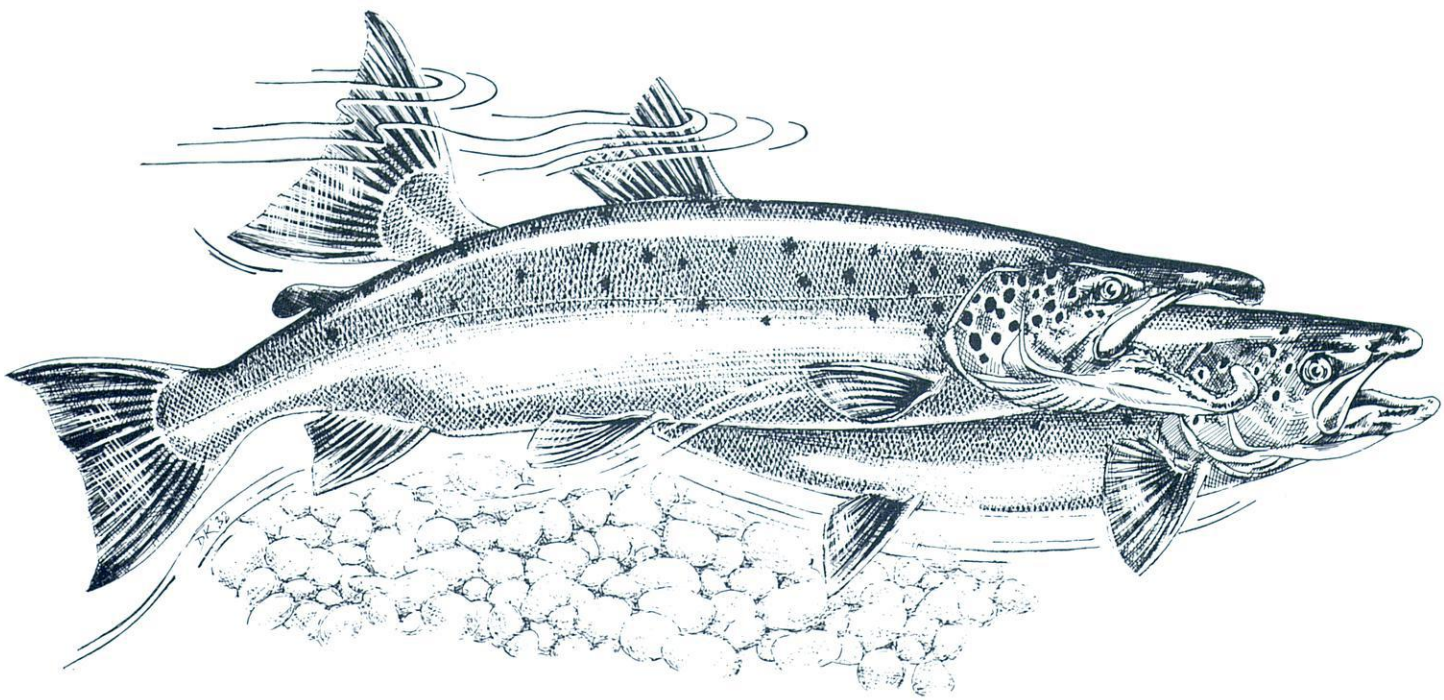
The Salmon Advisory Committee

The effects of fishing at low water levels



Ministry of Agriculture, Fisheries and Food
Department of Agriculture and Fisheries for Scotland
Welsh Office Agriculture Department

SALMON ADVISORY COMMITTEE

THE EFFECTS OF FISHING AT LOW WATER LEVELS

Introduction

1. The Salmon Advisory Committee was established by Fisheries Ministers in October 1986. Its membership is shown at Appendix I.

2. The terms of reference of the Committee are:

> "To examine and report on those matters relating to the conservation and development of salmon fisheries in Great Britain which are referred to it by Fisheries Ministers".

One of the matters which Ministers have asked the Committee to examine is the influences on salmon stocks of fishing at low water levels. In this report the word 'salmon' is to be read as including grilse unless the context requires otherwise; it does not include sea trout but some analyses of sea trout catches were made.

3. The Committee were aware of the context in which concerns were expressed about fishing at times of low flows and which led to Ministers asking them to address this issue. During Parliamentary consideration of the Salmon Bill (now the Salmon Act 1986), Ministers were pressed to introduce measures that would restrict fishing during times of drought. It was suggested that at such times salmon tended to congregate in estuaries or river mouths where they could be caught in large numbers by nets and that fishing under such conditions led to unacceptable exploitation rates. The effect of water abstraction was also cited as a contributing factor to low flows and increased exploitation.

4. Although it was suggested that there was evidence to substantiate these concerns, Ministers questioned this. They agreed that reported rod catches were reduced in drought years but attributed this to the reluctance or inability of the fish to swim upstream during low water flows. Ministers knew of no evidence which suggested that netting during times of low flow threatened the conservation of stocks. They also drew attention to the practical difficulties of applying measures to restrict fishing activities under low flow conditions,

particularly where such restrictions would be likely to differ between rivers. However, acknowledging that this was a complex issue of concern to many, they agreed to refer it to the Committee for further assessment.

5. In making its assessment the Committee decided that it should:

(i) consider criteria to be used to determine "low flow";

(ii) assess the evidence for any significant effect on salmon stocks of fishing at low water levels;

(iii) if insufficient information is available upon which to base such an assessment, indicate what data may need to be obtained;

(iv) consider the extent to which the issue lends itself to national assessment, or to a regional or river-by-river approach;

(v) if there appears to be sufficient evidence of a problem, consider practicable and enforceable steps which might be taken to control fishing at such times.

6. As the Committee concluded in its report "Information on the status of salmon stocks", little is known about the size of salmon stocks as distinct from catches. It therefore considered that there was insufficient information on variations in the size of stocks to make a direct assessment of the effects on them of fishing at low water flows. There are now reliable electronic fish counters installed on some rivers but they have not yet provided long enough time series of data for analysis. For these reasons it is not possible on the basis of existing data to demonstrate any change in annual exploitation rates (ie the proportion of the available fish caught). It was recognised that a steady catch rate would not necessarily imply that the exploitation rate was constant: if the number of fish available to a fishery were to decline under particular conditions, then an unchanged catch rate would mean that the exploitation rate had increased. It was decided that in the absence of data on the availability of fish to a fishery, any assessment of the need for restrictions on fishing at low flows would have to be based on effects on catches, rather than on exploitation rates.

7. It is difficult to establish whether there is any causal relationship between the amount of the river flow and the size of the catch made by salmon nets. It was therefore felt that where data on daily catches and flows are

available for a river for several years, it should be possible to show whether unusually large catches occur at times of low river flow. Consideration was also given to the use of data from electronic fish counters in this context but no counter is sited where it would give a measure of the availability of fish at a net fishery over a short period.

8. It was noted that fishermen might increase or decrease their fishing effort at times of low flows, and that this could affect catches. However, it was recognised that the matter of concern was the effect of flow on the absolute level of catches and that effort did not therefore need to be allowed for. Further, the Committee did not consider the effects of river discharge on catches of fisheries operating in the sea at a distance from estuaries because these catches cannot be associated with the flow in any particular river.

Pattern of flow

9. The flows in rivers supporting stocks of migratory salmonids are typically very variable and the freshwater discharge under peak flood conditions is sometimes as much as 100 times greater than under low summer flows. Large increases in water levels can occur quickly after heavy rain but very low flows usually develop gradually after extended periods of dry weather. However, increasing demand for water for domestic, agricultural and industrial supply has resulted in discharges of some rivers being modified or regulated, thus changing both short and long-term flow patterns.

10. River levels are generally recorded at gauging stations and are used to calculate the flow or discharge, usually expressed as cubic metres per second ($m^3 s^{-1}$ or cumecs). Measurements are recorded at regular intervals throughout the day and mean, maximum and minimum flows for each day are derived from them; these data can then be used to describe longer term flow patterns.

