~~MINISTRY OF TECHNOLOGY~~

DEPARTMENT OF THE ENVIRONMENT

WATER POLLUTION RESEARCH LABORATORY

The Possible Effect on Migratory Fish in the River Dee of Increased Water Abstraction

Report for North-East of Scotland Water Board

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Introduction

The North-East of Scotland Water Board proposes to increase the statutory rate of abstraction from the River Dee at the Cairntorn intake about 3 miles west of Banchory from the present 15 mil gal/day (27.8 cusecs) to 20 mil gal/day (37.1 cusecs), the effect of which would be an increase in reduction of flow from 15.8 per cent to 21.1 per cent of the extreme dry-weather flow and from 2.2 per cent to 2.9 per cent of the average flow. Since the river supports migratory fish an attempt has been made on behalf of the Board to assess the likely effect on the fisheries of the increased rate of abstraction, attention being directed mainly at catches on rod and line. The approach adopted is to assume a causal relation between catches and river flow and to use past observations for predictive purposes. It must be recognized, however, that estimates of the effects of reduced flow made in this way are likely to be unreliable because they neglect the variability and uncertainty of other germane factors such as the availability of fish to enter the river from the sea, the incidence of diseased fish, the fishing effort of anglers, the local importance to fisheries of depth, and the velocity of the water at critical times and positions in the river; and perhaps above all the effect on fish migration of changes in water quality associated with natural spates. This last factor, which would not be affected by abstraction, could be of overriding importance.

Data Used

Details of catches of migratory fish in the Dee are not available for publication, but data on the relative numbers of salmon, grilse, and sea trout caught annually and monthly in the Dee area and in the rest of Scotland for the 19-year period 1952-1970 have been calculated from

information supplied by the Department of Agriculture and Fisheries for Scotland. These are adequate for the purposes of the present analysis.

Records of daily flows in the River Dee at Woodend have been provided by the North-East of Scotland Water Board for the same period and have been used to calculate median flows for each month and each fishing season, the median being chosen as a general measure of central tendency and also because inspection of the data showed it would be correlated fairly precisely with minimum values.

Results

Long-term trends

The relative total catches for the Dee area and for the whole of Scotland are shown, together with the ratio of the relative catches and also the median flow for the appropriate fishing season, in Figs. 1, 2, and 3 for salmon, grilse, and sea trout respectively. Over the 19-year period in the Dee area there is a decline in the catch of salmon and an increase in that of grilse and sea trout, showing that, for these three migratory fish, catches are independent of each other and that the effect of seasonal median flow, if an important causal factor, must be different for each.

These trends in catches are also found to some extent for the whole of Scotland, particularly with grilse and sea trout, although the downward trend of catches of salmon in the Dee is greater than that for Scotland as a whole. Notable is the coincidence in the peaks and troughs in the graphs for sea trout and to a lesser extent for salmon, for example the low value for 1970. Thus variations in catches for the Dee are not entirely unrelated to those elsewhere in Scotland. Over the same period the flow of the Dee has fluctuated widely and there has been a slight tendency for it to increase, but it is not known to what extent this has been paralleled over the rest of Scotland.

Catch and flow

Catches over the fishing season are at their height in February to May for salmon and in July for grilse and sea trout, while river flows are highest in February to May and lowest in July (Fig. 4). To allow for this in estimating the correlation of catch and flow, the data have been examined on a monthly basis.

Regression analysis shows that there is a positive correlation between catch and flow for some months, but the level of significance is generally low. Examples of the most significant regressions are given in Fig. 5 for salmon (March and July), grilse (July and August), and sea trout (June and July). It is noteworthy that with salmon there was a negative correlation for April and May, the two months of highest average catch.

