	0.37	0.03	0.54
B	0.33	0.56	0.04	0.11	1.40	3.10	0.10	1.90	0.02	2.07	1.39	0.38	0.16	1.93	0.54	0.83	0.55	1.35	0.12	2.14
C	2.83	1.00	0.02	0.42	2.30	2.50	0.40	1.90	0.46	3.15	0.22	0.32	1.00	7.46	0.64	1.60	0.19	18.49	0.28	2.81
D	25.83	2.08	0.34	4.62	12.50	1.80	8.60	0.40	0.98	1.06	2.64	1.32	2.16	3.90	1.06	1.70	9.34	2.82	0.58	15.18
E	1.46	1.50	0.15	1.01	9.60	3.00	5.10	1.80	1.07	6.29	1.17	2.30	1.20	1.95	3.90	0.16	2.27	2.70	0.17	11.20
F	8.94	6.21	1.70	4.42	16.10	2.70	15.80	1.30	0.72	18.45	1.26	2.30	0.78	12.68	2.54	1.00	2.54	1.73	0.17	8.47
G	8.15	1.77	0.82	3.80	15.20	5.30	3.40	2.30	0.17	6.74	2.20	2.01	1.20	8.26	4.33	3.50	0.93	1.29	0.13	6.66
H	8.06	4.78	1.01	3.31																
I	16.10	0.55	0.06	1.66	0.20	0	2.90	0.06	0.78	1.14	0.12	0.90	0.07	3.43	2.00	1.00	1.44	1.56	0.30	3.54
Average	8.00	2.06	0.62	2.37	7.46	2.66	4.58	1.25	0.54	5.07	1.13	1.22	0.82	5.02	1.89	1.25	2.16	3.79	0.22	6.32
Coastal area																				
A	1.34	7.04	0.04	91.28	78.40	27.90	2.40	1.10	1.00	1.50	0.70	0.30	0.80	0.05	0.67	0.43		8.67	4.12	0.40
B	0.50	8.40	0.78	22.64	33.70	3.80	1.40	3.91	2.88	2.45	0.40	2.19	0.38	1.20	0.08	1.65	1.45	1.13	1.43	1.04
C	2.34	2.00	0.73	1.58	18.80	0.50	2.30	0.07	2.33	0.63	0.93	0.88	1.08	0.16	6.48	4.38	0.82	0.59	1.12	0.31
D	1.93	2.75	1.26	0.20	21.60	12.30	0.80	1.05	1.14	3.14	1.53	1.76	0.84	4.60	0.77	9.18	2.62	0.26	0.60	15.58
E	0.36	0.67	0.13	0.84	31.40	3.80	0.80	0.25	0.23	1.01	1.71	0.65	0.20	8.22	0.06	6.28	0.70	0.28	0.19	11.56
F	0.14	0.60	0.13	0.03	5.40	3.40	0.70	0.03	0.05	0.17	0.23	0	0	0.63	0.05	0.52	0.02	0.95	0.40	12.50
Average	1.10	3.58	0.51	19.43	31.55	8.62	1.40	1.07	1.27	1.48	0.92	0.96	0.55	2.48	1.35	3.74	1.12	1.98	1.31	6.90
Total Dutch nursery weighted average	7.46	5.52	2.27	16.30	29.00	9.81	10.21	2.03	3.06	3.66	4.45	2.51	1.49	5.61	1.92	10.80	2.89	3.82	5.77	18.14

Annex 1, Table 2. Numbers of young plaice (13-19 cm) per 1 000 m^2 in the Dutch nurseries: Waddensea, Zeeland estuary and coastal area by Sub-areas for spring (April-May) and autumn (September-October) cruises in the period 1969-1978.

Sub-Area	1969		1970		1971		1972		1973		1974		1975		1976		1977		1978	
	Apr-May	Sep-Oct	Apr-May	Sep-Oct	August	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct
Waddensea																				
A	5.52	1.00	0.12	2.50	3.20	8.90	4.10	2.63	5.15	3.32	1.57	2.74	1.06	3.56	0.44	2.15	6.65	11.93	7.35	4.95
B	9.84	2.00	1.50	1.80	3.80	7.20	10.70	6.31	17.45	1.67	6.83	10.67	3.48	1.93	1.53	4.71	2.11	9.96	8.54	53.36
C	10.75	2.50	0.87	4.70	18.00	2.60	8.80	2.49	1.10	3.13	10.39	17.49	2.43	10.71	2.24	9.89	2.26	6.46	24.40	10.04
D	19.68	2.80	2.56	4.80	11.00	4.30	21.10	5.79	3.79	11.65	21.91	3.44	12.47	3.66	0.86	3.93	3.58	2.82	2.47	4.85
E	8.78	4.60	4.55	2.70	4.00	1.10	5.40	4.16	2.16	2.18	0.94	1.22	0.82	0.70	0.35	2.22	0.14	10.66	0.22	3.98
F	30.66	11.90	5.66	4.20	3.30	1.10	26.30	3.20	54.48	0.37	2.43	4.50	12.35	3.70	2.23	2.60	0.58	1.13	31.38	6.05
G	52.45	1.00	5.41	0.70	11.30	7.90	2.00	3.20	0.90	0.80	0.60	0.53	0.37	0.63	0.23	3.30	0.43	0.23	1.03	0.57
H	3.91	16.50	4.18	4.50	5.60	3.40	3.60	1.08	2.67	0.18	1.10	1.32	0	1.69	1.28	4.63	1.15	0.45	0.99	1.06
K		1.10	0.19	0	0.40	1.30	1.40	1.33	1.03	1.60	0.07	0.55	0.17	1.67	0.13	2.24	0.37	3.33	2.16	0.97
L			0.25	0.60	0.60	0.70	0.30	0.34	0.30	0.88	0.06	0.40	0.26	1.01	0.02	0.16	0.18	0	1.08	1.72
M			1.48	1.30	0.08	1.50	0.30	0.34	0.19	0.53	0.40	1.22	0.53	0.04	0.27	0.79	0.18	0.96	0.56	3.19
N			1.04		1.30	1.60	8.00	3.39	0.09	1.53	0.60	1.47	1.16	1.10	2.26	3.33	6.26	12.70	42.53	9.57
X			2.53	4.60	11.80	3.00	6.20	1.79	1.89	7.85	2.53			6.10	0.48	10.90		4.56		6.93
Average	17.70	4.82	2.32	2.53	5.22	3.47	7.67	2.86	7.44	2.32	3.91	3.75	2.93	2.81	0.95	3.91	1.99	5.01	10.23	8.25
Zeeland estuary																				
A	0.08	0	2.79	0.88	0.20	0.30	0.30	0.20	0.13	0.22	0.07	0.02	0.08	0.05	0.03	0.07	0	0.07	0.03	0.03
B	0.06	0.11	0.04	0.08	0.20	1.10	0	1.00	0.03	0.32	0.76	0.07	0.07	0.23	0.22	0.09	1.08	0.18	0.02	0.16
C	0.42	0.09	0	0.06	0.30	0.80	0	0.80	0.22	0.56	0.06	0.31	0.13	0.19	0.44	0.05	0.08	0.55	0.10	0.39
D	14.50	3.24	0.56	10.52	1.50	1.40	1.60	3.10	0.58	2.86	1.20	6.50	9.07	2.33	0.52	3.30	4.38	4.90	1.12	9.30
E	0.29	1.25	0.19	0.70	0.90	2.20	1.70	0.90	0.45	0.97	0.98	7.16	0.91	0.15	0.67	0.24	1.27	2.00	0.07	1.40
F	4.02	2.07	2.94	7.32	2.10	1.20	3.30	0.70	0.49	6.27	1.08	0.88	0.29	0.57	0.40	0.90	0.77	0.84	0.10	1.07
G	1.23	0.56	0.43	1.56	0.30	0.70	2.50	1.20	0.18	0.60	0.28	0.20	0.51	2.42	0.29	2.00	0.66	0.82	0.04	0.34
H	2.44	1.39	0.59	2.40																
I	3.40	0.35	0.18	10.14	0.10	0.50	1.30	1.00	0.28	0.68	0.12	1.82	0.40	1.45	0.47	1.90	0.84	2.20	0.22	1.58
Average	2.94	1.01	0.86	3.74	0.70	1.03	1.34	1.11	0.30	1.56	0.57	2.12	1.43	0.92	0.38	1.07	1.14	1.45	0.21	1.78
Coastal area																				
A	2.31	1.59	0.86	39.13	14.90	9.90	3.80	5.07	1.75	1.53	0.47	3.20	0.80	0.55	0.83	0.57	0	16.17	2.36	1.00
B	1.20	9.56	3.70	13.35	14.60	3.30	1.90	5.43	2.28	2.85	0.38	2.19	0.54	1.67	0.19	0.85	0.78	5.99	3.35	1.29
C	3.05	1.55	3.05	4.70	6.00	1.70	3.90	0.62	1.90	0.36	0.86	0.24	0.79	0.43	2.55	3.20	0.50	1.23	1.06	1.71
D	0.76	0.75	3.45	0.18	0.60	1.10	0.30	1.36	1.11	0.21	0.49	0.35	0.16	0.11	0.37	4.14	2.55	0.16	0.23	0.59
E	0.13	0.05	0.32	0.35	0.20	0.70	0.80	0.57	0.77	0.07	0.87	0.07	0.01	0.76	0.03	2.14	0.56	0.31	0.15	0.57
F	0.07	0.25	0.27	0.49	0.10	0.10	0.10	0.13	0.08	0.01	0.08	0	0.01	0.16	0.06	0.46	0.02	0.93	0.27	0
Average	1.25	2.29	1.94	9.70	6.07	2.80	1.80	2.20	1.32	0.84	0.53	1.01	0.39	0.61	0.67	1.89	0.88	4.13	1.24	0.86
Total Dutch nursery weighted average	4.82	2.72	1.94	7.75	5.49	2.81	2.99	2.26	2.52	1.20	1.24	1.67	1.00	1.09	0.71	2.25	1.13	4.11	1.69	2.48

Annex 1, Table 3. Numbers of young sole (< 13 cm) per 1 000 m^2 in the Dutch nurseries: Waddensea, Zeeland estuary and coastal area by Sub-areas for spring (April-May) and autumn (September-October) cruises in the period 1969-1978.

Sub-Area	1969		1970		1971		1972		1973		1974		1975		1976		1977		1978	
	Apr-May	Sep-Oct	Apr-May	Sep-Oct	August	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct
Waddensea																				
A	1.09	5.80	13.12	25.30	3.60	70.90	1.00	2.46	1.76	1.96	6.39	0.39	0.85	3.10	0	13.28	6.70	8.79	0.02	6.85
B	1.87	2.60	8.82	8.20	15.20	6.90	1.60	5.46	0.85	13.23	2.43	2.76	1.27	2.92	1.11	0.91	1.41	1.35	0.10	11.93
C	3.14	2.30	2.64	3.30	10.40	1.70	0.50	1.10	0	6.66	0.54	10.01	0.04	1.77	0.03	12.15	0.26	0.71	0.03	17.83
D	6.15	4.70	10.73	5.80	10.80	2.70	1.20	0.98	0	4.50	8.82	9.62	2.68	1.67	0.12	1.51	2.23	0.41	0.19	2.23
E	2.63	9.60	7.69	1.50	2.50	2.20	0.80	0.30	0	0.60	1.60	3.65	0.76	0.17	0	2.30	0	0.94	0.08	26.42
F	15.87	11.70	24.40	33.40	24.50	2.10	1.80	1.23	0.63	1.13	2.13	6.83	3.75	4.25	0.33	0.30	0.05	0	0.28	1.33
G	2.86	3.60	23.25	0.40	6.40	26.80	0.20	0.43	0	2.90	0.27	0.30	0.13	0.83	0	3.03	0.07	0.57	0.20	1.23
H	3.48	8.30	3.49	45.50	15.40	19.30	0.60	1.40	0.05	5.12	2.72	1.10	0.21	1.03	0.20	2.84	0.26	0.06	0.18	2.16
K		17.90	9.97	22.30	6.80	33.50	0.40	4.78	2.87	2.94	1.60	0.14	0.57	2.12	0.02	7.14	1.94	11.67	0.11	4.97
L			5.58	8.40	14.40	3.40	0.20	1.04	3.34	2.19	0.72	0	0.66	1.32	0.02	3.07	0.87	0.35	0	10.57
M			5.31	27.80	20.70	44.00	0.30	0.34	0.38	0.68	1.34	0.46	1.19	0.57	0.14	1.44	1.24	1.89	0.04	11.03
N			15.26		49.40	31.90	0.40	0.79	0	7.03	3.50	1.21	3.41	0.26	0.79	1.11	7.66	5.79	0	17.37
X			3.07	24.40	12.90	10.50	0.60	1.25	0.03	4.95	1.93			0.14	0	4.74		0.90		21.61
Average	4.64	7.39	10.86	16.54	15.01	20.45	0.75	1.69	0.82	4.08	2.67	3.04	1.29	1.55	0.21	4.14	1.89	2.57	0.10	10.43
Zeeland estuary																				
A	0.60	0	1.30	8.89	3.30	8.60	0.50	0.05	0.09	0.83	1.07	0.05	0.20	0.48	1.14	0.83	0.27	0.80	0	2.54
B	3.88	0.18	3.99	3.98	3.60	6.40	0.80	0.60	0.02	0.81	2.26	0.22	0.99	2.86	1.54	0.10	0.50	4.18	0.24	2.75
C	9.81	0.13	28.95	3.79	2.90	5.60	7.00	0.10	0.94	0.97	18.37	0.07	1.86	0.78	13.81	0.51	7.44	5.24	0.70	5.74
D	1.65	0.36	1.30	19.80	6.90	2.30	4.30	0.10	0.14	1.54	0.12	0.16	0.50	1.45	0.34	0.16	3.58	2.18	0.08	24.80
E	0.42	0.16	0.19	25.65	2.60	11.30	0.50	0.10	0.08	5.43	0.13	0.16	0.06	0.25	0.40	0	0.38	0.80	0.03	1.63
F	0.90	6.08	0.90	13.26	9.00	3.30	0.60	0.10	0.15	21.90	0.20	0.12	0.03	2.04	0.28	0.15	0.77	0.18	0.02	2.61
G	0.42	1.18	0.07	14.54	17.00	5.50	0.10	0.30	0	3.64	0.50	0.37	0.03	3.32	0.13	2.02	0.77	0.26	0.09	2.80
H	0.79	0.38	1.06	23.41																
I	1.19	0.84	0	0.59	0.20	0.20	0.10	0	0.15	0	0	0.20	0	0.25	0	0.10	0.12	0.36	0	0.38
Average	2.18	1.03	4.20	12.66	5.69	5.40	1.74	0.17	0.20	4.39	2.83	0.17	0.46	1.43	2.21	0.47	1.73	1.75	0.15	5.41
Coastal area																				
A	0.27	44.57	0	58.59	98.30	9.20	0	0.47	0.20	0.57	0	0.10	0	1.25	0	0.83		1.93	0	0.03
B	0.03	81.95	0.03	58.80	45.90	7.10	0	1.42	0.56	11.76	0.03	2.64	0.01	0.64	0	1.00	0.13	0.83	0.03	0.03
C	0.65	8.99	0.08	1.72	7.60	1.20	0	0.21	0.04	7.05	0.07	0.30	0	0.98	0.10	10.46	0.16	0.26	0.01	0.48
D	0.45	2.94	0.77	3.15	74.30	10.20	0.60	0.35	1.05	10.98	0.87	1.18	0.47	8.19	0.14	14.02	0.87	0.16	0.23	17.62
E	0.28	11.41	5.26	12.05	47.30	7.00	0.10	0.09	1.12	6.40	1.01	0.31	0.15	13.90	0.19	8.14	3.14	0.76	0.25	14.39
F	0.07	1.15	0.20	8.29	15.60	8.00	0.10	0	0	7.07	0.26	0.10	0.01	3.30	0.03	2.24	0.02	0.18	0.07	7.80
Average	0.29	25.67	1.06	23.77	48.17	7.12	0.13	0.42	0.50	7.31	0.37	0.77	0.11	4.71	0.08	6.12	0.86	0.69	0.10	6.73
Total Dutch nursery weighted average	1.34	19.98	3.35	21.42	38.02	9.78	0.38	0.67	0.54	6.41	1.04	1.20	0.38	3.80	0.27	5.28	1.14	1.16	0.10	7.40

Annex 1, Table 4. Numbers of young sole (13-19 cm) per 1 000 m^2 in the Dutch nurseries: Waddensea, Zeeland estuary and coastal area by Sub-areas for spring (April-May) and autumn (September-October) cruises in the period 1969-1978.