11. In most rivers, flows fall to their lowest annual levels between June and August, but summer flows may vary considerably from year to year. The concept most widely used by river purification boards in Scotland and water authorities in England and Wales to compare flows is that of flow frequency, or 'Q' values. 'Q' values express the frequency of occurrence of a given flow based on several years' data. For example, the Q95 is the flow that was exceeded on 95% of days in the available data record; ie flow is lower than the Q95 on an average of 18.3 days each year. Similarly, the lower flow expressed as Q99 is the flow exceeded on 99% of days, ie flow is lower than the Q99 on an average of only 3.65 days per year. The Committee adopted this widely recognised

measure of flows but noted that on different rivers there would be significant differences between the distribution of days when flows fall below a particular 'Q' value. For example, the flow in one river may fall below the Q95 for a few short periods every year while on another it may fall to this value only in some years but for longer periods. The Committee also recognised that the same 'Q' value will not be directly comparable between rivers in terms of its effects on salmon movements and fisheries (particularly when comparing figures for regulated and unregulated rivers). Thus, salmon may continue to enter a large river even when flow falls below the Q95 but only enter a small river at higher flows. The Committee therefore acknowledged that no single 'Q' value can be used to define exceptional conditions on all rivers but noted that the Q95 was widely used as a reference point for low flow.

12. As an example, Table 1 shows 'Q' values and equivalent flows at two locations: the gauging station at Park, about 20 kilometres upstream from the head of tide of the Aberdeenshire Dee, calculated from flows measured at this station between 1973 and 1983; and the gauging station at Preston, 4 kilometres above the head of tide on the River Teign, based on flow data measured between 1970 and 1987.

Table 1

Q Value	Flow (cumecs)	
	Aberdeenshire Dee	River Teign
50	31.5	5.25
75	17.5	2.26
90	11.0	1.38
95	8.4	1.10
98	6.1	0.89
99	5.3	0.78
99.5	4.7	0.57
99.9	3.6	0.33

To provide an illustration of variation in summer flow patterns between years, the number of days in June, July and August in each of the years studied on the Dee at Park, and for the same years on the Teign at Preston, when daily mean flows fell below their Q95 values are presented in Table 2.

Table 2

	Aberdeenshire Dee at Park			River Teign at Preston		
Year	June	July	August	June	July	August
*1974	0	0	5	0	0	0
*1976	0	14	28	17	31	30
*1982	4	15	5	0	0	0
1983	0	4	31	0	0	11
1984	0	22	29	0	16	19
1985	0	0	0	0	0	0
1986	0	0	0	0	0	0

(* The three years when summer flows were consistently very low at Park on the Aberdeenshire Dee from 1972 (when the station was commissioned) to 1982. See paragraph 15).

Availability and Quality of Data

13. The Committee endeavoured to identify a representative range of rivers throughout Great Britain for the assessment, recognising the need to cover both small and large rivers. However, the selection was limited by the availability of adequate data on daily flows and catches.

14. In Scotland the salmon catch statistics collected by DAFS are reported on a monthly, not daily, basis and are therefore not suitable for this analysis. However many netting companies keep detailed daily records, some of which have recently been made available. Major rivers for which such data were available to the Committee, along with the necessary flow data, included the rivers Dee (Aberdeenshire), Don, Spey, Tay and Tweed.

15. The data from the River Dee were considered most suitable for analysis because comprehensive records are available for each of the fixed nets adjacent to its mouth; for the fixed nets at the entrance to the harbour (the start of the estuary); and for a net-and-coble fishery in the estuary itself (Figure 1). DAFS was therefore asked to analyse the catches by these nets in relation to water flow. The analysis covered the last four years of the fishery's operations (1983 to 1986) and also the three years between 1972 and 1982 when summer flows were consistently very low (1974, 1976 and 1982).

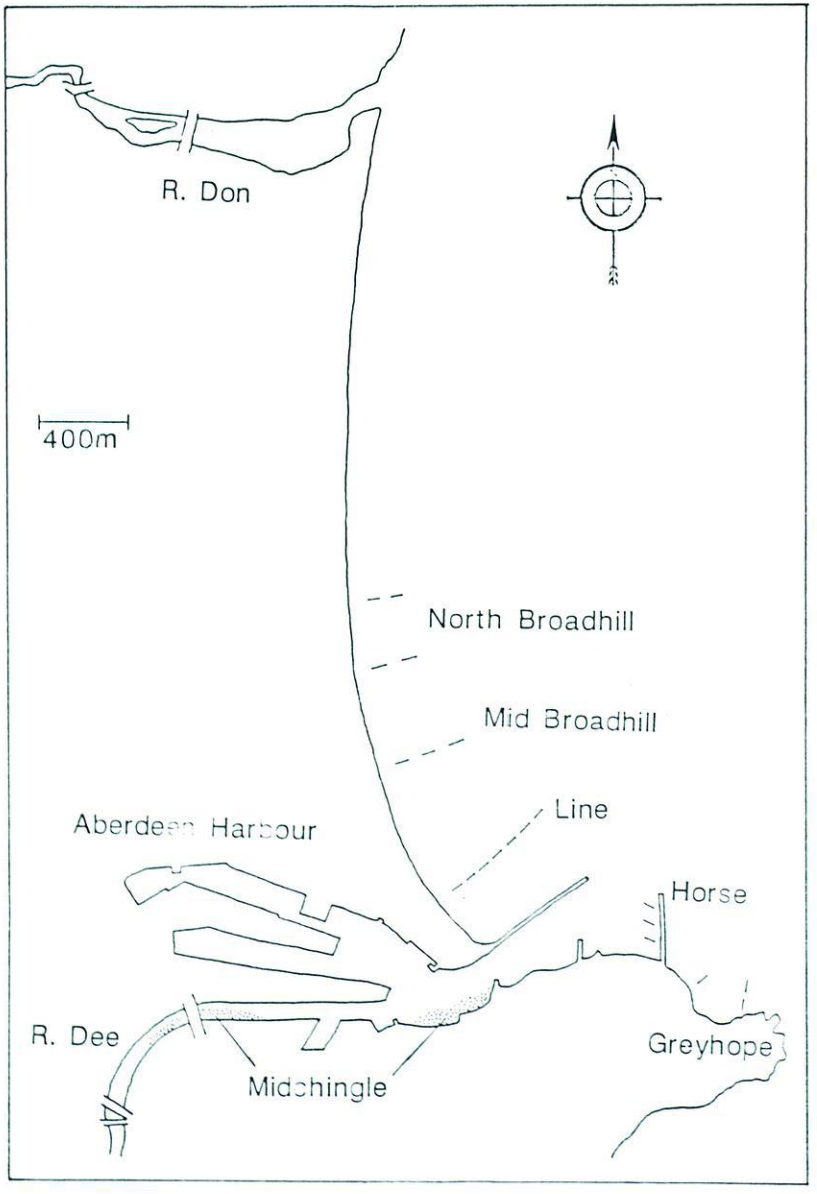


Figure 1. Map showing the location of netting stations around the River Dee, Aberdeenshire.

