USE OF ROD CATCH-EFFORT DATA

TO MONITOR

MIGRATORY SALMONIDS IN WALES

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by

D.A.Bunt

National Rivers Authority
(Welsh Region)
Rivers House
St. Mellons Business Park
Cardiff

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ABSTRACT

Rod catch and effort data for salmon and sea trout were analysed from over 11,600 returns for 57 Welsh rivers for the 1988 season.

Total reported effort was 159,113 visits with a median of 7 visits per angler. Larger rivers (measured as average daily flow, A.D.F.) received greater fishing effort and yielded larger catches than smaller rivers.

CPUE (fish per visit) for the whole region was 0.0582 for salmon and 0.1894 for sea trout, with considerable variation between rivers. CPUE was underestimated as it was not possible to separate fishing effort between salmon and sea trout.

An index of fish abundance (n) is proposed which reduces variability in catch (C) due to flow index (q) and fishing effort (f); $n = C/qf$. Calculation of n allows comparison between rivers in any one year and interyear trends in individual rivers, though more refined use of flow data is recommended to determine q more accurately.

Changes to the method of reporting effort are proposed to allow separation of effort between species for future years, yet maintain comparability with earlier seasons. The issue of log books to season anglers is recommended to increase the quality of catch data.

Detailed analysis of archived and future data is recommended to determine the need to collect effort and flow information, and if it is possible to accurately separate salmon and sea trout effort data.

I. INTRODUCTION

Each year in the Welsh Region of the National Rivers Authority (NRA), over 16000 licences are sold entitling anglers to fish for migratory salmonids, ie. salmon (Salmo salar L.) and sea trout (Salmo trutta L.) in over 57 rivers. Catch records have been collected on most since 1952, though it is only since 1976 that a standardised approach has been adopted.

It has long been recognised that catch data alone are not a reliable measure of the rivers' stocks, and may not even be suitable to indicate trends in catch over the long term (Harris, 1988). Catch per unit effort (CPUE) is widely accepted as a more accurate index of the stock size (Ricker, 1975; Prouzet & Dumas, 1988). Effort data in itself can provide useful information to the Fisheries Manager on the patterns of use of the fisheries resources.

In 1988, in its publication "Information on the Status of Salmon Stocks", the Salmon Advisory Committee stated that information on fishing effort was essential as one of the minimum requirements to monitor salmon stocks, representing a significant advance in the interpretation of catch information.

In Wales, information on fishing effort was not collected on a routine and regional basis until 1984. These data have been archived together with catch data and whilst the latter have been published annually, information on fishing effort has not been analysed. Catch and effort data received from anglers statutory returns for the 1988 season were therefore analysed with the objectives:

1. To present baseline data on effort and CPUE for 1988.
2. To recommend how archived effort data should be analysed and presented.
3. To recommend how future effort data should be collected, analysed and presented.

II. METHOD & MATERIALS

Catch returns are mandatory for salmon and sea trout anglers with information recorded on a form provided with the licence.

Returns were received voluntarily at the end of the fishing season in late October, and following a postal reminder in mid February. The following information was abstracted from each return:

1. No. visits (days or part days fished) to each specified river.
2. No. salmon caught where effort data was specified.
3. No. salmon caught where no effort data was specified.
4. No. sea trout caught where effort was specified.
5. No. sea trout caught where no effort data was specified.

A record was also kept of:

6. The number of returns received for each river where no effort data was specified, whether fish were caught or not.
7. The number of returns where no river was specified.
8. The number of returns that indicated no fishing had taken place.

After collation data were analysed using the "Minitab" statistical computer software package. The Hydrology Dept. supplied river flow data.

III. RESULTS

Returns

	No. Sold	No. Received	% Return	No. with Unknown Rivers	No. with no Fishing
Voluntary		6095	32.9	318	135
Reminder		5519	29.7	561	285
Total	18594	11614	62.5	876	420

Table I. Summary of returns received.

Effort

Total reported visits to rivers ranged from a minimum of 8 on the Soch to 20110 on the Wye, with the total number of visitors to each river ranging from 2 on several rivers to 1825 on the Wye (Table II.) Fishing effort was highly positively skewed; mean visits per angler = 13.87, median = 7. The average river received a mean of 2785 reported visits, median = 1507.

Catch

Total reported catch in 1988 was the highest for salmon since the late 1960's, and the second highest on record for sea trout.

Catch was found to be proportional to effort when data for all rivers were plotted together (Fig. 1) (rivers for which there were less than 20 sets of usable data were excluded). This was a function of the size of the river as those with higher A.D.F. received greater fishing effort (Fig. 2) and yielded higher catches of both salmon and sea trout (Fig. 3). For sea trout, the Wye, Usk and Dee are excluded as it can be reasonably assumed that the vast majority of effort on these rivers is for salmon only.

CPUE

CPUE for salmon and sea trout for each river (Table III.) has been calculated as:

$$\frac{\text{No. fish caught (where effort is specified)}}{\text{No. visits}}$$

CPUE for salmon ranged from 0 on some of the smaller rivers to 0.1361 on the Lledr (a tributary of the Conwy) and for sea trout from 0 on the Kenfig and Rhydhir to 0.6154 on the Gwendraeth Fawr (the latter represents returns from only 11 anglers with 1 angler being particularly successful with 46 fish; CPUE = 1.92). CPUE for the whole region was 0.0582 for salmon (= 17.2 visits per fish) and for sea trout, 0.1894 (= 5.3 visits per fish), omitting the Wye, Usk and Dee.

The frequency distribution of CPUE for all rivers is positively skewed, particularly for salmon, which indicates that sea trout are more widely abundant than salmon, and/or easier to catch.

The plot of salmon CPUE against sea trout CPUE (Fig. 4) is a convenient graphical representation to compare each river for each species. The mean CPUE for salmon and sea trout are shown and the distance of each river point above or below the 45^{o} line represents its 'performance' as a salmon or sea trout fishery. No relationship is implied, but it is interesting to note that very few rivers are 'above average' for both salmon and sea trout.

Catch per return (per visitor) (C/R) has been used in the past as an index of CPUE when true effort data has not been available. There was a significant correlation between C/R and CPUE for both salmon ($p<0.001$, $R^2=0.78$) and sea trout ($p<0.001$, $R^2=0.76$) (Figs. 5,6).

Catchability

River flow is the major stimulus to migration and subsequent capture of migratory salmonids, particularly salmon (Millichamp & Lambert, 1966; Banks, 1969; Alabaster, 1970; Gee, 1980; Clarke & Purvis, 1989). Mean monthly river flow (cumecs) has been calculated for most rivers during the fishing season (February - October for the Wye, Usk and Dee; April - October for all other rivers). Despite being a simple measure, mean flow was found to be significantly correlated with total catch for rivers in 1988 (Fig. 3). For each river a flow index (q) was calculated as the mean monthly flow in 1988 as a % of the long term average during the fishing season. For most rivers q was greater than 100% (mean = 131%) indicating that 1988 was a generally "wet" year in the Welsh Region. Hydrographs indicated that this was due to regular freshets; that for the Usk (Fig. 7) is typical.

