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COMPARISON OF COMBINED AND SEPARATE SEX ASSESSMENTS FOR NORTH SEA SOLE

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ABSTRACT

Combined and separate sex VPAs for North Sea sole are compared. Separable VPAs show that sampling errors are probably higher in the separate sex data. Minor differences are found in the estimates of stock numbers, recruitment and fishing mortality; larger discrepancies occur in estimates of stock biomass.

RESUME

Des évaluations du sexe effectuées en combinaison ou séparement pour les soles de la mer du Nord sont comparées. Les VPA séparables démontrent que les erreurs d'échantillonnage sont probablement plus nombreuses pour les données du sexe séparées. De légères différences ont été constatées dans les estimations du nombre d'individus du stock et de la mortalité des poissons par pêche; des écarts plus larges mais toujours insignifiants se présentent dans les estimations du poids du stock.

INTRODUCTION

The Flatfish Working Group has traditionally carried out the North Sea flatfish assessments by dealing with males and females separately in VPAs and forecasts. This treatment more than doubles the workload involved in carrying out the assessment; it also increases the size and complexity of the report which makes it difficult for non-participants to check and understand the results.

The purpose of this paper is to evaluate the need for separate sex assessments by comparing the results of combined and separate VPAs for North Sea sole based upon the data in the 1981 Working Group report. An important justification for combining the catch-at-age data is found in the results of separable VPAs (Pope and Shepherd, in prep.) which are dealt with first.

SEPARABLE VPA RESULTS

This technique is based upon the hypothesis that the fishing mortality (F) on each age-group is composed of two independent components. The first is a level of F which applies to a particular year; the second is a pattern of relative F (selectivity or S) which is assumed to apply in every year. The program finds values for the two components which explain the maximum amount of variation in the log catch ratios. Departures from the model are indicated by the sums of squared deviations of the observed and predicted log catch ratios. Bad fits to the model exist either because the model does not fit (the exploitation pattern has changed) or because of sampling errors in the catch-at-age data.

For North Sea sole the coefficients of variation for combined and separate data are shown in Table 1. These were calculated for age range 2 to 14 years and specified periods. The input values of 'F' and 'S' were 0.5 in each case. The results show that, in each period, the male data do not fit the separable model as well as those for females and that combining the data for the two sexes improves the fit by a considerable amount. This suggests that the deviations from the separable model are largely due to sampling errors and that better results will be obtained from the VPA if the data are combined rather than kept separate.

There are apparent differences in the exploitation patterns between males and females in each 6-year period up to 1974 but these are not consistent differences (Figure 1). This probably indicates that they are due to sampling errors, particularly in the male catch data, especially since the change in the female pattern in successive periods is a progressive one of increasing F on the younger age groups. In the more recent period (1975-80) there is very little difference in the exploitation pattern between males and females.

TRADITIONAL VPA RESULTS

Traditional VPAs were initiated using the terminal F values used by the 1981 Working Group, or, in the case of the combined VPA, with the arithmetic mean of the separate sex values. Weights-at-age in the catch and stock for the combined VPA were calculated as the mean of the separate sex data, weighted by the catch number in each sex.

1. Stock numbers and recruitments

The results are shown in Table 2. For stock number, the discrepancies between the combined and separate sex VPAs are all less than 1% except in 1980 which shows a +5% difference which is due to the anomalously high number of 1-year-olds estimated by the terminal F values

chosen for combined VPA. For recruits at age 1 the discrepancies are again very small except for the 1979 year class (for the same reason).

2. Fishing mortality

Arithmetic mean values on ages 2 to 7 are compared in Table 3. The discrepancies are between +2.3 and -4.7%.

3. Stock biomass

Total and spawning stock biomass (age 3+) results are shown in Table 4. For total stock the discrepancy ranges from -9.1 to +1.6%; for spawning stock the discrepancy is in the range -6.4 to +1.7%. The larger negative discrepancies (combined/separate ratio <1) occur in the earlier years but there is little difference in the more recent period.