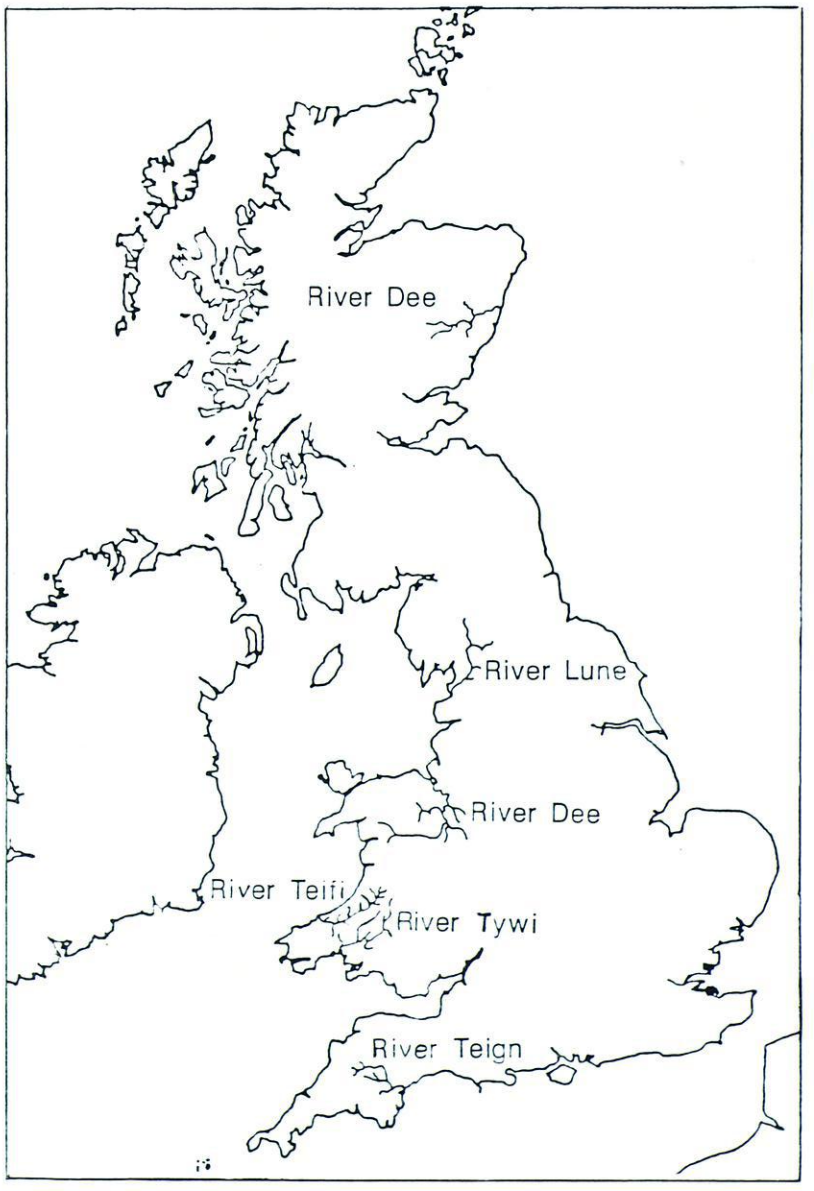


Figure 2. Map showing the location of the six rivers in Great Britain selected for analysis.

16. In England and Wales the availability of suitable data was assessed for the Committee by MAFF's Directorate of Fisheries Research. Although data on flows and catches were available from many rivers, the following features were considered necessary for analysis: data on flows near the head of tide; returns from at least five net fishing licences; and an annual declared catch in the fishery (rod or net) of at least 100 fish. This approach indicated that data from 15 net fisheries and 18 rod fisheries from a total of 21 rivers would be suitable for analysis, and five rivers were selected from these covering a wide geographic area and a range of commercial fishing methods; they were the rivers Teign in Devon and Lune in Lancashire and the rivers Tywi, Teifi and Dee in Wales. The location of these rivers is shown in Figure 2.

17. The Committee recognised that their approach to the selection of rivers had excluded data from very small rivers, where catches were too small for statistical analysis, and also relied on the data sets known by the Fisheries Departments to be available. It therefore invited the regional water authorities in England and Wales and the Association of Scottish District Salmon Fishery Boards to indicate whether they were aware of any problems caused by fishing at times of low flow or if they knew of any adequately detailed records held by fishery owners or operators which might be made available for analysis. The few sufficiently comprehensive data sets that were identified as a result of this exercise did not include rivers that differed in character from those already selected for analysis.

Analyses of the data

18. The analysis of data from the River Dee (Aberdeenshire) showed a clear pattern to both catches and river flows in most of the years studied: daily catches were higher in the summer when river flow was often relatively low. This gives rise to an apparent relationship between catch and flow when the one is plotted against the other for each day over a whole year. An example is shown in Figure 3. However, this relationship is not principally due to a direct effect of flow on catch rates. It reflects the relatively small number of fish entering the river at the beginning of the netting season when flow is generally high, as against the greater number of salmon normally available for capture in summer when river flow is low, as shown by catches in both wet and dry years.

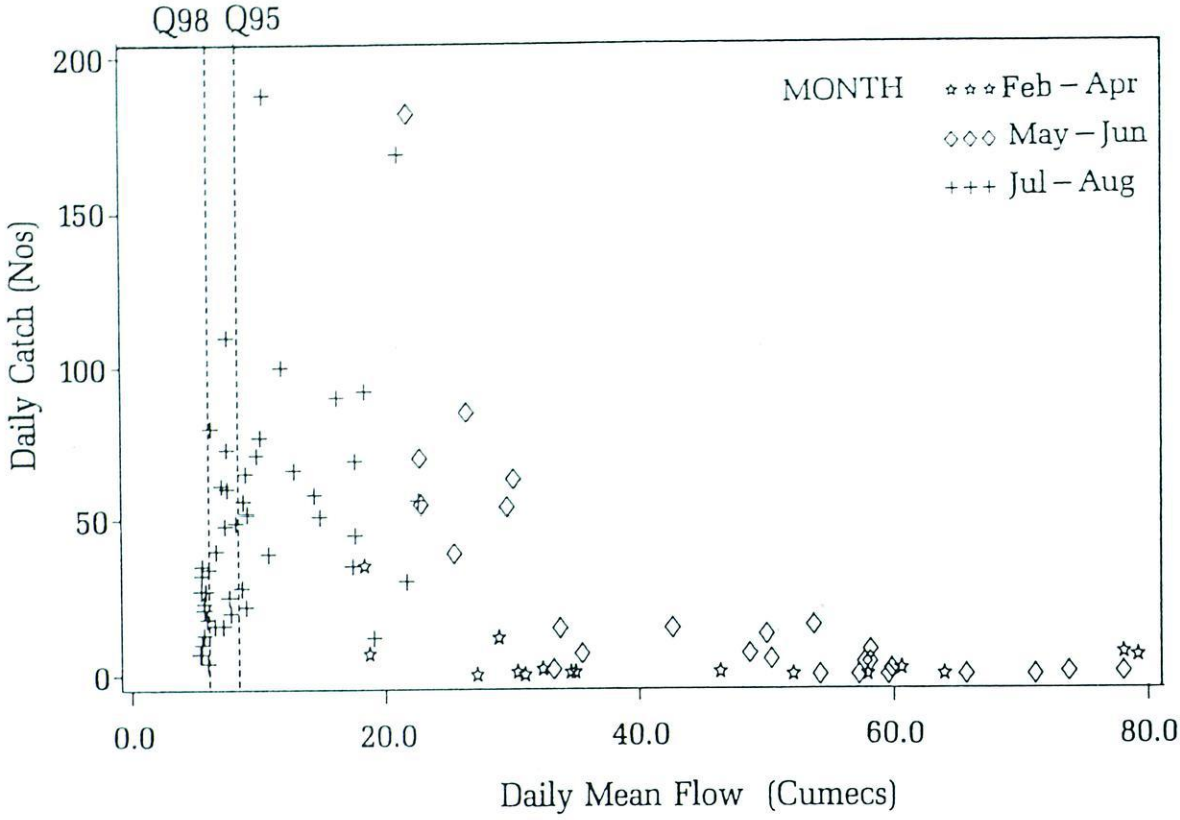
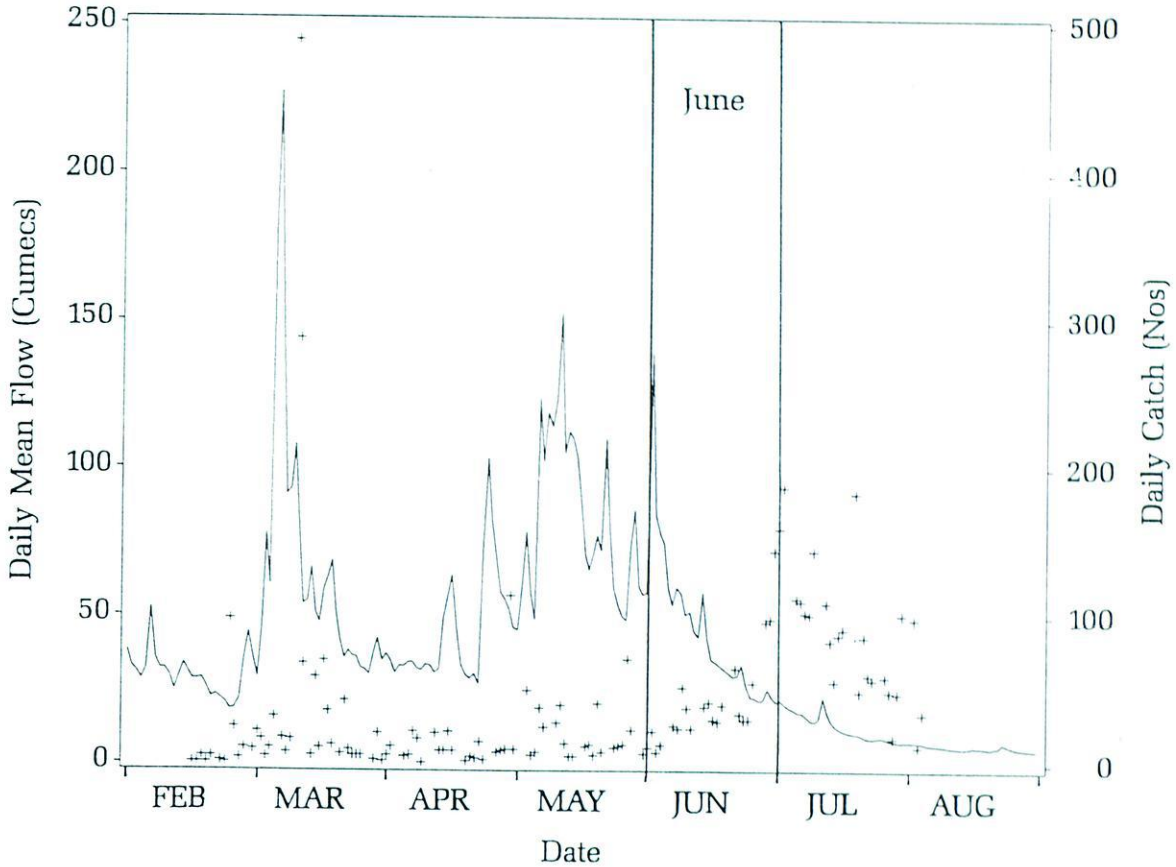