Sub-Area	1969		1970		1971		1972		1973		1974		1975		1976		1977		1978	
	Apr-May	Sep-Oct	Apr-May	Sep-Oct	August	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct	Apr-May	Sep-Oct
Waddensea																				
A	0.12	0	0.64	0.08	0.50	0	0.20	0	0.09	0.05	0.13	0	0.08	0.03	0.02	0.14	0.87	0.15	0.03	0
B	0.10	0.30	0.56	0.90	0.20	0	0.10	0.84	0	0.28	0.50	0.03	0.05	0.43	0.26	0.10	0.29	0.04	0	0
C	0.05	0	0.28	0.30	1.30	0	0	0	0	0.14	0	0.03	0.07	0.06	0	1.21	0.13	0.19	0	0
D	0.22	0.20	0.69	2.10	1.00	0	0.20	0	0	0	0.74	0.32	0.10	0.94	0	0.16	0.35	0.05	0.07	0.06
E	0.08	3.60	0.31	0.20	0.20	0	0.10	0.12	0	0	0.10	0.16	0	0.25	0	0	0	0.18	0.04	0
F	0.13	0.80	1.26	10.00	0.90	0	0.20	0.97	0	0	0.10	0.77	0.45	1.48	0	0	0	0	0.10	0
G	0.08	0.10	1.29	4.90	0.30	0.60	0	0.35	0	0	0	0.07	0.07	0.07	0	0	0	0.13	0.13	0
H	0.06	0.20	0.16	0.40	0.30	0	0.30	0.14	0	0.12	0.07	0.56	0.09	0.11	0.03	0	0.19	0	0.09	0
K		0	0.57	0	0.04	0	0.03	0	0	0	0.04	0	0	0	0	0	0.20	0.06	0	0
L			0.33	0	0	0	0.03	0	0	0	0	0	0.02	0	0	0	0.10	0	0.07	0
M			0.76	0	0.04	0.10	0.10	0	0.02	0	0.05	0	0.15	0	0.06	0	0.29	0	0	0
N			1.18		0.10	0	0.10	0	0	0.23	0	0	0.40	0	0.13	0.03	2.36	0.03	0.03	0
X			0.22	0.40	0.80	0	0.10	0.07	0	0	0.14			0	0.03	0.27		0.69		0
Average	0.11	0.58	0.67	1.72	0.41	0.06	0.11	0.20	0.01	0.07	0.14	0.16	0.12	0.26	0.04	0.15	0.40	0.12	0.05	0.00+
Zeeland estuary																				
A	0	0	0.43	1.23	0.10	0.30	0.10	0.03	0.04	0.08	0.10	0.11	0.37	0	0	0.55	0.27	0.03	0	0
B	0.06	0.05	0.23	0.45	0.10	0	0.10	0.40	0	0.09	0.18	0.34	0.29	0.13	0.06	0.34	0.49	0	0.15	0
C	0.35	0.02	2.37	0.11	0.20	0.03	0.80	0.50	0.07	0.18	1.06	0.23	0.42	0	0.36	0.08	1.29	0.30	0.28	0.18
D	0.06	0.07	0.13	3.93	3.30	1.20	0.40	0.20	0.06	0.18	0	9.48	0.33	1.68	0.14	0.18	2.06	0.20	0	1.08
E	0	0.12	0	1.21	0.10	0.10	0.03	0.20	0	0.07	0	0.96	0.03	0	0.07	0	0.07	0	0	0
F	0.02	0.59	0.46	0.99	0.10	0	0.10	0.10	0.02	4.73	0	0.27	0.02	0.02	0.04	0.07	0.52	0	0	0
G	0.02	0.08	0.04	0.31	0.10	0.02	0.20	0	0	0.10	0.13	0.43	0.06	0.13	0.02	0.24	0.53	0.10	0	0
H	0.04	0.17	0.14	1.24																
I	0	0.16	0	0.38	0	0	0	0	0	0	0	0.08	0	0	0	0	0	0	0.04	0
Average	0.06	0.14	0.42	1.09	0.50	0.21	0.22	0.18	0.02	0.68	0.17	1.49	0.19	0.25	0.09	0.18	0.65	0.08	0.06	0.16
Coastal area																				
A	0.06	0	0	0	0.80	0	0	0.03	0	0.03	0	0	0	0	0	0.23		0.03	0	0
B	0.04	0.24	0.01	0.63	0.70	0	0	0.02	0.08	0.10	0.01	0.47	0	0.01	0	0.18	0.25	0.03	0.03	0.01
C	0.09	0.11	0.03	0.49	0.30	0	0	0.03	0	0.13	0	0.04	0.03	0.03	0.01	1.54	0.04	0.03	0.16	0.02
D	0.03	0.11	0.12	0.78	0.10	0.02	0.10	0.04	0	0.15	0.01	0.78	0.04	0.11	0	0.78	0.53	0.07	0.28	0.04
E	0	0.12	0.62	0.47	1.70	0	0	0.01	0.16	0.08	0.03	0.14	0.11	0.13	0.03	0.12	0.66	0.05	0.28	0
F	0.02	0.07	0.07	0.27	0.10	0.01	0.01	0	0	0.19	0.08	0.08	0.03	0	0	0.46	0.06	0.08	0.06	0
Average	0.04	0.11	0.14	0.44	0.62	0.01	0.02	0.02	0.14	0.11	0.02	0.25	0.04	0.05	0.01	0.55	0.31	0.05	0.14	0.01
Total Dutch nursery weighted average	0.06	0.21	0.27	0.76	0.57	0.04	0.05	0.07	0.10	0.14	0.06	0.33	0.07	0.11	0.02	0.44	0.35	0.07	0.12	0.02

Annex 1, Table 5a. Average weighted catch per 1 000 m^2 of sole <13 cm in the total Dutch nursery.

Year class	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Spring	1.34	3.35	-	0.38	0.54	1.04	0.38	0.27	1.14	0.10	-
Autumn	-	19.98	21.42	9.78	0.67	6.41	1.20	3.80	5.28	1.16	7.40
Combined	5.16	11.67	12.31	5.08	0.61	3.73	0.79	2.04	3.71	0.63	4.25

Annex 1, Table 5b. Average weighted catch per 1 000 m^2 of sole 13-19 cm in the total Dutch nursery.

Year class	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Spring	0.06	0.27	-	0.05	0.10	0.06	0.07	0.02	0.35	0.12	-	-
Autumn	-	0.21	0.76	0.04	0.07	0.14	0.33	0.11	0.44	0.07	0.02	-
Combined	0.07	0.24	0.66	0.04	0.09	0.10	0.20	0.07	0.40	0.10	0.02	-

Annex 1, Table 6. Regression - analysis.

Year class	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
ln 0-group		1.641	2.457	2.510	1.625	-0.494	1.316	-0.236	0.713	1.311	-0.462	1.447
ln 1-group	-2.659	-1.427	-0.416	-3.101	-2.408	-2.303	-1.609	-2.659	-0.916	-2.303	-3.912	
ln VPA R_2	11.47	10.77	11.85	10.42	11.25	11.52	11.47	10.50	11.67			
ln 0 - ln 1		-3.068	-2.873	-5.611	-4.033	-1.809	-2.925	-2.423	-1.629	-3.614	-3.450	

Average 1967-1978: -3.14

	r	a	b
0-group estimate (y) - VPA R_2 (x)	-0.025	1.77	-0.056
1-group estimated (y) - VPA R_2 (x)	+0.640	-14.40	1.11
0-group (x) - 1-group (y) estimate	+0.221	-2.07	0.18

Annex 1, Table 7a. Average weighted catch per 1 000 m^2 of plaice <13 cm in the total Dutch nursery.

Year class	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Spring	7.46	2.27	-	10.21	3.06	4.45	1.49	1.92	2.89	5.77	-
Autumn	-	5.52	16.30	9.81	2.03	3.66	2.51	5.61	10.80	3.82	18.14
Combined	8.80	3.90	14.12	10.01	2.55	4.06	2.00	3.77	6.85	4.80	15.71

Annex 1, Table 7b. Average weighted catch per 1 000 m^2 of plaice 13-19 cm in the total Dutch nursery.

Year class	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
Spring	4.82	1.94	-	2.99	2.52	1.24	1.00	0.71	1.13	1.69	-	-
Autumn	-	2.72	7.75	2.81	2.26	1.20	1.67	1.09	2.25	4.11	2.48	-
Combined	5.71	2.33	6.71	2.90	2.39	1.22	1.34	0.90	1.69	2.90	2.15	-

Annex 1, Table 8. Regression - analysis.

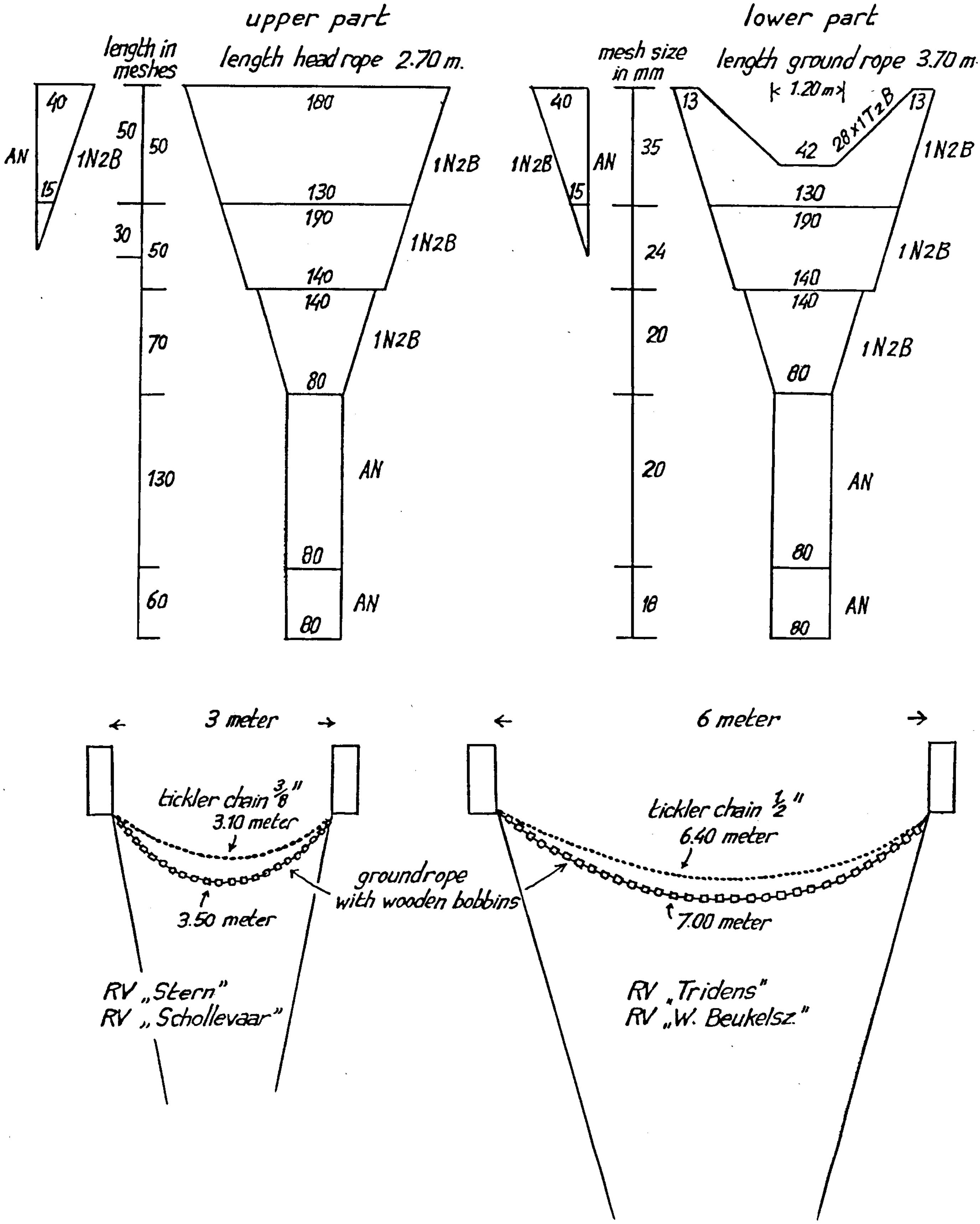
Year class	1967	1968	1969	1970	1971	1972	1973	1974	1975	1976	1977	1978
ln 0-group		2.175	1.361	2.648	2.304	0.936	1.401	0.693	1.327	1.924	1.564	2.[illegible]
ln 1-group	1.742	0.846	1.904	1.065	0.871	0.199	0.293	-0.105	0.525	1.065	0.765	
ln VPA R_2	12.39	12.65	12.82	12.58	12.37	13.48	13.04	12.56	12.95			
ln 0 - ln 1		-1.329	+0.543	-1.583	-1.433	-0.737	-1.108	-0.798	-0.802	-0.859	-0.804	

Average 1967-1978: -0.891

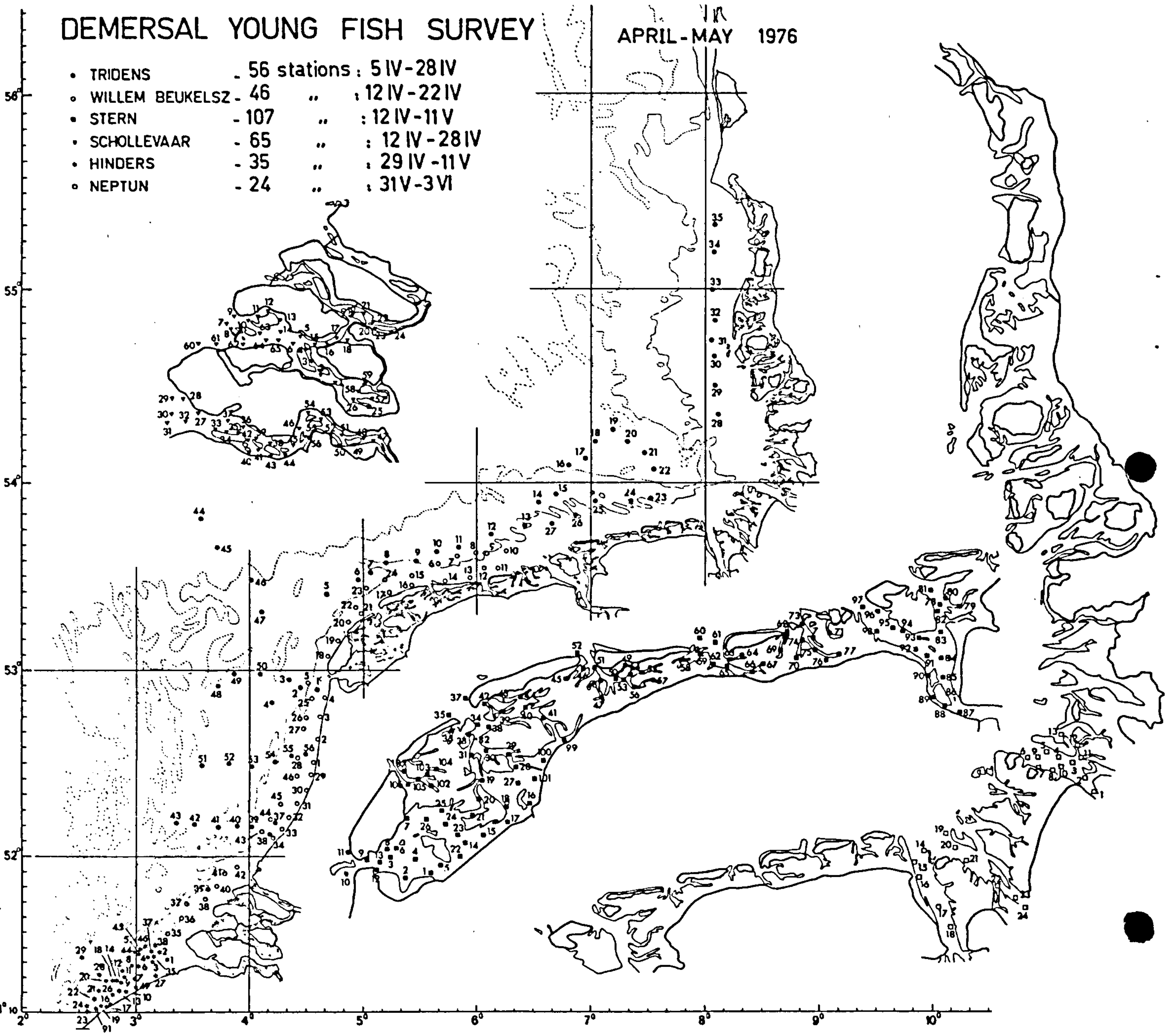
	r	a	b
0-group estimate (y) - VPA R_2 (x)	-0.559	15.78	-1.11
1-group estimate (y) - VPA R_2 (x)	-0.418	11.03	-0.801
0-group (x) - 1-group (y) estimate	+0.508	-0.01	0.461

excluding the data of the 1972 year class

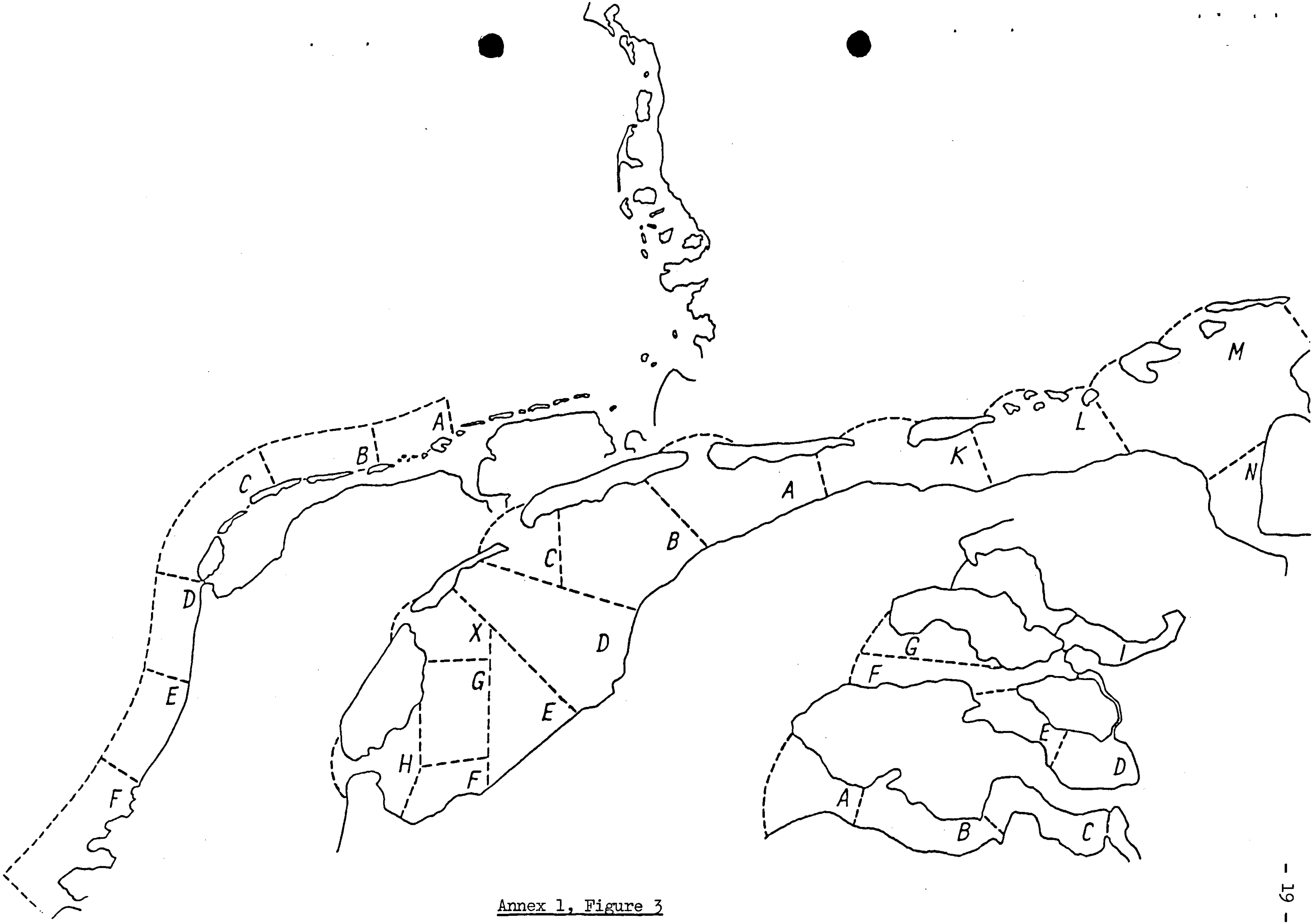
	r	a	b
0-group estimate (y) - VPA R_2 (x)	-0.440	17.97	-1.29
1-group estimate (y) - VPA R_2 (x)	-0.263	10.07	-0.73
0-group (x) - 1-group (y) estimate	+0.432	0.116	0.402