To test the suitability of using this flow index for an individual river over a period of time, catch was plotted against q for the River Teifi for the period 1976-1988 (Fig. 8). Salmon catch was significantly correlated with flow index ($p=0.005$, $R^2=0.53$). The correlation for sea trout was less significant ($p=0.066$, $R^2=0.27$).

IV. DISCUSSION

Effort

Fishing effort alone gives very useful information to the fisheries manager on the intensity of fishing and the number of anglers visiting the river.

The mean and median number of visits made by anglers to a river possibly indicate the type of angler utilising the resource. A low number of median visits (eg. Conwy, Dyfi) suggests a high proportion of visiting anglers or short term licence holders whereas a high figure (eg. Neath, Ogmore) suggests the majority of fishing is by local anglers. Anglers close to a fishery are likely to spend less time fishing per trip than those who travel progressively further

(G.W.Mawle, unpublished data; Talhelm, 1976) so total fishing effort in hours may, comparatively, be an overestimate for such rivers in this study.

Catch

The relationship between catch and effort for all rivers (Fig. 1) shows the pattern of use for different rivers in one year. A similar plot over a number of years for each river, when both parameters are likely to vary, will indicate if the rate of exploitation is above or below the point of maximum sustainable yield where the relationship changes from being linear to a plateau (Ricker 1975). This relationship is complicated by factors which may affect stock availability and catchability. However, Mills et al. (1986) found that the highest single determinant of salmon and sea trout catch on Lough Feeagh was fishing effort.

CPUE

Data on CPUE is often obtained from intensive creel surveys of specific, often closely managed fisheries, whilst more extensive studies covering a range of river types are rarer. CPUE for certain rivers is compared with data obtained in other more intensive surveys (Table IV.) In these other surveys fishing effort has been measured in hours so for direct comparison, the mean no. hours per visit found on the Tywi and Conwy (4.75 ± 1.22) has been applied to the other investigations and to the data in this study (this figure is similar to that of 5h for all game anglers (N.O.P., 1971)).

CPUE for both species on the Conwy in this study are within the range recorded in recent years from intensive studies. However, the 1988 figures are higher in the intensive investigation which may be explained by:

1. The intensive survey was targetted at selected regular season anglers who are possibly more successful than the average visitor (Alabaster 1986).
2. Effort was split between the 2 species.

CPUE for the intensive studies on the Tywi and Tawe were also higher than for this investigation, which is probably due again to targetting of angling club members who have better local fishing knowledge. The differential was much higher for sea trout than for salmon which may be explained by the intensive surveys utilising log books to collect data. There is probably less tendency towards undereporting when details of fishing trips are recorded regularly in a specially designed booklet, especially when there is much information to record.

Results for the Wye are lower than those found by Gee (1980), which may be explained by:

1. Many Wye anglers make a nil return, stating that they reported the catch to the fishery owner
2. The calculated mean length of each visit may be an underestimate for the Wye (many visiting anglers fish the Wye).

The Dyfi is conspicuously above average in comparison to other rivers for both salmon and sea trout (Fig. 4). This may be due to being truly productive for both species, and/or having very strict rules and limited membership in the local angling association.

Catchability

Gulland (1969) expressed catch (C) as:

$$C = f\ q\ N/A$$

where q = a constant expressing catchability

f = fishing effort

N = abundance of stock

A = area inhabited by stock

Catchability of migratory salmonids is affected by many factors including water temperature, skill of anglers, method used (Gee, 1980; Alabaster, 1986), stock composition (Shearer, 1988) weather conditions (Mills et al. 1986) and river flow (Millichamp & Lambert, 1966; Alabaster, 1970; Gee, 1980). Flow is the most important factor (Mills et al., 1986) and is certainly the most easily measured.

Whilst many authors have associated migration and capture with optimum flow regimes it is only recently that increased catchability (of salmon) per se, as opposed to mere availability, has been demonstrated to be linked with changes in flow (Clarke & Purvis, 1989). Essentially, salmon are more catchable in the 10 - 14 days following entry into freshwater, and freshets stimulate entry when fish are available.

Millichamp & Lambert (1966) described optimum flow ranges for migration and capture of salmon on the Usk. In the absence of similar information for all Welsh rivers, a simple measure of flow, the % of the long term average during the fishing season (flow index) is proposed as an index of catchability. Whilst this has been demonstrated to have had some success, river flow is not adequately described by a mean value (Alabaster, 1970). Flow variability is a more important factor (Banks, 1969; Clarke & Purvis, 1989).

As experienced anglers are receptive to suitable fishing conditions, it is possible that effort alone may be found to be correlated with catchability. In the 1989 drought year, Water Bailiffs reported that anglers were met far less frequently on the river than in 1988 when flows were higher.

Abundance

Fishery managers ultimately wish to know accurately stock abundance. In the absence of direct counting methods (counters, traps) for migratory salmonids on most rivers, abundance can only be estimated for those fish that are available during the fishing season.

Working from the assumptions that fishing effort and catchability do not vary between years, rod catch has been used as the adult abundance rating (Dempson, 1980). Such constancies cannot be assumed as effort over the long term has increased considerably with increased popularity of angling (Gee & Milner, 1980; Harris, 1988) whilst marked short term variations are attributable to differences in weather and fishing conditions between each year. There has been considerable variation in the mean visits per angler for each season on the Conwy in recent years (Davidson, 1989). However, in several cases a reasonable balance between rod catch and stock abundance has been observed (Elson, 1974; Chadwick, 1982).

Based on the single assumption that vulnerability is constant between years, CPUE has been widely used as an abundance rating of migratory salmonids (Cousens <u>et al.</u>, 1982; Prouzet & Dumas, 1988). Unless it can be demonstrated that effort is an accurate index of catchability, some consideration of catchability must be made.

If, in Gulland's equation, N/A is replaced by n, an index of abundance then:

$$n = C/qf$$

which reduces variability in catch that may be attributable to effort and flow. Although flow variability is less important for sea trout migration than for salmon (Banks, 1969; Purvis & Clarke, 1990), and techniques for sea trout angling often differ to those for salmon, n has been applied to sea trout, as well as salmon for comparative purposes only (Fig. 9).

Observing trends in the abundance index may then be more meaningful than those in CPUE or catch. By examining this parameter over a number of years where stock abundance can be measured accurately by traps or counters it may be possible to establish a relationship between n and total stock.

Collection, analysis and presentation of data - past & future

It is recommended that in the Welsh Region summary catch-effort data for all rivers should be presented as demonstrated in tables II. and III., and included in the annual catch statistics publication.