Figure 3. Catch of salmon by all of the fixed engines around the mouth of the River Dee, Aberdeenshire plotted against daily mean flow for each day of the netting season in 1983. The Q98 and Q95 are marked by vertical dotted lines. Data for six days when flows were greater than 80 cumecs and catches were very low have been excluded.

19. In order to reduce the effect of seasonal trends in the analyses, the catch and flow data were examined for each month of the last four years of the fishery (1983-86). Only during June 1983 and 1984 for fixed engines, and during June 1983 for net and coble, was there a clear relationship between catch and flow. This can be attributed to the steadily dropping river flows of June coinciding with the arrival of increasing numbers of grilse during that month, see Figure 4a and b. These two opposite trends produce a strong correlation although they are not necessarily directly related. In contrast, by July when flows have generally fallen to their low summer levels, catches fluctuate with no strong directional trends. It should also be noted that in June 1983 the flow in the River Dee did not drop below 20 cumecs, so all the catches were made at flows greater than the Q70 value.

a. net and coble



b. fixed engine

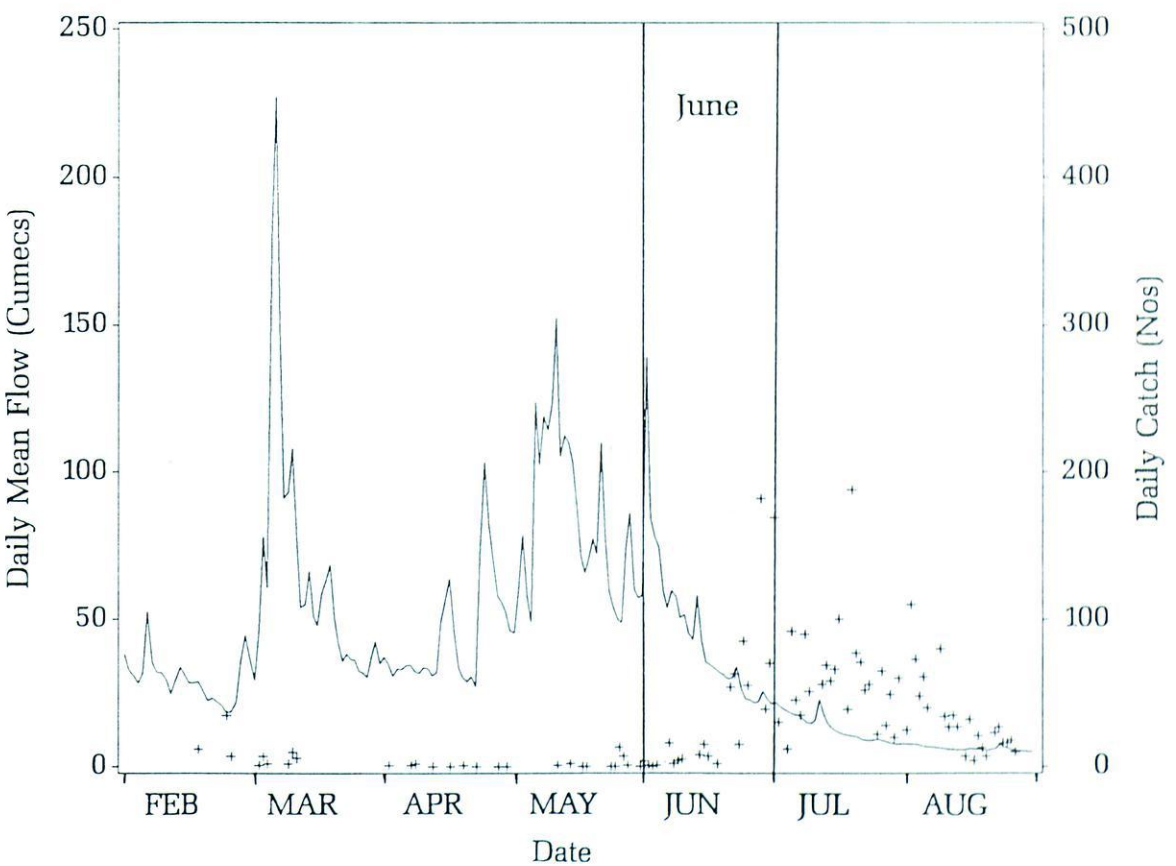
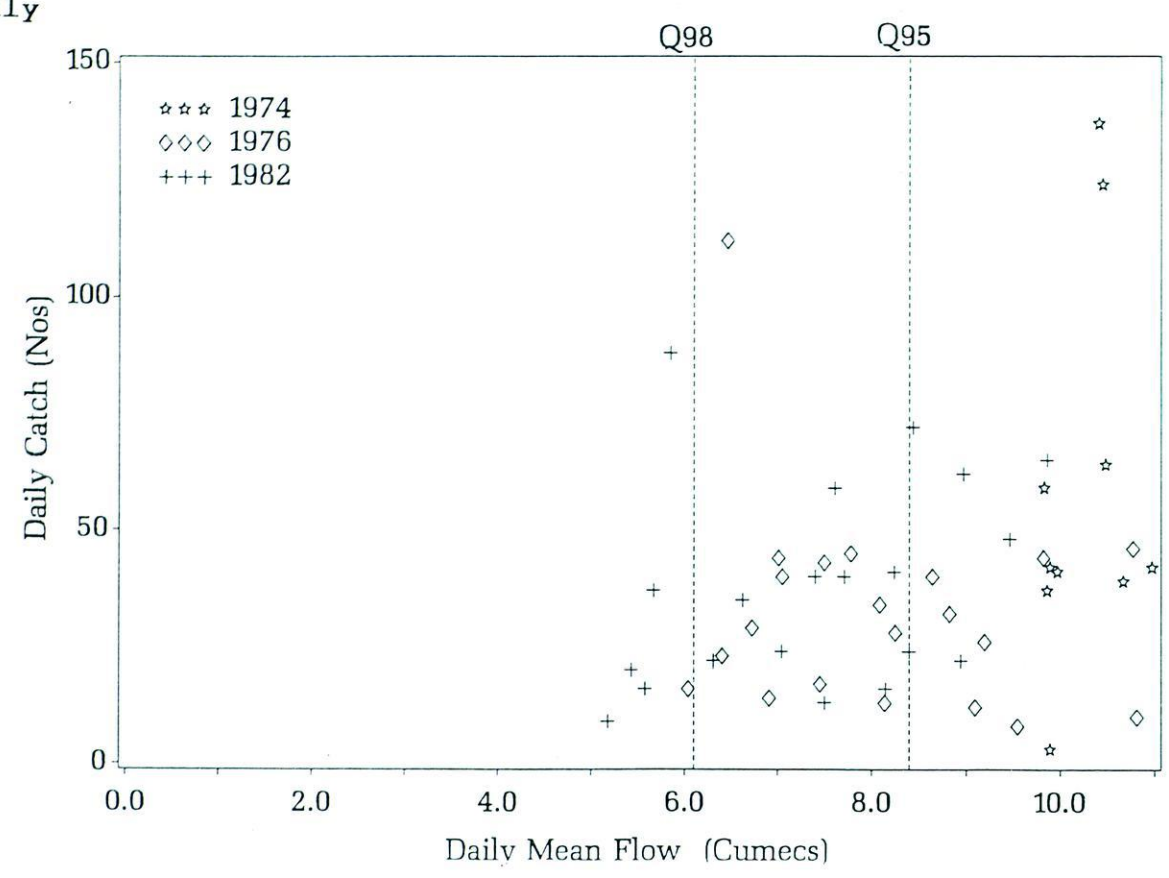