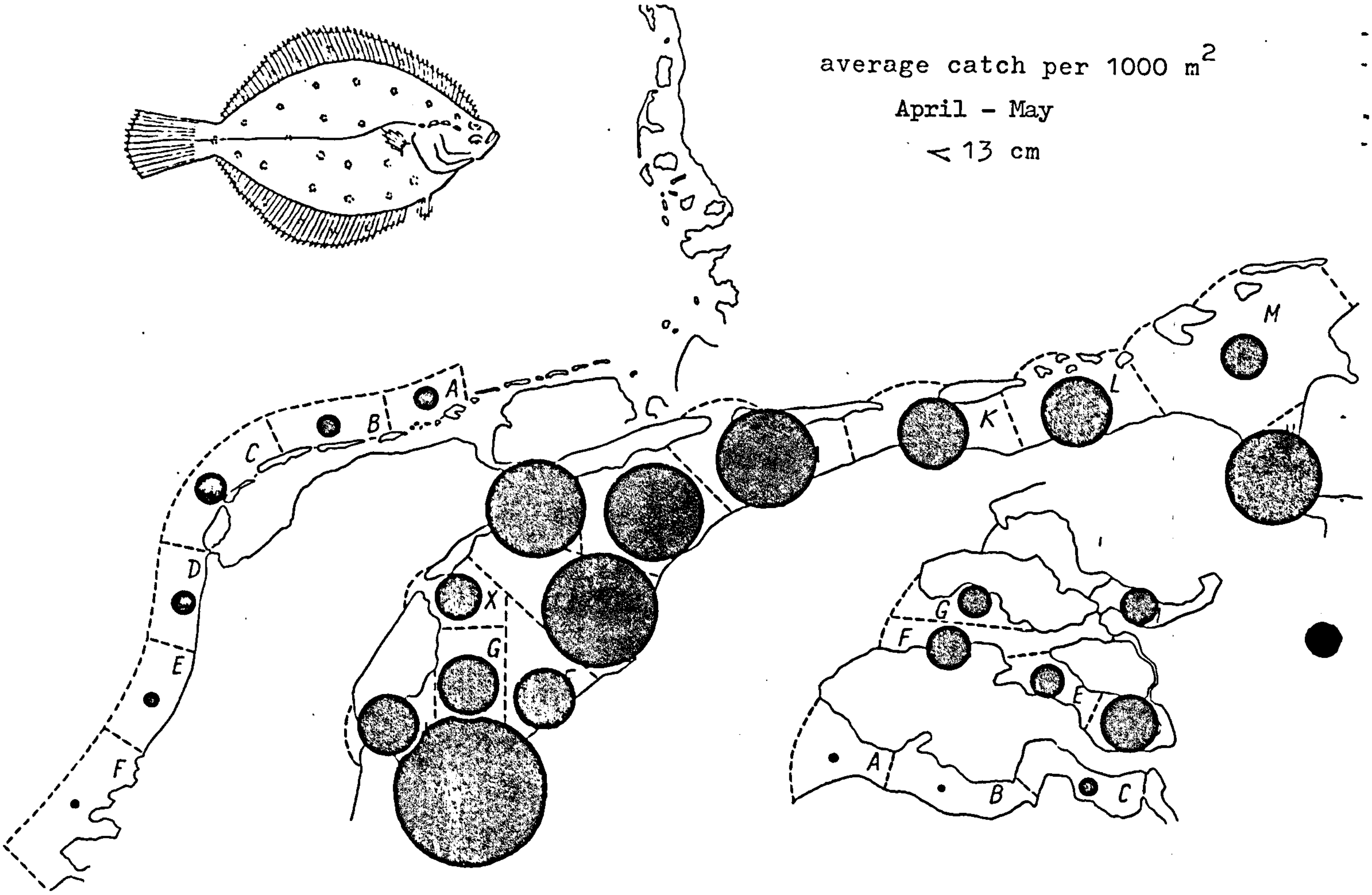
Annex 1, Figure 1

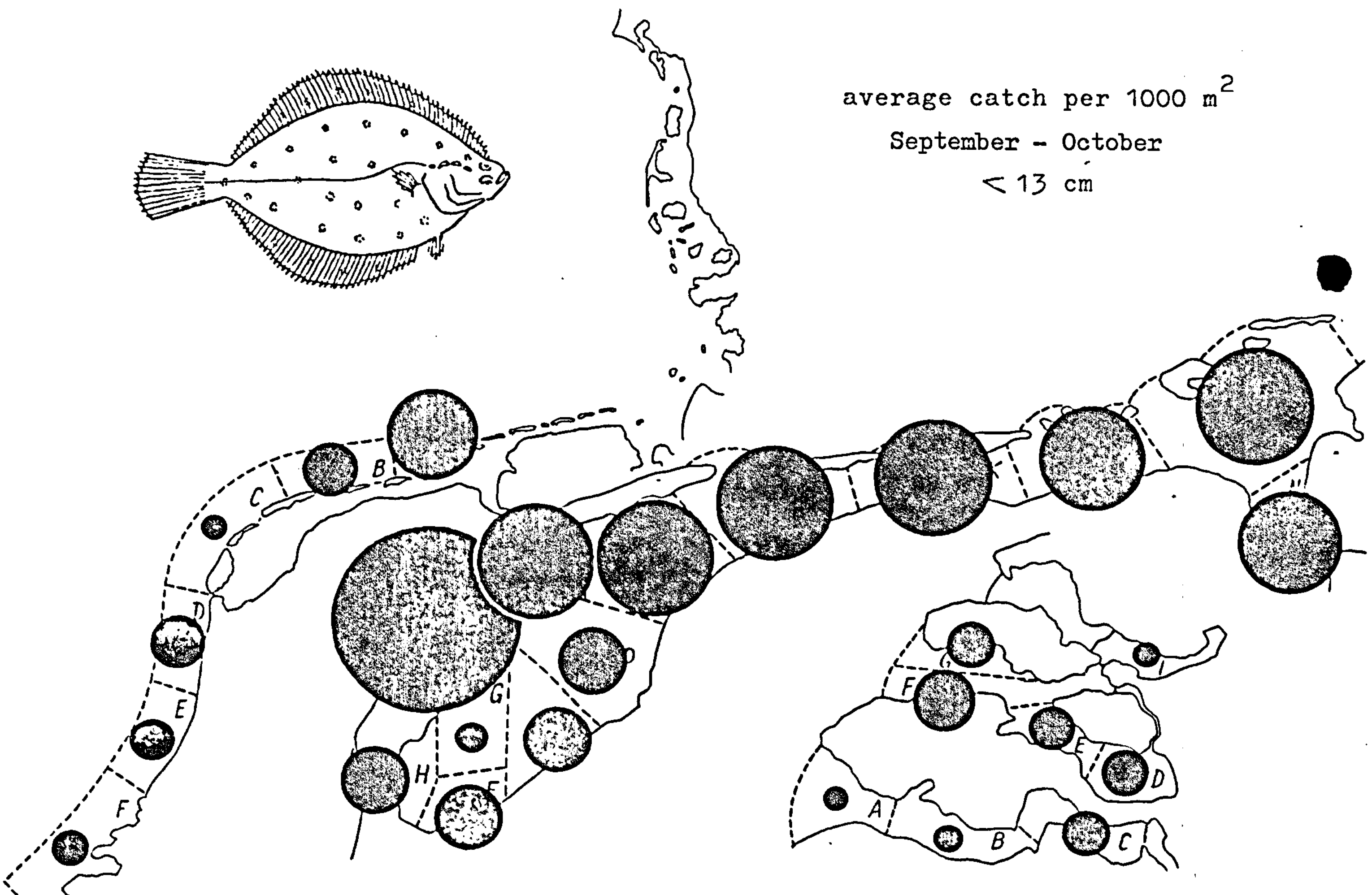


Annex 1, Figure 2

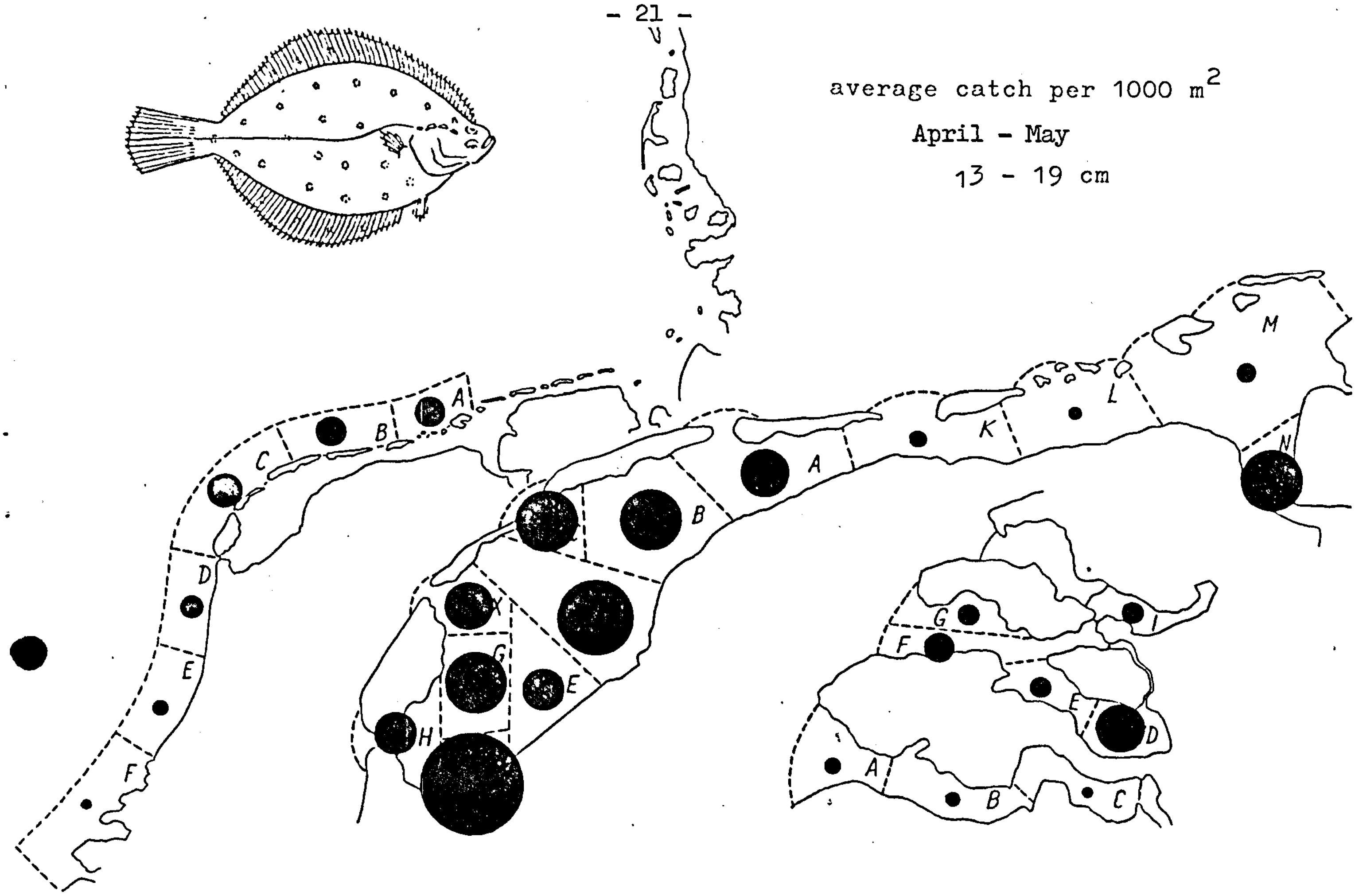


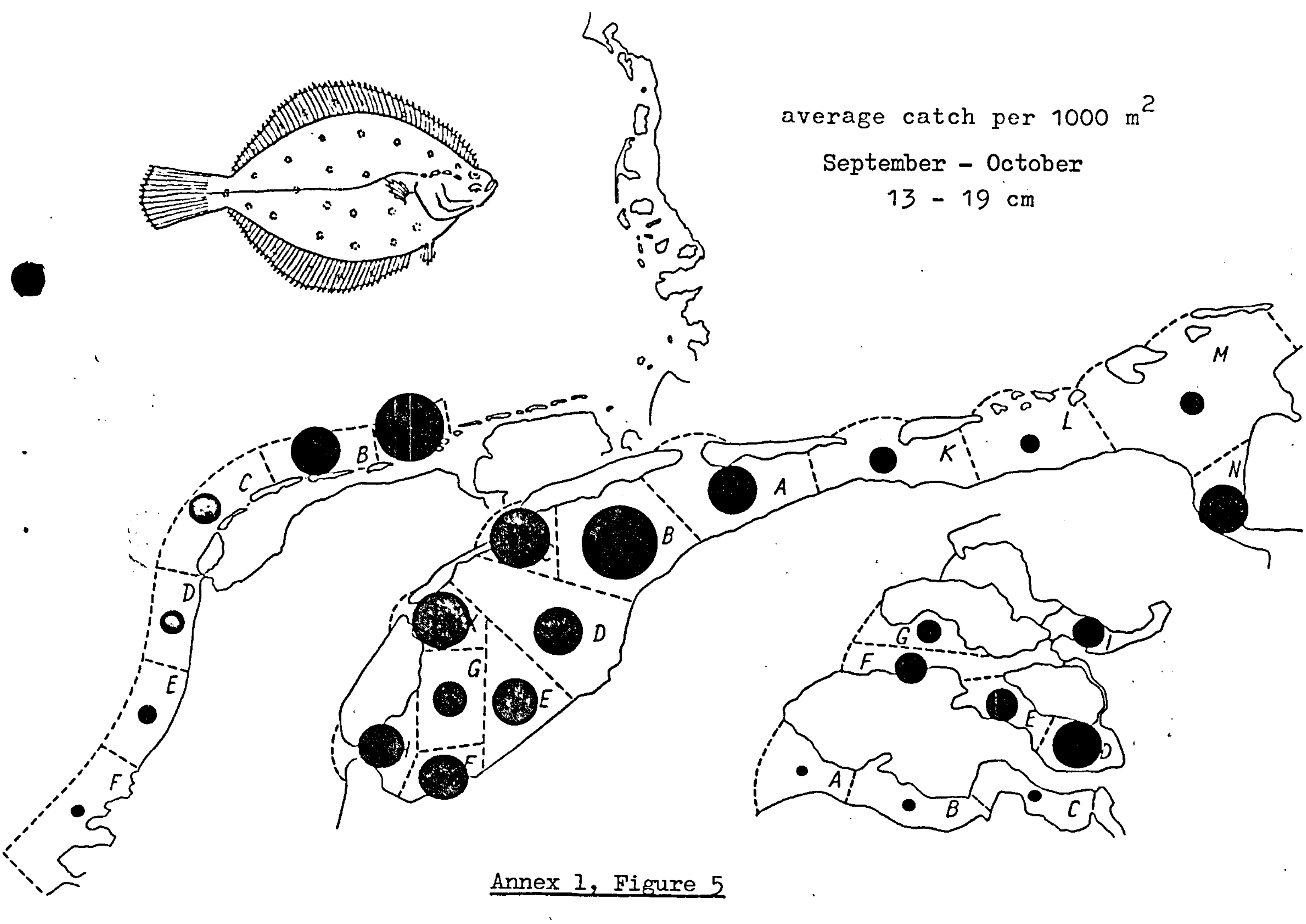
Annex 1, Figure 3



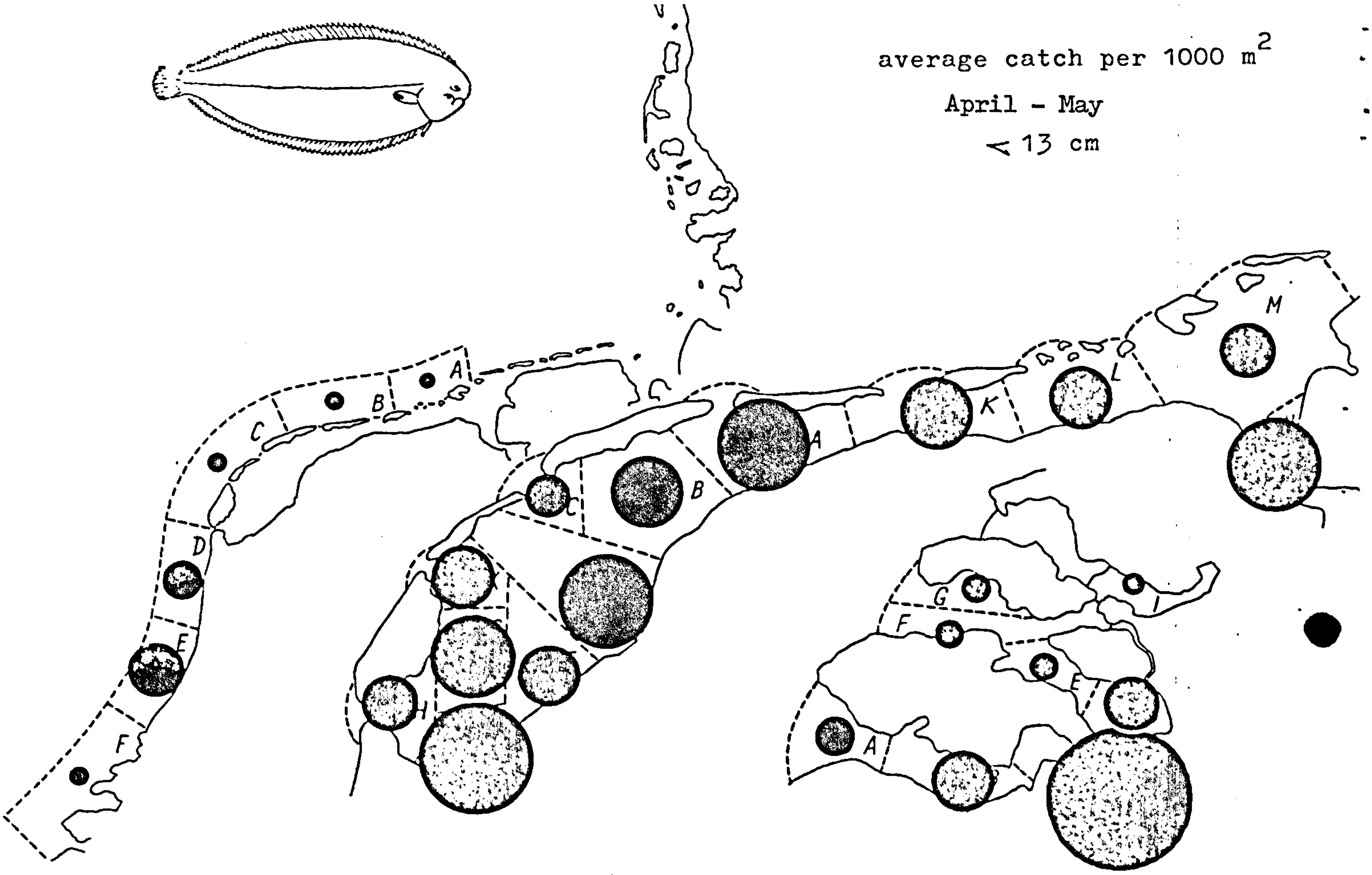


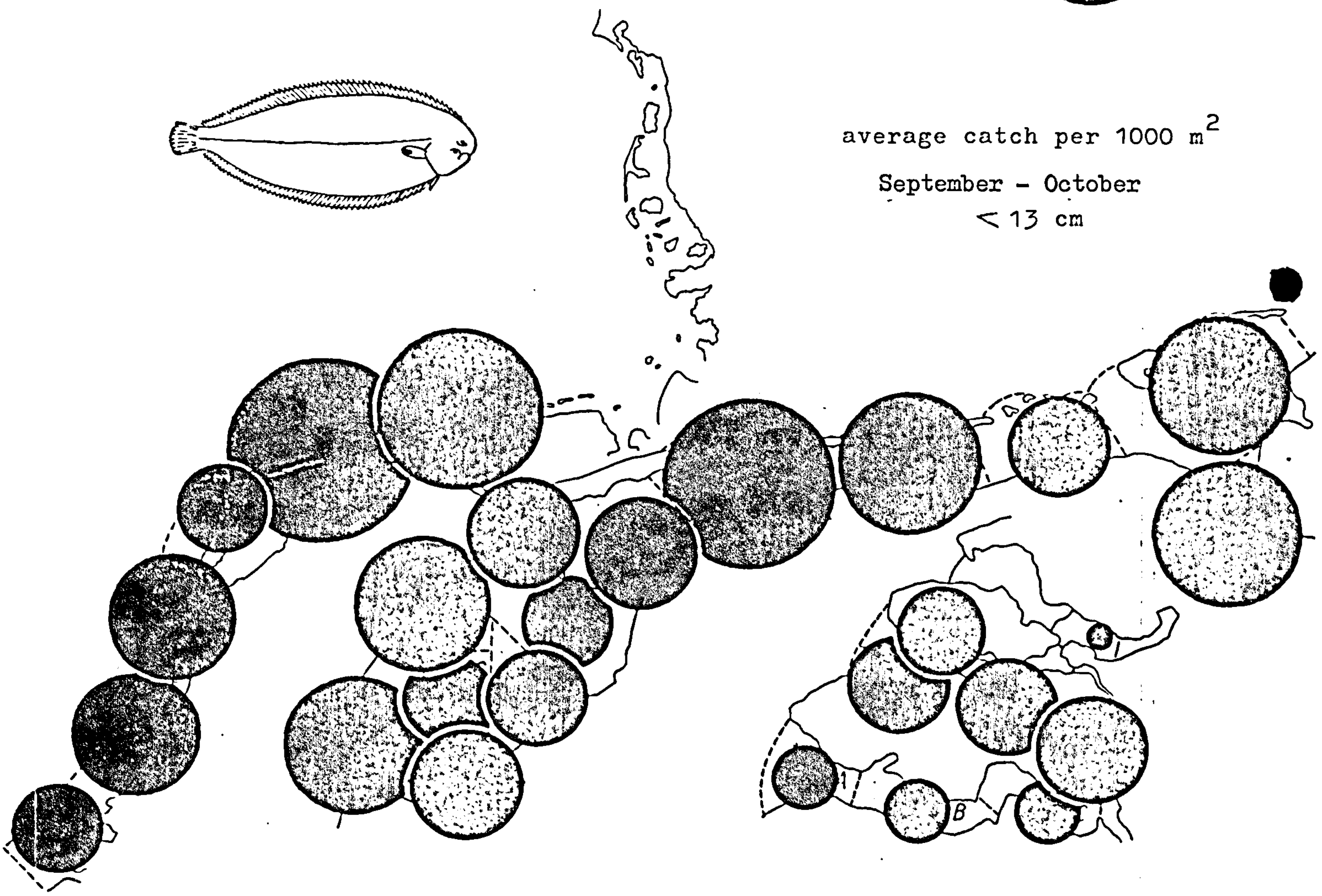
Annex 1, Figure 4



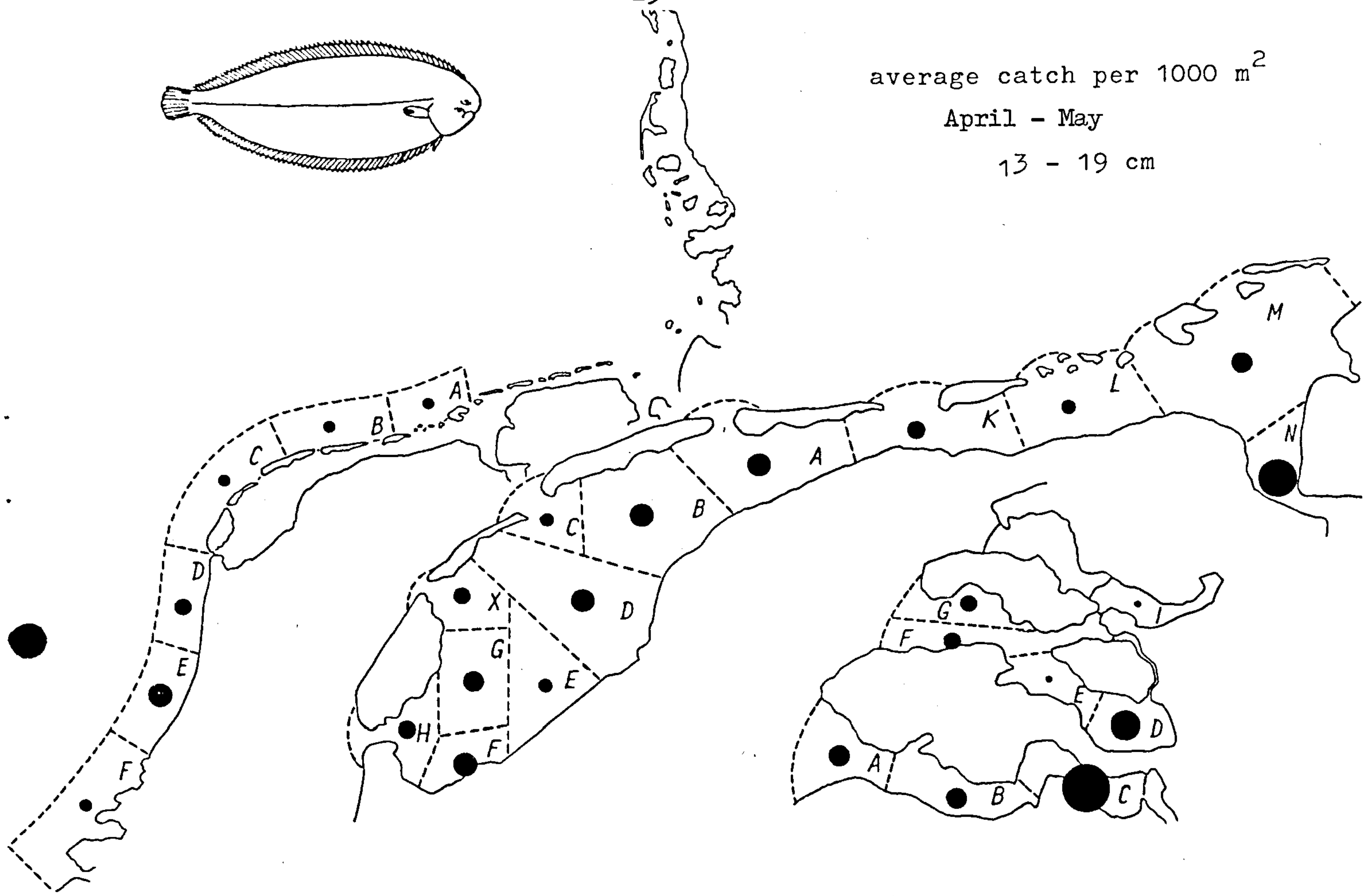


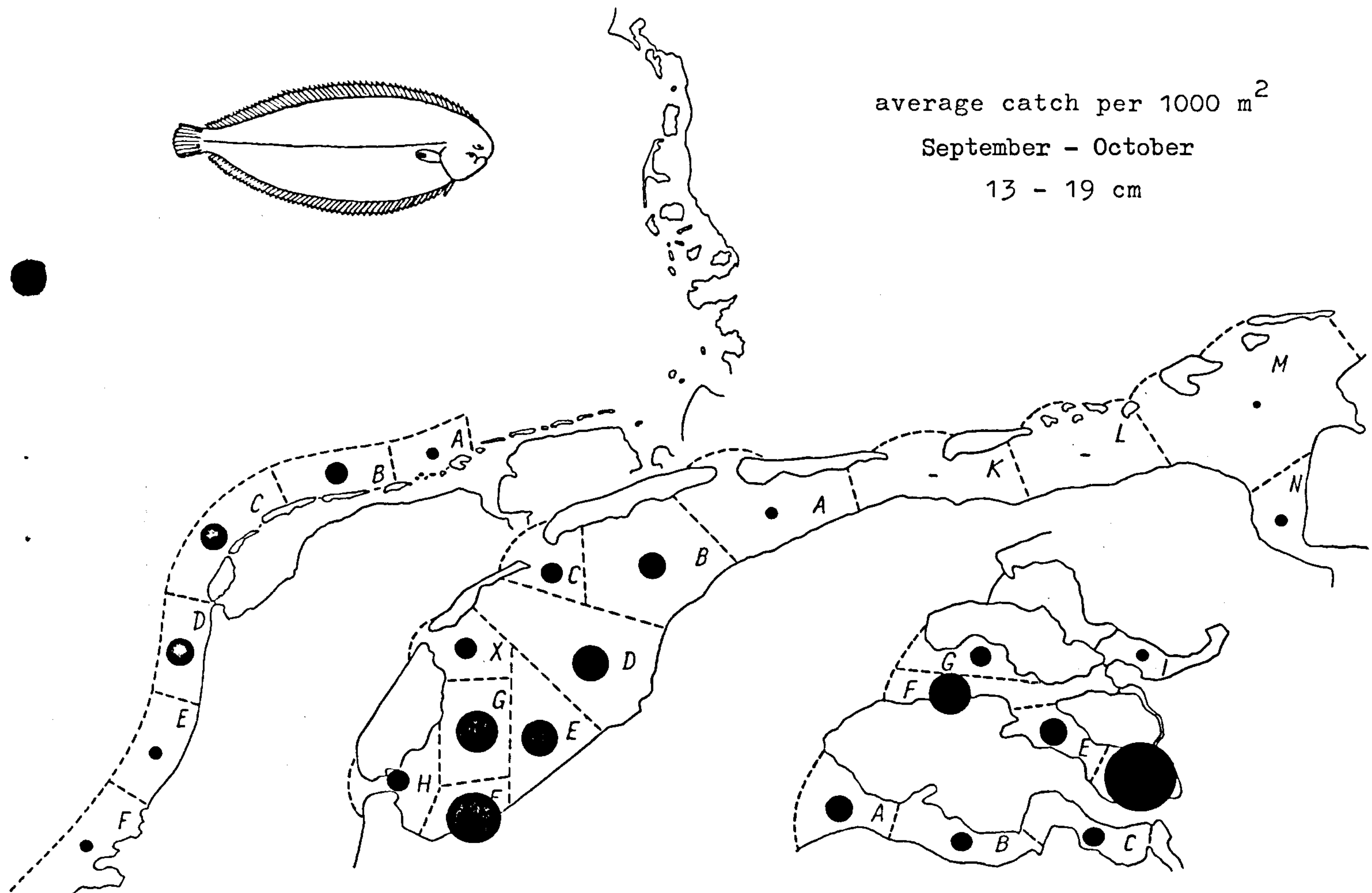
Annex 1, Figure 5





Annex 1, Figure 6





Annex 1, Figure 7

ANNEX 2

ADDITIONAL SAMPLING PROGRAMMES FOR FLATFISH AND BROWN SHRIMP ON THE TIDAL FLATS IN THE WADDENSEA AND ALONG THE BEACH

by

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Since 1969, the Federal Republic of Germany, the Netherlands and Belgium are sampling 0- and 1-year old flatfish and brown shrimps (Waddensea project) in the coastal areas and estuaries. The intention of these investigations was to show the importance of the Wadden and other coastal areas as nurseries for young flatfish and brown shrimp. In later stages the surveys are also intended for assessment purposes.

The surveys are carried out in April and September by different ships. The sampling gear is a beam trawl. Hauls are made along the coast and in the channels of the Waddensea and Zeeland estuary. The data give information about the relative abundance of the year classes as 0- and 1-year olds in the different areas.

The duration of a survey is about 3 weeks. When in this period migration takes place, sampling for censuses is inadequate. Probably this situation can occur in plaice, which migrates in early spring from the open sea to the coastal waters. The duration and period in which this migration takes place is not exactly the same every year. The catches in April can be influenced by time and place.

Another disadvantage is the difference in tide during fishing. Catches in the tidal zones are highly influenced by the prevailing tide. However, because of practical reasons (limited sampling time) no distinction can be made between low tide and high tide. Young plaice and small shrimp feed at the tidal flats at high tide. In this period they are very inadequately sampled in the channels. Thus sampling gives an underestimation of the numbers present. At low tide they are concentrated in the channels. That is why it is very difficult to compare the catches for specific small areas from year to year, when they are made in different phases of the tide.

For a big area these differences will cancel-out when a large number of stations is visited during all phases of the tide. For this last reason an additional sampling programme was developed for use on the tidal flats.

Since 1976 in May and September a number of tidal flats is sampled at high tide with a rubber dinghy towing a 2 m beam trawl. The gear is rigged with a nylon net with a mesh size of 10 mm and a double cod end. At each place 4 to 8 five-minute hauls have been made on the tidal flat fishing with the current towards shallow water. The area fished per haul is on ± 500 m^2 and the depth varied between 50 cm and 2 metres.