Part of the background to this is illustrated in Figure 2 which shows the sex ratio of the cumulative catch (input data to the separate sex VPAs) and the recruitment (estimated by the separate sex VPAs) by year classes. For some (at the moment inexplicable) reason the sex ratio favoured males in the year classes 1942 to 1952, and then favoured females in the 1953 to 1978 year classes with the exception of 1965 and 1970 in which it favoured males. The time series is certainly not a random one, nor is it correlated with year class strength. The explanation may lie in either the sampling procedure (since it occurs in the input catch-at-age data) or, possibly, the biology of the pre-recruits.

The changing sex ratio is unlikely to be the main explanation of the discrepancy between estimated biomasses because the combined stock weights-at-age were calculated by weighting the values by the observed catch numbers-at-age which include the sex ratio differences. It is probable that the explanation lies in the slightly different values of stock numbers-at-age estimated in the combined VPA.

SUMMARY

1. The separable VPA indicates that there is a consistently higher sampling error on males than on females and that a better fit to the separable model is obtained when the catch-at-age data are combined.

2. Differences in the exploitation patterns of males and females occur in the period up to 1974; sampling error is again likely to be the explanation since the female patterns show a consistent trend.

3. Comparison of the combined and separate sex VPAs shows that stock numbers, recruitments at age 1 and fishing mortalities are not appreciably affected by combining the data.

4. Stock biomass estimates are influenced to the extent of ±10%; this is probably due to differences in the estimated stock numbers-at-age rather than the considerable sex ratio differences observed between year classes.

CONCLUSIONS

Assessments of the North Sea sole stock using combined sex data are very little different from those carried out with separate sex data. The main discrepancies are in stock biomass estimates which are as great as -9.1% in the case of total stock biomass.

The combined sex VPA is likely to give better convergence and hence make it easier to produce a consistent final VPA, these quite apart from the other advantages (reduced workload; smaller and more easily understood reports). Extension of the combined sex approach into the catch forecast is unlikely to introduce any difficult problems- the sex ratio differences between year classes are (at the moment) unpredictable and a ratio of 1.0 in recruiting year classes may be assumed with only a small probability of error since the prediction would affect only the two youngest year classes in the TAC year.

Table 1 Separable VPA results for North Sea sole: coefficients of variation (%) of log catch ratios (observed-fitted). Age range 2-14 years

Period	Coefficient of variation (%)		
	Male	Female	Combined
1957-62	82.3	62.5	25.7
1963-68	81.0	42.1	36.0
1969-74	74.9	68.2	40.8
1975-80	45.4	34.0	30.4
1963-80	76.6	50.2	39.6

Table 2 Comparison of separate and combined VPAs for North Sea sole: stock and recruit numbers in millions of fish

Year	Total stock numbers			Recruits at age 1		
	Separate	Combined	Ratio (comb/sep)	Separate	Combined	Ratio (comb/sep)
1957	609.7	607.3	0.996	160.9	160.9	1.000
1958	662.1	659.9	0.997	144.8	144.8	1.000
1959	1112.2	1109.9	0.998	556.4	556.2	1.000
1960	1021.3	1019.2	0.998	70.8	70.7	0.999
1961	971.2	969.5	0.998	128.3	128.5	1.002
1962	782.1	780.3	0.998	36.6	36.3	0.992
1963	649.8	648.3	0.998	42.3	42.4	1.002
1964	798.2	797.6	0.999	591.0	591.1	1.000
1965	808.4	807.7	0.999	124.9	125.0	1.001
1966	718.9	718.9	1.000	65.3	65.3	1.000
1967	565.5	565.5	1.000	66.2	66.2	1.000
1968	467.3	467.3	1.000	104.4	104.4	1.000
1969	344.2	344.2	1.000	51.5	51.5	1.000
1970	386.9	386.9	1.000	155.7	155.7	1.000
1971	322.3	322.3	1.000	38.0	38.0	1.000
1972	301.4	301.4	1.000	89.0	89.0	1.000
1973	321.6	321.3	0.999	117.3	117.3	1.000
1974	347.6	347.2	0.999	111.1	111.1	1.000
1975	289.5	289.2	0.999	41.4	41.4	1.000
1976	307.6	307.7	1.000	119.1	119.1	1.000
1977	361.2	361.0	1.000	136.2	136.0	0.999
1978	297.6	297.3	0.999	41.5	41.3	0.995
1979	204.2	204.0	0.999	7.5	7.5	1.000
1980	264.9	278.0	1.049	152.0	165.3	1.088