The percentage change in monthly rod and line catch associated with a reduction in flow of 20 mil gal/day (37.1 cusecs) based on these regressions and detailed in Table 1, is perhaps best considered in relation to the proportion of the total seasonal catch in each month (from Fig. 4). When this is done (Fig. 6) it is clear that the largest reduction in monthly catch is for grilse in July and August, and for sea trout in July; the percentage reduction in the 19-year annual mean seasonal catch is 0.9, 1.7, and 2.1 for salmon, grilse and sea trout respectively. This would appear to represent the maximum likely effect of a reduction of 20 mil gal/day (37.1 cusecs) in the natural flow throughout the fishing season were the relationship between catch and flow found in this analysis a causal one. However the actual effect would probably be less because of interaction between succeeding months, reduced catches one month being followed by increased catches the next, and vice versa, as has been indicated for the River Coquet (Alabaster, 1970). Analysis of the data for salmon in the Dee suggests that some 30 per cent of the deviation of the points about the combined regression for all months could be accounted for in this way. The remaining 70 per cent is, however,

Table 1. Effect on percentage of monthly mean catch of a reduction of 20 mgd (37.1 cusecs) in flow (-, reduction in percentage catch; +, increase in catch)

	Salmon	Grilse	Sea trout
February	- 1.9**		+ 6.7**
March	- 1.8**✓		- 0.3*
April	+ 0.3**	+ 3.2*	+ 0.9*
May	+ 0.5*	+ 0.9*	- 2.1*
June	- 2.1**	- 2.2*	- 5.6****✓
July	- 1.5**✓	- 2.0*✓	- 1.8*✓
August	- 1.2*	- 6.3***✓	- 1.1*
September	- 0.2*	- 7.0*	+ 1.0*

* P > 5%

** P = < 5%

*** P = < 1%

**** P = < 0.1%

✓ Illustrated in Fig. 5

unexplained, but presumably would be partly attributable to variation from month to month and year to year in the availdbility of fish and in the fishing effort, and perhaps also in the accuracy of catch returns.

General Conclusions

There have been considerable variations and some trends in the numbers of salmon, grilse and sea trout caught on rod and line in the River Dee over the period 1952-1970. These are to some extent reflected by catches for the whole of Scotland, making it doubtful whether the flow of the River Dee has been mainly responsible for the catches, particularly since the trends are different for salmon, grilse and sea trout.

For some months the variation in catches in the River Dee over this period is positively related to flow, but the levels of the statistical significance of the correlations are generally low and some of the variation is attributable to the interaction of catches in adjacent months. A large part remains unaccountable, and is likely to have been caused by variation in both the natural runs of fish and possibly also in the fishing effort.

The relation between catch and flow varies with different months, but the overall effect, taking into account the variation in catch over the season, is for seasonal catches to increase with increase in flow. For a reduction in flow of 20 mgd (37.1 cusecs) which is four times the reduction presently proposed by the Board, the percentage reduction in the seasonal catch is 0.9, 2.7, and 2.1 for salmon, grilse, and sea trout respectively. This is not to say that such a reduction in flow would necessarily reduce the catch at all, but that if a reduction in catch occurred it would be unlikely to exceed the percentages given.

Reference

Alabaster, J. S. (1970). River flow and upstream movement and catch of migratory salmonids. J. Fish Biol., 2, 1-13.