The catches consisted mainly of young plaice (0- and 1-group), small shrimps, gobies(*Pomatoschistus microps* and *P. minutus*) and shore crabs. Other species are less common on the tidal flats. The data give information of the relative importance of the different areas for 0- and 1-year old plaice and young shrimps.

For O-group plaice the May survey is less useful. In this period plaice larvae settle on the flats and the efficiency of the gear is still very low. In the course of the summer the catchability of O-group plaice increases strongly owing to growth. In this case the same objections can be made as mentioned before for the Waddensea Project in April. 1-group is caught only in May and is nearly absent in the catches in September. It could be possible that the gear is not able to catch them when, owing to increasing temperature they avoid the gear, but one could expect the same behaviour for the same size of flounders, which can be caught in September in considerable quantities on the same grounds. It is more likely that they migrate to deeper channels.

In 1978 the May surveys were carried out 2 weeks earlier than in 1976 and 1977. The catches were considerably lower. Thus it is not correct to compare the O-group plaice data in May in 1978, 1977 and 1976.

In September these problems do not occur. Catches on the tidal flats are comparable. However, they could be slightly influenced by catches of Ulva.

Data are given in Table 1 (p. 26) and Figures 1, 2 and 3 (pp. 27-29).

The differences in abundance on the different positions cannot be explained easily. In the Balgzand area (positions 19, 20, 21 and 22) catches are always large just like in the Zwarte Haan area (positions 10, 11 and 12), while other positions like Scheurrak (18) are always very poor. Catches on positions annually show large variations which cannot only be due to differences in year class strength. In future years we intend to examine the possibility of an "overflow principle" which says that in the case of a very rich year class (like 1978) in its first year not only the richest food areas are strongly occupied, but also the less convenient areas.

To investigate differences between the various flats, bottom samples of the macrofauna were taken last year in May and September. The samples were taken at low tide on the same spots where the hauls had been made. Bottom samples for sand structure and percentage lutum were also taken. This will be continued in 1979.

A small coastal zone (± 1 000 m) along the beach cannot be sampled in the standard Waddensea project surveys because the vessels cannot fish in this shallow area owing to the draught. In 1978 this zone was sampled with the rubber dinghy in the same way as on the tidal flats. When possible once a month 4 stations (Egmond aan Zee, Wijk aan Zee, IJmuiden and Noordwijk) were sampled.