Ideally it should be possible to identify effort separately for salmon and sea trout fishing. This would enable calculation of actual CPUE for each species. Trends only may be identified when combined effort is utilised, and this assumes that the proportion of effort for each species in mixed stock fisheries does not vary. It is therefore recommended that the method of reporting effort should be expanded to request from anglers:

1. No. visits fished for salmon only
2. No. visits fished for sea trout only
3. No. visits fished for both species at the same time

Thus 1. + 3. = visits for salmon

and 2. + 3. = visits for sea trout

which has been used with some success on the Conwy (Davidson, 1989).

There are potential problems with this method. For example, it is possible to catch either species utilising methods usually applied for the other. However, 1. + 2. + 3. = total visits for salmon and sea trout which allows comparison with data where effort is combined. This has been implemented as from the 1990 season.

Log books should be issued to season anglers so that they are able to record this and other information more accurately so that fewer returns are based on recollection alone (Wightman, 1987; W.W.A., 1987). A trial log book scheme to test if more accurate information is received has been implemented in the 1990 season.

By using visits as the unit of effort it is assumed that the mean hours per visit by an angler is constant. Whilst this may be true for the Region between years, there are likely to be differences between rivers. Total hours fished would be more accurate and would improve comparability with intensive studies. The issue of log books would be imperative to accurately collect this information.

Flow data should be closely analysed on a regular basis where available for the monitored rivers. A more accurate index of catchability based on flow variability and the number of flow days within the optimum flow range for angling catch should be calculated. Calculation of the abundance index may then be refined in which interyear trends should be observed.

Ultimately, it should be possible to measure n on a monthly basis, though this would require monthly effort data which is logistically difficult to collect using current reporting methods.

By applying these statistics to models formulated by Beverton & Holt (1957) and Ricker (1975) it may be possible to estimate the size of parental stock which maximises catches catches in the long term, which is the ultimate aim of the fishery manager (Prouzet & Dumas, 1988). However, such models have been developed for commercial fisheries where CPUE has economic constraints and catchability is determined primarily by efficiency of the gear. In sport fisheries CPUE is affected by anglers' psychology and catchability is determined largely by fishing conditions.

Analysis of data in future years will determine:

1. If it will be possible to effectively separate fishing effort between salmon and sea trout.
2. If it is necessary to consider catchability.
3. If it is necessary to collect effort data.

Collection of catch and effort data requires rationalisation nationally now that responsibility to monitor inland fisheries in England and Wales lies with one organisation.

V. RECOMMENDATIONS SUMMARY

1. Effort data should be separated between salmon and sea trout fishing on a trial basis. Analysis of future returns will assess the feasibility of this method.
2. Catch and effort data should be presented as in tables II. and III. In future years additional information will report catch and effort data separately for salmon, sea trout and both species. Combined data should also be presented to allow comparison with previous years.
3. Log books should be issued to all season licence holders on an annual basis, particularly if the trial yields favourable results.
4. Consideration should be made to gain information on hours fished. This task would be easier and the information more accurate with the use of log books.
5. Consideration should be given to obtaining catch-effort data on a monthly basis.