FIG. 1 DISTRIBUTION OF RELATIVE CATCHES OF SALMON AND FLOW IN R. DEE

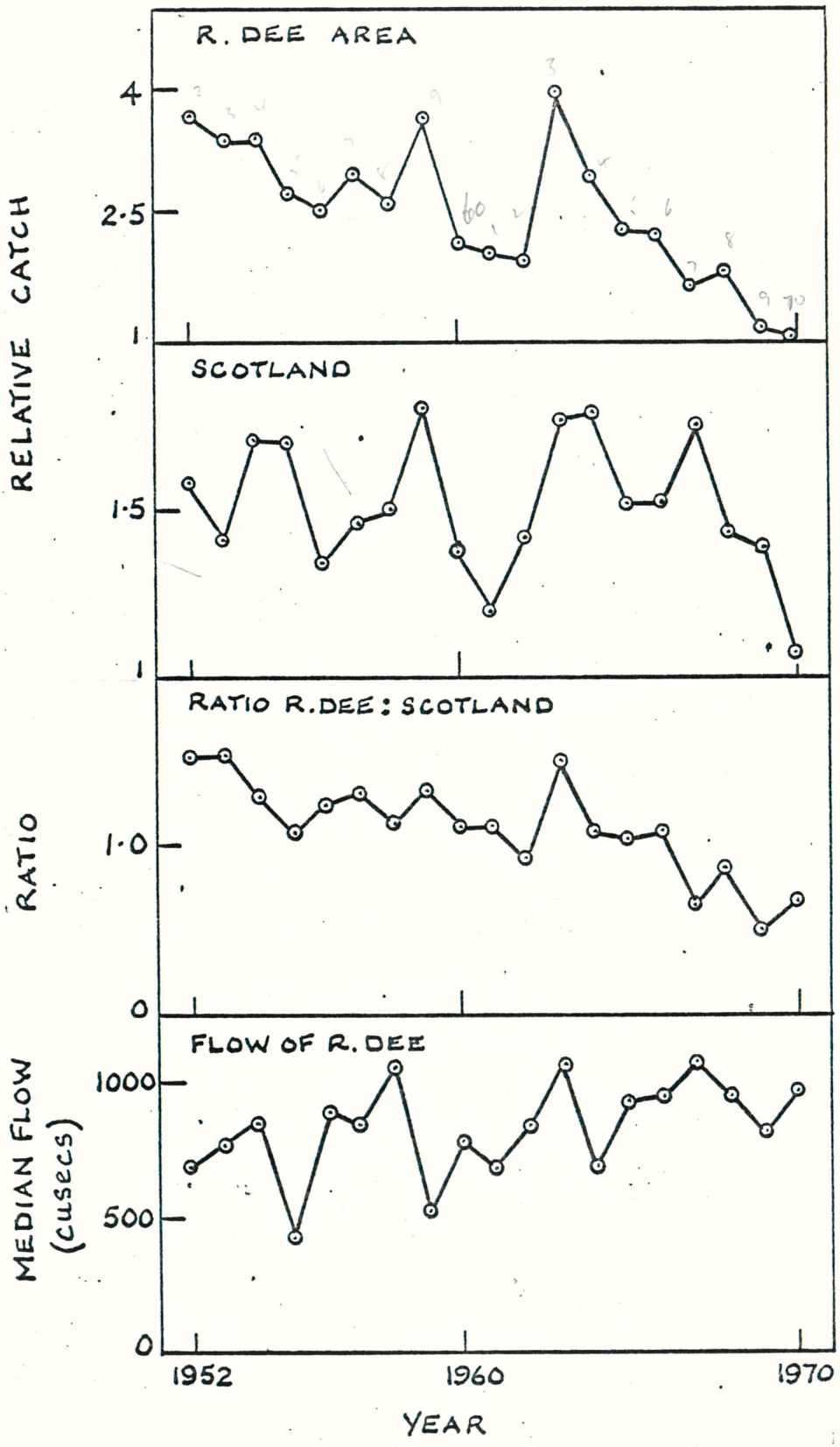

FIG. 2 DISTRIBUTION OF RELATIVE CATCHES OF