At each station 5 ten-minute hauls were made at 1, 2, 3, 5, and 7 m. The number of species on the beach is richer than on the tidal flats. O-group dab, -plaice, -sole and shrimps are common along the beach. Also less important species as lesser weever, common sea snail, gobies and O-group turbot are regularly caught.

Figures 4, 5, 6 and 7a (pp. 30-32) show the mean numbers of the most important species on the beach (mean overall hauls per month).

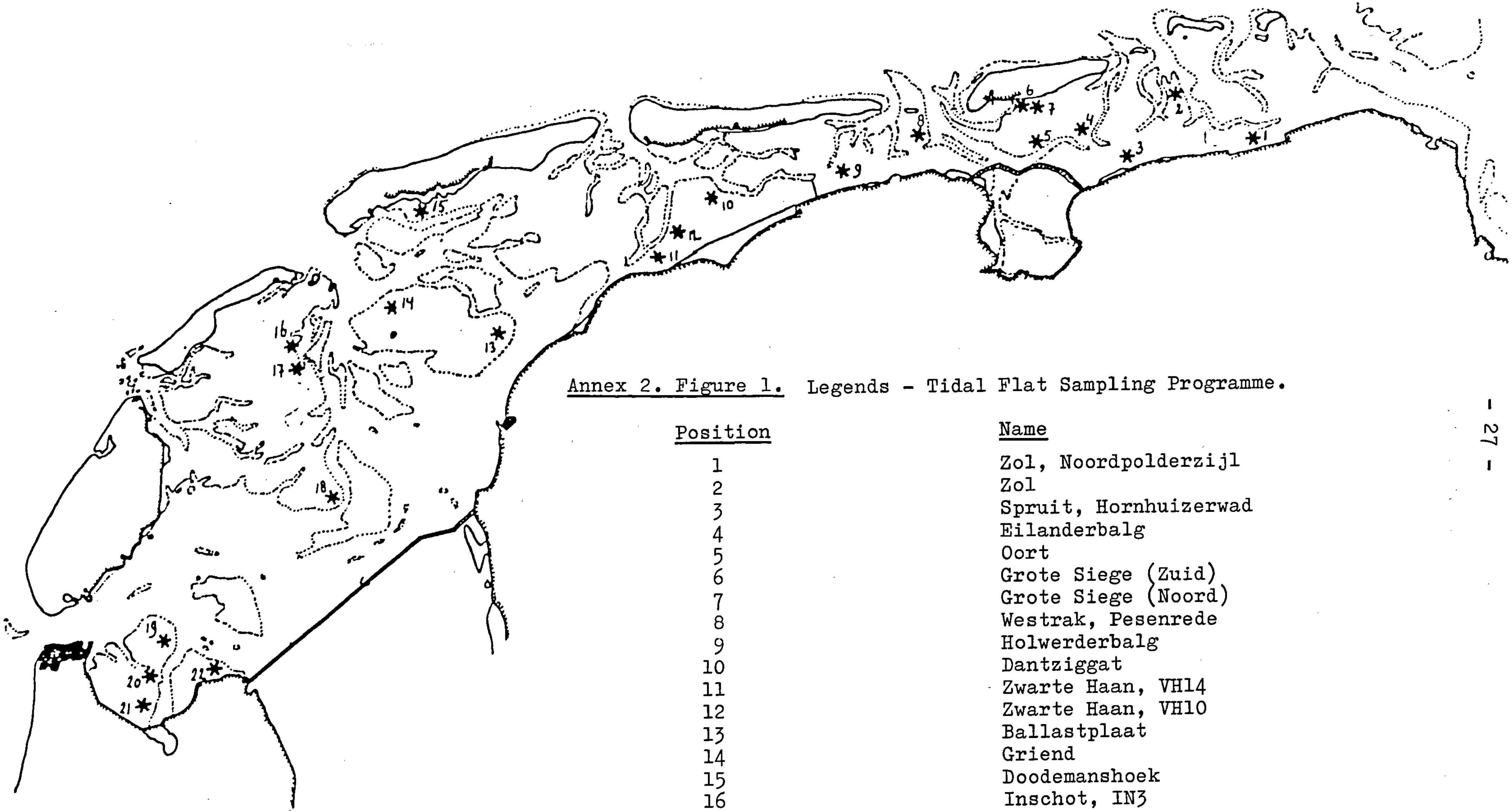
It seems that the beach can be an important nursery area for dab, sole, and plaice. The smallest shrimps (31 mm) are not abundant on the beach. These species show a very clustered distribution. For instance, catches of 0 to 20 numbers next to catches of 150 to 250 numbers in July and October/November are common for sole.

For comparison with the tidal flats, the Breehorn station (nr. 22) in the Waddensea was fished regularly (Figures 7b and 8, pp. 32-33).

Position	MAY									SEPTEMBER								
	plaice O-group			plaice I-group			brown shrimp			plaice O-group			plaice I-group			brown shrimp		
	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978	1976	1977	1978
1 ZOL, Noordpolderzijl			-			7.1			3			79.5			-			9286
2 ZOL			3.6			1.9			36			56.7			-			2389
3 SRUIT, Hornh.wad			9.6			5.6			76			68.8			-			12052
4 EILANDERBALG			3.7			5.5			33			127.3			-			1687
5 OORT			9.7			11.3			35			76.8			-			682
66 GROTE SIEGE			6.1			19.5			28			109.1			-			5062
7 GROTE SIEGE			14.9			20.4			56			31.8			-			12796
8 WESTRAK, Pesenrede			4.2			1.7			167									
9 HOLWERDERBALG		24.2	6.2		13.9	7.2		2786	82		18.5			-			2361	
10 DANZIGERGAT		46.0	0.6		7.5	9.0		3132	6	30.7	34.3	54.0	4.1	1.2	0.3	3663	252	477
11 ZWARTE HAAN (14)	83.7	19.2	8.9	17.4	2.6	16.1	12238	936	458	76.4	4.2	31.5	10.5	2.0	6.3	4902	658	3708
12 ZWARTE HAAN (10)	119.0	23.1	2.5	12.1	3.4	5.7	1620	315	44	45.3	10.4	119.8	2.2	-	0.6	3283	265	32
13 BALLASTPLAAT	3.6	55.5	13.0	60.1	41.7	27.4	227	8050	610	15.5	31.3	21.6	6.6	7.3	22.7	3640	773	6555
14 GRIEND, Franikergat	22.2	25.2	0.5	6.3	4.9	5.1	533	95	81	8.5			0.5			5856		
15 DOODEMANSHOEK	11.3	23.3		7.4	1.7		371	2410			8.0			0.7			118	
16 WAARDGRONDEN (IN3)		15.2	1.9		3.7	4.7		2663	44	32.6	18.2	326.3	4.4	-	0.5	9026	806	11109
17 WAARDGRONDEN (IN5)	2.9	16.4	0.5	2.2	3.2	2.3	765	4881	58	16.9	33.2	31.4	4.9	-	8.6	10087	584	2147
18 SCHEURRAK (SO30	-	2.0	1.0	3.3	4.0	3.3	2731	1137	337	1.6	6.3	3.4	1.0	-	3.2	4160	220	492
19 BALGZAND I		7.9	13.9		9.6	8.4		996	398	23.4	9.6	4.0	3.2	5.4	0.6	4146	1793	1692
20 BALGZAND II	7.0	8.6	9.7	8.7	12.3	40.3	2680	1138	483	30.8	12.6	30.1	8.1	4.7	-	3544	2266	1451
21 BALGZAND III		28.0	21.8		7.5	26.9		3053	125	8.2	24.5	47.8	8.7	7.7	8.4	2963	637	1449
22 BREEHORN	22.1	55.0	25.5	17.6	38.9	75.4	15422	12265	112	11.3	23.6	36.8	7.9	8.0	12.5	7433	427	2341
mean	28.6	24.8	7.5	14.3	10.6	14.2	3834	3005	166	24.9		62.2	5.0		4.2	5239	899	4449
percentage brown shrimp 31 mm							85.0	96.4	28.9							65.9	46.5	20.5
31-53 mm							14.8	4.5	68.1							33.6	49.2	72.7
53 mm							0.2	0.1	3.0							0.5	4.3	6.8

catch in numbers per 1000 m^2

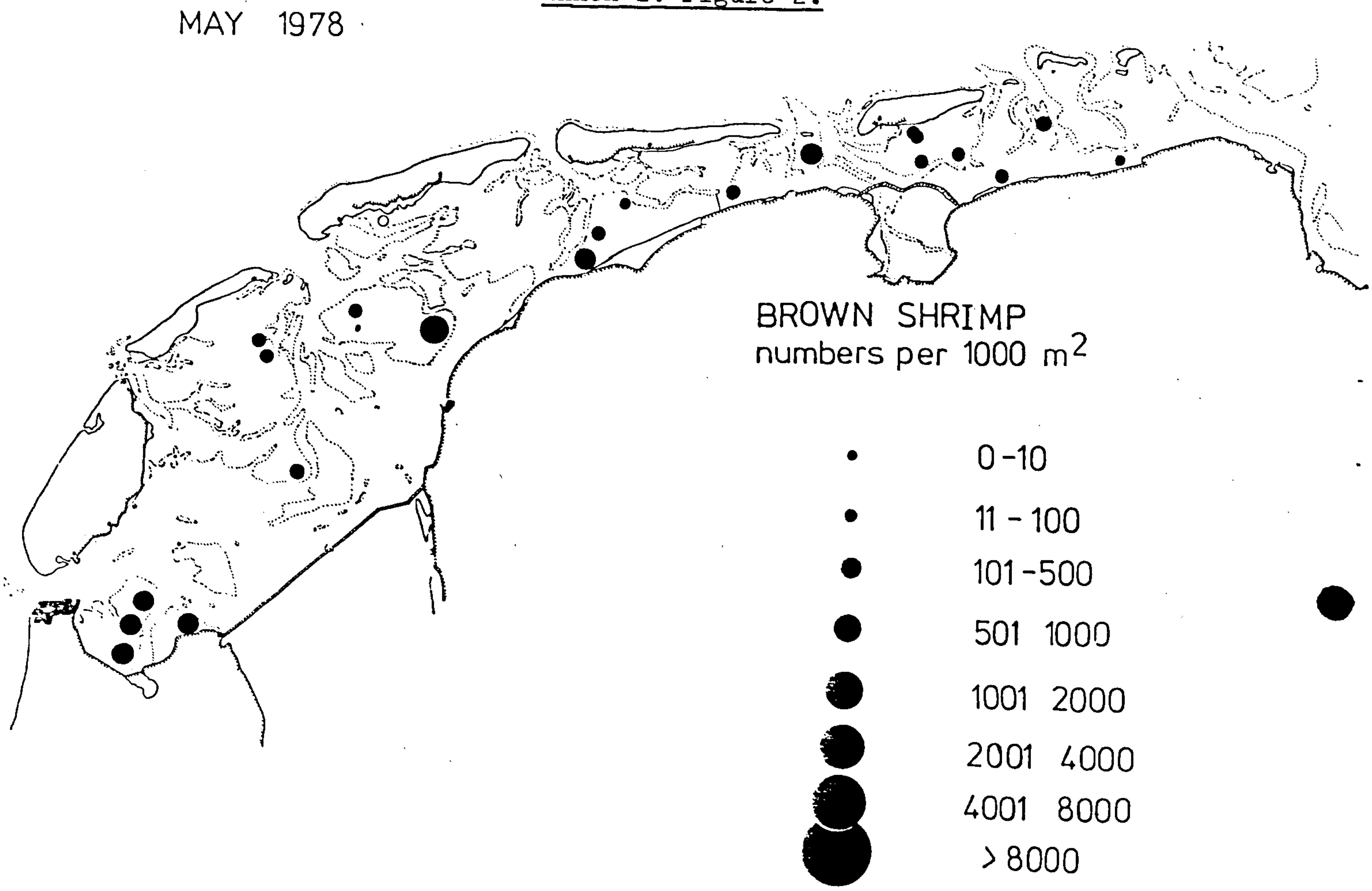
Annex 2.Table 1. Tidal flat sampling programme.

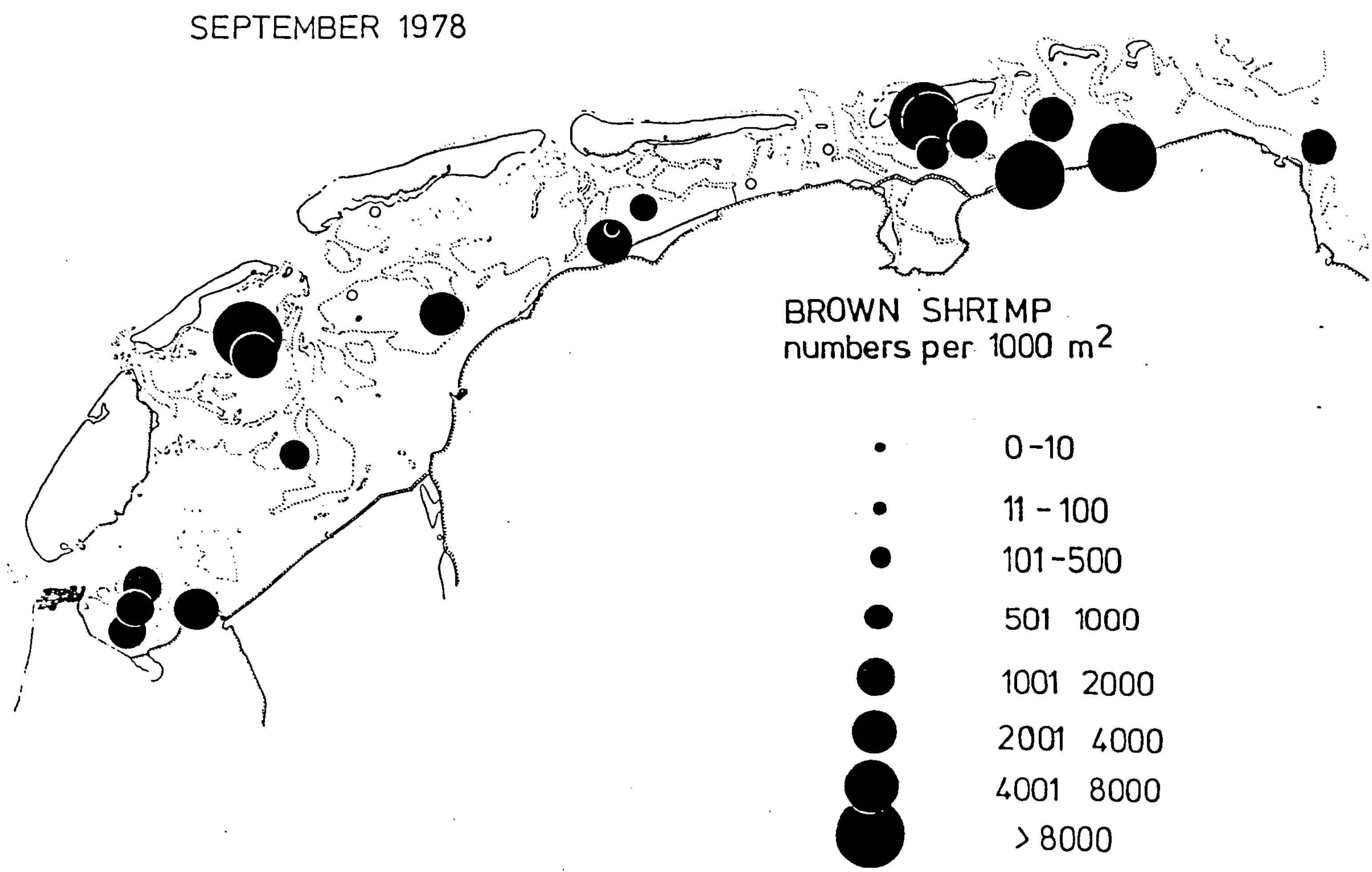


Annex 2. Figure 1. Legends - Tidal Flat Sampling Programme.