6. The Flow Index requires refinement according to the number of flow days within an optimum flow range for catch and the flow frequency factor for each river. Results from tracking investigations and other studies would be of use to these calculations. It may be necessary to bias this estimation of catchability (q) in periods of the season when runs of fish are greater.
7. Abundance index should be calculated annually using $n=C/qf$ for each species in each river.
8. Interyear trends for each river should be analysed in catch, effort, CPUE, and abundance index.
9. Catch should be plotted against effort to possibly give an estimation of MSY.
10. On rivers with direct counting facilities such as the Usk and Dee, the relationship between run size and abundance index should be examined.

11. Output in terms of total catch and CPUE can be presented in relation to a) flow and b) available catchment area, to compare yield of each river in relation to its size.

12. The relationship between effort and catchability should be examined over time. If found to be closely correlated, flow index need not be calculated thereafter.

The views expressed in this report are those of the author only, and do not necessarily reflect those of the National Rivers Authority.

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A similar paper will be presented at the Humberside Institute of International Fisheries Studies symposium on "Catch-Effort Sampling Techniques and their Application in Freshwater Fisheries Management", 2-6 April 1990.

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VIII. TABLES & FIGURES

RIVER	ABBREV-IATION	VISITORS WITH EFFORT	No. VISITS	MEDIAN VISITS PER ANGLER	MEAN VISITS PER ANGLER	VISITORS NO EFFORT	TOTAL VISITORS	% NO EFFORT
ABER	AB	15	65	3.0	4.33	2	17	11.8
AERON	AE	79	1507	10.0	19.08	20	99	20.2
AFAN	AF	60	1372	15.0	22.78	12	72	16.7
ALWEN	AL	19	91	2.0	4.78	6	25	24.0
ARTH	AR	15	225	10.0	15.00	5	20	25.0
ARTRO	AT	60	785	6.0	13.08	5	65	7.7
E.CLEDDAU	EC	148	1908	10.0	12.89	19	167	11.4
W.CLEDDAU	WC	123	2794	14.0	22.71	18	141	12.8
CLWYD	CL	279	4521	10.0	16.20	37	316	11.7
CONWY	CN	322	3747	4.0	11.64	54	376	14.4
COTHI	CO	480	4234	5.0	8.82	75	555	13.5
DEE	DE	853	11211	6.0	13.14	102	955	10.7
DULAS	DL	2	16	8.0	8.00	0	2	0.0
DULAS N.	DN	37	277	4.0	7.49	3	40	7.5
DULAS S.	DS	29	267	5.0	9.21	6	35	17.1
DYFI	DF	570	4470	4.0	7.84	74	644	11.5
DYSYNNI	DY	157	2071	6.0	13.19	19	176	10.8
DWYFACH	DC	24	180	6.5	7.50	4	28	14.3
DWYFAWR	DR	283	3430	6.0	12.12	32	315	10.2
DWYRYD	DD	62	1291	10.0	20.82	12	74	16.2
EDEN	ED	10	146	6.5	14.60	3	13	23.1
ELWY	EL	257	3102	8.0	12.07	24	281	8.5
ERCH	ER	31	388	10.0	12.52	4	35	11.4
EWENNY	EW	37	810	11.0	21.89	1	38	2.6
GLASLYN	GL	184	2192	5.0	11.91	39	223	17.5
GWAUN	GW	8	148	13.0	18.50	0	8	0.0
GW.FACH	GC	73	1233	10.0	16.89	9	82	11.0
GW.FAWR	GR	11	130	8.0	11.82	3	14	21.4
GWILI	GI	135	1656	8.0	12.27	38	173	22.0
GWYRFAI	GF	26	283	7.5	10.88	10	36	27.8
KENFIG	KE	2	9	4.5	4.50	0	2	0.0
LERI	LE	3	22	4.0	7.33	1	4	25.0
LLEDR	LD	103	955	5.0	9.27	13	116	11.2
LLUGWY	LG	18	176	4.0	9.78	5	23	21.7
LOUGHOR	LO	133	2965	12.0	22.29	22	155	14.2
LLYFNI	LF	86	1147	7.5	13.33	12	98	12.2
MAWDDACH	MA	515	5543	5.0	10.74	75	590	12.7
NEATH	NE	94	2392	16.0	25.44	16	110	14.5
NEVERN	NV	108	1713	8.0	15.86	16	124	7.9
OGWEN	OW	78	1889	17.0	24.22	15	93	16.1
OGMORE	OM	137	3257	12.0	23.77	37	174	21.3
RHEIDOL	RH	178	2821	6.0	15.85	26	204	12.7
RHYDHIR	RD	6	36	5.0	6.00	0	6	0.0
RHYMNEY	RM	2	86	43.0	43.00	0	2	0.0
SEIONT	SE	199	3245	8.0	16.30	26	225	20.8
SOLVA	SL	2	27	13.5	13.50	0	2	0.0
SOCH	SC	2	8	4.0	4.00	0	2	0.0
TAF	TA	161	2804	9.0	17.41	44	205	21.5
TAFF	TF	69	1542	10.0	22.35	7	76	9.2
TAWE	TW	182	2616	10.0	14.37	26	208	12.5
TEIFI	TE	1298	18357	7.0	14.14	183	1481	12.4
TYWI	TY	1184	20102	10.0	16.98	220	1404	15.7
USK	US	587	9208	7.0	15.69	68	655	10.4
WNION	WN	166	1672	5.5	10.07	17	183	9.3
WYE	WY	1601	20110	6.0	12.56	224	1825	12.3
WYRE	WR	17	214	6.0	12.59	2	19	10.5
YSTWYTH	YS	96	1025	5.0	10.68	23	119	19.3
OTHERS		23	341	10.0	14.82	4	27	14.8
UNKNOWN		28	281	4.5	10.00	796	824	96.6
TOTAL/OVERALL		11468	159113	7.0	13.87	2513	13981	18.0
MEAN PER RIVER		200	2785		14.14	43.3	230	14.4
MEDIAN PER RIVER		86	1507		13.08	15.0	99	12.5

