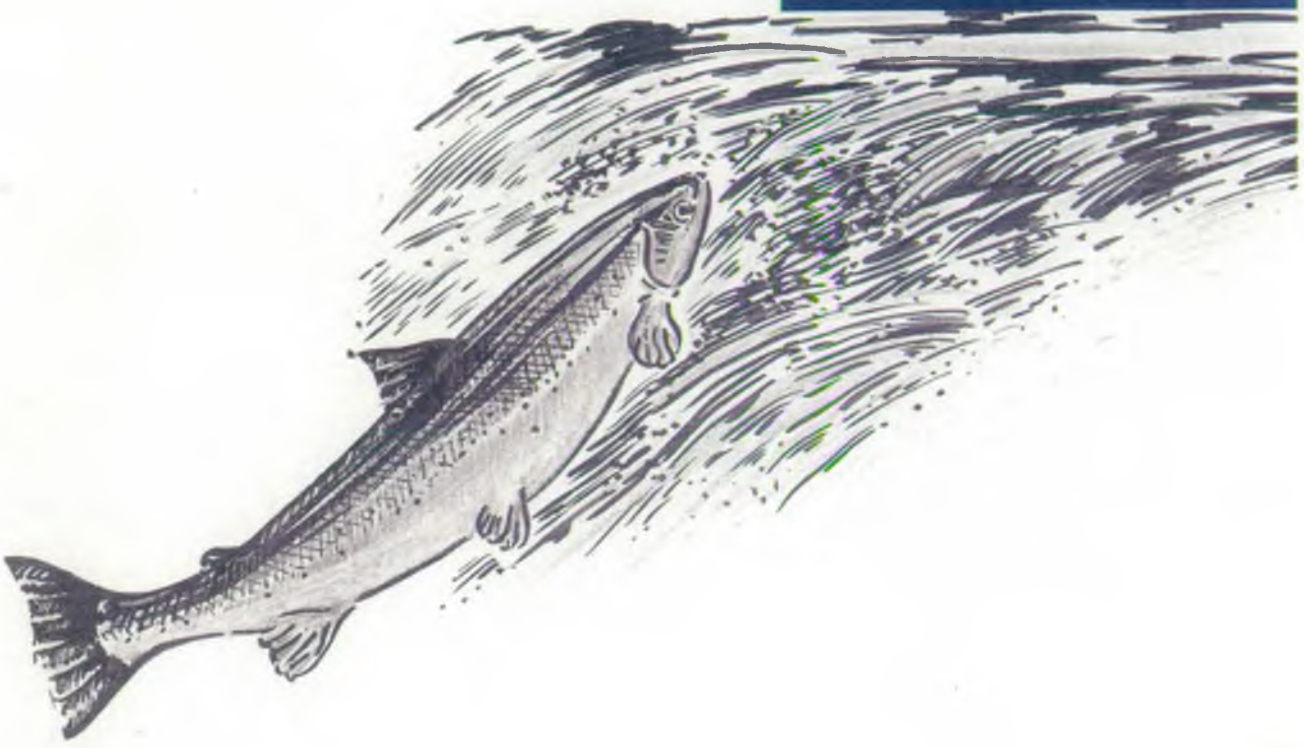
SALMON
Action Plan
CONSULTATION



River Tavy
October 1999

ENVIRONMENT AGENCY

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Executive summary.

Local salmon action plans provide a means by which the Environment Agency can implement the aims and objectives of the national salmon management strategy, as introduced in February 1996. This strategy represents an entirely new approach to salmon management within the UK and introduces the concept of river specific salmon spawning targets as a salmon management tool. In addition, salmon action plans have for the first time, attempted to evaluate in economic terms, all of the contributory components of the salmon fishery.

The River Tavy Salmon Action Plan follows that for the River Tamar and River Lynher and is the third of seven action plans that will be produced for salmon rivers managed by the Cornwall Area FER department. The salmon action plans for the remaining five rivers:- the River Fowey, River Camel, River Plym and the River Yealm will be written within the next three years following a similar format.

The River Tavy Salmon Action Plan contains a description of the river catchment and highlights particular features that are relevant to the salmon population and the associated fishery.

The analysis of recent and historical catches of salmon on the River Tavy from both the rod and net fisheries, indicated the fishery's reliance upon post 1 June salmon. Historically, annual salmon catches (both rod and net) on the River Tavy have been found to consist of a much higher proportion of pre 1 June (spring) salmon. Evidence is provided that illustrates the extent of the decline within this stock component since the early 1980s.

The status of juvenile salmon stocks on the River Tavy in 1998 have been assessed. Salmon fry production appeared to be lower than average with good densities achieved at certain favourable locations, notably on the main River Tavy. Salmon parr densities in 1998 were generally found to be excellent which is consistent with historic data. Redd counting performed in 1998 identified the main areas of salmon spawning.

The salmon egg deposition (spawning) target for the River Tavy was calculated as 287 eggs per 100 m^2 of the available wetted area. This is shown to be equivalent to a total annual rod catch of 90 salmon. Spawning target compliance-testing using historic rod catch data indicated that there have been two failure "episodes" within the last 10 years. These can be largely attributed to low river flows that would have reduced the availability to the rod fishery of the predominant post June stock component. Factors considered to be currently limiting or have in the future the potential to limit the salmon population have been identified.

Future actions aimed at the elimination or reduction of specific limiting factors impacting upon the River Tavy salmon population are presented, together with an assessment of their likely cost and overall benefit. The aim of these actions is to enable the consistent achievement of the salmon egg deposition target in future years.

SUMMARY OF THE MOST URGENT ACTIONS REQUIRED ON THE RIVER TAVY

Issue	Actions
Diminishing run size of pre - 1 June Salmon.	• Restrictions to fishing methods. • Introduction of catch limits. • Introduction of catch and release.
Impact of river flows upon salmon migration and distribution.	• Reduce exploitation by estuary nets. • Investigate the impact of flows upon salmon migration.
Poaching.	• Maximise the frequency of patrols within freshwater and the estuary. • Maximise the number of full time enforcement officers.
Mortalities at licensed, in-river abstraction points.	• Investigate smolt screening at hydropower abstraction points.

The current budget for fisheries work within Cornwall area is £ 590,000. It is estimated that 70% of this funding is currently used to monitor, enhance and protect salmonid fisheries within the area. However, this funding is vulnerable due to cuts in grant-in-aid and some of the proposed actions cannot be accommodated within the Agency's fisheries budget. This plan is therefore designed to encourage the active involvement of all interested parties so as to maximise the opportunities for the generation of new funding sources and facilitate a co-ordinated approach to the resolution of issues.

PART 1. INTRODUCTION

- In February 1996, the National Salmon Management Strategy was launched by the Environment Agency's predecessor the National Rivers Authority (NRA, 1996).

- The strategy concentrates on four main objectives for the management of salmon fisheries in England and Wales. These are primarily aimed at securing the well being of the stock but in doing so will improve catches and the associated economic returns to the fisheries:

  (i) Optimise the number of salmon returning to home water fisheries.
  (ii) Maintain and improve fitness and diversity of salmon stocks.
  (iii) Optimise the total economic value of surplus stocks.
  (iv) Ensure necessary costs are met by beneficiaries.

- These four objectives will be addressed through local Salmon Action Plans (SAPs) which the Agency will produce for each of the principal salmon rivers by the year 2001. Each plan will review the status of the stock and fisheries on a particular river, identify the main issues limiting performance, and draw up a list of costed options to address these.

- A new concept introduced by SAPs is that of setting 'spawning targets' to assess stock and fishery performance – providing a more objective approach than has previously been possible (Appendix 1). The process of target setting and compliance assessment are developing ones and are likely to be improved upon in the coming years. Nevertheless, the targets described in this document represent a sound starting point for using this important technique in the management of salmon stocks – one which has been successfully applied on Canadian rivers for a number of years and has recently been advocated by the North Atlantic Salmon Conservation Organisation (NASCO) to facilitate salmon management in the North Atlantic Commission Area.

- In delivering each SAP it is essential that the Agency seeks the support (including in some instances the financial support) of local fishery and other interests. This collaborative approach is vital to secure the best way forward for salmon rivers at a time when stocks are generally at an historic low, environmental pressures are as great as ever, and funding for salmon fisheries is diminishing. Hence the document presented here is for consultation and will be circulated widely.

- The final SAPs which result from consultation will publicly define the Agency's intentions for salmon management into the next century, with a commitment to review progress on an annual basis. In turn, the local plans will be summarised in Regional and National plans which will guide the Agency's business activities in the wider context. Furthermore, each SAP will feed into Local Environment Agency Plans or LEAPs (the successors of Catchment Management Plans) which serve to integrate all environmental responsibilities within the Agency's remit, including management of air, land and water.

PART 2. DESCRIPTION OF THE CATCHMENT

- The River Tavy, together with the Rivers Tamar, Plym and Lynher constitute the main rivers that discharge into the Tamar estuary and collectively drain an area of 822 km^2. The estuary of the River Tavy joins the Tamar estuary on its eastern bank in the south-west corner of Devon just north of the city of Plymouth. (**Figures 1 and 2**).

- The river supports both a rod and line and commercial licensed net fishery for migratory salmonids (Atlantic salmon, *Salmo salar* L. and Sea trout, *Salmo trutta* L.). In addition, the river also supports a Brown trout (*Salmo trutta* L.) population.

- The River Tavy rises on Dartmoor at a level of 550m AOD (Above Ordnance Datum). It runs in a South Westerly direction for approximately 35km at a gradient of 15.6 m/km draining an area of 220.75 km^2 before reaching the tidal limit at Lopwell Dam (SX745 6502). The average daily flow of the River Tavy is 7.2 cumecs (1996-1997).

- The River Tavy has many tributaries most of which support migratory salmonid spawning and subsequent juvenile production. The largest tributary, the River Walkham, supports good populations of both salmon and trout as do other smaller such as the River Burn and River Lumburn.

- The geology of the Tavy catchment is varied. The Rivers Tavy and Walkham drain from the igneous granite of Dartmoor in the eastern part of the catchment. The geology north of the town of Tavistock is dominated by carboniferous rocks of the culm measures with intrusive areas of Dolerite and Diabase, as well as extrusive Spilitic lava. The southern part of the catchment is mainly sedimentary rocks in the form of Old Red Sandstone of the Upper Devonian period. (Edmond et al., 1975).