GRILSE AND FLOW IN R. DEE

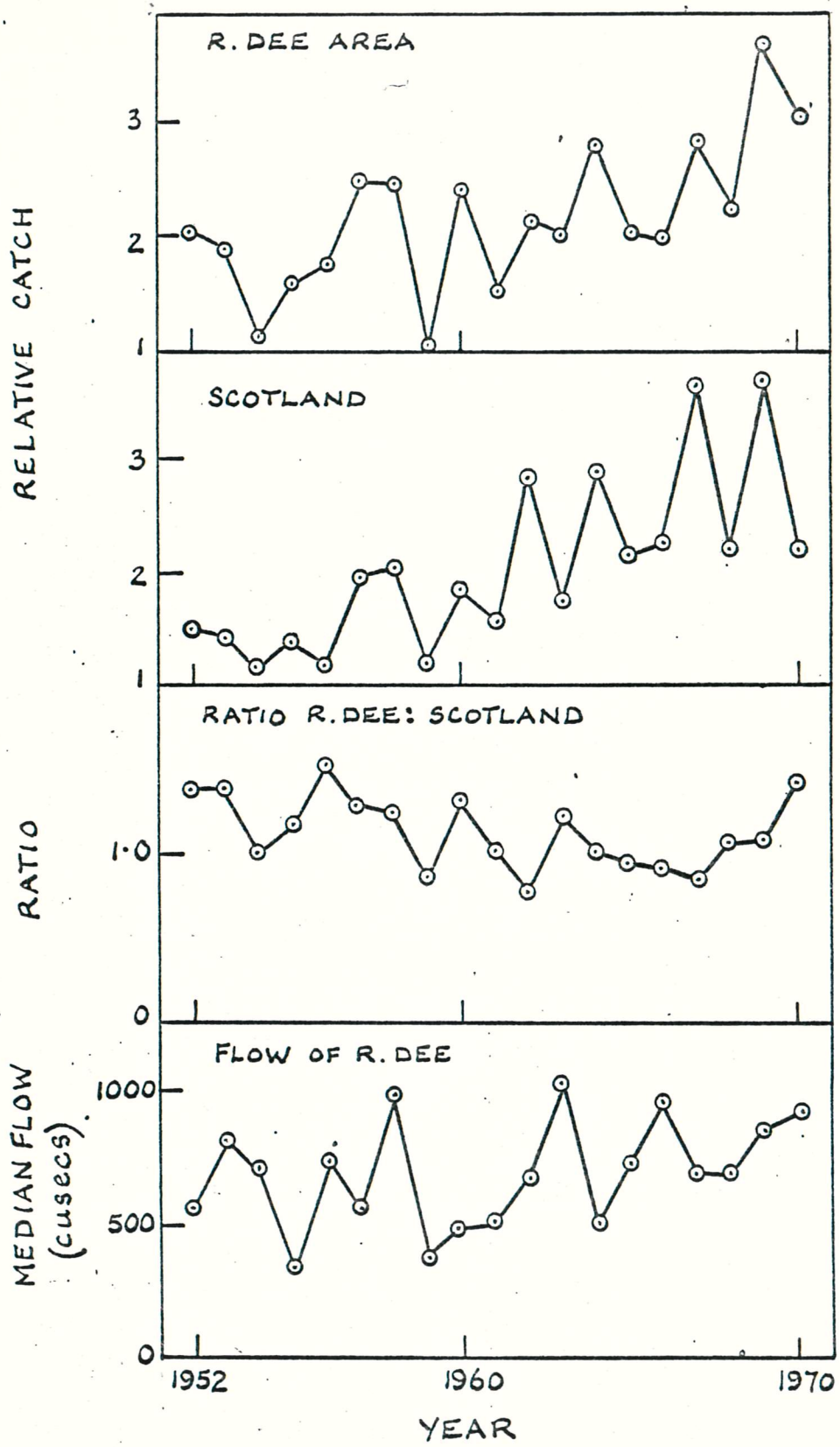

FIG.3. DISTRIBUTION OF RELATIVE CATCHES OF SEA TROUT AND FLOW IN R. DEE