Table 2. Summary of Effort Data for all Rivers.

RIVER	SALMON WITH EFFORT	SEA TROUT WITH EFFORT	CPUE SALMON	CPUE SEA TROUT	TOTAL SALMON PER VISITOR	TOTAL SEA TROUT PER VISITOR	MEAN FLOW CUMECS	FLOW INDEX (%)	SALMON ABUND. INDEX (ns)	SEA TRT ABUND. INDEX (nt)
ABER	0	2	0.0000	0.0307	0.06	0.23	-	-	-	-
AERON	28	857	0.0186	0.5687	0.53	10.42	-	-	-	-
AFAN	1	176	0.0067	0.1283	0.01	2.97	-	-	-	-
ALWEN	12	0	0.1319	0.0000	0.72	0.08	3.98	109	12.10	0.00
ARTH	2	70	0.0089	0.3111	0.20	3.95	-	-	-	-
ARTRO	6	173	0.0076	0.2204	0.09	3.29	-	-	-	-
E.CLEDDAU	55	542	0.0288	0.2841	0.49	4.37	5.10	142	2.03	2.00
W.CLEDDAU	46	410	0.0165	0.1467	0.43	3.50	-	-	-	-
CLWYD	111	584	0.0246	0.1292	0.44	2.20	3.29	109	2.26	11.85
CONWY	412	251	0.1099	0.0670	1.41	1.15	15.70	127	8.65	5.28
COTHI	159	1059	0.0376	0.2501	0.46	2.34	8.15	123	3.06	20.33
DEE	743	100	0.0663	0.0089	1.05	0.15	36.95	109	6.08	0.82
DULAS	0	9	0.0000	0.5625	0.00	6.00	-	-	-	-
DULAS N.	6	84	0.0217	0.3032	0.18	2.10	-	-	-	-
DULAS S.	3	94	0.0112	0.3521	0.11	4.01	-	-	-	-
DYFI	401	1608	0.0897	0.3597	0.97	3.69	18.50	129	6.81	27.88
DYSYNNI	25	332	0.0121	0.1603	0.19	2.26	4.18	115	1.05	13.94
DWYFACH	6	30	0.0333	0.1667	0.21	1.79	-	-	-	-
DWYFAWR	79	1496	0.0230	0.4362	0.30	5.37	1.99	102	2.25	42.76
DWYRYD	27	163	0.0209	0.1263	0.80	2.82	-	-	-	-
EDEN	5	19	0.0343	0.1301	0.92	1.85	-	-	-	-
ELWY	114	325	0.0368	0.1045	0.51	1.35	1.90	109	3.38	9.59
ERCH	1	39	0.0026	0.1005	0.03	1.11	-	-	-	-
EWENNY	0	86	0.0000	0.1062	0.00	2.45	1.96	117	0.00	9.08
GLASLYN	45	484	0.0205	0.2208	0.38	3.52	5.10	105	1.95	21.03
GWAUN	1	40	0.0068	0.2703	0.13	5.10	0.82	148	0.46	18.26
GW.FACH	3	563	0.0024	0.4566	0.05	8.40	-	-	-	-
GW.FAWR	4	80	0.0308	0.6154	0.14	6.21	-	-	-	-
GWILI	16	686	0.0097	0.4143	0.13	5.85	4.02	155	0.63	26.73
GWYRFAI	19	44	0.0671	0.1555	1.00	1.47	1.55	88	7.65	17.63
KENFIG	0	0	0.0000	0.0000	3.50	0.00	-	-	-	-
LERI	0	4	0.0000	0.1818	0.00	2.00	1.50	131	0.00	13.88
LLEDR	130	34	0.1361	0.0366	1.53	0.29	-	-	-	-
LLUGWY	9	6	0.0511	0.0341	1.09	0.61	-	-	-	-
LOUGHOR	17	344	0.0057	0.1160	0.17	2.63	2.41	190	0.30	6.10
LLYFNI	39	458	0.0340	0.3993	0.55	8.19	-	-	-	-
MAWDDACH	206	1033	0.0372	0.1864	0.54	2.16	-	-	-	-
NEATH	33	468	0.0138	0.1957	0.47	5.14	7.80	104	1.33	18.82
NEVERN	26	695	0.0152	0.4057	0.31	7.89	-	-	-	-
OGWEN	123	105	0.0651	0.0556	2.12	1.38	-	-	-	-
OGMORE	27	529	0.0083	0.1624	0.22	5.06	6.56	150	0.55	10.83
RHEIDOL	63	655	0.0223	0.2322	0.62	4.01	-	-	-	-
RHYDHIR	2	0	0.0556	0.0000	0.50	0.17	-	-	-	-
RHYMNEY	0	14	0.0000	0.1628	0.00	7.00	4.40	143	0.00	11.38
SEIONT	240	398	0.0740	0.1227	1.36	2.17	3.30	95	7.78	12.90
SOLVA	0	6	0.0000	0.2222	0.00	7.00	-	-	-	-
SOCH	0	0	0.0000	0.0000	0.00	0.00	-	-	-	-
TAF	114	243	0.0407	0.0867	0.80	2.42	6.01	160	2.54	5.42
TAFF	101	194	0.0655	0.1258	1.50	2.74	16.10	159	4.12	7.91
TAWE	58	452	0.0222	0.1728	0.44	2.52	14.07	179	1.24	9.65
TEIFI	1251	2650	0.0684	0.1443	1.28	2.40	20.20	141	4.85	10.23
TYWI	765	3310	0.0381	0.1647	0.84	3.44	31.30	159	2.40	10.36
USK	1114	41	0.1210	0.0045	2.11	0.09	25.65	130	9.31	0.35
WNION	26	188	0.0156	0.1124	0.19	1.36	-	-	-	-
WYE	2547	15	0.1267	0.0007	2.15	0.03	48.00	149	8.50	0.05
WYRE	1	2	0.0047	0.0094	0.26	5.32	-	-	-	-
YSTWYTH	40	302	0.0390	0.2946	0.47	3.67	4.45	113	3.45	26.07
OTHERS	0	62	0.0000	0.1818	0.00	3.19	-	-	-	-
UNKNOWN	0	12	0.0000	0.0427	0.02	0.19	-	-	-	-
TOTAL	9262	22626	0.0582	0.1422	1.20	2.74	-	-	4.44	10.85
MEAN PER RIVER		-	0.0340	0.1896	0.61	3.32	10.52	131	3.61	12.80
MEDIAN PER RIVER		-	0.0220	0.1603	0.44	2.69	5.10	129	2.40	10.83
MINUS DEE, USK, WYE										
TOTAL/ OVERALL		22470	-	0.1894	-	3.61	-	-	-	14.46
MEAN PER RIVER		-	-	0.2001	-	3.15	7.47	131	-	14.23
MEDIAN PER RIVER		-	-	0.1626	-	2.52	4.43	128	-	11.61