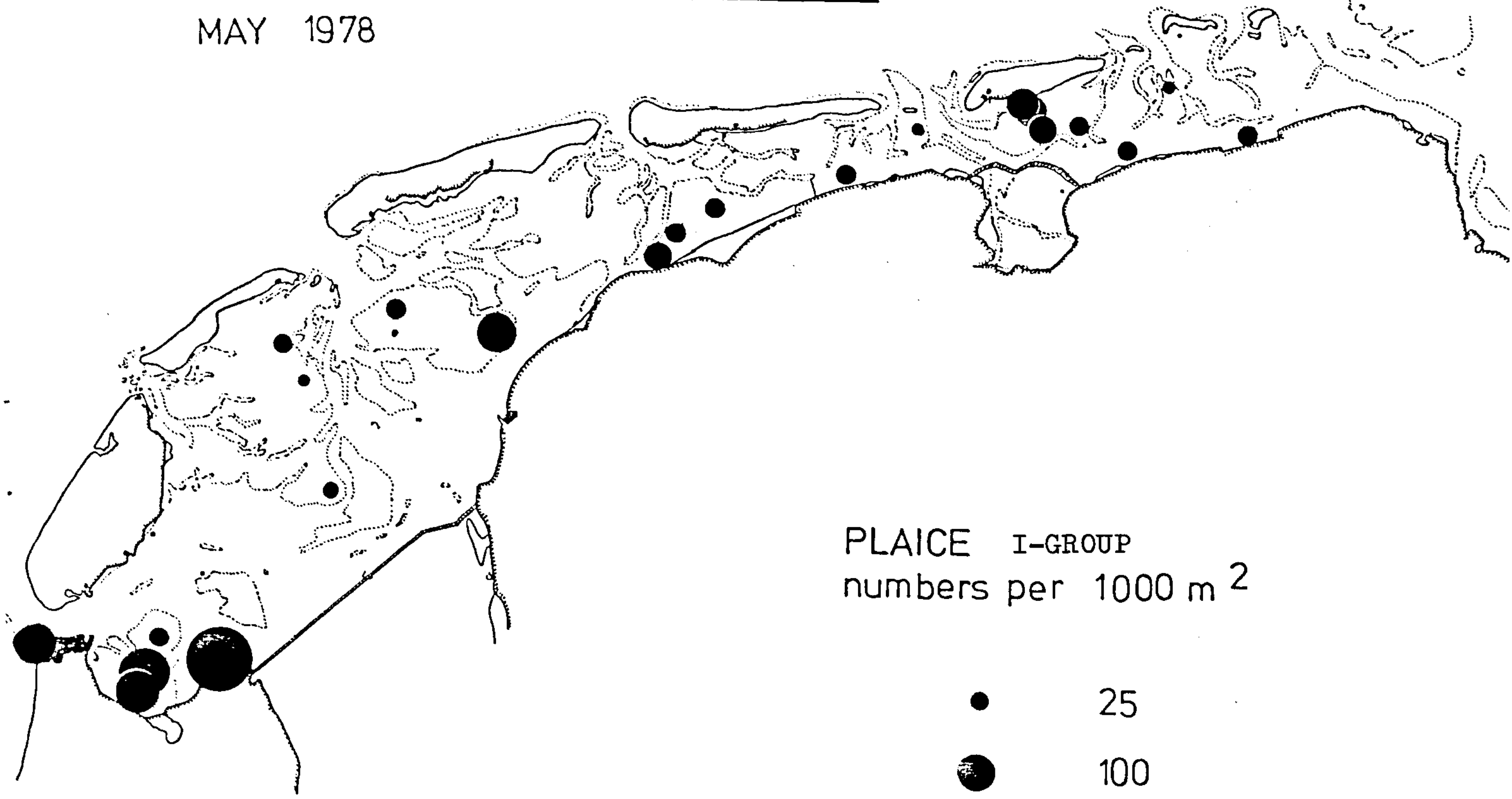
Position	Name
1	Zol, Noordpolderzijl
2	Zol
3	Spruit, Hornhuizerwad
4	Eilanderbalg
5	Oort
6	Grote Siege (Zuid)
7	Grote Siege (Noord)
8	Westrak, Pesenrede
9	Holwerderbalg
10	Dantziggat
11	Zwarte Haan, VH14
12	Zwarte Haan, VH10
13	Ballastplaat
14	Griend
15	Doodemanshoek
16	Inschot, IN3
17	Inschot, IN5
18	Scheurrak-Omdraai, SO30
19	Balgzand 1
20	Balgzand 2
21	Balgzand 3
22	Breehorn

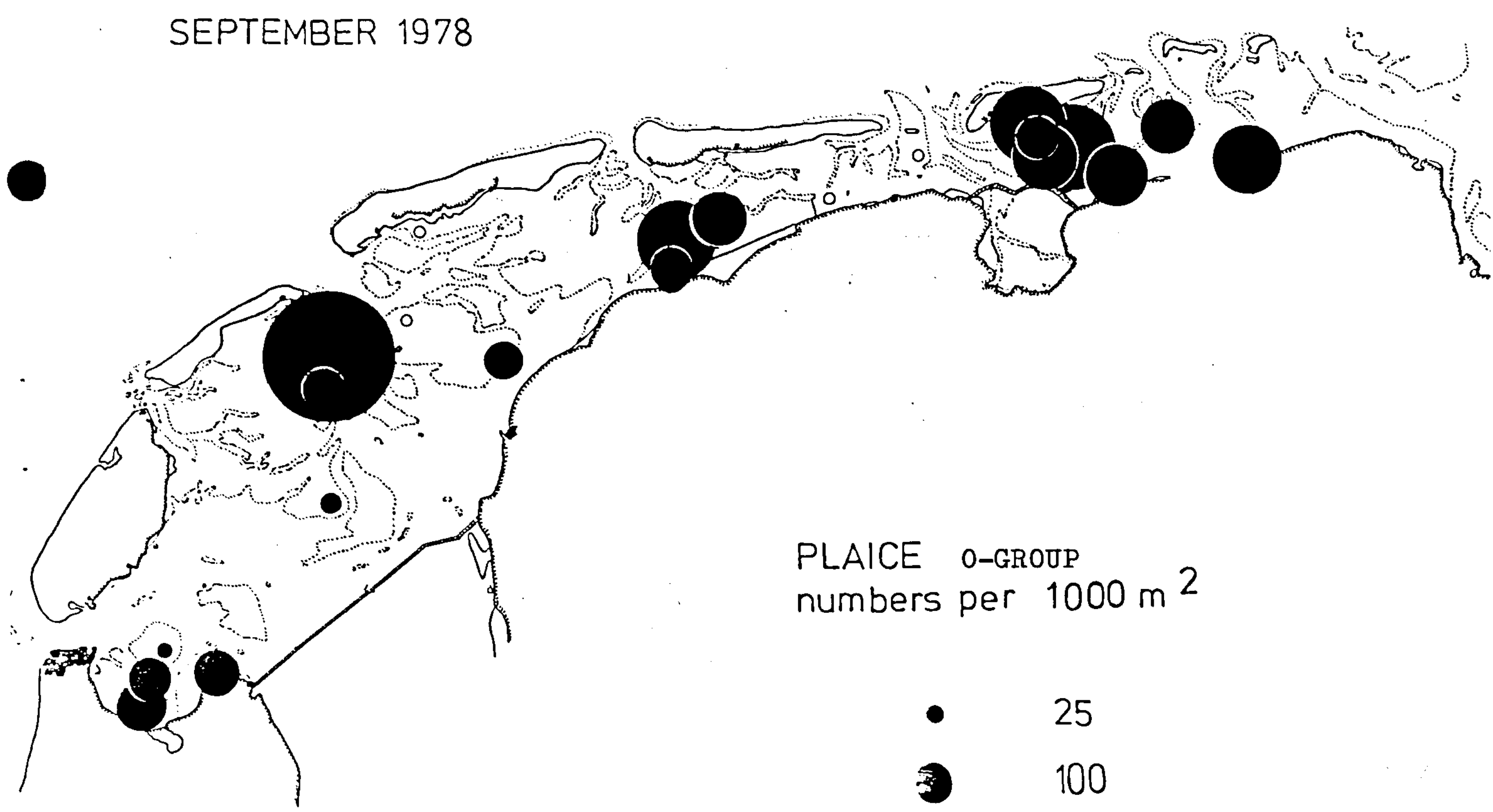
Annex 2. Figure 2.





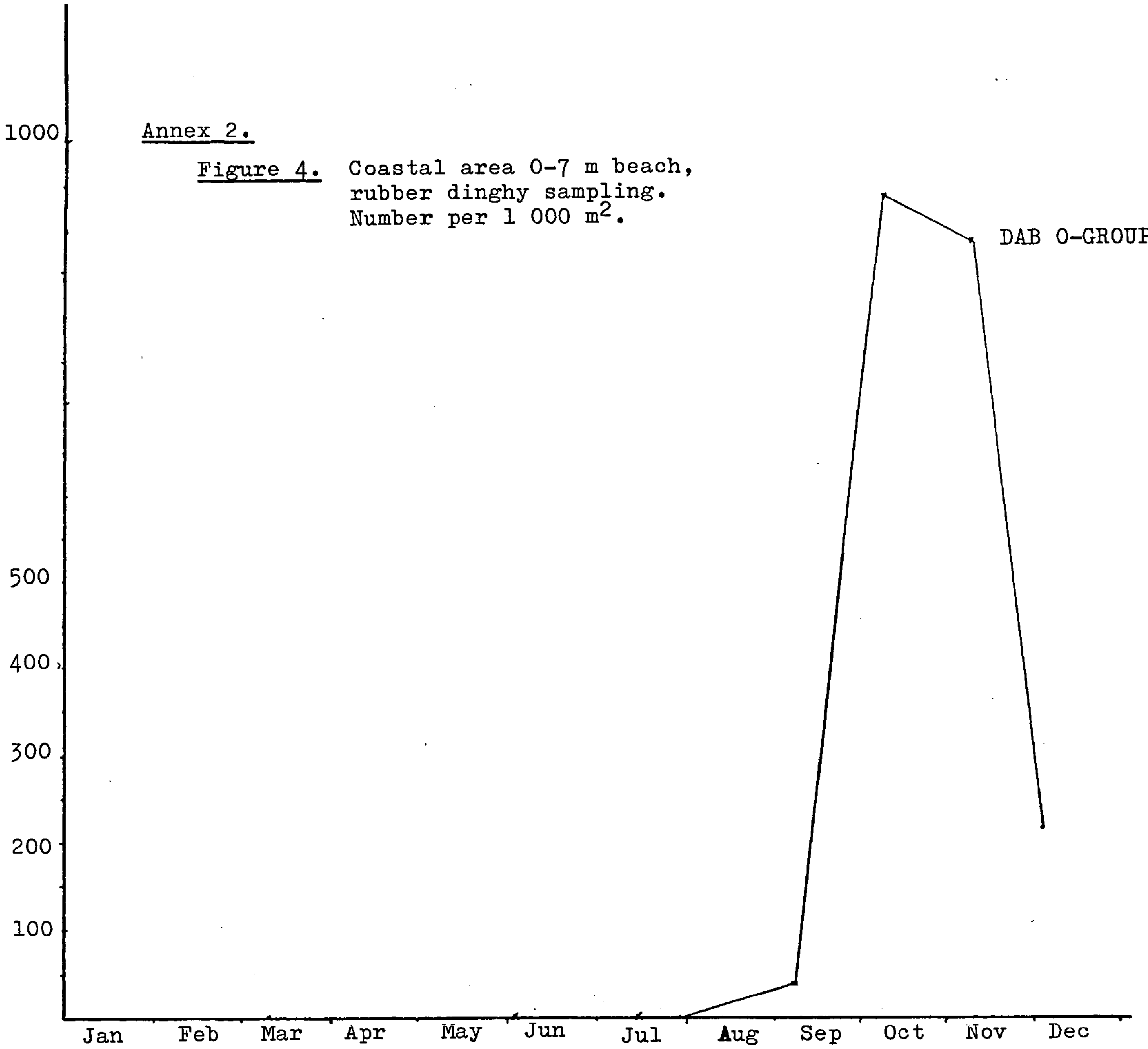
Annex 2. Figure 3.





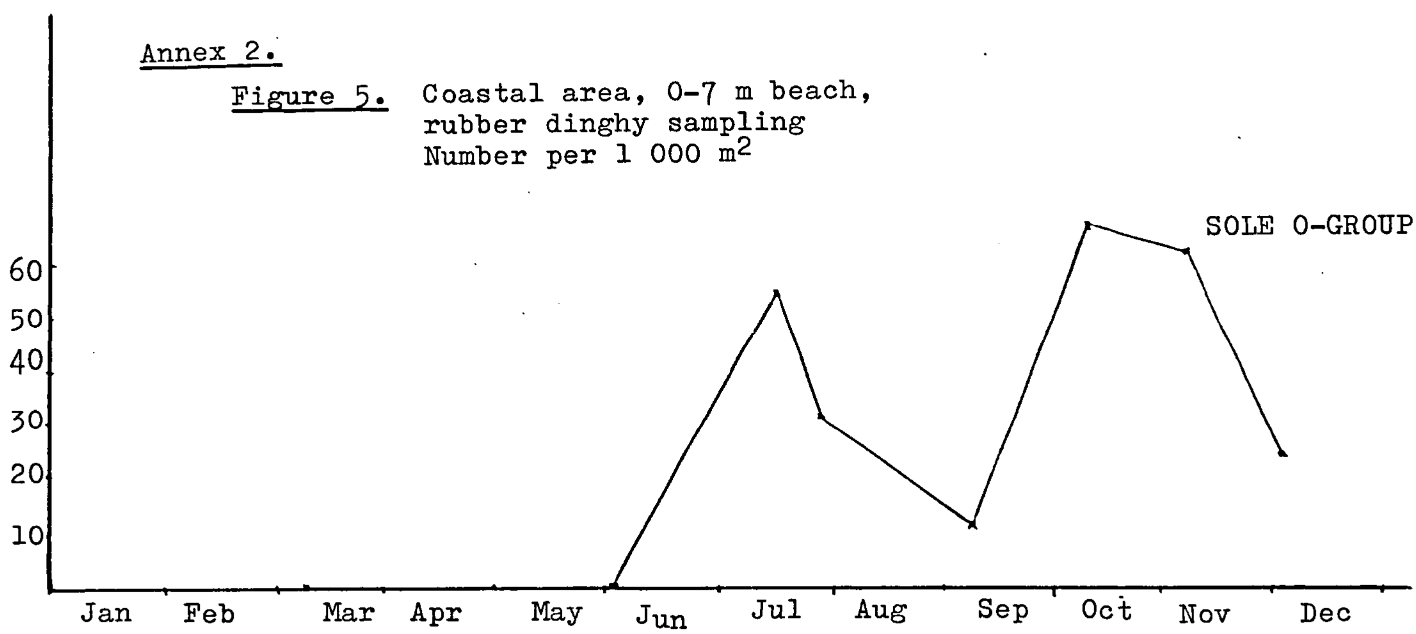
Annex 2.

Figure 4. Coastal area 0-7 m beach, rubber dinghy sampling. Number per 1 000 m^2.



Annex 2.

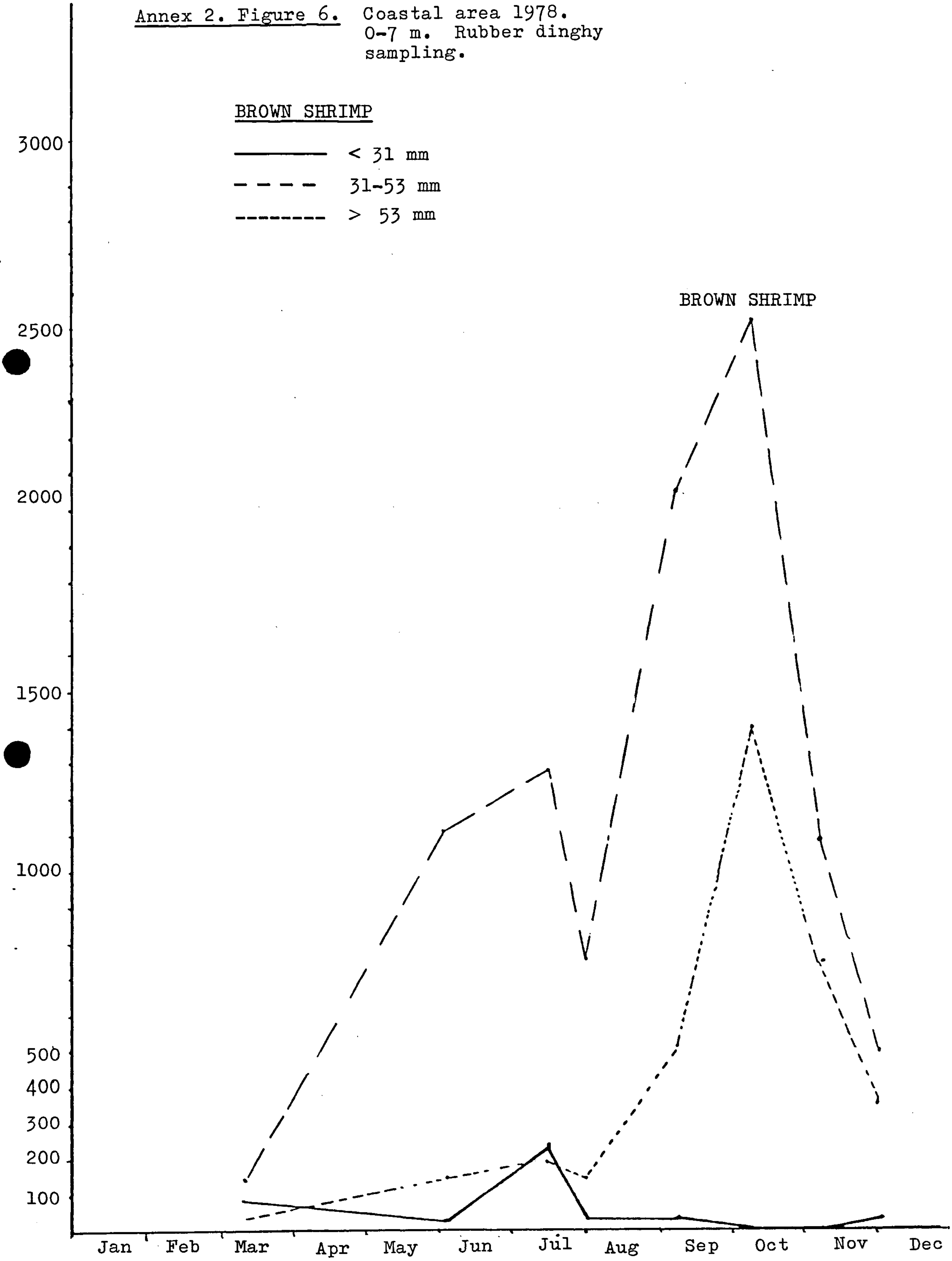
Figure 5. Coastal area, 0-7 m beach, rubber dinghy sampling Number per 1 000 m^2



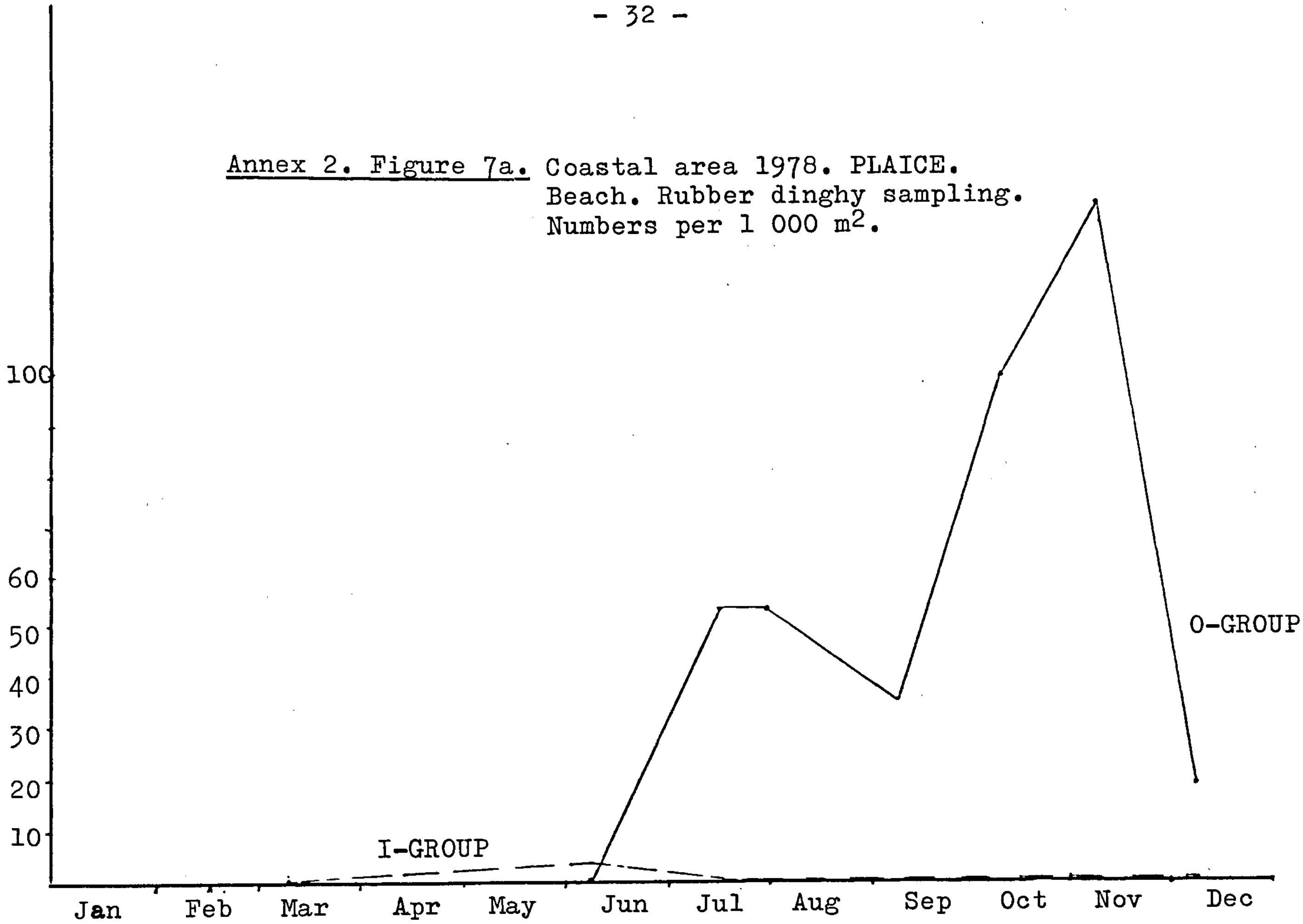
Annex 2. Figure 6. Coastal area 1978. 0-7 m. Rubber dinghy sampling.