Figure 4. Daily mean flow (—) on the River Dee, Aberdeenshire with daily catches of salmon, excluding zeros, (+) for: **a. the net and coble** and **b. the fixed engine** fisheries in 1983. The beginning and end of June are marked by vertical lines to draw attention to the decrease in flow during that month and the coincident increase in catches. (See paragraph 19 for explanation)

a. July



b. August

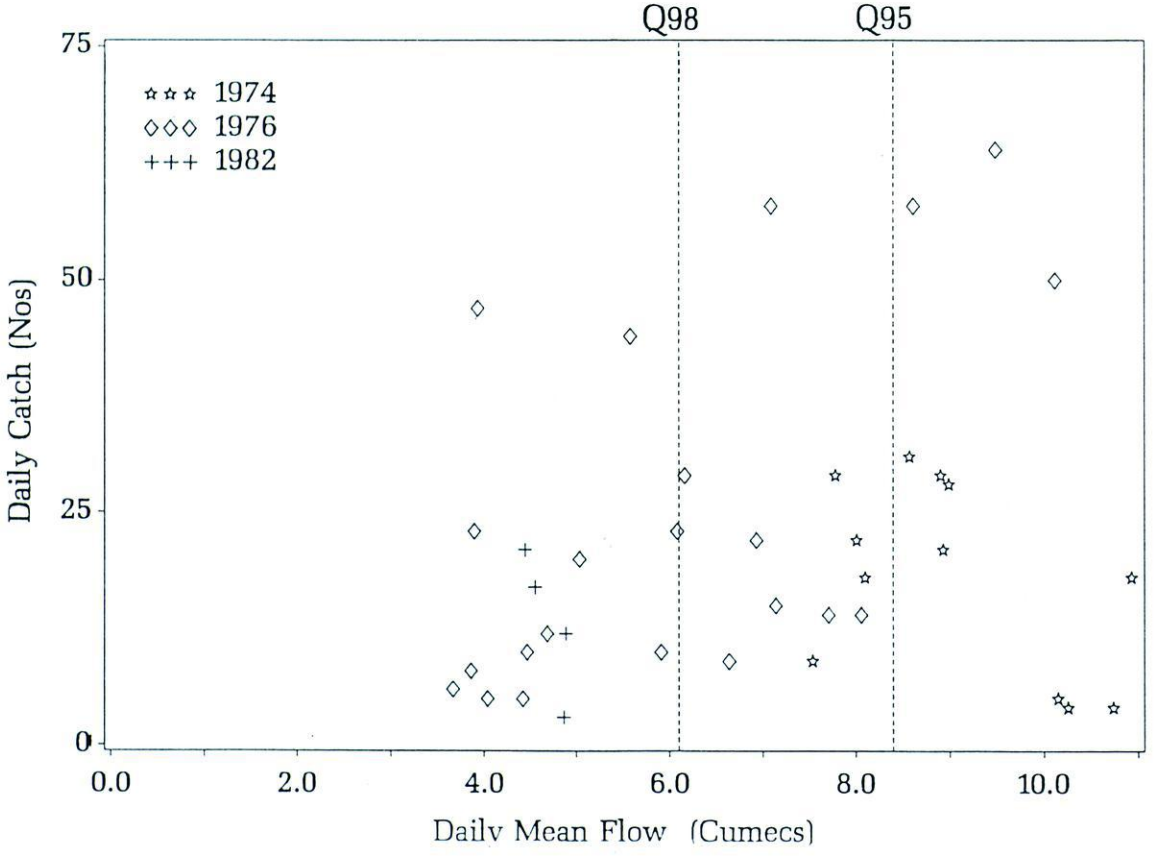


Figure 5. Daily catches of salmon from the 'Horse' fixed engine (River Dee, Aberdeenshire) plotted against daily mean flow in: **a. July** and **b. August** for the years 1974,1976 and 1982. Data for flows greater than 11.0 cumecs (Q90) have been excluded. (See paragraph 20 for explanation)

20. In order to look for changes in catches at particularly low summer flows, below about Q95, the catch for each day in July and August was plotted against the daily mean flow for each of the three dry-summer years, 1974, 1976 and 1982. Data for days when flows exceeded Q90 were excluded to focus attention on the relationship during low flows. There was no discernible pattern of catch in relation to flow except a slight suggestion that at the very lowest flows the catch is reduced. Typical plots are shown in Figure 5 from which it is clear that while high catches occur at times of lower flows there is a wide range of catches under these conditions. A full description of this analysis is given in DAFS Scottish Fisheries Working Paper No. 13/89.

21. The daily catches of salmon and sea trout from the Aberdeen Harbour Board's fishery on the Dee were offered for sale at auction each day. A separate analysis of these data in relation to flow in the Dee for the years 1973-1986 was carried out (Pirie, 1989). There was a suggestion that higher total annual catches of sea trout occurred in years with lower summer flow. For certain years the data were also analysed as described in paragraphs 18-20 for both salmon and sea trout, and in addition, rolling averages of the daily catch figures were compared with the flow figures to detect any correlations. The conclusion from these analyses was that there was no evidence for these net catches being enhanced during times of the lowest river flows.

22. MAFF's Directorate of Fisheries Research analysed the effects of low river flow on declared catches of migratory salmonids in five selected rivers in England and Wales (see paragraph 16). Data for one dry year (1984) were compared with those for one or more normal years (1985-1987) on each river. The five rivers illustrate a range of flow patterns and in two, the Rivers Tywi and Welsh Dee, flows are heavily regulated by variations in abstraction and reservoir releases. On each river the declared net catches of salmon are highest in July or August regardless of the annual flow pattern. As on the Aberdeenshire Dee, this is also the season when flows tend to be low and thus there is a tendency for high catches to be associated with reduced flows (Figure 6). However, there is no indication that salmon catches are enhanced at times of very low flows (eg below Q98) and, for the rivers examined, catches were either unaffected or were less under these conditions (Figure 7). In addition, the relationship between catches and flow was the same on both regulated and unregulated rivers.

23. The Committee also looked at similar data for sea trout in England and Wales. The peak of the net catches in the five rivers examined tended to occur about a month earlier than for salmon and this is probably common to most rivers. Thus the highest catches of sea trout are usually recorded before flows fall to low summer levels, and catches are generally low at times of lowest flows (Figures 8 and 9).