Table 3. Summary of Catch-Effort Data for all Rivers.

RIVER	SOURCE	YEAR	SALMON CPUE	SEA TROUT CPUE
Tywi	(Clarke, Unpub.)	1985	0.0533	0.3676
Tywi	(Clarke, Unpub.)	1986	0.0565	0.5814
Tywi	(Present study)	1988	0.0381	0.1647
Tawe	(Wightman, 1987)	1986	0.0365	0.0526
Tawe	(Present study)	1988	0.0222	0.1728
Wye	(Gee, 1980)	1977	0.2138	N/A
Wye	(Present study)	1988	0.1267	(0.0007)
Conwy	(Davidson, 1989)	1982	0.3100	0.1470
Conwy	(Davidson, 1989)	1983	0.0930	0.0410
Conwy	(Davidson, 1989)	1984	0.0530	0.0420
Conwy	(Davidson, 1989)	1986	0.1600	0.0860
Conwy	(Davidson, 1989)	1987	0.0970	0.0670
Conwy	(Davidson, 1989)	1988	0.1760	0.0900
Conwy	(Present study)	1988	0.1099	0.0670

Table IV. Comparison of CPUE between rivers in the present study and those studied intensively in recent years.

Figure 1. Relationship Between Catch and Effort for each River.

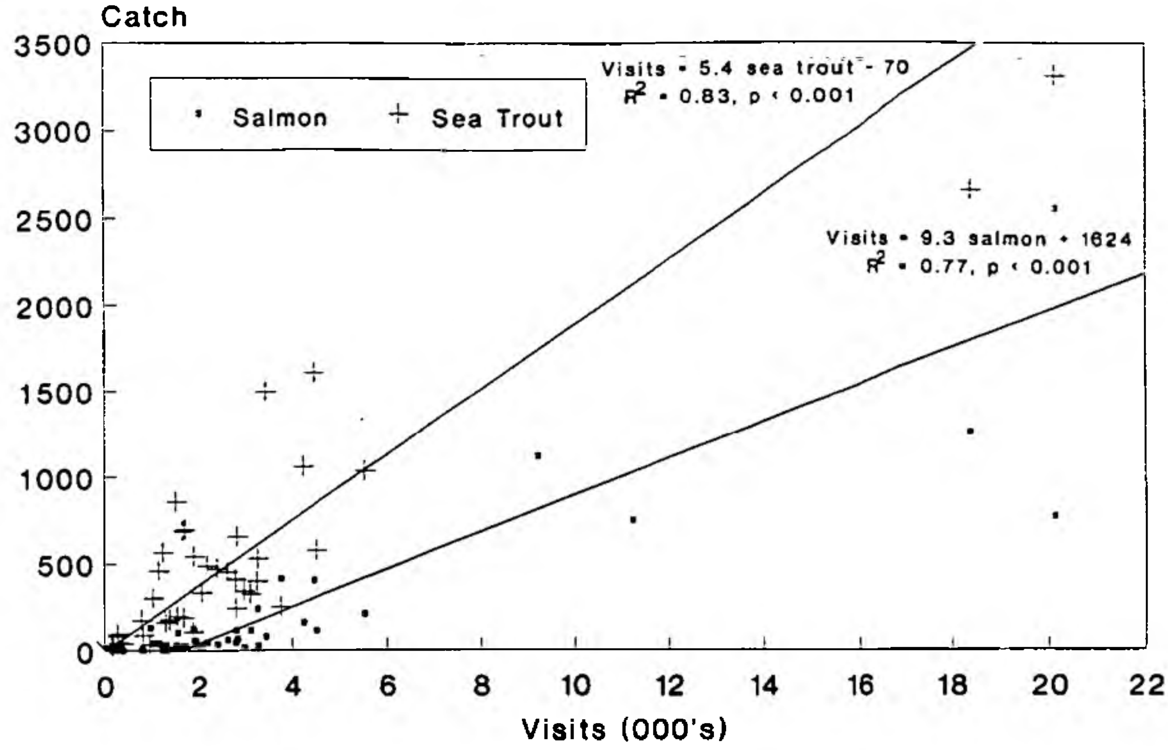

Figure 2. Distribution of River Flow (Cumecs) and Effort Various Rivers 1988

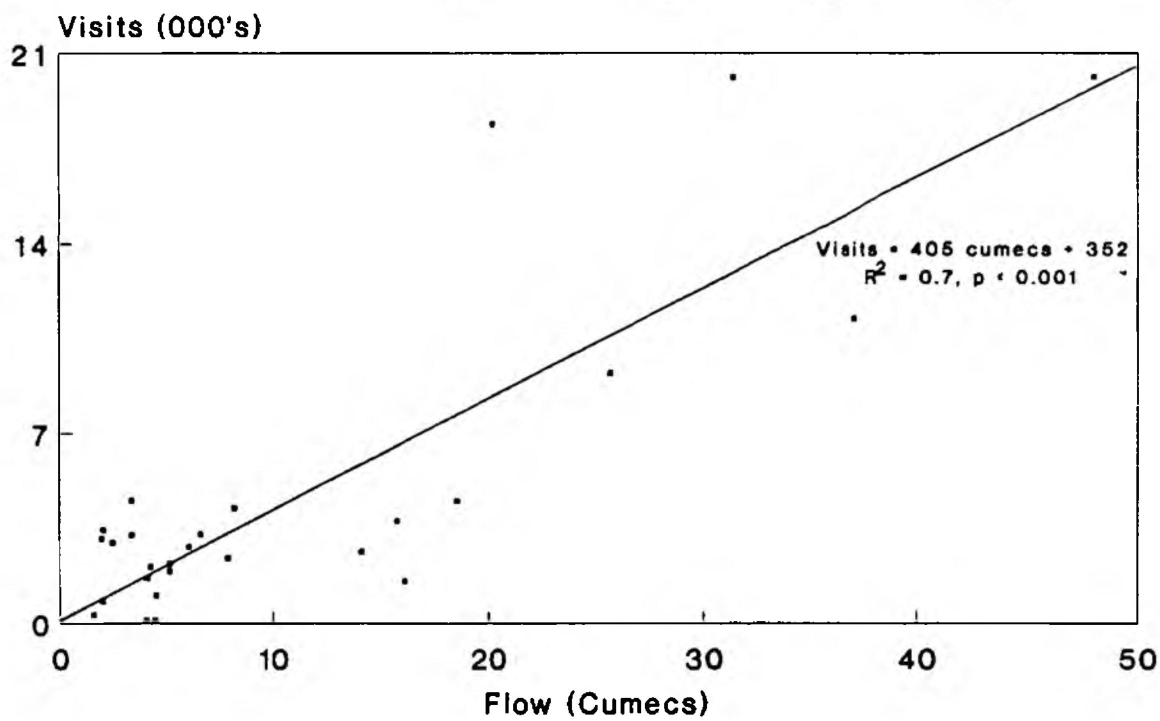

Figure 3. Relationship Between River Flow (Cumecs) and Catch Various Rivers 1988

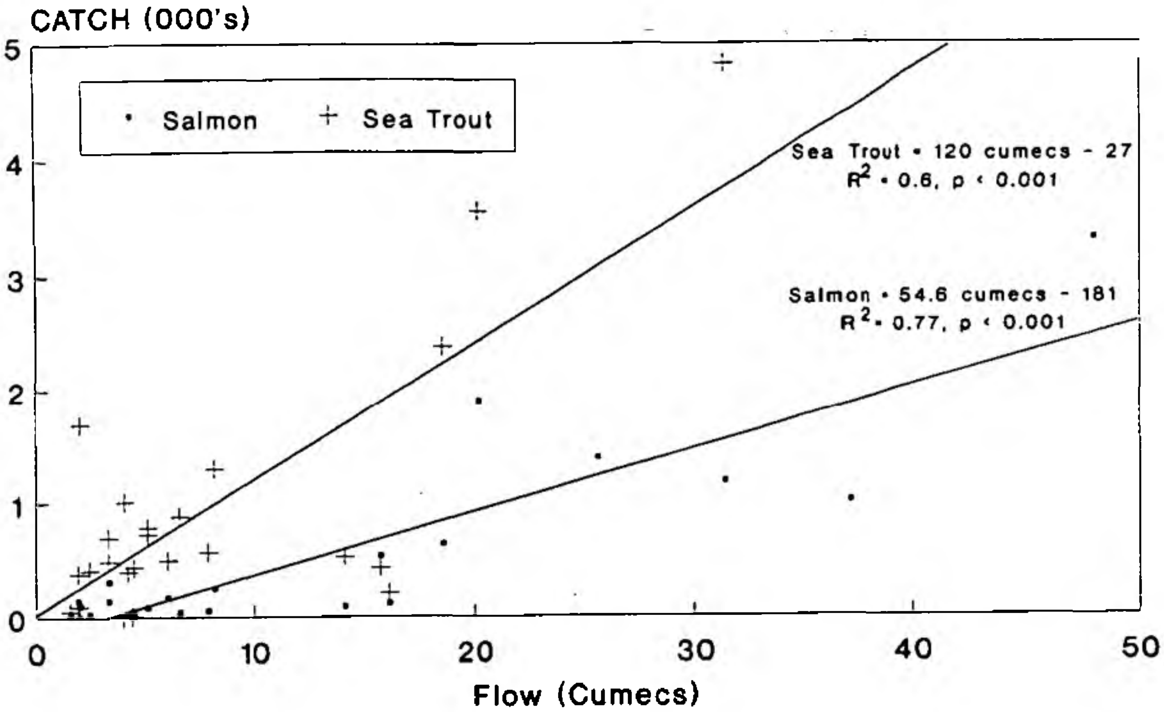

Figure 4. Distribution of Salmon and Sea Trout CPUE for each River

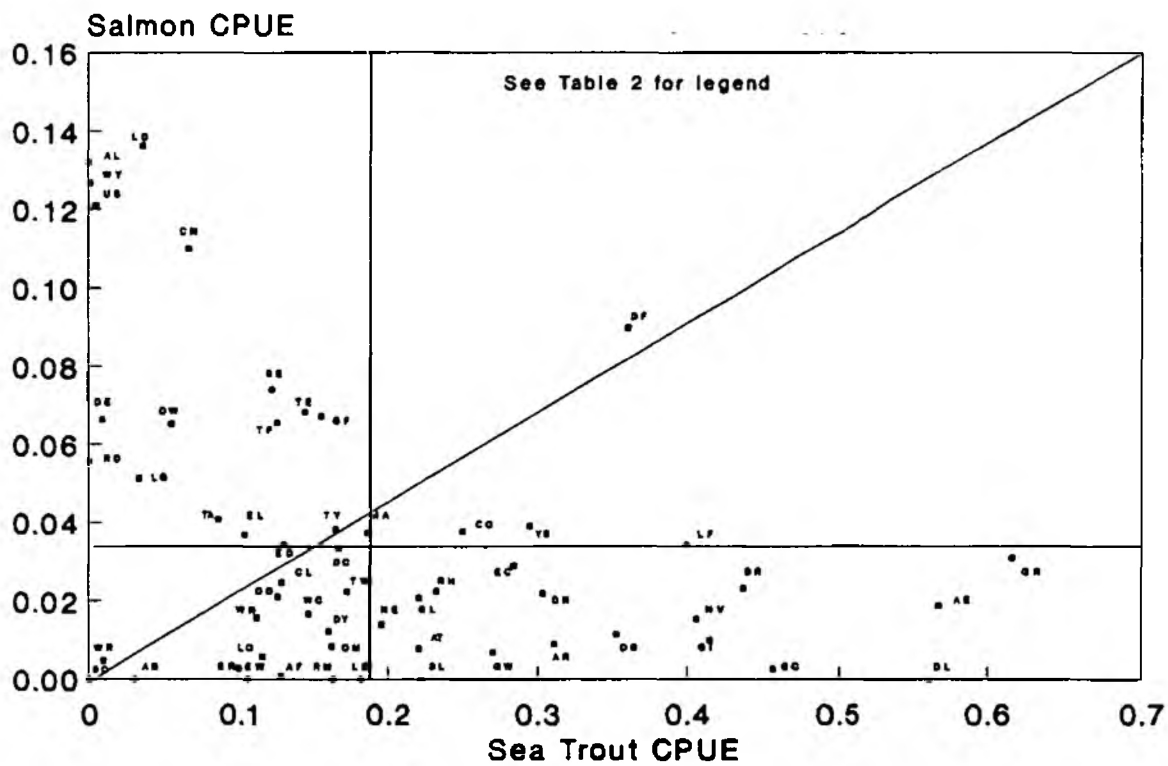

Figure 5. Relationship Between CPUE and Catch per Return (Salmon)

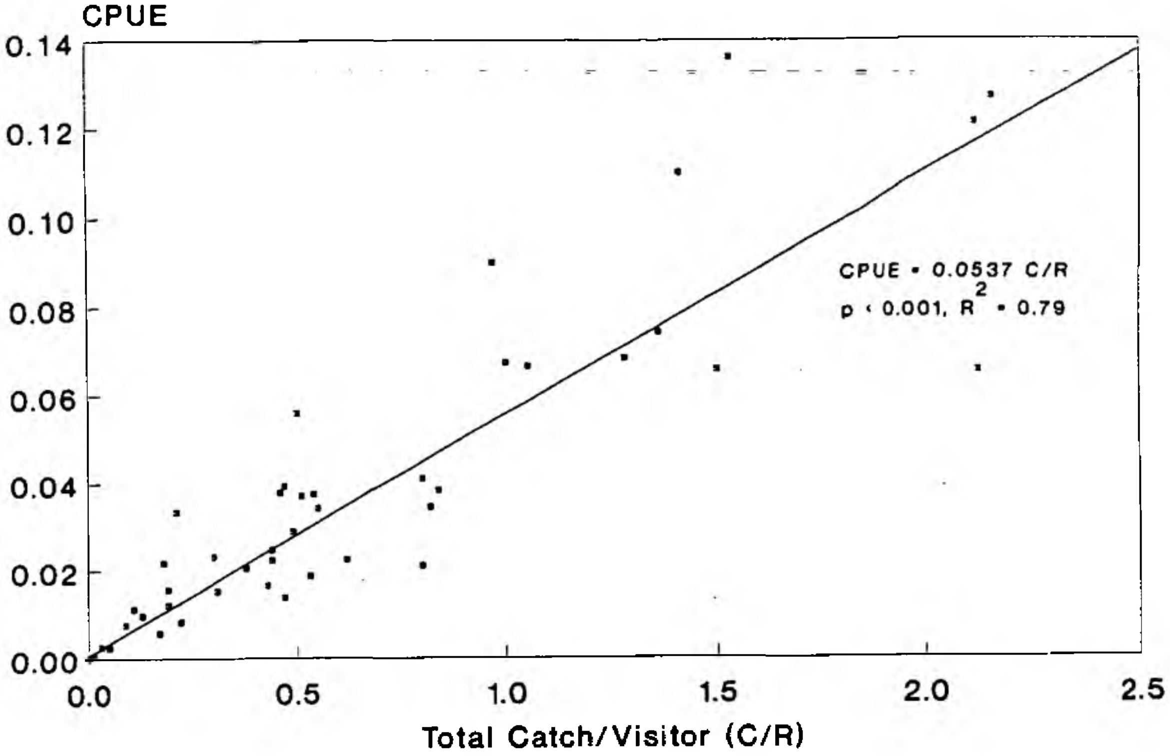

Figure 6. Relationship between CPUE and Catch per Return (Sea Trout)