Table 3 Comparison of separate and combined VPAs for North Sea sole: fishing mortality as arithmetic mean of that on 2 to 7-year-olds

Year	Fishing mortality ($\bar{F}_{2-7}$)				
	Separate			Combined	Ratio (Comb/ sep)
	Male	Female	Average		
1957	.085	.123	.104	.106	1.019
1958	.133	.129	.131	.134	1.023
1959	.132	.173	.153	.155	1.013
1960	.244	.178	.211	.201	0.953
1961	.198	.207	.202	.200	0.990
1962	.210	.179	.195	.190	0.974
1963	.202	.282	.242	.247	1.021
1964	.256	.257	.256	.256	1.000
1965	.241	.184	.213	.210	0.986
1966	.196	.184	.190	.189	0.995
1967	.246	.300	.273	.274	1.004
1968	.904	.649	.776	.760	0.979
1969	.464	.410	.437	.437	1.000
1970	.383	.392	.387	.385	0.995
1971	.452	.392	.422	.419	0.993
1972	.461	.355	.408	.406	0.995
1973	.415	.471	.443	.447	1.009
1974	.577	.418	.498	.490	0.984
1975	.398	.429	.414	.415	1.002
1976	.418	.443	.430	.431	1.002
1977	.431	.461	.446	.446	1.000
1978	.517	.420	.469	.466	0.994
1979	.445	.461	.453	.454	1.002
1980*	.502	.468	.485	.485	1.000

* Input values

Table 4 Comparison of separate and combined VPAs for North Sea sole: biomasses in thousands of tonnes

Year	Total stock			Spawning stock		
	Sep	Comb	Ratio	Sep	Comb	Ratio
1957	124.8	123.0	0.986	113.6	115.5	1.017
1958	130.0	126.0	0.969	114.8	113.4	0.988
1959	117.6	106.8	0.908	98.3	97.8	0.995
1960	138.5	133.3	0.962	105.7	100.9	0.955
1961	145.3	144.5	0.994	139.0	140.5	1.011
1962	158.3	154.9	0.978	149.6	145.9	0.975
1963	154.2	152.1	0.986	151.0	149.7	0.991
1964	68.2	66.8	0.979	54.4	52.7	0.969
1965	108.3	101.5	0.937	59.2	56.0	0.946
1966	114.1	113.4	0.994	103.0	103.6	1.006
1967	97.7	96.5	0.987	91.9	92.3	1.004
1968	89.8	85.3	0.950	82.1	80.6	0.982
1969	88.2	88.7	1.006	76.3	77.0	1.009
1970	69.7	69.8	1.001	60.5	60.6	1.002
1971	78.1	77.9	0.997	60.8	60.5	0.995
1972	64.6	60.4	0.935	58.1	57.3	0.986
1973	63.1	63.1	1.000	49.9	49.7	0.996
1974	57.5	56.2	0.977	43.3	41.9	0.968
1975	59.3	59.2	0.998	47.4	47.2	0.996
1976	49.9	50.4	1.010	42.3	42.9	1.014
1977	50.2	50.5	1.006	35.7	35.9	1.006
1978	54.5	54.1	0.993	40.2	39.8	0.990
1979	50.0	50.4	1.008	45.2	45.4	1.004
1980	41.4	42.1	1.016	34.8	34.8	1.000