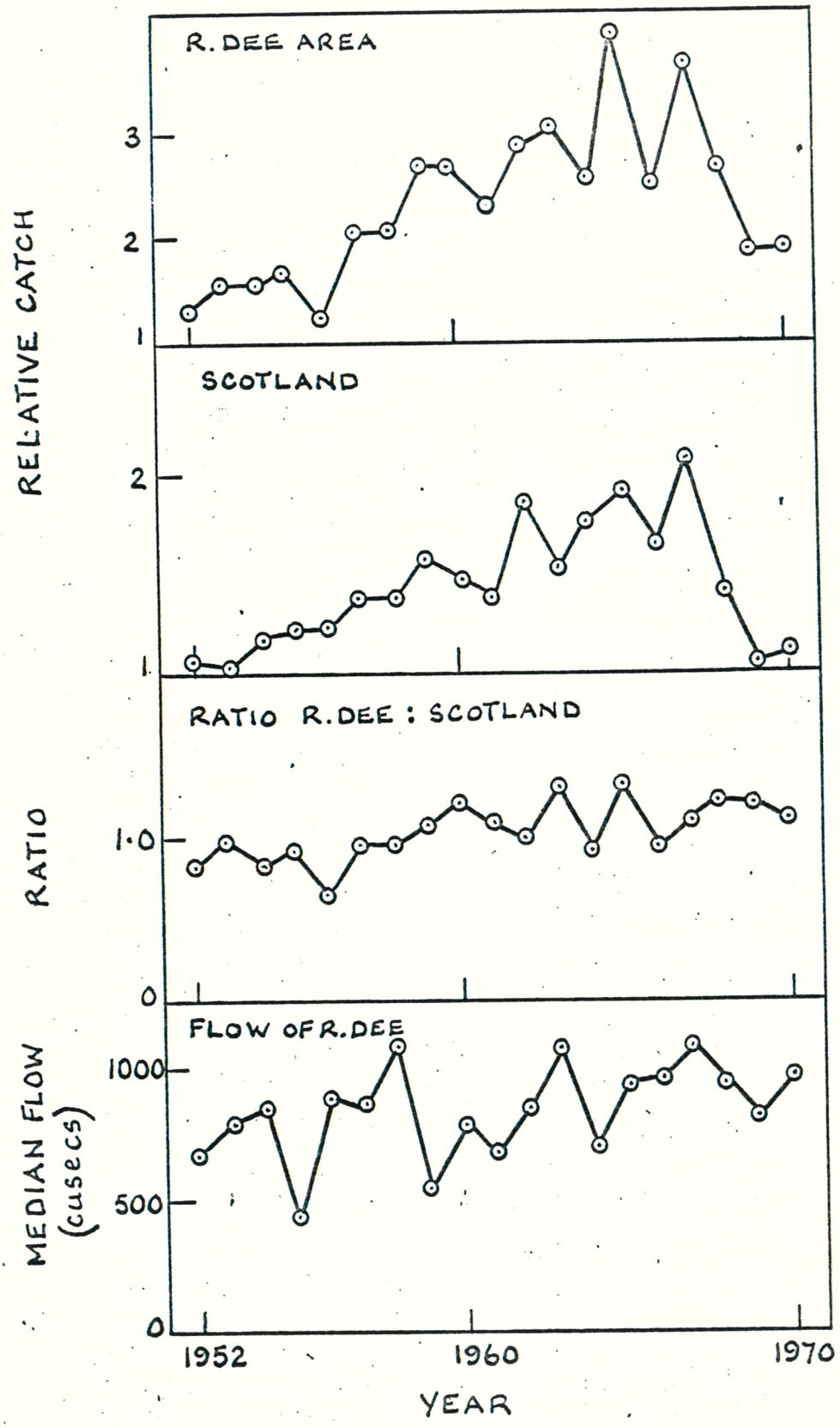

FIG. 4 AVERAGE DISTRIBUTION OF MONTHLY CATCH ON ROD AND LINE AND MEDIAN FLOW AS PERCENTAGE OF YEARLY AVERAGES IN R. DEE 1952 – 1970