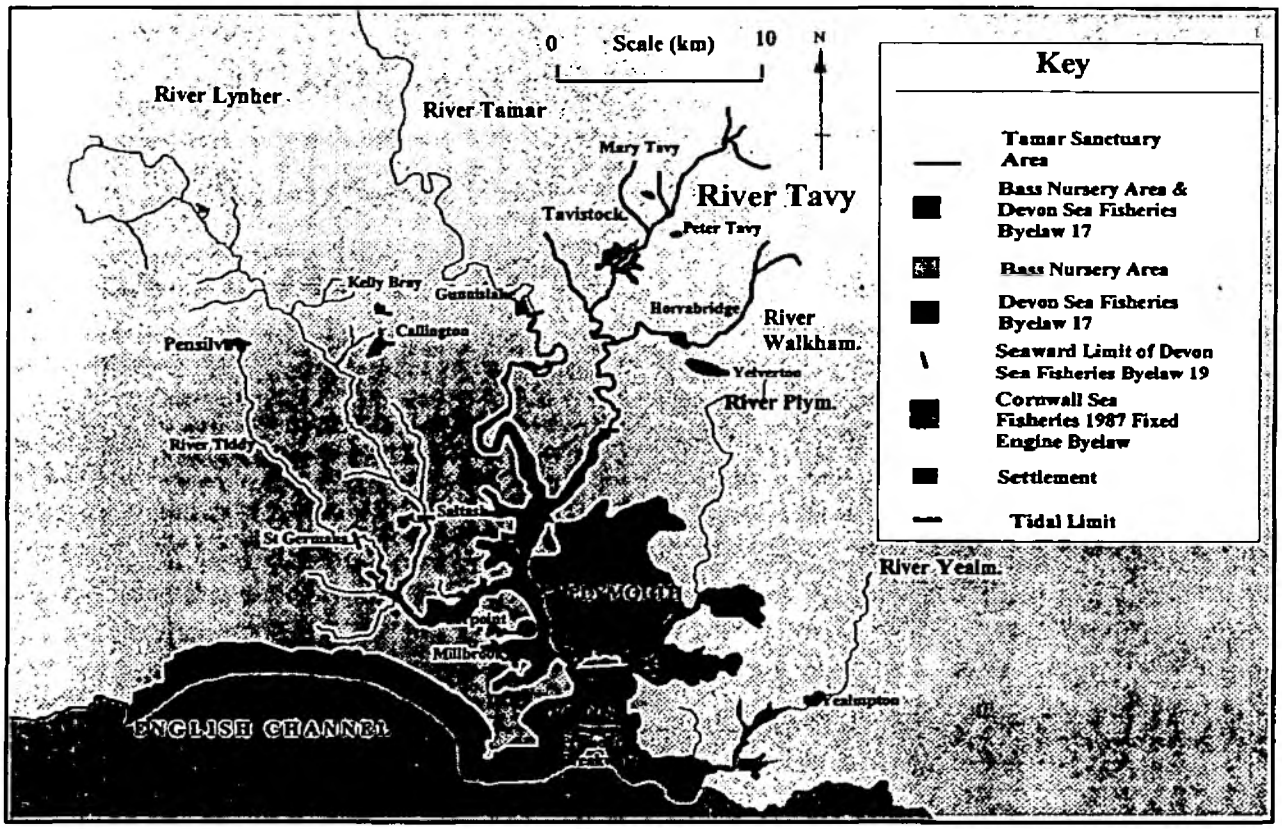
- Historically, mineral mining has been an important industry within the Tavy catchment. Copper mining was particularly intensive along with lead, silver and tin. This activity has lead to a legacy of watercourses within the catchment being contaminated by metalliferous compounds to varying degrees. This is especially noticeable within the Cholwell Brook which receives seepage from abandoned adits and mine discharges associated with Copper mining in the vicinity of Mary Tavy.

- Water quality data obtained from monitoring points situated within the Tavy catchment indicates that the river reaches its River Ecosystem (RE) targets. These are set by the Environment Agency to ensure that water quality standards are maintained to support a healthy migratory salmonid fishery.

- The majority of the river attains the highest water quality grading of RE1. However, there are certain areas within the catchment where pH (Upper Tavy and Upper Walkham) and Zinc and Copper (Cholwell Brook) are in excess of the limits set by the RE classification system and other legislation such as the EC Fisheries Directive for Salmonid fisheries (EC 78 / 659). Owing to the long term, chronic nature of historical mining contamination and the nature of the local geology, this data has been subject to "set aside" by the Environment Agency when setting the RE objectives. This has been done in order to safeguard the other RE water quality parameters, such as Biochemical Oxygen Demand

(BOD), ammonia and dissolved oxygen, which are vital for the protection of a healthy salmonid fishery.

Figure 1 – The position of the River Tavy in relation to the River Tamar and other main tributaries of the Tamar Estuary



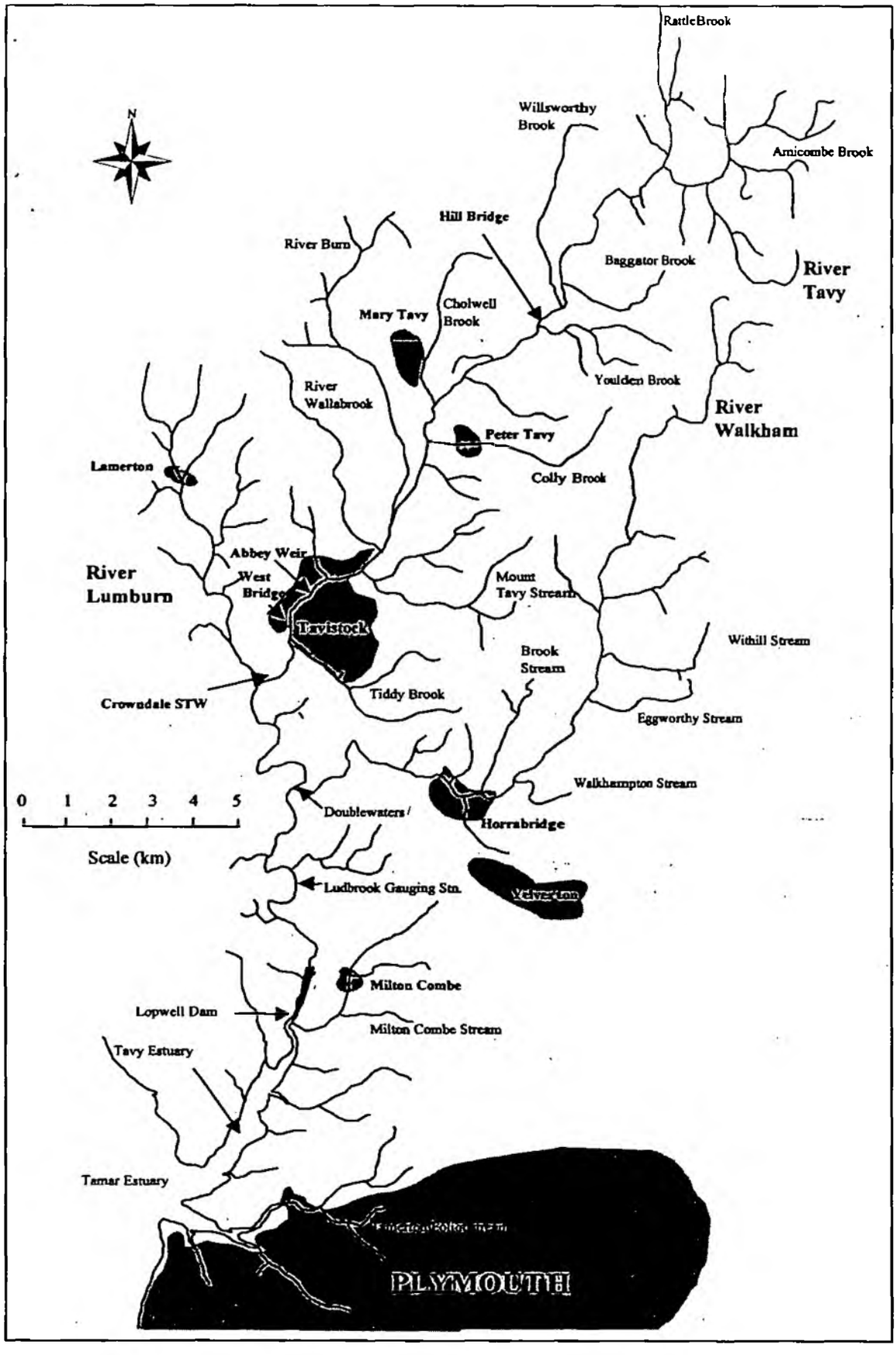
- Three stretches of the main River Tavy are currently set an RE objective of less than 1. The stretch from Kelly School to Harford bridge is currently achieving RE 2 with a long term objective of RE 1. The site from West Bridge to below Crowndale STW is currently achieving the lowest RE objective, RE4, with a long term objective of RE 2. This should now be closer to its target due to improvement works undertaken on a Combined Storm Overflow (CSO) at West Bridge and Crowndale STW. The stretch below Crowndale to Wash ford is currently achieving RE 2 with a long term objective of RE 1.

- In the short term, the above sites are compliant, but for the long term objectives they arc marginally, or in the case of downstream Crowndale, significantly failing their objectives. Dissolved copper has caused a marginal failure in the stretch from source to Hill Bridge on the River Tavy.

- The River Walkham is marginally failing its RE objectives for BOD in two stretches, Ward Bridge – Magpie Bridge and Magpie Bridge – Tavy confluence. This is as a result of water samples taken on one day. Zinc has also caused a marginal failure on the River Walkham from the source to Merrivale Bridge.

- The River Lumburn has two stretches that marginally fail their RE objectives for BOD. These two sites cover the complete River Lumburn from its source to the confluence with the River Tavy.

Figure 2 – Map of the River Tavy catchment with the location of all major tributaries



- The BOD failures on both the Walkham and Lumburn occurred during the same sample run and have not occurred since. It is likely that the next calculations of compliance to RQO will result in these sites passing.

- The upper reaches of the River Tavy and River Walkham are classified as heathland, moorland and rough pasture. The agricultural land in the remainder of the catchment is primarily used as meadow land and permanent grassland with only some arable usage. The majority of the catchment is rural with Tavistock and Horrabridge being the only urban areas of any significance.

- The western part of the catchment, including the upper reaches of the River Tavy and River Walkham, are in an area of potential acidification. This has been attributed to the surrounding geology, in addition to the naturally acidic moorland environment. The geology in this area has little or no acid buffering potential. Therefore acid deposition through rainfall into this area of the catchment can exacerbate the problem of the natural acidification.

- Within the River Tavy catchment there are eighty two licensed water abstractions. This figure may be divided between 67 groundwater and 15 surface water abstractions. The types of usage and the volumes licensed for abstraction (Surface and groundwater combined) are summarised in **Table (1).** Water abstraction for hydropower accounts for the highest demand on water resources within the catchment. Some of this water (36,368 Ml/year), abstracted at Abbey weir for Morwellham power station, is lost to the catchment and eventually discharges into the upper reaches of the Tamar estuary. A SWWSL abstraction at Lopwell Dam is licensed to take 33,215 Ml/year which is used as a public supply for Plymouth. The water lost from the river which could be affecting migration of salmonids upstream is 69,583 Ml/year or 190.6 Ml/day (190,638 m^3/day).