BROWN SHRIMP

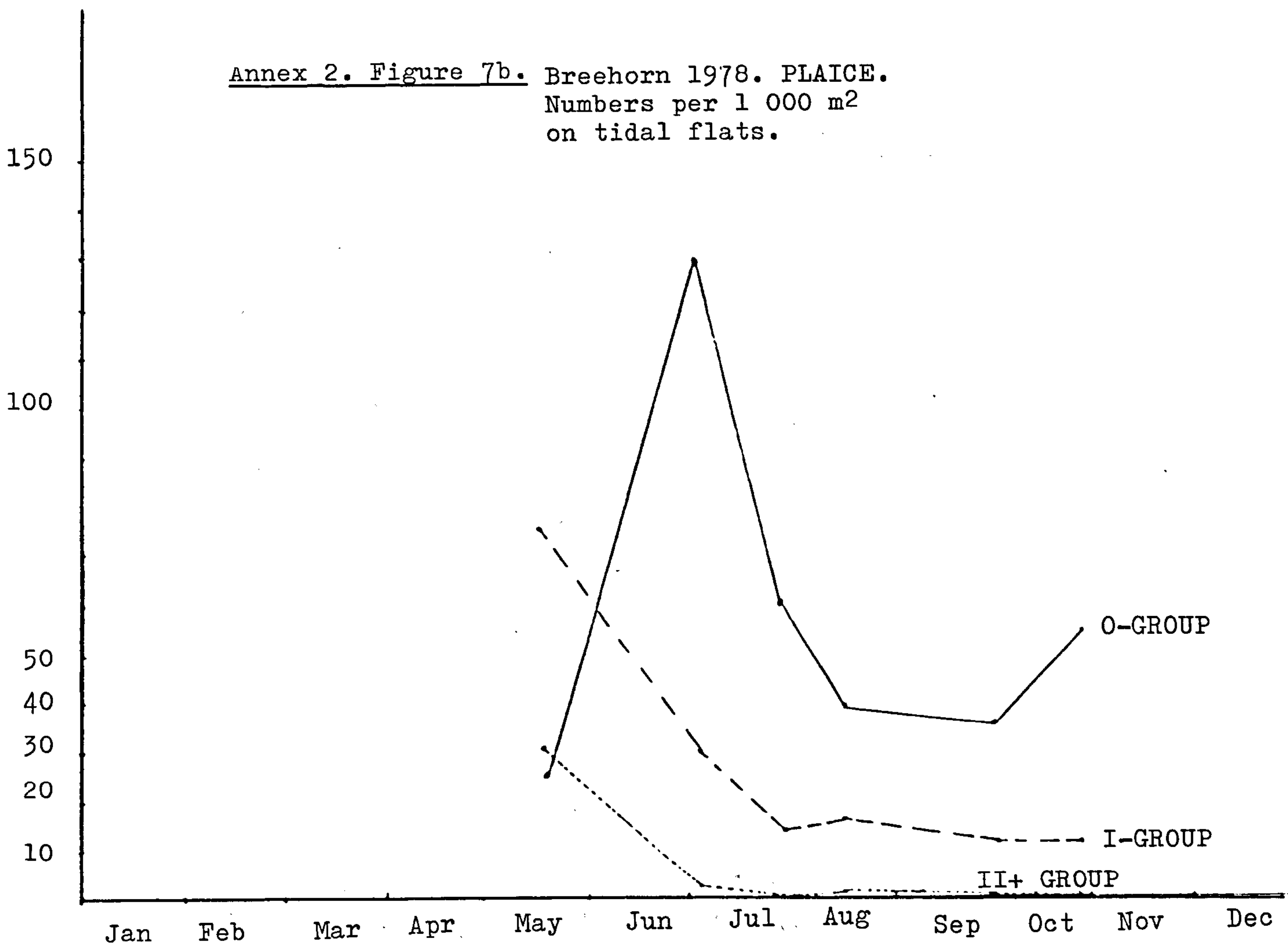
——— < 31 mm
– – – – 31-53 mm
-------- > 53 mm



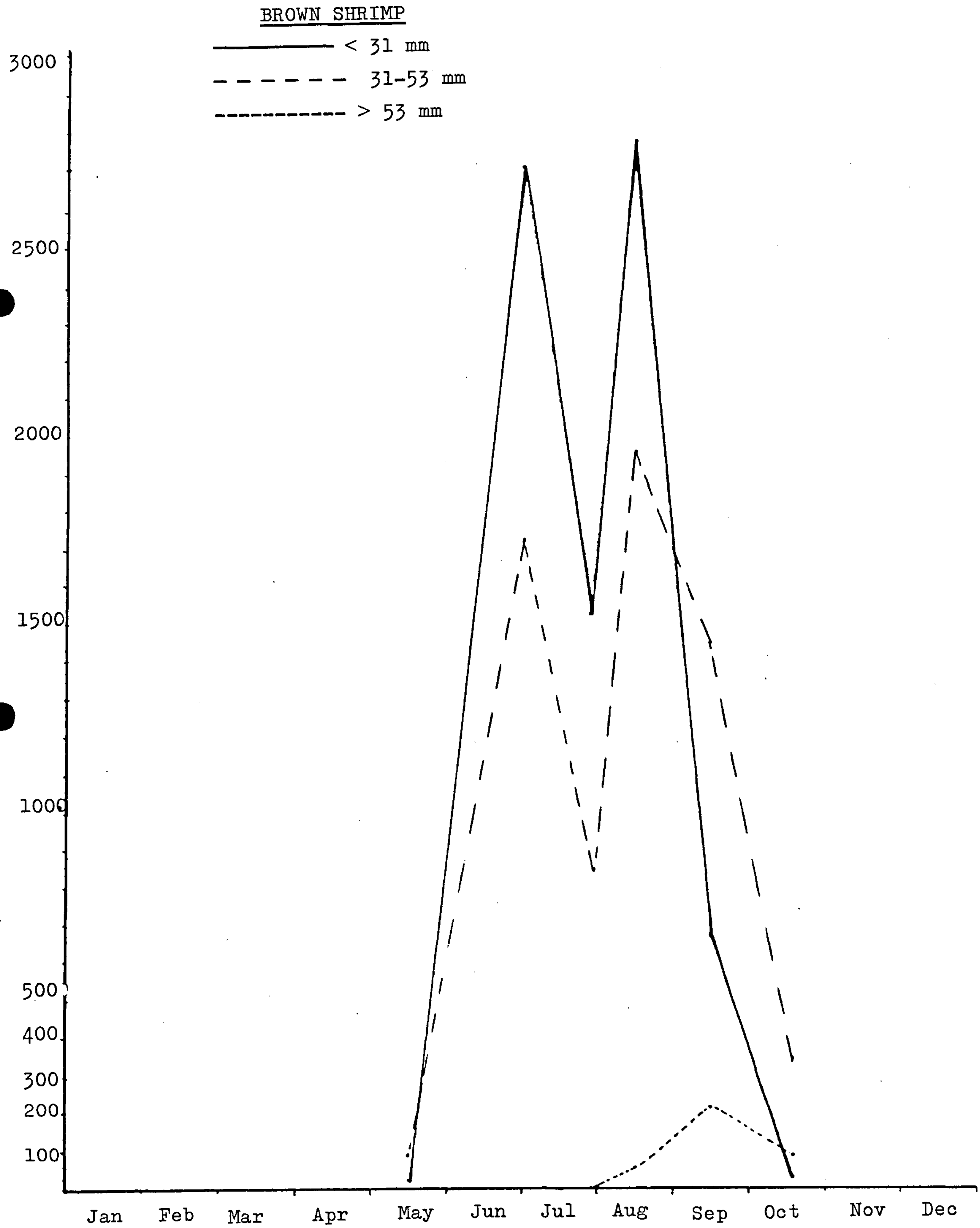
Annex 2. Figure 7a. Coastal area 1978. PLAICE.
Beach. Rubber dinghy sampling.
Numbers per 1 000 m2.



Annex 2. Figure 7b. Breehorn 1978. PLAICE.
Numbers per 1 000 m2
on tidal flats.



Annex 2. Figure 8. Breehorn 1978. BROWN SHRIMP. Numbers per 1 000 m^2 on tidal flats.



ANNEX 3

COMPARATIVE FISHING USING THE 3 m CONTINENTAL BEAM TRAWL AND THE ENGLISH 2 m BEAM TRAWL

by
John D Riley, Fisheries Laboratory
Lowestoft

The gears were used rigged in the recommended way and used at the recommended speeds, i.e. about 35 m/min for the 2 m trawl and 100 m/min for the 3 m trawl. The only modification made was that the 3 m trawl was fitted with a distance-measuring wheel of the Lowestoft pattern.

The comparison for sole was done in September 1977 and for plaice in September 1978 on the basis of catch/1 000 m^2. The results are shown in Table 1 (p. 35) for 0- and 1-group plaice and sole, respectively.

Significant differences were detected between the two gears for 0-group plaice and 0- and 1-group sole, respectively. There were no significant differences for 1-group plaice.

The mean catches for the 0-group were in the proportion:

2 m : 3 m,	28.2 : 21.2	for plaice
and	6.7 : 2.4	for sole.

It is intended that similar comparative experiments will be repeated in 1979 in different areas and, if possible, different types of seabed.

An Attempt to integrate the 0-group Plaice and Sole Historic Data available from English and Continental Surveys

A review of the data available since 1970 from both English and Belgian, Dutch and German surveys indicated that for most years gaps in the areas covered would make the calculation of a combined figure extremely difficult. The data for 1973-75 were found to give good cover of the areas investigated in these surveys. English and continental data were integrated by processing the continental data following the method of Riley (1977), and then correcting the population indices to allow for relative gear efficiency (Tables 2 and 3, p. 36-37).

In 1975, the proportion of 0-group plaice on the English and continental sides of the North Sea was approximately 19:102. The values for 0-group sole were 27:59 (see also Figures 1 and 2, p.38-9).

Bearing in mind that in the German Waddensea no tickler chain has been used in the standard gear (see Chapter 2.2, p.1), the ratios mentioned above underestimate the relative importance of the German nurseries.

When information from comparative fishing experiments on the effect of tickler chains on the catch rates is available, it will be possible to make the necessary corrections and to carry out a new integration of the English and continental surveys.

Annex 3, Table 1. Comparative fishing: 2 m Lowestoft beam trawl vs 3 m continental beam trawl. Based on catch/ 1 000 m^2.

Paired t-test analysis

Species	$\bar{x}$	n	t	Probability
0-group plaice	6.90	31	2.90	p<.01
1-group plaice	-1.30	30	1.38	p<.20*
0-group sole	15.78	12	5.77	p<.001
1-group sole	4.36	12	3.42	p<.01

Species	2m BT			3m BT		
	$\bar{x}$	σ	$\frac{\sigma}{x}$ %	$\bar{x}$	σ	$\frac{\sigma}{x}$ %
0-group plaice	28.2	14.5	51.4	21.2	11.2	52.8
1-group plaice	8.5	4.7	55.3	9.8	4.3	43.9
0-group sole	22.4	10.9	48.7	6.6	6.6	100
1-group sole	6.7	3.9	58.2	2.4	2.4	100
			53.4			

$\bar{x}$ = mean difference between 2m BT and 3m BT.

* t value not significant.

Apart from 1-group plaice the Lowestoft 2m BT gives significantly higher catches than the continental 3m BT.

ANNEX 3. TABLE 2. PLAICE 1975: DENSITIES AND POPULATION INDICES.

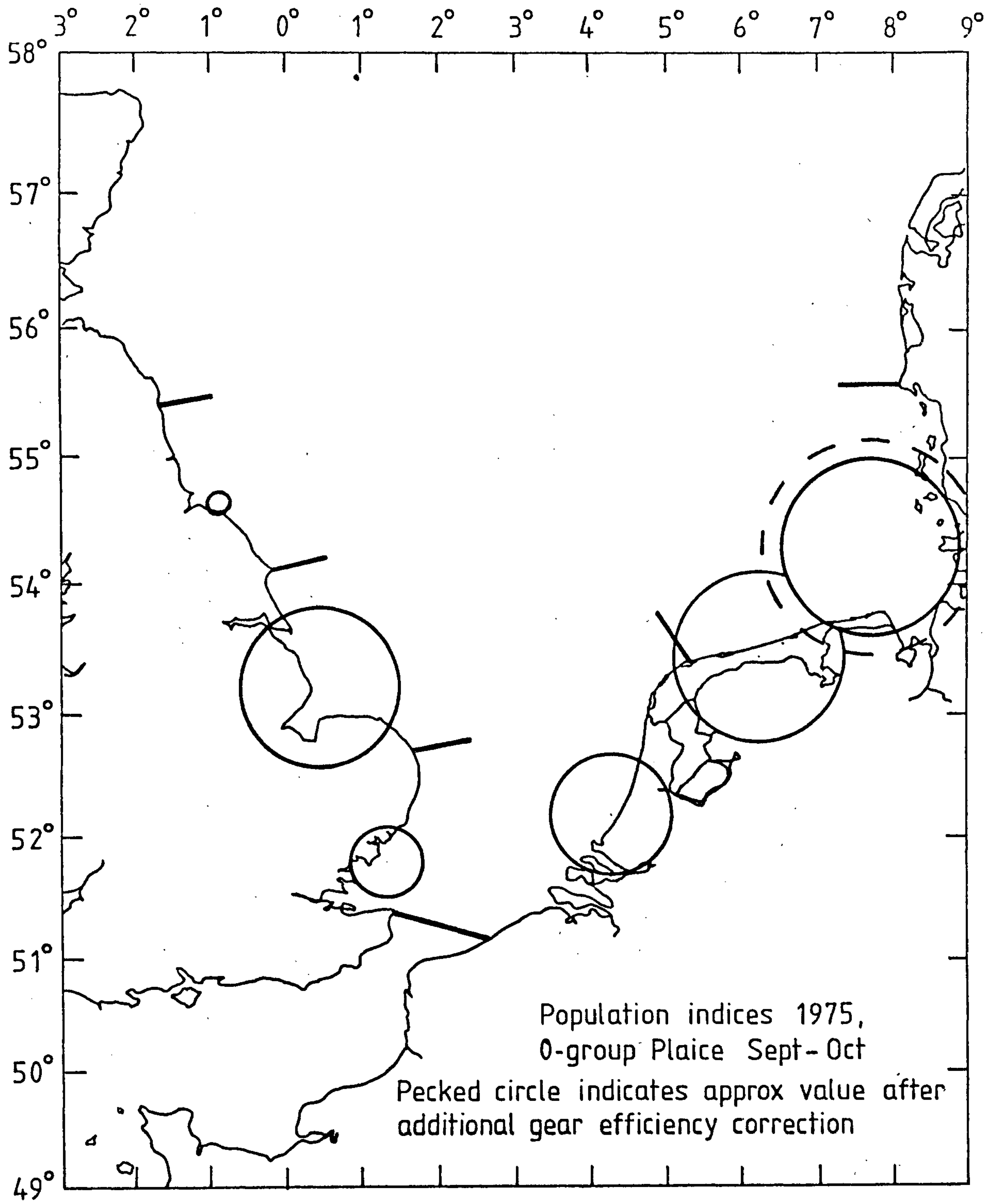
REGION	AREA (MILLIONS m2)				DENSITY (NUMBER PER 1 000 sq metres)											
					0-2 m			2-6 m			6-12 m			12-20 m		
	0-2 m	2-6 m	6-12 m	12-20 m	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%
Horn Reef - Terschelling	1381.0	1430.9	2192.8	4172.6	5.2	7.9	12.0	2.7	4.2	6.5	1.7	3.5	7.3	0.6	0.8	1.1
Waddenzee	595.6	269.2	250.8	123.8	16.5	24.9	37.5	8.3	13.3	21.4	4.8	8.1	13.7	1.6	2.8	4.9
Terschelling - French Border	285.4	900.1	1573.1	2482.0	0.2	0.4	0.6	4.6	7.6	12.8	2.5	3.2	4.1	1.0	1.4	1.8
N Foreland - Winterton	280.2	565.8	762.8	1001.2	6.8	17.4	44.7	0.3	0.4	0.5	0.2	0.3	0.5			
Winterton - Flamborough	166.5	539.5	1121.1	1803.6	30.5	76.4	191.5	5.1	11.9	27.9	2.6	5.5	11.7		Poor sampling	
Flamborough - Scottish Border	41.2	64.8	146.7	243.7	5.6	9.3	15.4	1.5	4.3	12.2	0.5	0.8	1.2			
Continental coast	2262.0	2600.2	4016.7	6778.4	12.3	16.8	22.9	6.4	8.4	11.0	3.4	4.3	5.3	1.2	1.4	1.7
English coast	487.9	1170.1	2030.6	3048.5	15.7	24.2	37.5	2.1	3.0	4.3	1.3	1.8	2.5	0.2	0.2	0.2