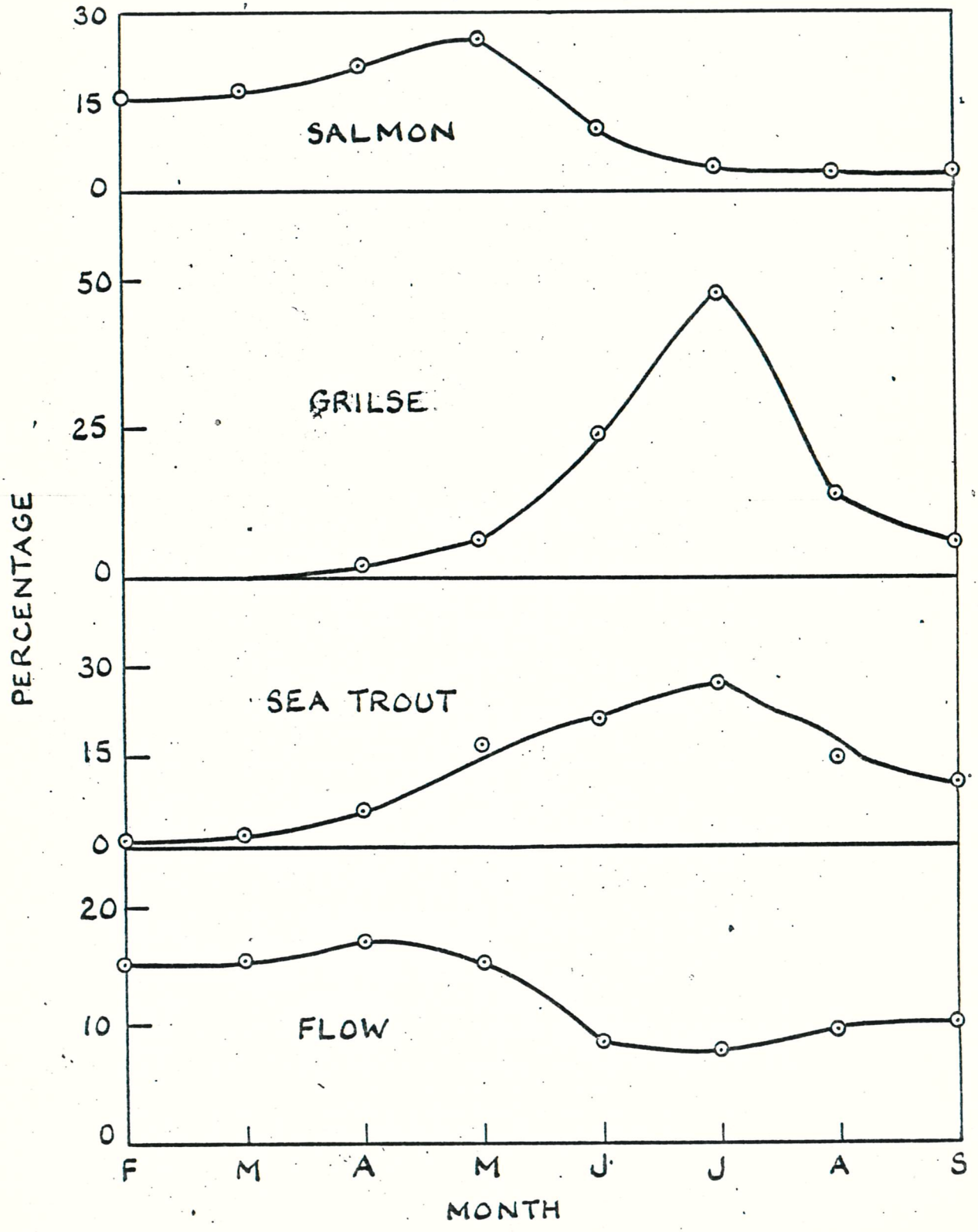

FIG 5 RELATION BETWEEN PERCENTAGE OF MONTHLY MEAN CATCH FOR SELECTED MONTHS OVER THE PERIOD 1952–1970 AND THE MEDIAN FLOW FOR THE CORRESPONDING MONTH