Table 1 - Licensed abstractions within the River Tavy catchment.

Usage	Number of Licences (Combined ground and surface waters)	Total Licensed Volume (m^3/year)*
Agriculture	**59**	**92862**
Spray irrigation	**1**	**191**
Private water supply	**11**	**1712589**
Hydropower	**1**	**17672**
Industry	**3**	**4959**
Fish farming	**4**	**12224850**
National Power Leat	**2**	**75009765**
Public water supply	**1**	**33215000**
TOTALS	**82**	**122277888**

* 1 m^3 is equivalent to 1000 litres.
1 Megalitre (1 million litres or 0.220 million gallons) per day is equivalent to 0.012 cumecs.

- The long term (1966-1998) daily average flow for the River Tavy is 7.068 cumecs. This equates to a long term annual discharge of 215 million m^3 per year.

- Lopwell dam was built within the period 1954-1959 by the Plymouth City Council to provide a suitable abstraction for public water supply to Plymouth. A fish pass was installed which began operating in 1956. At the time of construction the pass was "of the most modern design" (Cornwall River Board, 1957). Even directly after installation there was consideration by the City Water Engineer for minor experimental variations to reduce water velocity through the pass at certain water levels. During 1962, Plymouth City Council installed an electronic fish counter at the top of the pass as a response to anglers' complaints that the pass was ineffectual at allowing fish migration. In 1974 the fish pass was again modified with the elimination of the observation chamber and the engineering of a straight pool and traverse fish pass design. It is still considered that improvements could be made and the Environment Agency is currently attempting to address this issue with an ongoing project.

- There are a number of other structures within the Tavy catchment that have the potential to restrict the movements of salmon within the main river and tributaries. Wallabrook weirs and waterfalls are passable by migratory salmon only under certain flow conditions, as are those at Withill on the Withill stream. The Mount Tavy weir seems to be impassable to salmon, although a recently constructed channel around this obstacle has enabled sea trout to spawn successfully above this obstacle.

- The three abstraction points for hydropower facilities on the Tavy present a number of difficulties to migratory movement of salmon. The Mary Tavy hydropower station abstracts water from two weirs, Hill Bridge and Tavy Cleave. This water is carried along old mining leats to storage reservoirs. After power generation, the water is returned to the River Tavy via the Cholwell Brook, but this can lead to stretches of river deprived of flow. The two abstractions for Mary Tavy power station operate under a licence of right. The maximum take at Hill Bridge is 0.84 cumecs. When the abstraction at Tavy Cleave is operating, 40% of the flow can be taken at Hill Bridge in April, and all of the flow in May. Below Hill Bridge a stretch of a few metres can be left completely dry only gaining water again from Youlden Brook. The same occurs at Tavy Cleave where the majority of the flow can legally be taken from the river during April and May. The timing of this can have an impact upon salmon and sea trout smolts. Dead smolts have been observed below the power station outfall.

- Water abstracted at Abbey Weir for transportation to Morwellham power station via the Morwellham canal is completely lost to the system, depriving the river of a large volume of water. In 1963, this abstraction was granted a licence of right and could take a maximum of 1.23 cumecs, with the clause that there should be sufficient flow through the fish pass equivalent to a flow of 0.25 cumecs over Abbey Weir. In 1968, this mean flow increased to 0.66 cumecs, and from 1981 it was proposed to gradually increase this flow to 1.77 cumecs. In 1995, the prescribed flow was set at 1.42 cumecs. The timetable in place allows for an increase in prescribed flow from 2000 to 2004: 29 mgd (1.58 cumecs) and from 2005: 32.4 mgd (1.76 cumecs), if the agreement continues until its conclusion. When the flow in the River Tavy falls below the prescribed flow, a sweetening flow of approximately 140 l per second in maintained within the Morwellham Canal.

- These abstractions will all reduce the potential opportunity for migratory salmonids to pass these structures. In addition, the leats built to facilitate the transport of water to the hydropower installations are currently not screened. Salmon smolts migrating downstream are easily drawn into these abstractions (Solomon, 1993) and the subsequent mortality involved will reduce the escapement of smolts to sea from the Tavy catchment. The Environment Agency undertakes smolt rescues every spring on the Bennet's leat to Mary Tavy Power station and from within the Morwellham canal.

- Radio tracking studies carried out 1991 to 1995 attempted to investigate the impacts of flow and abstractions on the migration of salmon (Solomon, 1997). It was concluded from the data collected that, when operating at the full permitted rate, the abstractions at Lopwell and Abbey Weir are having an adverse effect on salmon migration up to and past the tidal limit. The impact of Abbey weir alone was not proved conclusively due to a lack of data.

- Tavistock fish farm also abstracts a large volume of water which can lead to much lower flows in the stretch between the abstraction and discharge point. There is also the potential for farmed fish to escape to the river and for smolts and kelts to enter the fish farm.

- Tavistock fish farm discharge, CSOs and Crowndale STW have all historically thought to have been associated with large blooms of the filamentous algae *Cladophora* sp. during March. This algae proliferates in water enriched with nutrients such as Phosphate and Nitrate. It is not yet known how the potential low flows impact on this annual event. Recently, algal proliferation has been observed higher up the catchment during the summer months.

- The Tavy estuary has a high nature conservation value and as such, is designated as a Site of Special Scientific interest (SSSI) under the UK Wildlife and Countryside Act (1981, as amended 1985). There are other SSSIs within the catchment: North Dartmoor (top of Tavy and Walkham), Sampford Spiney (Walkham), Grenofen Wood and West Down (Walkham), Whitchurch Down (Mount Tavy Stream) and Lydford Railway Ponds (River Burn). The majority of the catchment to the west of Tavistock is covered by the Dartmoor Environmentally Sensitive Area. The Dartmoor National Park area covers a large area to the east of the catchment in the upper reaches of the River Tavy and much of the River Walkham.

- The estuary forms part of the Plymouth Sound and estuaries candidate Special Area of Conservation (cSAC) which is being considered under the EC Habitats Directive (92/43/EEC). If designated, this site will require a coherent, co-ordinated management plan to be drawn up between all relevant authorities. This will ensure that nature conservation will be a primary consideration in assessing the potential impact of future developments within the estuary.

- Due to the extensive number of perceived problems associated with water flow within the River Tavy catchment, the NRA designated the Tavy as an Alleviation of Low Flow (ALF) river. This designation has secured a number of investigative projects to investigate the impact of water resource utilisation upon the ecology and riparian interests within the river. Tavy ALF fisheries monitoring began in 1993 and is still continuing

along with investigations from other Agency departments. The designation of an ALF river allows integrated commitment by all sections through co-ordination by the water resources department.

- The hydroacoustic fish counter at Lopwell and the Phabsim study carried out by the Institute for Hydrology have both been funded from the ALF programme.

- Atlantic Salmon are listed as a protected species under Annex (II) of the EC Habitats Directive. Annexe (IV) lists them as a species that is subjected to exploitation and which must be managed in such a way as to ensure a sustainable population is maintained.

- Other issues not specifically relating to salmon that affect the River Tavy catchment are outlined in the Tamar Estuary and Tributaries LEAP, Consultation report. (Environment Agency, 1996).

PART 3. DESCRIPTION OF THE FISHERIES (ROD AND NET).

- The River Tavy supports both a rod and line and commercial net fishery for migratory salmonids. Many of the regulations that guide the fisheries activities are laid down in the form of byelaws that apply specifically to the migratory salmonid fisheries. These byelaws are enforced by the Environment Agency within freshwater and the immediate environs of the Tamar estuary complex.

3.0.1 The River Tavy rod fishery.

- The rod fishery on the River Tavy extends from the tidal limit at Lopwell dam to Hill Bridge. The principal angling clubs within the River Tavy catchment are Plymouth and District Freshwater Angling Association and the Tavy, Walkham and Plym Fishing Club. Other important riparian owners include Roborough estates and other private riparian interests.

Rod fishery regulations.

Historical review.

- In 1961, a byelaw was introduced that reduced the length of the early spring salmon rod fishing season by four weeks. The new season then began on 1 March and closed on 30 September.
- In 1973, the rod fishing season for salmon was extended by 14 days. The closing date for the rod fishery then became 14 October.
- For 1995 and 1996, the NRA requested the introduction of voluntary catch restrictions on the River Tamar and Tamar estuary tributaries (with the exception of the River Plym) in an attempt to reduce angling pressure on spring salmon stocks. Within this area, anglers were asked to retain a maximum of two salmon prior to 1 June.
- On 15 April 1999 new Spring Salmon byelaws came into force. Any angler catching a salmon before 16 June must return it with minimum injury. Angling for salmon before 16 June can only be with artificial fly or artificial lure.

Current Status

The existing rod fishing seasons for migratory salmonids on the River Tavy are as follows:

- Salmon: 1 March to 14 October
- Sea trout: 3 March to 30 September

3.0.2 The River Tavy commercial net fishery.

- The netting stations on the Tavy are situated between Lopwell Dam and the railway bridge known as Tavy bridge. The majority of netting occurs at Maristow a short distance below Lopwell. Lopwell Dam forms a major barrier to salmonid migration, with fish having to make use of the fish pass. Salmon ascending the river but not using the fish pass will drop down the river back into the area of netting.

Net fishery regulations.

Historical review.

- In 1961, following the introduction of the byelaw known as the "Limitation of salmon and migratory trout netting licences order" the total number of netting licences on the River Tamar and tributaries was restricted. A number of these licences were allocated to the main Tamar estuary, the River Lynher estuary, the River Tavy estuary and some joint estuary nets. In 1962 the maximum number of nets on the Tavy estuary was 11 including the joint estuary nets. In 1971 this was reduced to 10. In 1977 it was reduced to 9 and from 1979 it was reduced again down to 5. The Net Limitation Order (NLO) for the Tamar Estuaries and tributaries was renewed in 1996 for a further 10 years. It will be reviewed again in 2001.
- In 1991 a night time buy back of netting time was introduced. Netting was not carried out from 1800 to 0600. This continued from 1992 until 1995. From 1992 the close times were from 2000 to 0600.
- In 1997 the netsmen were paid not to net from 21 April to 7 June to protect the spring run of salmon. They were also paid not to fish from 2 August until 31 August.
- In 1998 there was a complete season net buyback of netting time ("buyback") for the River Tavy netsmen.
- In 1999 limited netting took place during the month of June. The nets have been bought off by Riparian owners from the 1 July until the 7 August . South West Water have bought off the nets from 8 August until 30 August as mitigation for the Roadford reservoir scheme.