	POPULATION INDEX															
	0-2 m			2-6 m			6-12 m			12-20 m			Total 0-12 m			
	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Amended Mean
Horn Reef - Terschelling	7.1	10.9	16.6	3.9	6.0	9.3	3.7	7.7	15.9	2.4	3.3	4.7	14.7	24.6	41.8	32.7
Waddenzee	9.8	14.8	22.3	2.2	3.6	5.8	1.2	2.0	3.4	0.2	0.3	0.6	13.2	20.4	31.5	27.1
Terschelling - French Border	0.1	0.1	0.2	4.1	6.9	11.6	3.9	5.0	6.4	2.6	3.4	4.5	8.1	12.0	18.2	16.0
North Foreland - Winterton	1.9	4.9	12.5	0.2	0.2	0.3	0.2	0.2	0.4				2.3	5.3	13.2	5.3
Winterton - Flamborough	5.1	12.7	31.9	2.8	6.4	15.1	2.9	6.2	13.1				10.8	25.3	60.1	25.3
Flamborough - Scottish Border	0.2	0.4	0.6	0.1	0.3	0.8	0.1	0.1	0.2				0.4	0.8	1.6	0.8
Total Southern North Sea	24.2	43.8	84.1	13.3	23.4	42.9	12.0	21.2	39.4				49.5	88.4	166.4	107.2
Continental coast	27.8	38.0	51.8	16.5	21.8	28.7	13.8	17.1	21.3	7.9	9.6	11.7	58.1	76.9	101.8	102.3
English coast	7.7	11.8	18.3	2.5	3.5	5.0	2.6	3.7	5.1	0.5	0.5	0.6	12.8	19.0	28.4	19.0

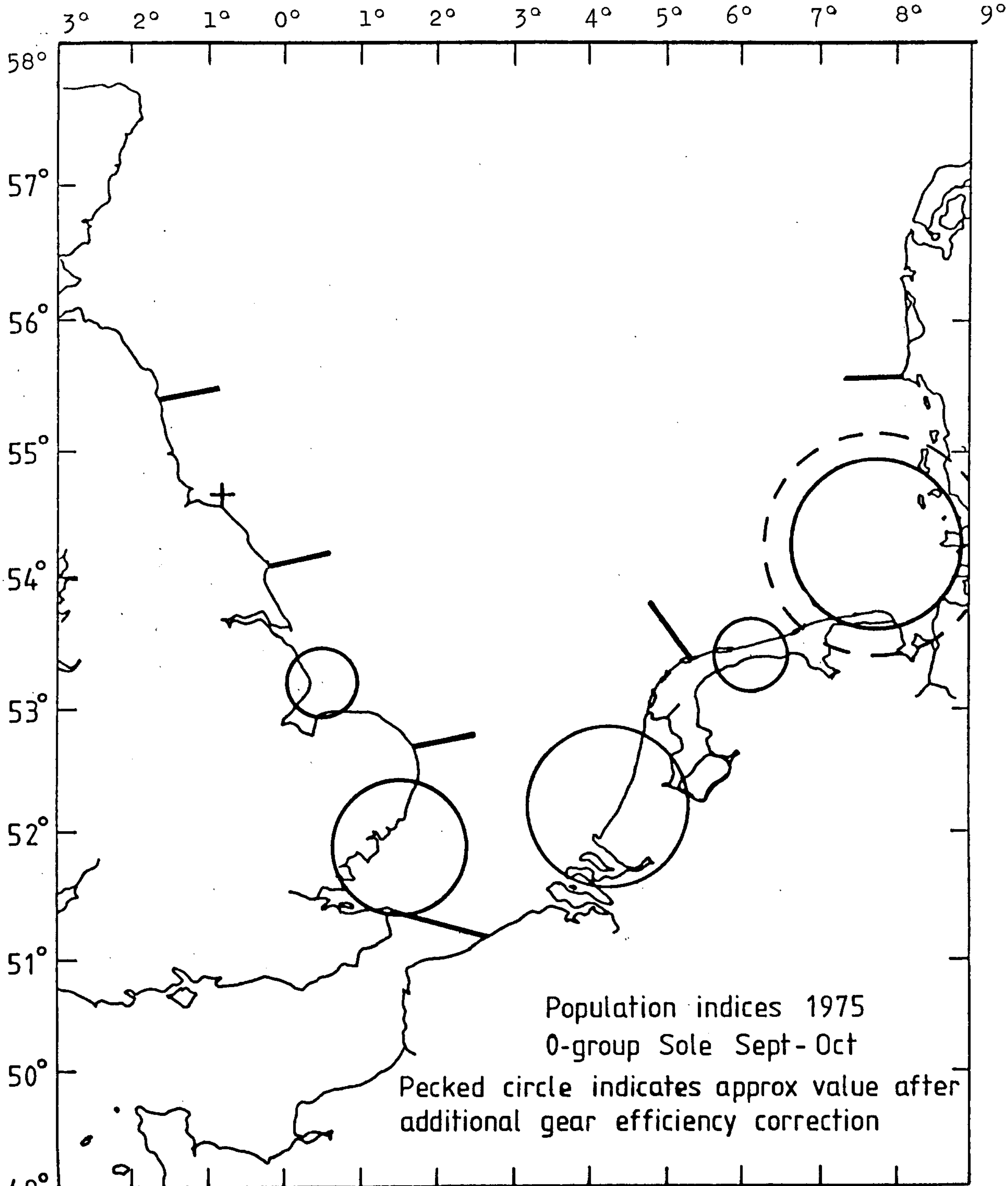
ANNEX 3. Table 3. SOLE 1975: DENSITIES AND POPULATION INDICES.

REGION	AREA (MILLIONS m^2)				DENSITY (NUMBER PER 1 000 sq metres)											
					0-2 m			2-6 m			6-12 m			12-20 m		
	0-2 m	2-6 m	6-12 m	12-20 m	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%
Horn Reef - Terschelling	1381.0	1430.9	2192.8	4172.6	1.6	2.6	4.2	0.6	0.8	0.9	1.0	1.6	2.6	2.7	4.9	9.0
Waddenzee	595.6	269.2	250.8	123.8	1.2	1.5	1.9	1.1	1.5	2.0	1.0	1.3	1.8	0.3	0.5	0.7
Terschelling-French Border	285.4	900.1	1573.1	2482.0	0.4	0.6	1.2	1.7	2.4	3.4	2.4	3.0	3.8	2.9	4.1	5.8
N Foreland - Winterton	280.2	565.8	762.8	1001.2	1.3	2.8	5.8	8.9	14.5	23.6	5.2	10.9	22.8	Poor sampling		
Winterton - Flamborough	166.5	539.5	1121.1	1803.6	0.6	1.1	1.8	1.7	3.7	8.2	1.8	3.3	5.9			
Flamborough-Scottish Border	41.2	64.8	146.7	243.7	0	0	0	0	0	0	0	0	0			
Continental coast	2262.0	2600.2	4016.7	6778.4	1.4	1.7	2.2	1.3	1.5	1.8	2.0	2.4	2.8	2.8	3.6	4.7
English coast	487.9	1170.1	2030.6	3048.5	1.1	1.7	2.5	7.6	11.8	18.4	4.4	7.0	11.2	4.6	15.0	48.9

	POPULATION INDEX															
	0-2 m			2-6 m			6-12 m			12-20 m			Total 0-12 m			
	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Lower 95%	Mean	Upper 95%	Amended Mean
Horn Reef - Terschelling	2.2	3.6	5.8	0.9	1.1	1.3	2.2	3.6	5.8	11.1	20.4	37.5	5.3	8.3	12.9	28.2
Waddenzee	0.7	0.9	1.1	0.3	0.4	0.5	0.2	0.3	0.4	0	0.1	0.1	1.2	1.6	2.0	5.4
Terschelling - French Border	0.1	0.2	0.3	1.5	2.2	3.1	3.7	4.7	6.0	7.2	10.2	14.5	5.3	7.1	9.4	24.1
N Foreland - Winterton	0.4	0.8	1.6	5.0	8.2	13.4	4.0	8.3	17.4				9.4	17.3	32.4	17.3
Winterton - Flamborough	0.1	0.2	0.3	0.9	2.0	4.4	2.0	3.7	6.6				3.0	5.9	11.3	5.9
Flamborough - Scottish Border	0	0	0	0	0	0	0	0	0				0	0	0	0
Total Southern North Sea	3.5	5.7	9.1	8.6	13.9	22.7	12.1	20.6	36.2				24.2	40.2	68.0	80.9
Continental coast	3.2	3.9	4.9	3.3	3.9	4.6	8.0	9.6	11.4	18.9	24.7	32.1	14.5	17.4	20.9	59.1
English coast	0.5	0.8	1.1	8.4	13.0	20.3	8.3	13.2	21.1	12.9	42.1	137.2	17.2	27.0	42.6	27.0



Annex 3, Figure 1



Annex 3, Figure 2

ANNEX 4

0- AND 1-GROUP DEMERSAL SURVEYS IN BELGIUM

by

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The surveys were started in May 1970 and are since then carried out along the Belgian coast (Figure 1, p.41). The RV "Hinders" is used for this exercise, having the following characteristics: length 21 m, 78 BT, 240 horse power. A beam trawl of 6 meter is used. The gear is similar to the Ducth gear on the RV "Tridens". The mesh size is 18 mm in the cod end.

At the beginning, the surveys covered 25 stations but now a total of 32 stations are sampled, covering a great part of the Belgian coast (Figure 1). Due to the sea bed structure of this coast, viz. composed by several sandbanks, the position of trawling had to be chosen between the sandbanks.

Sampling procedure

The sampling procedure is given in Figure 2 (p.42). From the catch on each haul a first separation is made between commercial fishes and the rest. The commercial fishes are measured and separated in length classes (standardised groups). The rest of the catch is then sieved to make a splitting between the shrimp fraction and the by-catch fraction (benthos and non-commercial fishes). Both of them are analysed in detail in the laboratory of the Institute.

The final results are given in numbers per 1 000 m^2 and sent to IJmuiden.

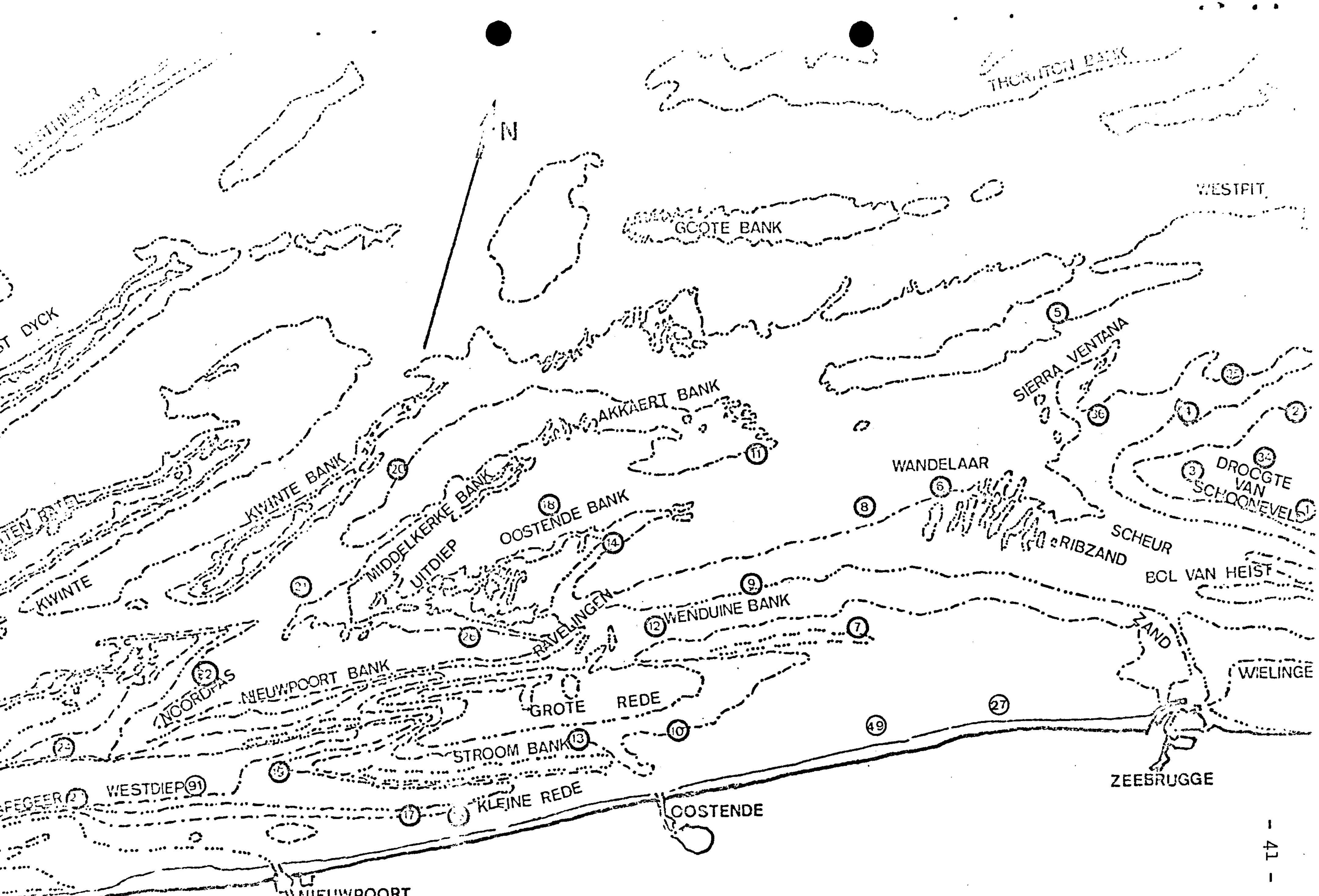
Additional research

On several stations a monthly survey is carried out for the following research topics:

- length frequency of sole, plaice, dab, whiting and cod.
- growth of juveniles per month
- length/weight relationship
- determination of heavy metals in adult fish (plaice, whiting, cod, shrimps)
- stomach analysis of the occurring fishes (predation on shrimps)
- tagging experiments.

Publications

"Demersal Young Fish Surveys"
"Annales Biologiques".



Annex 4. Figure 1

CATCH

↓

juvenile and adult fish → fish fraction → analyse length and numbers

↓

by- catch (shrimps,non-commercial fishes,benthos)

↓

sieving

shrimp fraction	benthos and non-commercial fish
↓	↓
total volume determination	total volume determination
↓	↓
sub-sample (1,000 cc)	sub-sample (4 l)
↓	↓
botlle + preservative	plastic bag
↓	↓
analyse lab institute	analyse lab institute (same day)

<u>Annex 4. Figure 2.</u>

Sampling procedure - RV "Hinders".

ANNEX 5

ESTIMATING THE MINIMUM SIZE OF THE SAMPLE IN THE DUTCH 0-GROUP SURVEYS FOR FLATFISH AND BROWN SHRIMP

by

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If we are aiming at the estimation of the mean number per 1 000 m^2 for a given area we have to consider what the minimum size of the sample at least should be. To answer this question we have to find the length of the confidence interval for the mean number per 1 000 m^2 ($= \mu$).

Suppose the total sample size is large enough to assume an approximately normal distribution for the stochastic variable $\bar{x}$ (indicating the estimated mean number per 1 000 m^2).

Let the sample size be $n_1 + n_2$, where n_1 is the number of hauls already carried out and n_2 the additional number to be estimated.

An unbiased estimate for the number per 1 000 m^2 for the area concerned is given by

$$s^2 = \sum_{i=1}^{n1} (x_1 - \bar{x}_1)^2/n_1 - 1$$

where $\bar{x}_1$ = arithmetic mean number per 1 000 m^2 of the first n_1 hauls.

Then $\frac{\bar{x} - \mu}{s}\sqrt{n_1 + n_2}$ has the Student's

t_{n_1-1} distribution. $\bar{x}$ = arithmetic mean number per 1 000 m^2 of $n_1 + n_2$ hauls.

The $(1 - \alpha)$ % confidence limits for μ are found to be

$$\bar{x} - t_{n_1-1,\ 1/2\,\alpha} \frac{s}{\sqrt{n_1 + n_2}} < \mu < \bar{x} + t_{n_1-1,\ 1/2\,\alpha} \frac{s}{\sqrt{n_1 + n_2}}$$

The length 2 d of the confidence interval is

$$2\,d = \frac{2\,t_{n_1 - 1,\ 1/2\,\alpha} \cdot S}{\sqrt{n_1 + n_2}}$$

Solving n_2 in this equation

$$n_2 = \left(\frac{t_{n - 1,\ 1/2\,\alpha} \cdot S}{d}\right)^2 - n_1$$

Thus, n_2 can be determined by prescribing certain values to α and d. The size of the additional sample is taken as the smallest whole number $\geq n_2$. By taking $\alpha = 0.05$ and $d = 1/4\,\bar{x}$, the sample size needed for all the surveys can be checked.