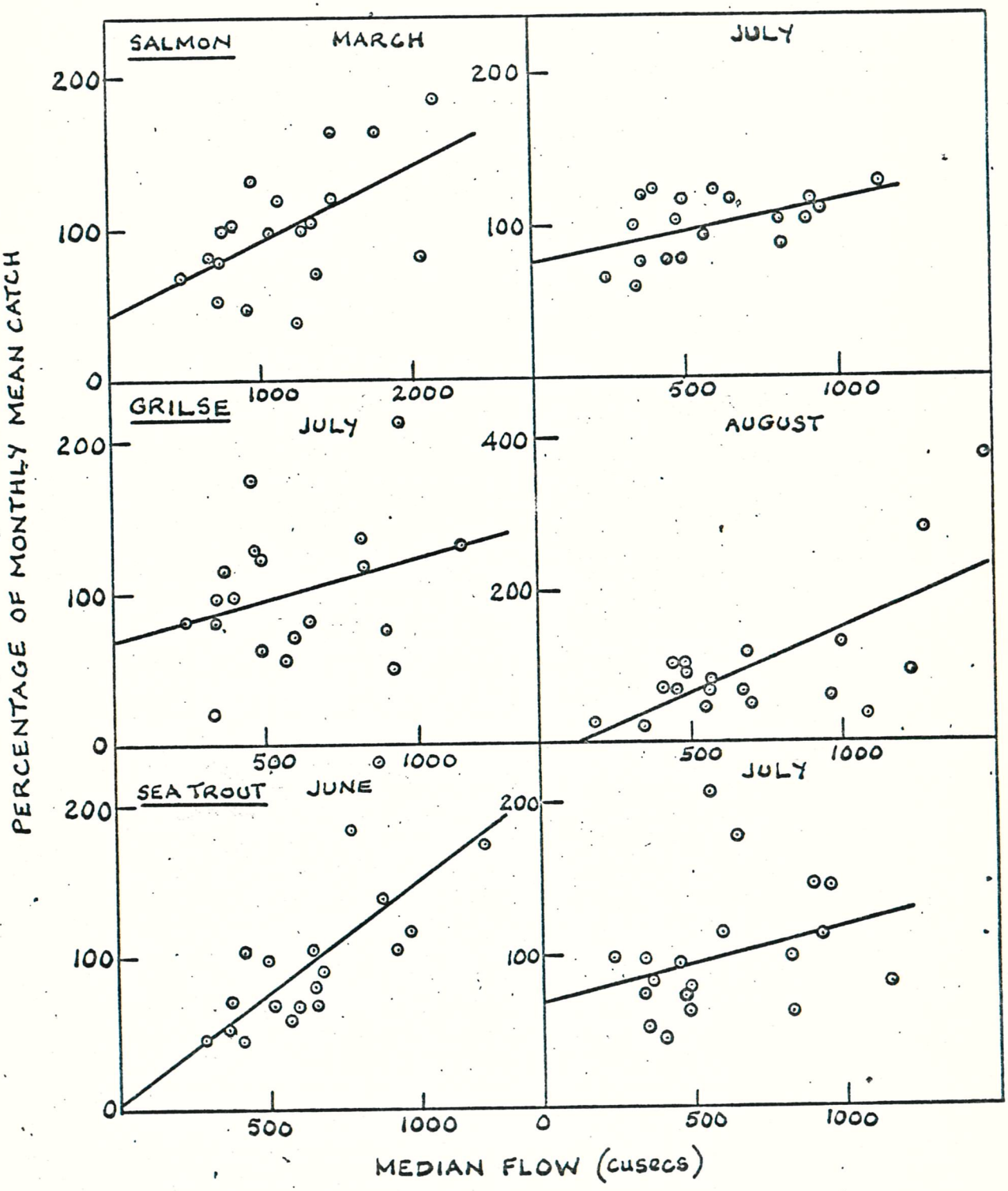

FIG. 6 CHANGE IN MONTHLY PERCENTAGE DISTRIBUTION OF CATCH ON ROD AND LINE ASSOCIATED WITH A REDUCTION OF FLOW IN R. DEE OF 20 m.g.d.