Current status.

- The River Tavy supports 5 licensed nets including 1 joint Tamar/Tavy net.
- The migratory salmonid estuarine netting season extends from 2 March to 31 August.
- Within the netting season, there are additional weekly netting close periods between the following times:

    - 0600 Fri to 0600 Mon (2 March to 31 May)
    - 0600 Sat to 0600 Mon (1 June to 31 August)

- In addition to the above, the Environment Agency also restricts the use of nets (fixed engines) within the estuary under Section 6 of the Salmon and Freshwater Fisheries Act 1975 (SAFFA 1975) as amended by Section 33 of the Salmon Act 1986 (SA 1986).

3.0.3 Additional legislation of relevance to the salmonid fishery.

- On 15 April 1999, the Environment Agency's national byelaws to protect stocks of early running salmon came into force. The proposals, which cover both rod and net fisheries, include the following measures:

    - Delay in the salmon and sea trout netting season to 1 June.
    - Any angler catching a salmon before 16 June must return it with minimum injury.

- Angling for salmon before 16 June can only be with artificial fly or artificial lure.

These byelaws will be in force for a period of ten years with a review after five.

- Although the Environment Agency remains as the body responsible for enforcing much of the fisheries legislation that protects migratory salmonids within the Tavy estuary, both the Ministry of Agriculture, Fisheries and Food (MAFF) as well as the Devon Sea Fisheries Committee (DSFC) also have legislation restricting netting activities. These are summarised below:

Ministry of Agriculture Fisheries and Food (MAFF).

- The Ministry of Agriculture Fisheries and Food (MAFF) have responsibility for the conservation of fish stocks and management of marine fisheries in UK waters.

- MAFF have been responsible for the provision of two orders which enabled the designation of protected nursery areas for Sea bass (*Dicentrarchus labrax*). This designation has in turn, assisted in the protection of migratory salmonids. The MAFF orders cover the estuaries of the Tamar, Lynher, Tavy, Plym and Yealm. The area covered by this legislation can be seen in **Figure (1).**

Devon Sea Fisheries Committee

- Within the estuarine and coastal waters of England and Wales, sea fisheries out to a limit of six miles are regulated by Sea Fisheries Committees (SFC). These bodies were established under the Sea Fisheries Regulation Act, 1966. The Devon Sea Fisheries Committee (DSFC) regulates sea fisheries within the Tamar estuary, as well as the coastal areas of the catchment.

- DSFC byelaws 17 (Fixed engine restrictions) and 19 (Netting prohibition introduced 1990) restrict the use of nets. Byelaw 19 prohibits all netting other than licensed fyke netting for eels, licensed migratory salmonid seine nets and landing nets used in conjunction with the rod and line fishery within the River Tavy. See **Figure (1).**

3.1 CATCHES AND CATCH EFFORT (ROD AND NET).

- In accordance with national guidelines, the spring salmon catch is defined as those fish caught before 1 June with fish caught after this date comprising later running multi-sea-winter (MSW) salmon and grilse (one sea winter fish).

- Historical salmon rod and net catch data have been derived from Area records and catch statistics published by MAFF (Russell et al, 1995), NRA (published 1992, 1993, 1994b, 1995) and the Environment Agency (published 1997, 1998, 1999).

3.1.1 River Tavy rod catches.

- Historic rod catch data for the River Tavy covering the period from 1954 to 1998 is presented in **Figure (3)**. The graph presents annual rod catch data together with the five year running average. The five year running average has been incorporated in an attempt to even out the substantial yearly variation that is exhibited by the data. Such variation can be attributed to both natural factors (such as river flow, changes in marine tidal currents, water temperature) as well as human factors (extent of the high seas fishery, number of rod anglers and fishing effort).

- The rod catch from the River Tavy shows no overall trend. What is seen, especially from the mid 1970s onwards, is a cyclical pattern in the rod catch. Periods of 3 to 4 years of high rod catches are typically followed by 3 years of lower catches. Many of the lowest catches occur in "Drought years" as these affect the number of fish recorded in the catch due to running up the rivers after the season is over. A drought year is defined as any year where the average river flow from April to September is less than 55% of the forty year average.

- The cyclical pattern observed in the rod catch data can be further investigated by identifying the contribution made to the overall rod catch by the pre and post June salmon stock components. **Figure (4)** provides a breakdown of the total annual salmon rod catch between the pre 1 June and post 1 June stock components for the years 1969 to 1996 inclusive.

- As in many other South West Rivers, within the period 1968 to 1979, there was a significant mortality observed in the salmon stock following an outbreak of Ulcerative Dermal Necrosis (UDN). This disease is reported to have had a particular impact upon the spring stock component and spawning fish owing to the relationship that exists between low water temperatures and the virulence of the disease. The disease was first recorded in the River Tavy in October 1970. The number of mortalities observed in the River Tavy are illustrated in **Table (2).** The River Tavy was particularly badly affected with large numbers of Spring fish succumbing to the disease. By 1973 the number of diseased fish was gradually declining and most seemed to be successfully spawning before dying from the disease.

Table 2 - Number of River Tavy salmonid deaths reported due to UDN.

Year	Salmon	Sea Trout
1970-71	**150**	**20**
1971-72	**128**	**7**
1972-73	**124**	**4**

Diseased fish continued to be recorded from catchments across Cornwall until at least 1980 although numbers and locations were not reported.

- In 1973, the rod fishing season was extended from 30 September to 14 October. This allowed anglers to take greater advantage of the late run of grilse.

Figure 3 - Total declared rod catch of salmon for the River Tavy – 1959 to 1998

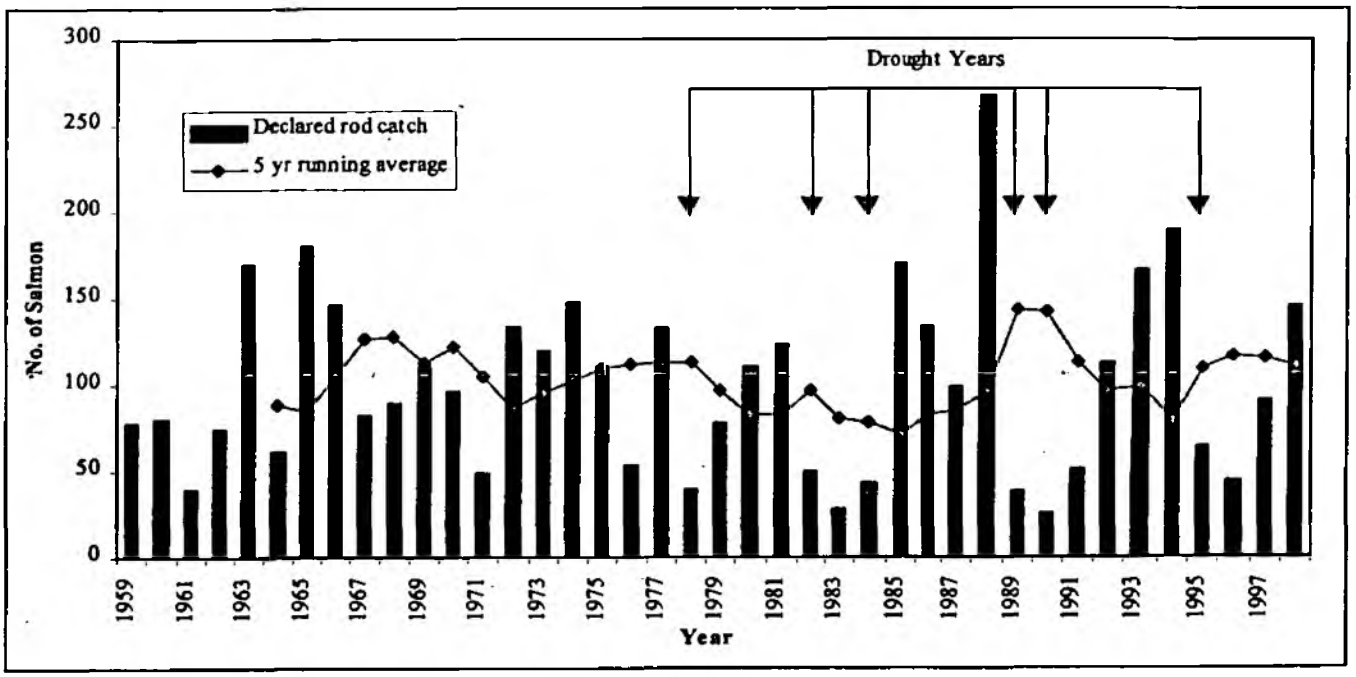


Figure 4 - Relative proportions of pre and post 1 June salmon within the total declared rod catch – 1969 to 1998.