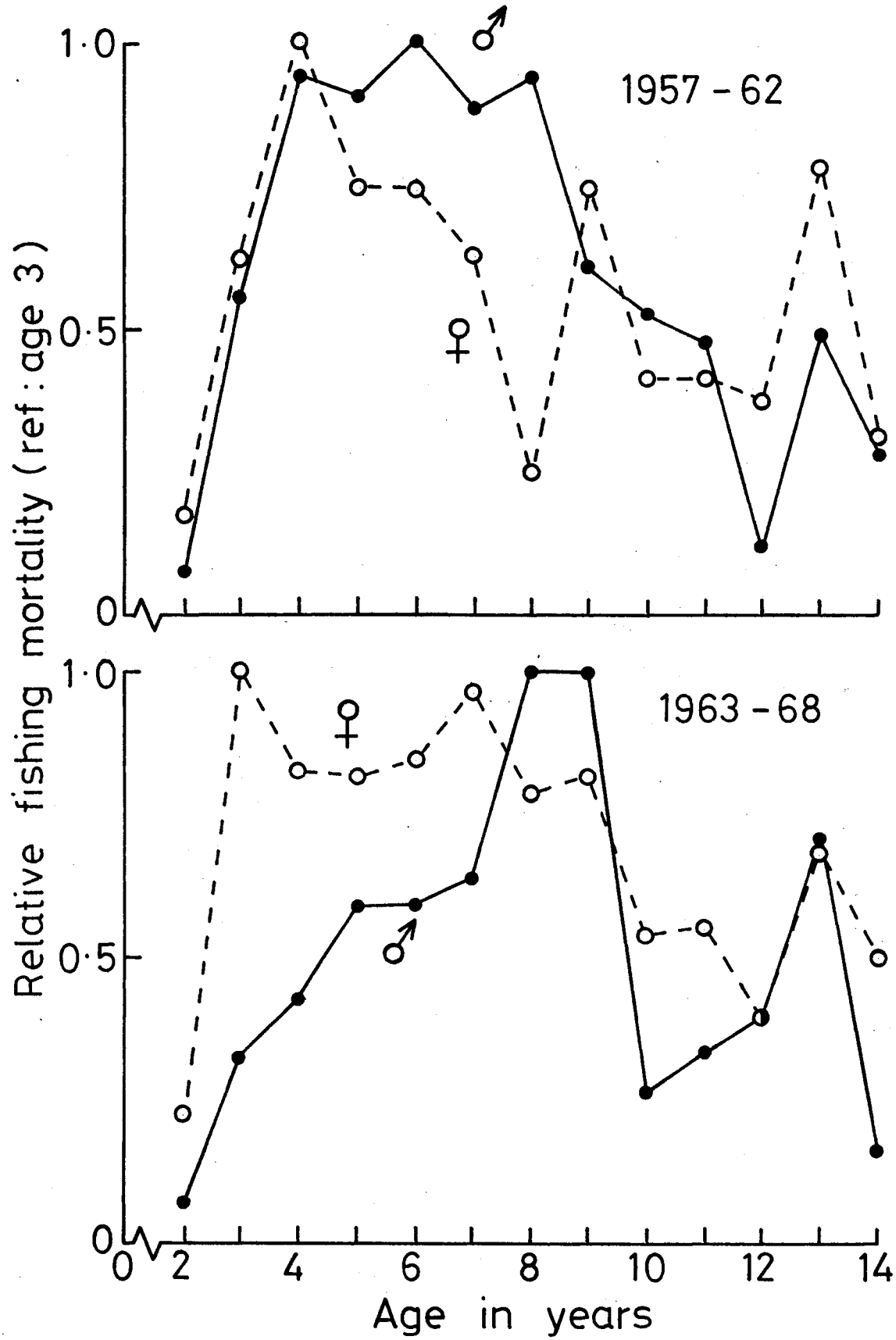

Figure 1 Separable VPA results for North Sea sole: exploitation patterns obtained for 6-year periods using input values of F and S of 0.5. (Note - the patterns for 1957-62 and that for males in 1963-68 have been made relative to the maximum S obtained which exceeded 1).