24. For the same five rivers, rod catches of salmon and sea trout often peak about one month after the respective net catches. Rod catches of salmon were generally very poor under low flows but were often fairly good under high flows (Figure 10). Sea trout however may be caught in large numbers during the summer months even when flows are low. The relationship between rod catches of sea trout and flow is thus similar to that for the salmon net fisheries, with catches increasing under low flows, because of coincident seasonal trends, but falling when flows fall to very low levels (Figure 11). A full description of this analysis is being published as a MAFF Fisheries Research Data Report.

25. The analysis of the daily catch and flow data from all the rivers studied indicates that the observed apparent relationship between net catches and flow during the summer arises from coincident seasonal trends in decreasing flows and increasing availability of grilse. There is no evidence in the data to suggest that catches are enhanced during periods of very low flow. On days with flows within the normal summer range, high catches do occur at lower flows but so however does the full range of net catches. There is thus no correlation between catch and flow except that explained by seasonal trends. In all the rivers examined large catches were recorded at a wide range of flows. However, under the lowest flow conditions catches tend to be reduced.

26. The Committee is aware that this conclusion will surprise some. Many people, including anglers, have long thought that during times of very low water flow migratory fish are particularly vulnerable to netting in the estuaries and at the mouths of rivers and that associated high net catches inevitably adversely affect stocks. However, thorough analysis of the data does not support this supposition. The Committee believe that lack of angling success at times of low water is not due to especially large catches being taken by nets at those times but may be related to the fishes' behaviour under these conditions. More information on this may be provided by current research on fish movements.

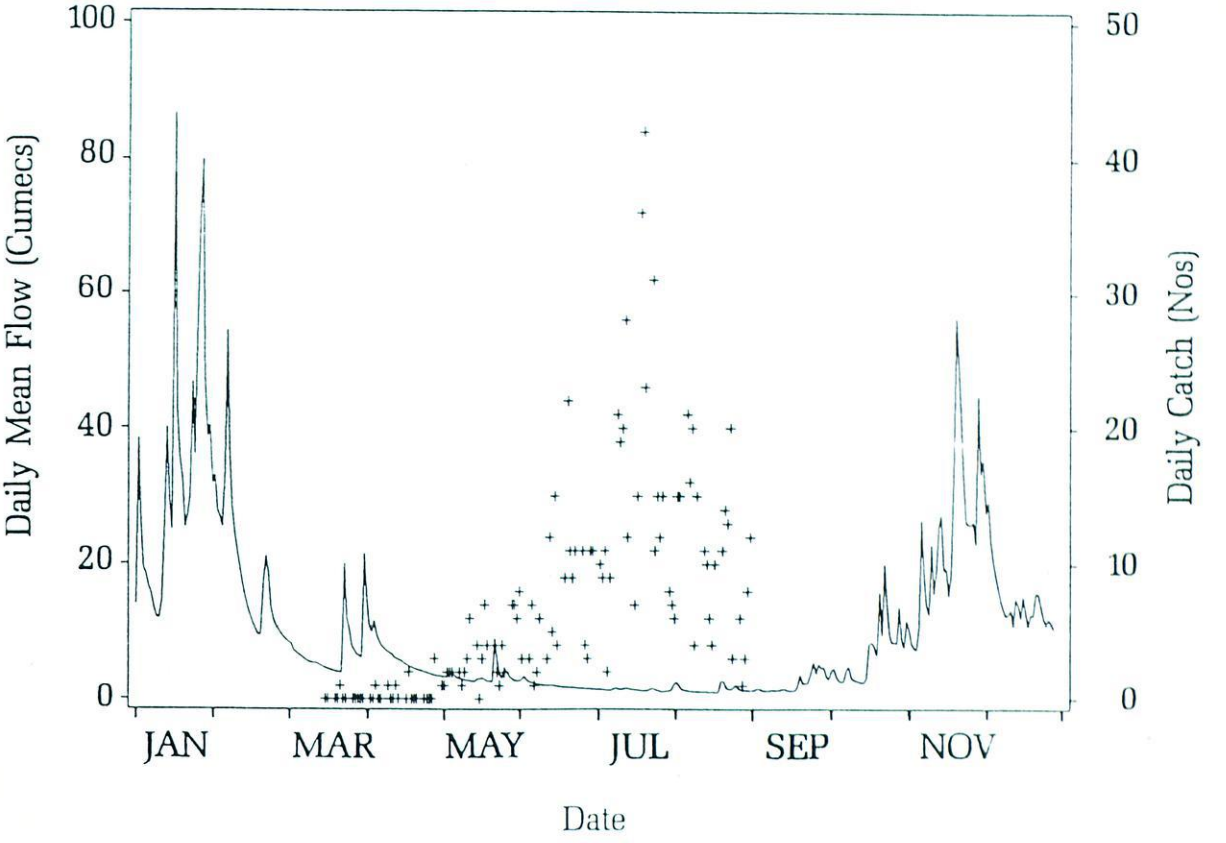


Figure 6. Daily mean flow (—) on the River Teign plotted with daily net catches of salmon (+) for 1984. The line of +'s close together indicates nil catches for most days before the beginning of May.

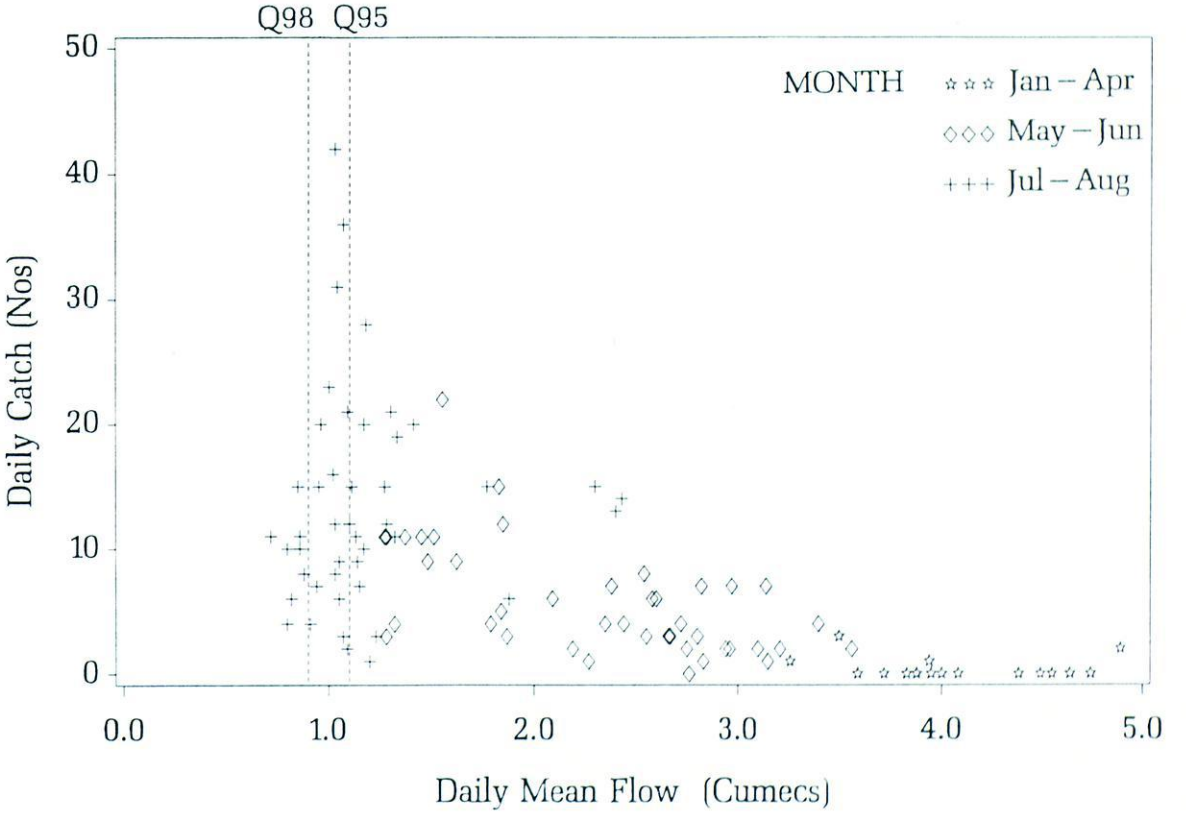


Figure 7. Daily net catches of salmon plotted against daily mean flow for the River Teign for 1984. Data for days when flows were greater than 5.0 cumecs have been ommitted to provide more detail of low flows.