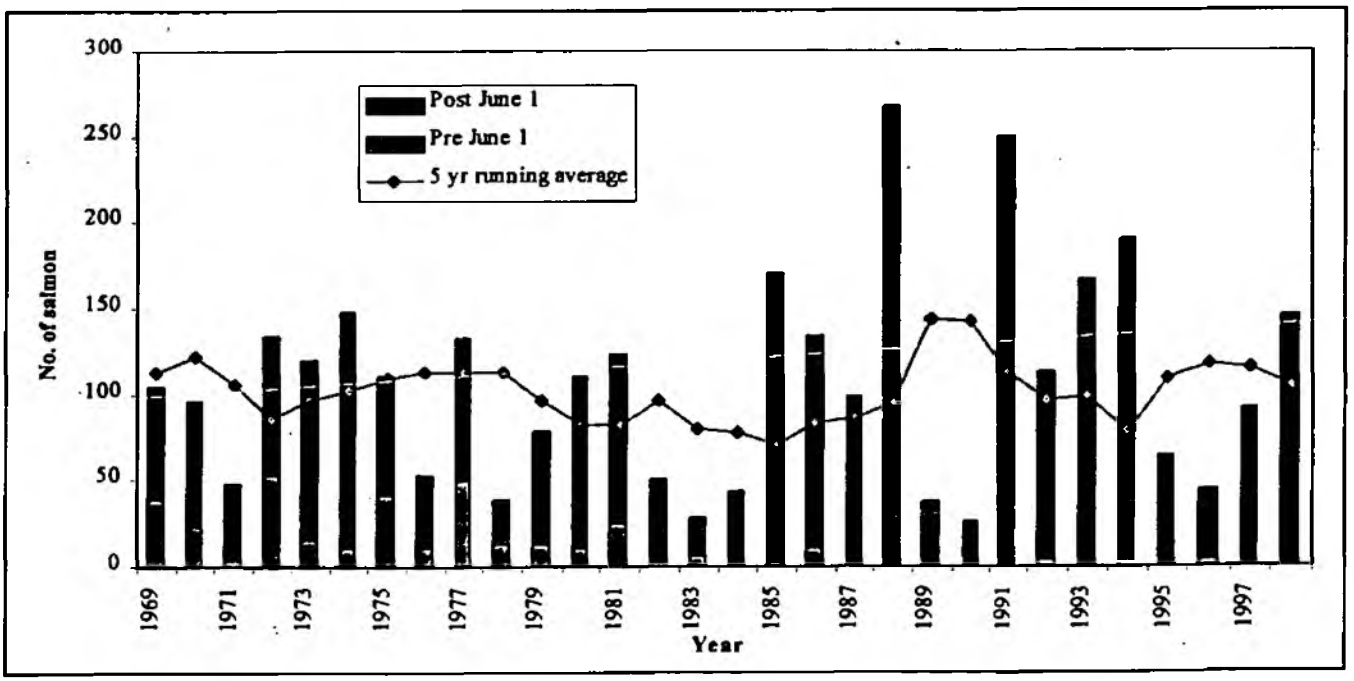
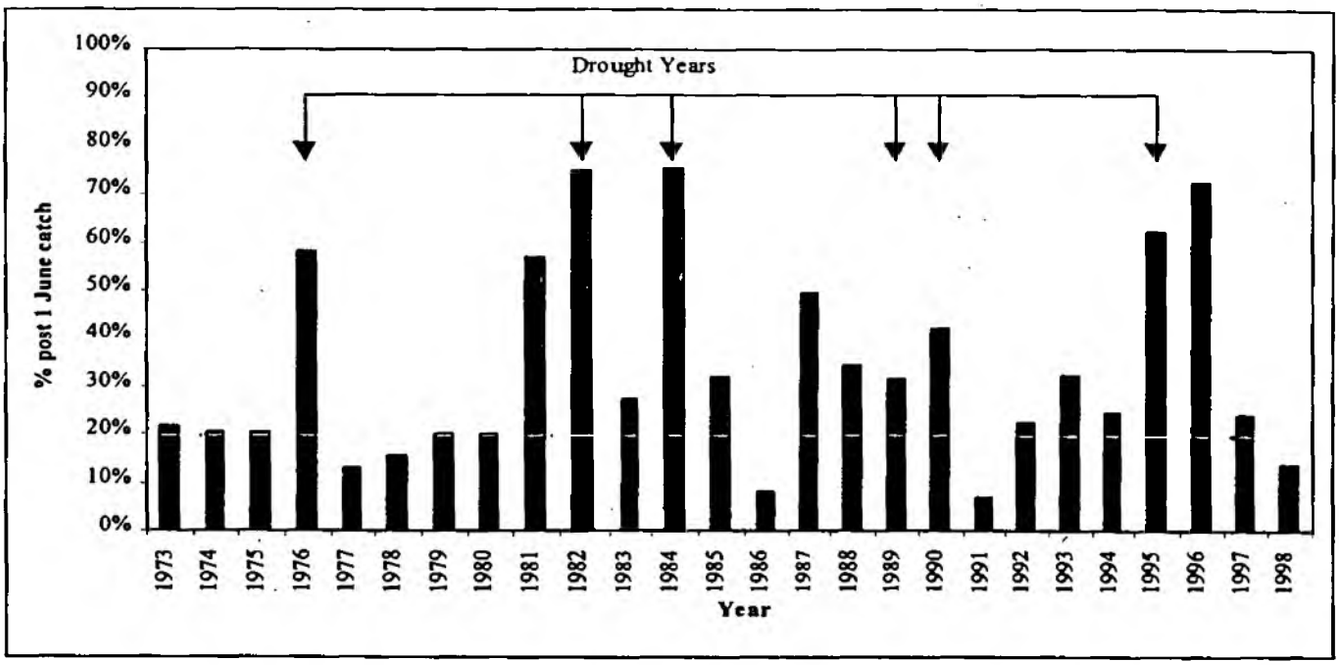


Figure 5 - October salmon rod catch - % of total post 1 June rod catch –1973 to 1998.



- Over the past twenty years it is evident that a significant proportion of the post June rod catch, during designated drought years, is made up of fish caught within October. This reached a maximum during 1982 and 1984 where 72% of the total catch consisted of fish caught between 1 October and 14 October (**Figure 5**).

- Despite the obvious current and historical importance of the post June fish to the rod fishery, the catches of pre-1 June fish, prior to and including 1981, were also found to have made a significant contribution to the annual rod catch. This is particularly well demonstrated within the period from 1972-1979. In these years, spring fish were found to increase as a percentage of the total rod catch (average 1976 to 1979: 25% of total catch) owing to the absence of a significant post June catch. The availability of the post June fish to the fishery would have been naturally reduced by the impact of low river flows, as discussed.

- From 1983 to 1998, the spring component of the salmon stock has been found to undergo a steady decline in abundance. Within the period 1972 to 1984, the average pre 1 June catch was 20 fish. This compares markedly with the average for 1984 to 1998 being only 2 fish. The average total catch for these periods were 94 and 123 respectively indicating the increasing importance of the post 1 June stock over the last 15 years.

- The total rod catch for 1998 (145 fish) has increased from 1996 and 1997 and is higher than the average rod catch for the whole period 1959 to 1997 (106 fish). However, at the same time there has been a significant reduction in the commercial licensed net fishing.

- The lowest recorded catches of post June fish within the 1990s are not dissimilar to the lowest post June catches recorded within the period 1976-1984. However, the more recent total rod catch of salmon has been supported by little or no pre June salmon. The catch of

salmon post June has increased in 1998. The almost complete loss of spring fish reflects both a change in fish availability and angling effort.

- Catch effort for rod fishing has only been recorded since 1993, and as such the actual fishing effort, measured in terms of numbers of anglers and duration spent fishing, is unknown prior to this period. However, catch per licence day (CPLD) data (Table 3) for 1998 indicates that there was an 212% increase in angling efficiency when compared to the average CPLD data for the period 1993 to 1997. This coincides with the complete buyback of the netting season.

- The numbers of days fished in 1998 (1031 days) was 22% lower than the five year average of 1160.

- In 1995, 1996 and 1997, the Environment Agency requested that all anglers fishing on the River Tavy help to conserve spring salmon by keeping a maximum of two salmon prior to 1 June. This request may have resulted in a reduction in angling effort during these years and so reduced the potential pre 1 June rod catch.

3.1.2 River Tavy net catches

- The net catch data (1956-1997) for the River Tavy estuary is presented in **Figure (6).** The graph shows that the salmon catch increased steadily from 1960 and peaked in the mid seventies at over 1000 salmon. At this time there were ten licences issued for seine netting on the Tavy including some joint licences for the Tamar and /or Lynher. Since this period, the catch has declined back to the levels similar to when detailed records began.

- River flow is not as crucial to the net catch as to the rod catch although flows would still be expected to have some impact on net catches. Low river flows would not encourage fish into the estuary from the sea and conversely higher river flows can make netting less efficient and encourage fish to run up river into freshwater. These factors will therefore account for some of the annual variability that exists within the data.

- A further decline in the net catch in 1997 is due to reduced fishing effort after net buy backs, and not because of a dramatic reduction in available salmon stock. In 1998 there was no netting on the Tavy estuary and in 1999 only June was netted. Table ? shows what measures have been taken to limit netting effort for the past ten years and its effect on the rod CPLD..

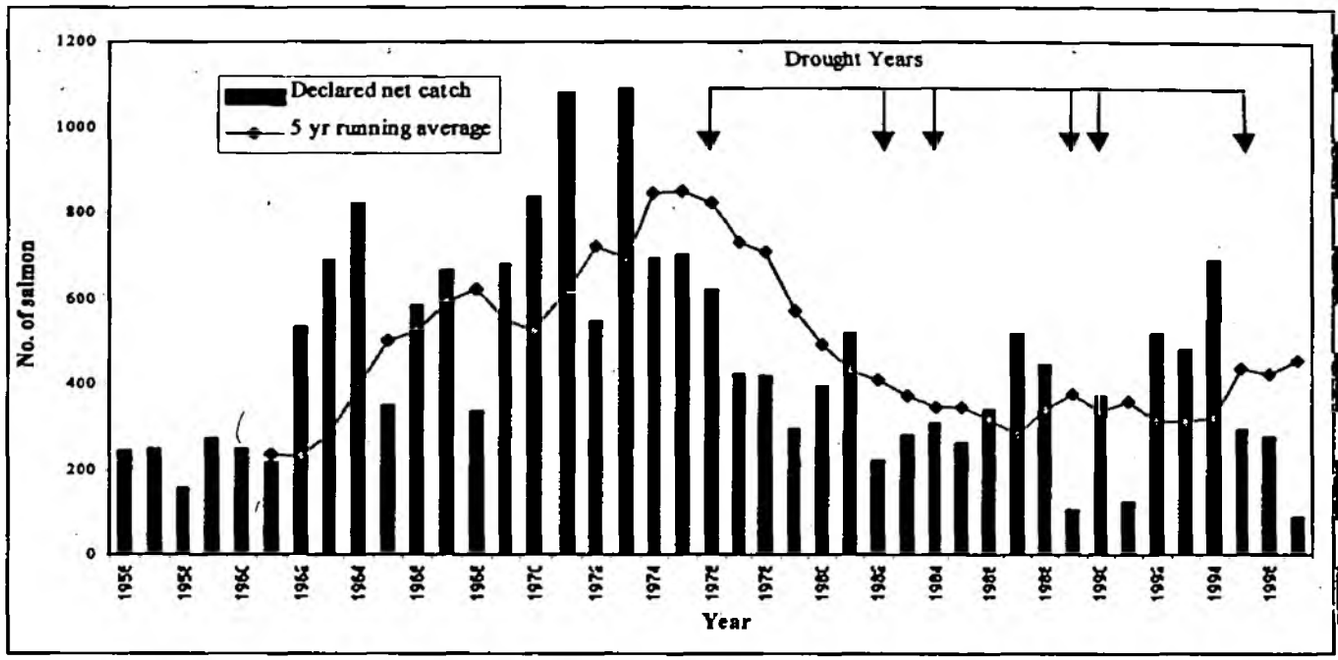
- CPLD data for the net fishery (Table 2) in 1997 indicates that catch efficiency is approximately 50% of that achieved within the period 1995-1996. This would appear either to indicate a reduction in the available salmon stock to the net fishery in 1997, or that the times of the buybacks coincided with times when the majority of fish are caught.

- **Figure (7)** provides a breakdown of the total annual declared net catch into the pre and post June stock components for the period 1963 to 1997. The graph indicates that historically, the post June catch has always been the major component of the net fishery's total catch, constituting on average 89% of the total catch for the period 1965 to 1980.