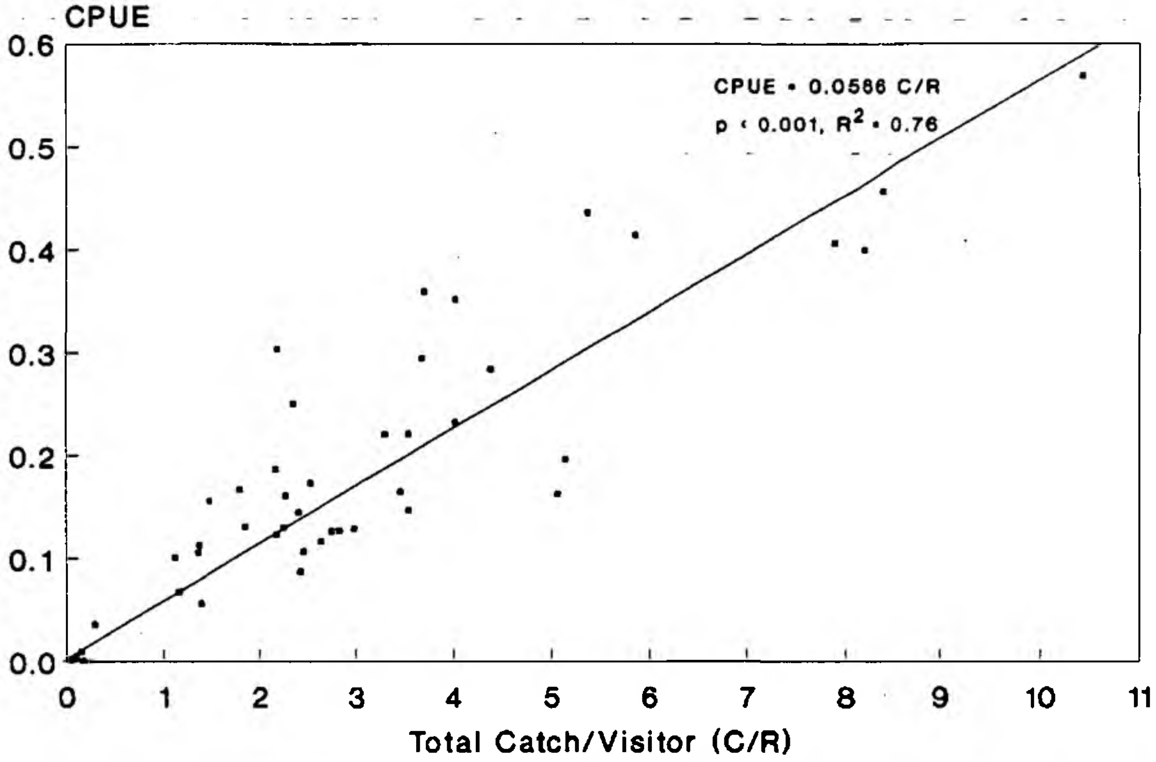

Figure 7. Flow on the River Usk 1988

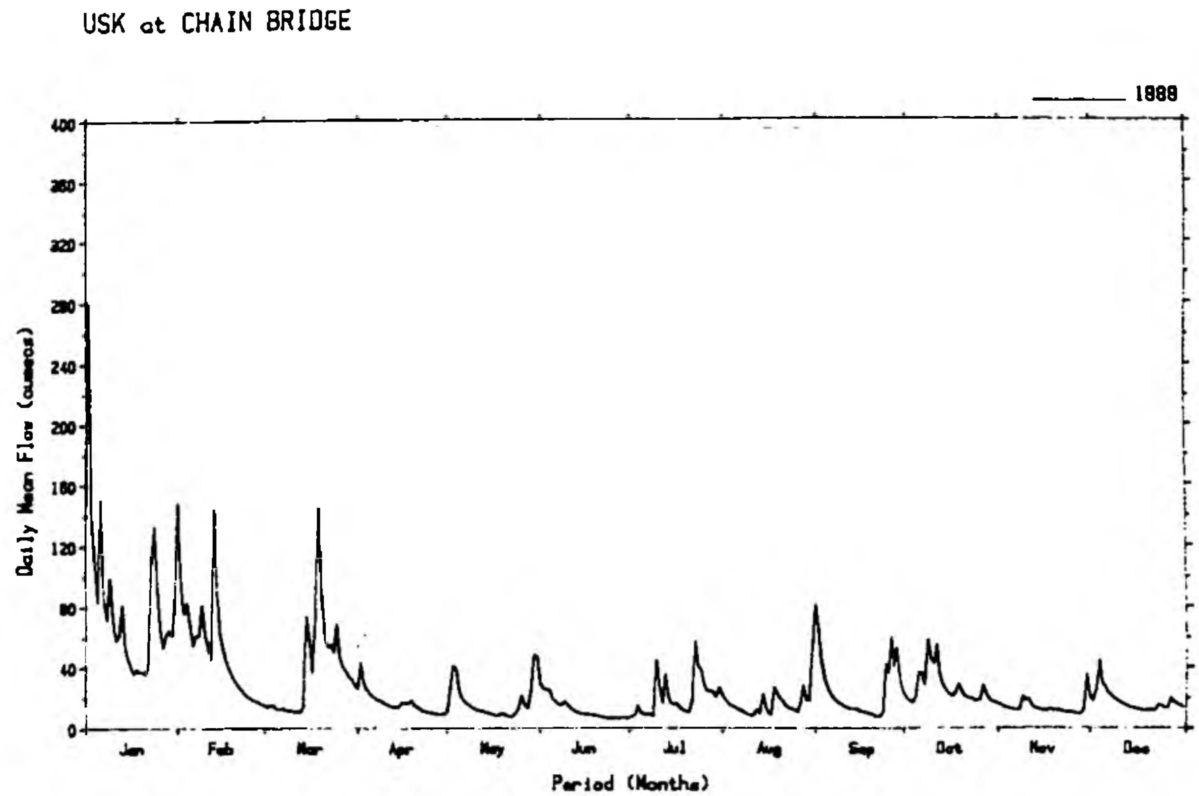

Figure 8. Relationship Between
Flow Index and Catch
R. Teifi 1976 - 1988

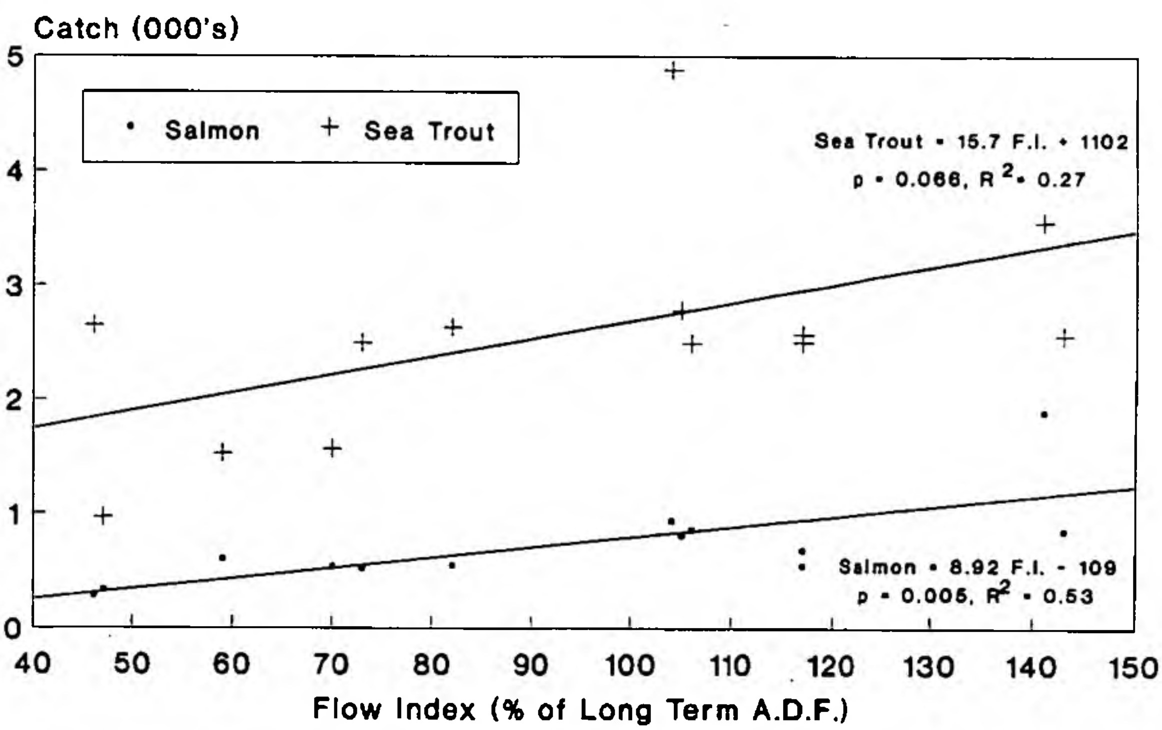

Figure 9. Distribution of Salmon and Sea Trout Abundance Index