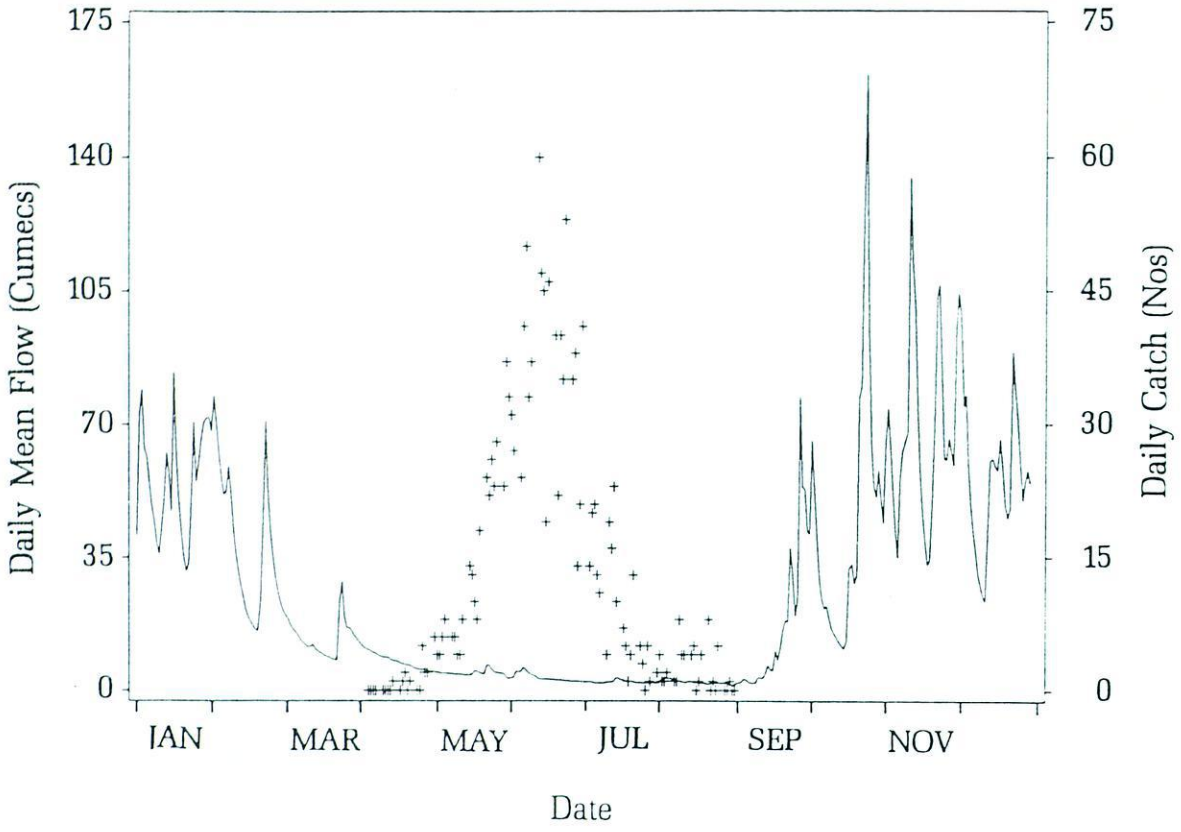


Figure 8. Daily mean flow (—) on the River Teifi plotted with daily net catches of sea trout (+) for 1984.

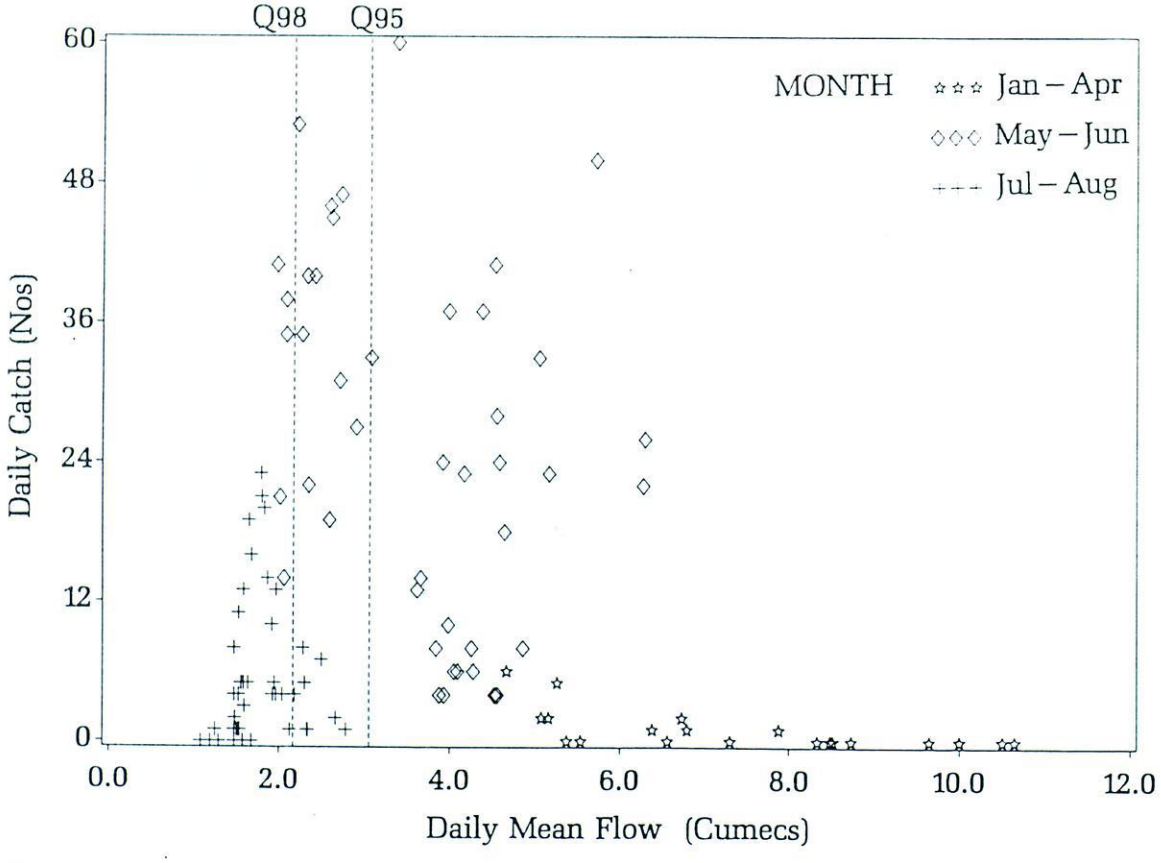


Figure 9. Daily net catches of sea trout plotted against daily mean flow for the River Teifi for 1984.