- In 1991, 1993 and 1995 no spring fish were recorded within the total net catch. This reflects, to a certain extent, a reduced fishing effort, with the netsmen concentrating their efforts upon the post June fishery.

- In 1997, the River Tavy netsmen agreed to a " buy back" of netting time that extended from 21 April to 7 June. This measure was introduced by SWWSL as mitigation for Roadford reservoir to allow extra adult salmon into the River Tamar. The Agency brokered the agreement in an attempt to help conserve the spring salmon stock. In addition, the Tavy netsmen were paid not to net the river in August, as the runs of post June fish in recent years were considered to be critically low.

Figure 6 - Total declared salmon net catch for the River Tavy – 1956 to 1997



- In 1998 there was a complete season buyback agreed by the River Tavy netsmen.

- In 1999 the new national byelaws were introduced on 15 April preventing netting of salmon until 1 June. Through negotiations with the Environment Agency, riparian owners bought the nets off from 1 July until 7 August. South West Water then bought the nets off from 8 August until the end of the season, 31 August as mitigation for the Roadford Reservoir scheme.

- Table (3), provides a summary for the declared rod and net catches obtained over the last 5 years. This table also includes information on the effort applied to each fishery over the same time period.

Figure 7 - 'Spring' and 'Summer' components of the total annual declared net catch of salmon – 1972 to 1996

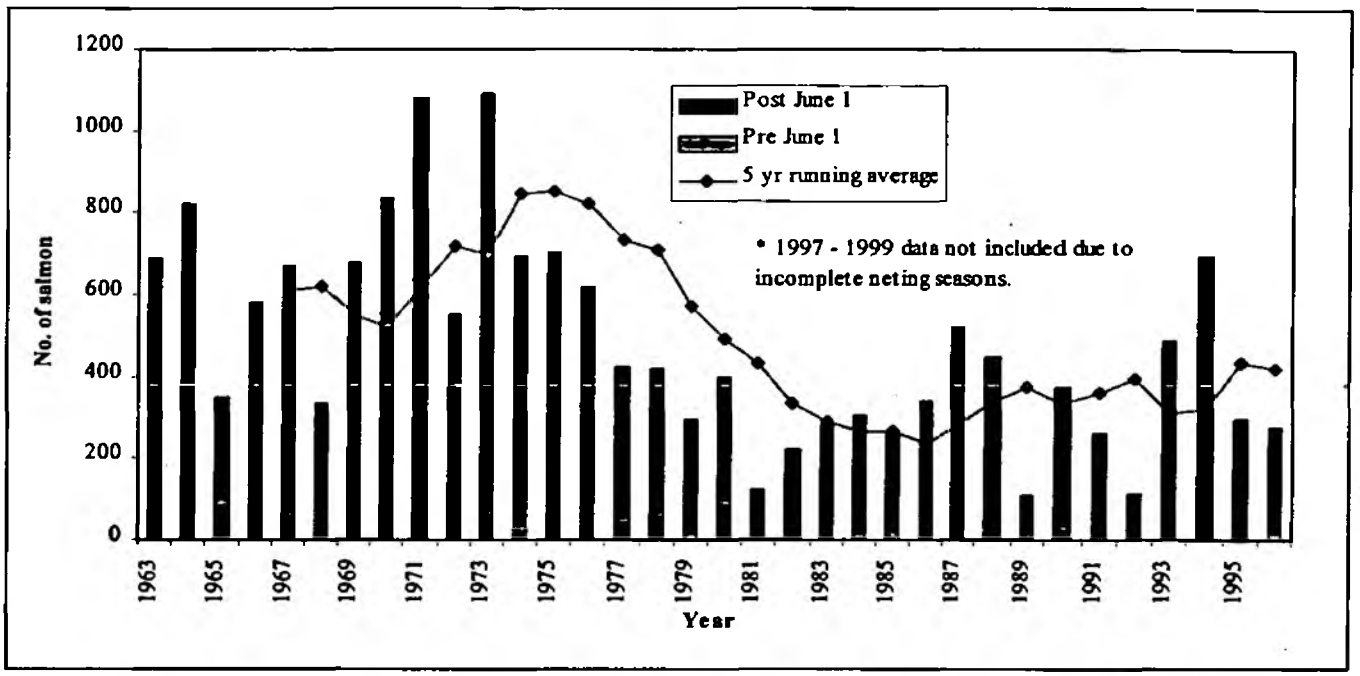


Table 3 - Salmon rod and net catch summary.

	1998	5yr mean (93-97)	1998	5yr mean (93-97)	1998	5yr mean (93-97)	1998	5yr mean (93-97)
Rods	1	1.6	144	109.4	145	111	0.131	0.062

	1997	5yr mean (92-96)	1997	5yr mean (92-96)	1997	5yr mean (92-96)	1997	1996
Nets	0	10.4	87	443.2	87	453.6	0.76	1.59

3.1.3 Sea trout rod and net catches.

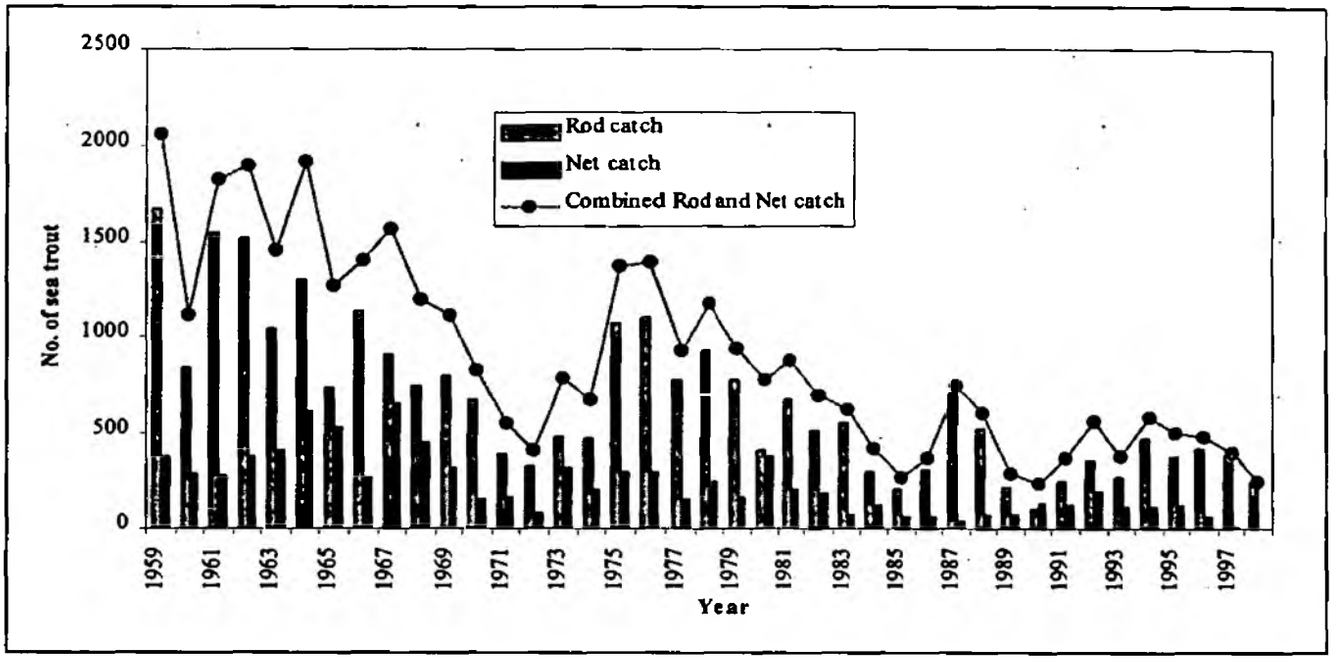
- **Figure (8)** indicates that between 1959 and 1997, the annual sea trout catch has fluctuated greatly. The lowest catches occurred in the drought years of 1989 and 1990. The average catch over the past ten years (1988-1997) is less than half that of the average catch from 1960 to 1980. This decline began to occur before the recent netting buy backs came into force.

- The reasons behind the diminishing trend in the sea trout catch on the River Tavy cannot easily be pinpointed. The netsmen have in recent years been concentrating their efforts on

the post June salmon fishery. As on many salmon rivers in Cornwall, the largest sea trout generally run into rivers during April and May and so changes in netting effort and timing will also contribute to a reduction in the sea trout catch. The netting effort changes may account for a decline in the net catch of sea trout.

- The interspecific competition that exists between salmon and sea trout and its potential impact upon spawning success and juvenile survival is currently unknown.

Figure 8 - Declared sea trout rod and net catches- River Tavy – 1959 to 1997.



3.2 PARTICIPATION AND FISHERY VALUE.

3.2.1 Participation.

- Participation of anglers within the rod fishery has been obtained from the national catch return statistics, as compiled on a yearly basis by the Environment Agency. Following the implementation of a national licence return reminder system in 1994, the percentage of licences returned has increased substantially. However, owing to the fact that only two-thirds of anglers who return their licences to the Environment Agency also record the effort that they have put into the fishery (as requested since 1993), it is necessary to apply a correction factor of 1.5 to the catch effort data (number of anglers and number of days fished) to obtain an estimate of the total effort applied.

Table 4 - Rod fishery participation.

Number of Anglers		Days Fished		Total Number of Anglers		Total days fished	
1998	5 year mean (93-97)	1998	5 year mean (93-97)	1998	5 year mean (93-97)	1998	5 year mean (93-97)
78	76	1031	1160	156	152	1545	1740

Table 5 - Net fishery participation.

Licensees		Endorsees		Total netsmen		Days Fished	
1997	5 year mean (92-96)	1997	5 year mean (92-96)	1997	5 year mean (92-96)	1997	5 year mean (92-96)
5	5	20	19	25	24	115	278

- The 1998 figures have not been included within Table 5 due to the complete buy back of netting on the River Tavy in 1998.

- Under schedule 2 of the Salmon and Freshwater Fisheries Act 1975 (SAFFA 1975), licensed netsmen (Licensees) are entitled to employ additional netsmen (Endorsees) who aid the netsmen in the netting operation. The maximum number of endorsees is set and agreed for each river by the Environment Agency as set out in SAFFA 1975. Netsmen on the River Tavy are entitled to a maximum of 4 endorsees each. Endorsees are not permitted to use a salmon net in the absence of the net licence unless written permission is granted by the Agency.

3.2.2 Economic Evaluation of the Salmon Fishery.

Minimum Nett Economic Value.