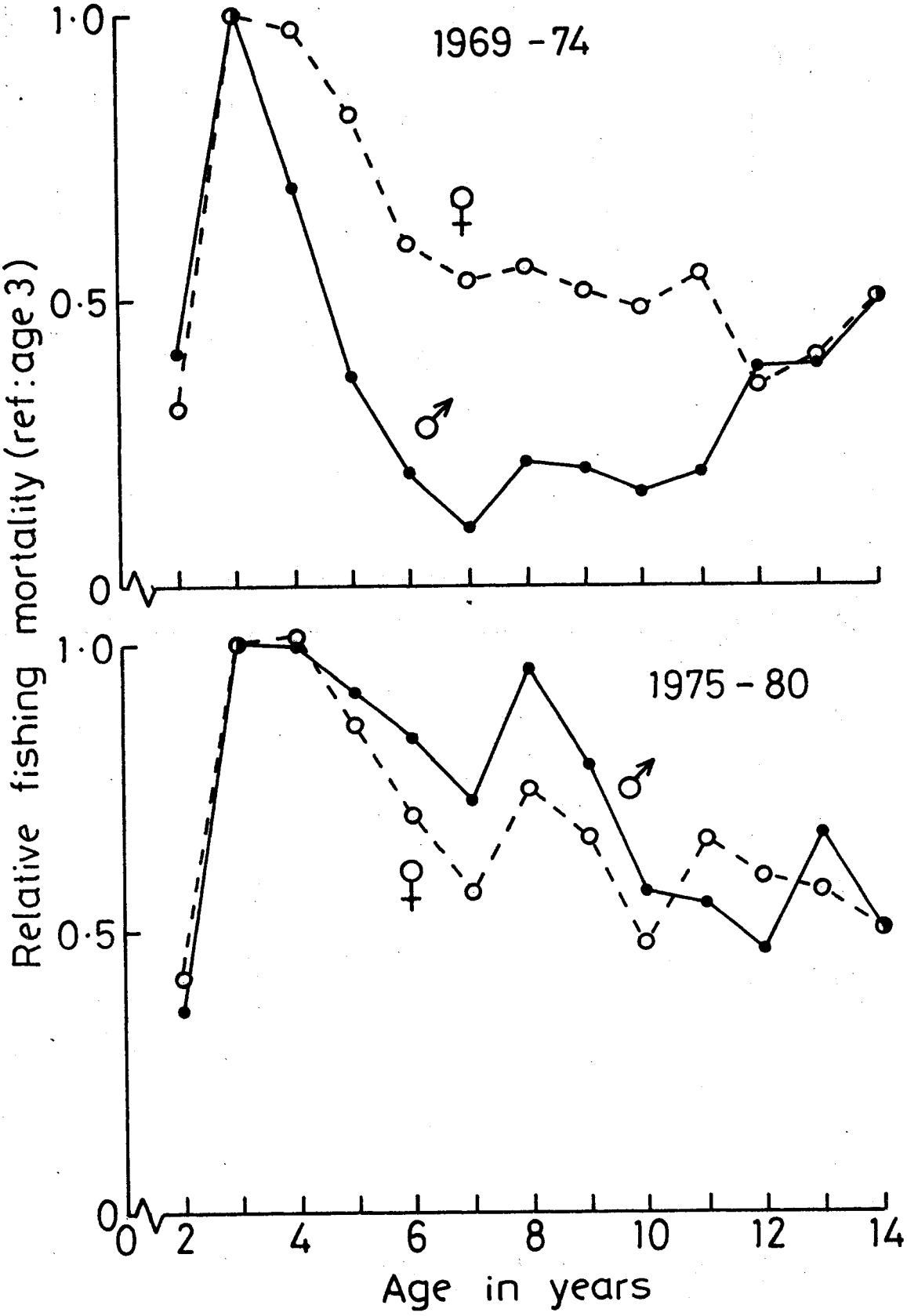

Figure 1 continued

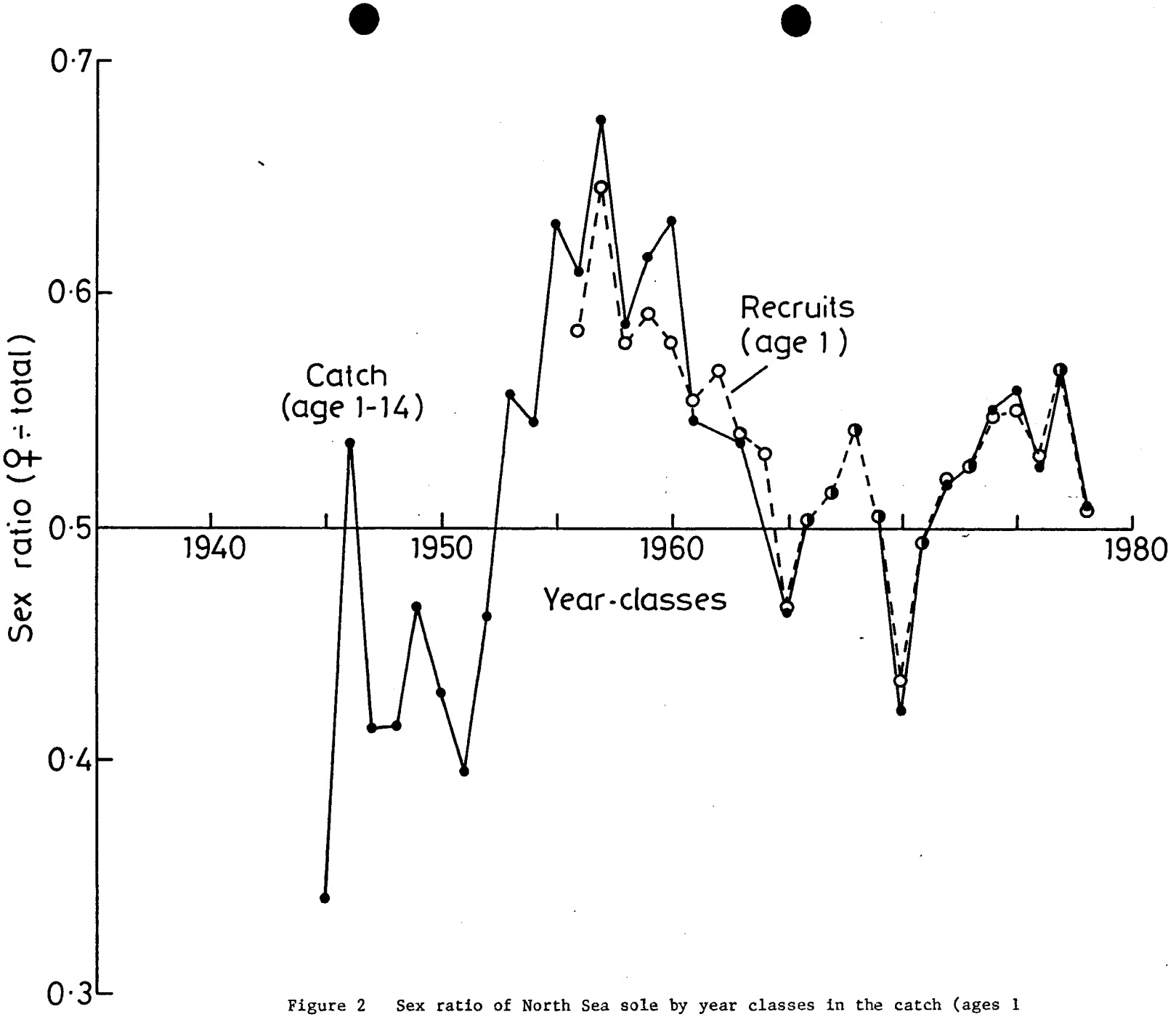

Figure 2 Sex ratio of North Sea sole by year classes in the catch (ages 1 to 14) and as recruits at age 1 estimated by VPA.