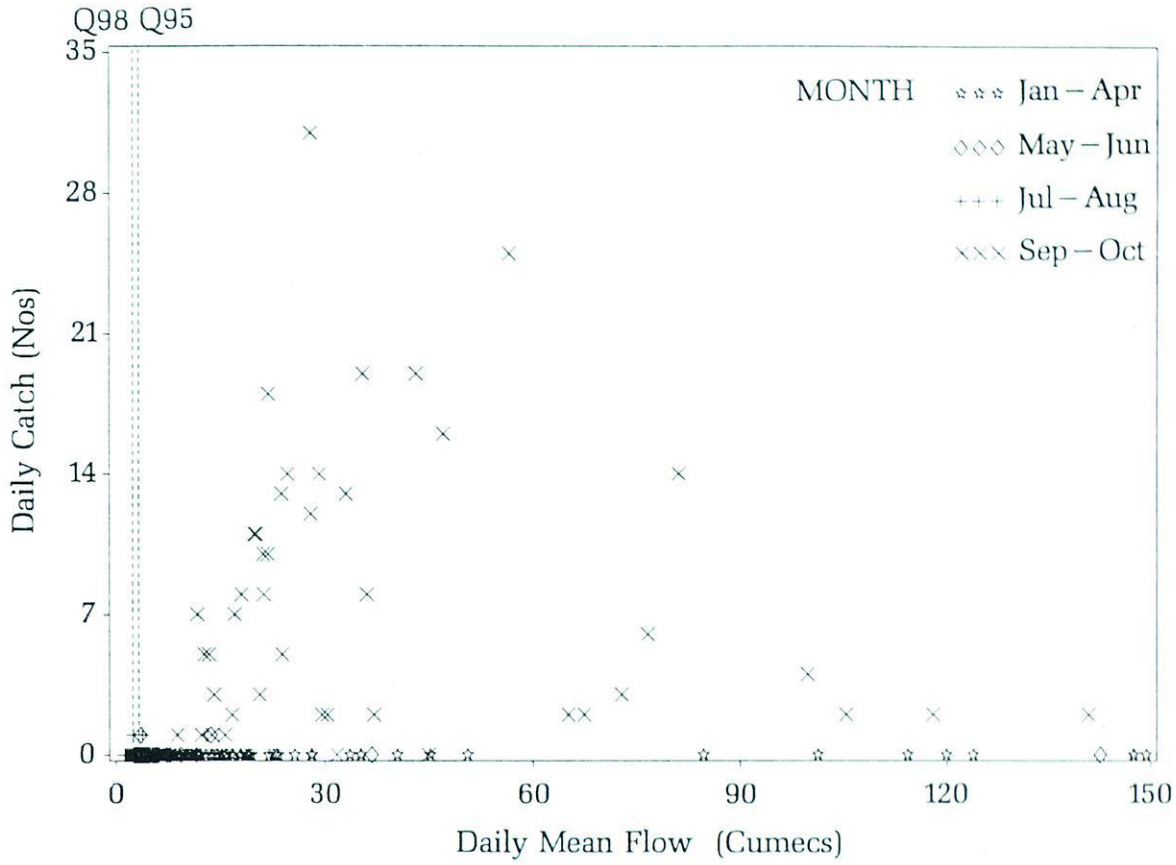


Figure 10. Daily rod catches of salmon plotted against daily mean flow for the River Lune for 1984. The black area indicates a large number of days during the fishing season when flows were low and no salmon were caught.

Salmon Tracking

27. The Fisheries Departments and water authorities have recently undertaken several salmon tracking studies to investigate the movements of salmon (fitted with transmitters) through estuaries and in fresh water. In these studies salmon were rarely observed to remain for long periods in those parts of estuaries subject to netting. Under low flow conditions the fish spent little time there but moved back out to sea until river discharge increased, or they moved quite rapidly through the estuary but remained in the lower reaches of the river. It is likely however that patterns of movements through estuaries will differ widely depending upon local conditions. Tracking studies in rivers have indicated that salmon are most vulnerable to rod fisheries within the first few weeks of entering fresh water, when they are moving up-river. Subsequently, fish may spend long periods, often several months, without moving, and during these periods they are rarely caught. They may later become more vulnerable when they resume their upstream movements. Thus rod fisheries take few salmon in periods of low flow because fish may not be entering rivers or moving upstream while those fish that have entered the river earlier in the year become difficult to catch.

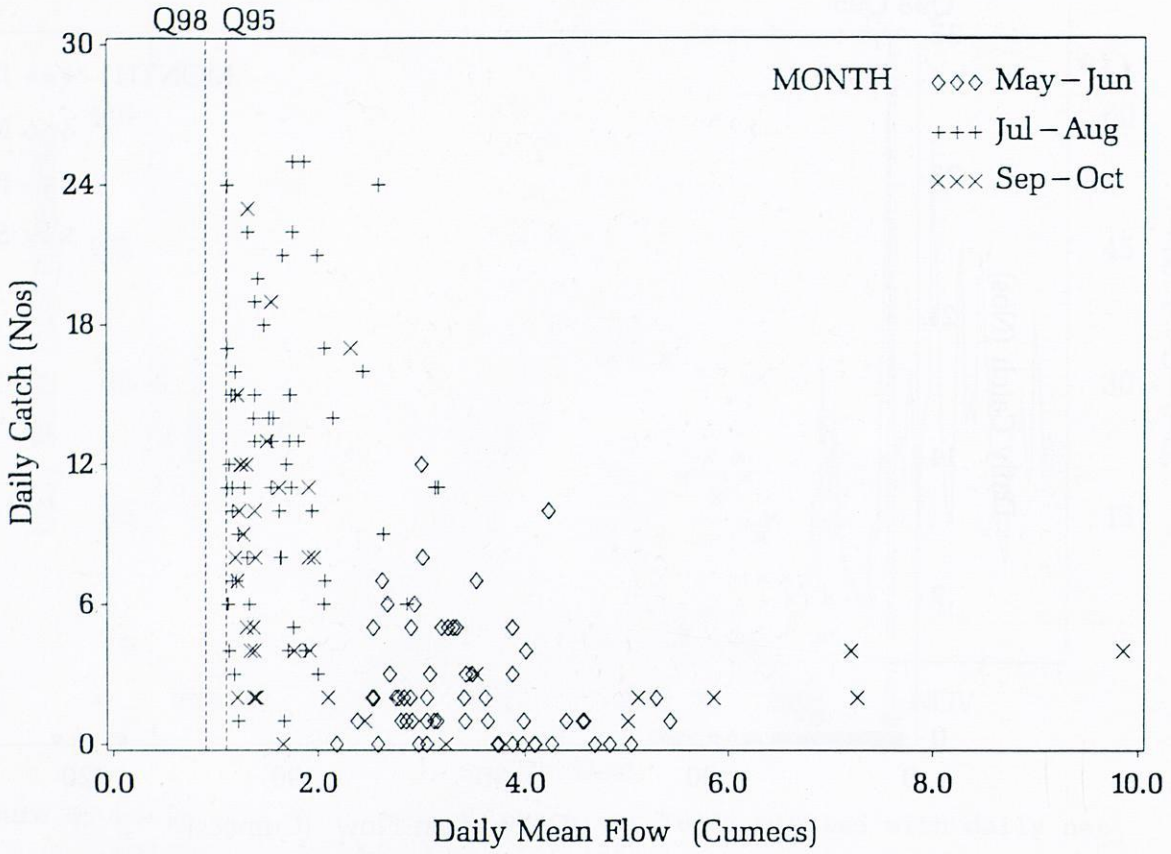


Figure 11. Daily rod catches of sea trout plotted against daily mean flow for the River Teign for 1987. Data for the period prior to May have been omitted to provide more detail of low flows.

Conclusions

28. The Committee have reached the following conclusions.

(i) The effect of fishing at low flows on catches and on stocks can only be addressed on a river by river basis. Having analysed data from six rivers the Committee found no evidence that fishing at times of very low flow results in enhanced catches of salmon by either nets or rods. It is therefore unlikely that there was any adverse effect on stocks.

(ii) There are no data to suggest that the situation is different on other rivers but it is possible that local problems may exist. (Where they are perceived fishermen and fishery managers should collect reliable daily catch and flow data for analysis.)

(iii) For statistical reasons, analyses were not possible for the rivers where only small catches were recorded.

(iv) Given that no evidence was found of enhanced catches at times of lowest flow, it was not necessary to define low flow levels or to consider what steps might be taken to control fishing at times of low flow.

(v) The data so far available from tracking studies are consistent with these conclusions. A better understanding of the behaviour of fish under low flow conditions should result from tracking work.

Acknowledgements

29. The Committee records its gratitude to the scientists in the DAFS Marine Laboratory at Aberdeen and in the MAFF Directorate of Fisheries Research at Lowestoft who undertook the task of collating and analysing the huge amount of data which was required for this study. The Committee would also like to thank the various organisations who agreed to make data available to the Committee for the purposes of this study.

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Salmon Advisory Committee
December 1989

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