- Until the introduction of salmon action plans, there has been no single means by which to measure the value of a salmon fishery on a given salmon river. Such measures are further confused by the differing perspectives of those involved in the fishery. As an example of this, anglers would be expected to value the fishery in a different way to the estuary netsmen or to local traders who may benefit from anglers' expenditure. The following calculation therefore attempts to calculate **Nett Economic Value** of a salmon fishery to the country and this is defined by summing the following components:

  - Value to fishery owners (calculated by estimating the market value of fishing rights).
  - Value to salmon anglers (calculated by estimating the consumers' (anglers) surplus).
  - Value to netsmen (calculated by estimating Nett profits from catch sales)

It is important to note that the estimated Nett Economic Value calculation includes some aspect of both the salmon and sea trout fisheries. As the fishery is not discrete for each of these species (particularly with regard to the rod fishery) this would appear to be a reasonable assumption.

Market value of the fishing rights

- This is defined as the present value of the capitalised future nett benefits to the owners of the fishery. The market value of a salmon fishery is a function of both the average annual rod catch and the value of each salmon caught within the fishery.

- In order to eliminate as much yearly variation from the rod catch data as possible, it would be appropriate to use a five year average of recent rod catches. However, as only a relatively small proportion of rod licence returns were received prior to the introduction of a national catch return licence reminder scheme in 1994, it would be prudent to only utilise declared catches from 1994 to 1996. In addition, to compensate for the 30 to 40% of anglers that still fail to make a catch return, the average annual declared catch has been multiplied by a correction factor of 1.1 (Small, 1998) to obtain an estimate of the total catch. The correction factor reflects the fact that 60% of anglers report 90% of the catch.

- Radford et al., (1991) performed a national survey in 1988 to establish the mean value of a salmon in various regions on England and Wales. Taking into account inflation within the intervening period, this study valued each rod caught salmon in the South West to be worth £9,000.

- The market value of the River Tavy rod fishery based upon the average annual total rod catch and the estimated value of a salmon in the South West is presented in Table (6).

Table 6 - Value of the fishery to fishery owners (Market value) and to salmon anglers (Anglers' consumers' surplus).

Mean declared rod catch 1994-96	Mean total rod catch 1994-96	Mean Regional value per salmon	Market (capital) value of the fishery	Ratio Anglers' consumers surplus : Market value	Anglers' consumers surplus
107	**118**	**£9,000**	**£1 million**	**1:1**	**£1 million**

***All economic valuation figures have been rounded to one significant figure.**

Anglers' Consumers' Surplus.

- This term describes a means by which an economic valuation can be put upon the value of the fishery to anglers. It can be defined as the difference between what anglers would be willing to pay for their fishing and what they actually pay. The final total for a given river represents the sum of the surpluses for all of the individual anglers who fish the river.

- There has only been one study to calculate the capitalised anglers' consumers' surplus of salmon anglers (Radford, 1984) and the techniques utilised in the assessment are complex. To simplify this, Radford (1984) attempted to make a comparison between the market value of the fishing rights and the capitalised anglers' surplus for four salmon

rivers throughout England and Wales. The resulting ratios obtained from this study were found to vary widely. Therefore, to ensure consistency on a national basis, the lowest ratio obtained (1:1) has been used as the basis for a conservative estimate of the capitalised anglers' consumers' surplus.

- In conclusion, for the purposes of this report, the capitalised anglers' consumers' surplus is taken to be equivalent to the estimated market value of the fishing rights (Table 5).

Value to the netsmen.

- The gross revenue to netsmen can be estimated by using the average declared weight of the two species of fish caught (salmon and sea trout) within the net fishery and the price (£) per unit weight received for the fish sold.

- Unlike the rod fishery, the small scale nature of the net fishery has ensured a consistent 100% return rate for net catches and as such the average of five years data (1992 to 1997) has been used to calculate the average declared net catch. Radford et al. (1991) surveyed the prices paid to netsmen for salmon and sea trout in England and Wales in 1988. Salmon from the South West were valued at £ 4.1 / kg and Sea Trout at £ 3.0 / kg. These figures would appear to be consistent with the current local market prices paid to netsmen for each species.

- In order to calculate the Nett profits to netsmen, it is necessary to subtract costs that they have incurred while operating the fishery, (i.e. Fuel, mooring charges, fishing gear, boat maintenance, cost of fishing licence etc.). Radford et al. (1991) assessed these costs in 1988 and found them to be on average (for England and Wales), 75% of the gross revenue. This figure has therefore been applied to the River Tavy netsmens' gross profit owing to the absence of any detailed information for the fishery.

- The Nett net fishery profits have been capitalised to ensure that the net fishery valuation is comparable to that of the capitalised rod fishery valuation.

Table 7 -Value to netsmen.

Species	Mean declared weight of fish (kg)	Price per kg	Gross revenue	Net profit	Capitlised Net profit
Salmon	**1138**	**£4.1**	**£5000**	**£1000**	**£10,000**
Sea trout	**153**	**£3**	**£500**	**£100**	**£1,000**

***All economic valuation figures have been rounded to one significant figure.**

Calculation of the Nett Economic Value.

- The minimum nett economic value for the River Tavy salmon and sea trout fisheries can be calculated by summing the components described above. The summary of the calculation is provided in **Table (8)**.

Table 8 - Fishery Nett Economic Value

Fishery component	Value*
Fishery owners.	**£ 1 million.**
Salmon anglers.	**£ 1 million.**
Netsmen.	**£10,000**
Minimum Nett Economic Value.	**£ 2 million**

*** All economic valuation figures have been rounded to one significant figure.**

3.2.3 Other Aspects of Economic Value

- In addition to the minimum estimate of nett economic value as described above, there are additional non-use values that apply to those that are not actively involved with the fishery. These include the following:

  - **Option value.** Defined as the value derived from having the option to participate in the fishery regardless of current involvement.
  - **Existence value.** Defined as the value of knowing that a stock of salmon and a salmon fishery exists on the river.
  - **Bequest value.** Defined as the value derived from knowing that the salmon stock and salmon fishery will be available for future generations.

- These values cannot be estimated at present. However, without doubt these values would be additive to the overall nett economic value of the fishery. Existence values in particular are known to be substantial on many rivers.

3.2.4 Impact of the rod fishery on the economy.

- This can be considered to be the economic activity generated by salmon fisheries within the area surrounding the fishery. This figure can be estimated by multiplying the average number of days which anglers spent fishing on the River Tavy by the average expenditure of salmon anglers per day fished. Radford et al. (1991) estimated the average expenditure by salmon and sea trout anglers in England and Wales to be £40 per day. The calculation of the estimated total anglers' expenditure is given in **Table (9)**.

Table 9 - Anglers' Expenditure.

Mean declared days fished 1994-96	Mean total days fished 1994-96	Expenditure per day	Total expenditure
1160	1740	£40	£70,000

- Although salmon anglers' expenditure is felt to be negligible on a national scale, it can be considered as more significant on a local level. The economy in Devon is heavily reliant on the tourist industry, and fishing represents a major attraction to many visiting the area. The above estimate of the impact of the fishery upon the local community's economy only takes into account resident anglers fishing on the river. Additional income would be generated by visiting anglers and as such, the total expenditure calculated in Table (9) should be viewed as a minimum estimate.

PART 4. DESCRIPTION OF STOCKS, CURRENT STATUS & RELEVANT TRENDS.

4.1 STOCK MONITORING.

- Comprehensive stock monitoring is a vital requirement in effective fisheries management. It is particularly important that it is performed when salmon stocks are known to be under pressure from a variety of sources. The Environment Agency and its predecessor organisations, have attempted to achieve this aim by targeting life cycle stages at times when physical river conditions have allowed data of a satisfactory precision to be obtained.
- It is useful to monitor all of the life stages of the salmon as each age class is subject to differing limiting factors. The quantified assessment of salmon stocks can be used to initiate more detailed investigations and where necessary, implement control procedures such as changes in legislation

- The methods utilised to monitor each of the salmon age classes within the River Tavy are as follows:

4.1.1 Adults.

- Declared rod and net catches provide a useful indicator on the yearly and historical runs of salmon into the river. However, as previously stated, this data is subject to many unknown factors. It is known that despite the introduction of a national licence return system in 1994, only 66% of anglers report their catches back to the Environment Agency. In addition, the rod catch cannot provide information on the runs of salmon that occur outside of the rod fishing season. Therefore, catch data can only provide an estimate of the total run occurring during the fishing season.

- The River Tavy does have the benefit of a fish counter that allows fish to be counted as they enter the river. The fish counts generated provide a first attempt to estimate migratory salmonid run within the Tavy.

- The hydroacoustic fish counter at Lopwell fish pass was installed in 1996. The counter provides a method to count upstream migrating salmonids without the need for extra weirs or other similar structures. Since 1997 a program of validation, including the use of video equipment has been assessing the performance of the counter.

- The counter is primarily aimed at providing information on the impact of the SWW abstraction on the movements of salmonids. Hydroacoustic fish counters are currently the subject of a great deal of research. Future developments could lead to the construction of a stock recruitment curves, in conjunction with juvenile survey data and a better understanding of exploitation rates.

Spawning adults: This can be assessed in two ways:

- By utilising the reported rod and net catch together with estimated exploitation rates to calculate salmon spawning estimates.
- By performing redd counts. Successful redd counting is reliant upon river conditions and historically both salmon and sea trout redds have been routinely counted and mapped throughout the catchment. Owing to budgetary constraints, this practice is now only performed on a limited basis. The results of redd counting performed in the late autumn and winter 1998 are discussed in section 4.3.

4.1.2 Juveniles.

- The River Tavy has been routinely sampled over the past twenty nine years. This sampling programme has been dedicated to producing accurate, quantifiable data on the abundance and health of salmonid and other fish populations within the river.

4.2 JUVENILE ABUNDANCE

Juvenile salmon can be considered as two separate age groups:

- **0+**. These are referred to as fry. They are fish that have hatched from eggs laid in the previous winter
- **>0+**. These are referred to as parr. They are young salmon that have spent at least one year in the river.

- Juvenile fish surveys are carried out on the Tavy catchment every three years as part of the Cornwall Area monitoring programme. In addition, a number of sites on the River Tavy and some of its tributaries are surveyed every year as a part of the Environment Agency's ALF monitoring programme.

4.2.1 Fry abundance

- The salmon fry densities recorded on the River Tavy in 1998 are presented in **Figure (9).** Figures 9 and 10 of salmon abundance are drawn up under the National Fisheries Classification Scheme Level One (FCS) (Absolute Abundance) (NRA 1994a).

- The salmon fry densities recorded in 1998 were lower than average for the upper Tavy catchment, although all were within the range of previous surveys. The best densities of fry were recorded on the main River Tavy and the main River Walkham.

- The highest salmon fry densities were recorded at Evan's Weir with a FCS grade of B. Other sites which achieved FCS grade B were found on the River Burn and on the River Walkham. Only 32% of sites sampled were FCS grade C or above with no sites grade A. No salmon fry were recorded at 42%.of the sites sampled. Grades D and E make up the remaining 26 % of the sites.

- Good densities of fry were also recorded from the River Burn with some production on the River Lumburn and Colly Brook.

4.2.2 Parr abundance

- The salmon parr densities recorded on the River Tavy in 1988 are presented in **Figure 10.**
- The 1998 survey showed that 59% of sites within the Tavy catchment achieved FCS class A-C. Parr were present at levels representing FCS class A at 35 % of sites sampled.
- The survival of salmon fry to parr within the Tavy catchment is very high. Although fry densities are often low, the survival from fry to parr is excellent. This would suggest that there is a limitation on spawning such as lack of suitable habitat or returning adults, and an abundance of habitat for parr production.
- Overall salmon parr production was generally good. Excellent production of parr was recorded in the main River Tavy and main River Walkham.
- The parr densities would suggest a high fry to parr survival rate, and therefore a relatively high production of smolts in relation to fry densities.

4.3 DISTRIBUTION OF SPAWNING AND UTILISATION OF THE CATCHMENT.

- Salmon have been recorded as far upstream as Coffin Wood on the River Tavy. The lack of spawning gravels between Coffin Wood and Tavy Cleave may deter further upstream migration. In addition, factors such as acidification within the moorland habitat and the impact of low flow as a result of the abstraction at Jewell's Leat may be inhibiting migration.
- The majority of the River Tavy and its tributaries support successful salmon spawning. The effects of flow can greatly affect the range of spawning within the catchment. Only during high autumn/winter flows are salmon able to penetrate the catchment up to the Wilsworthy Brook or Merrivale at the top of the River Walkham. On the River Tavy these problems are exacerbated as a result of abstraction for Hydropower generation. This has been shown through the results of radio tracking (Solomon, 1997).
- The upper reaches of the Cholwell Brook are inaccessible owing to the presence of a waterfall. The lower reaches of this tributary are subject to heavy metal contaminated water as a result of historical mining practices. This is the only tributary in the catchment that is unsuitable due to water quality.

Figure 9 – Fisheries Classification Scheme (FCS)–River Tavy–Salmon fry(0+) 1998

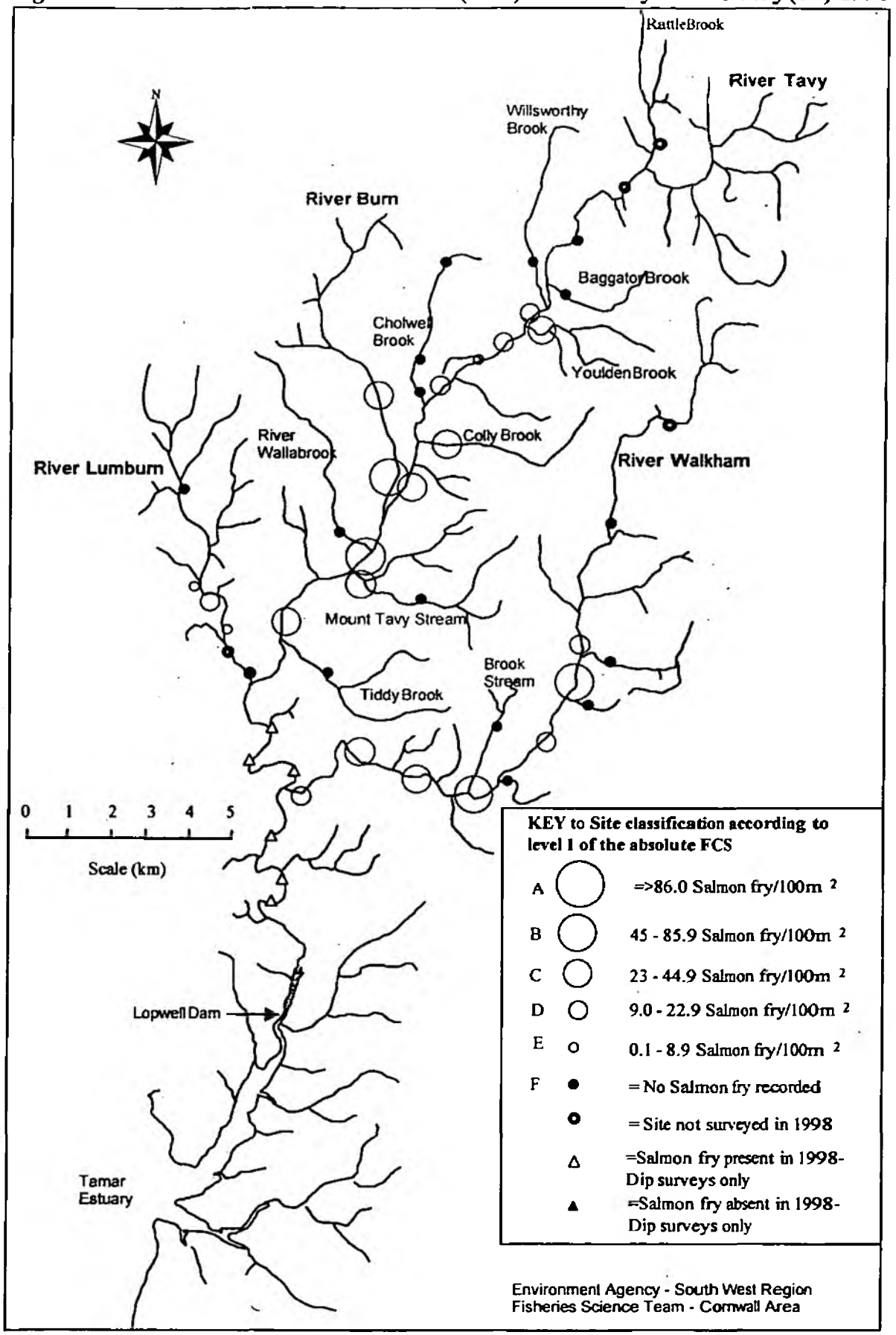
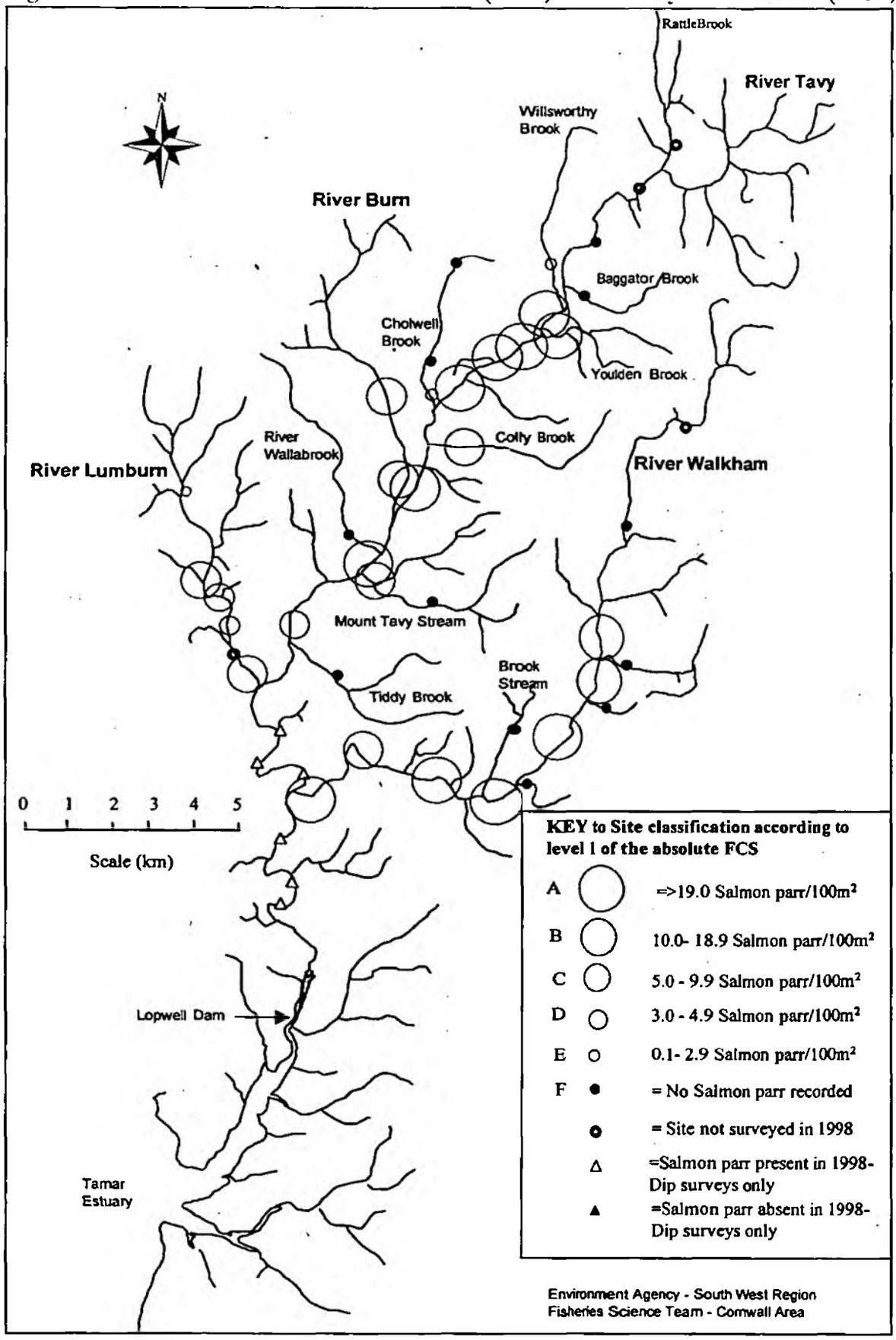


Figure 10 – Fisheries Classification Scheme (FCS)-River Tavy-Salmon Parr (>=1+)1998



- A redd count was performed throughout much of the Tavy catchment in the Autumn/Winter of 1998. Unfortunately the survey could not be completed due to adverse weather conditions in January 1999.

- The redd counts that were undertaken up until the end of December indicated that the majority of salmon that had spawned had done so in the River Walkham between Grenofen Bridge and Ward Bridge. Good numbers of redds were also observed on the main River Tavy as far as Hill Bridge.

- Redds were also recorded from the River Lumburn and Youlden Brook. Particularly good numbers were observed on the River Burn.

- On the occasion of the last redd count, 7 December 1998 a number of salmon were seen within the river that were yet to spawn. Their spawning would have occurred in the period when weather conditions prevented further redd counting.

PART 5. ASSESSMENT OF STOCK AND FISHERY PERFORMANCE.

5.1 SPAWNING TARGETS.

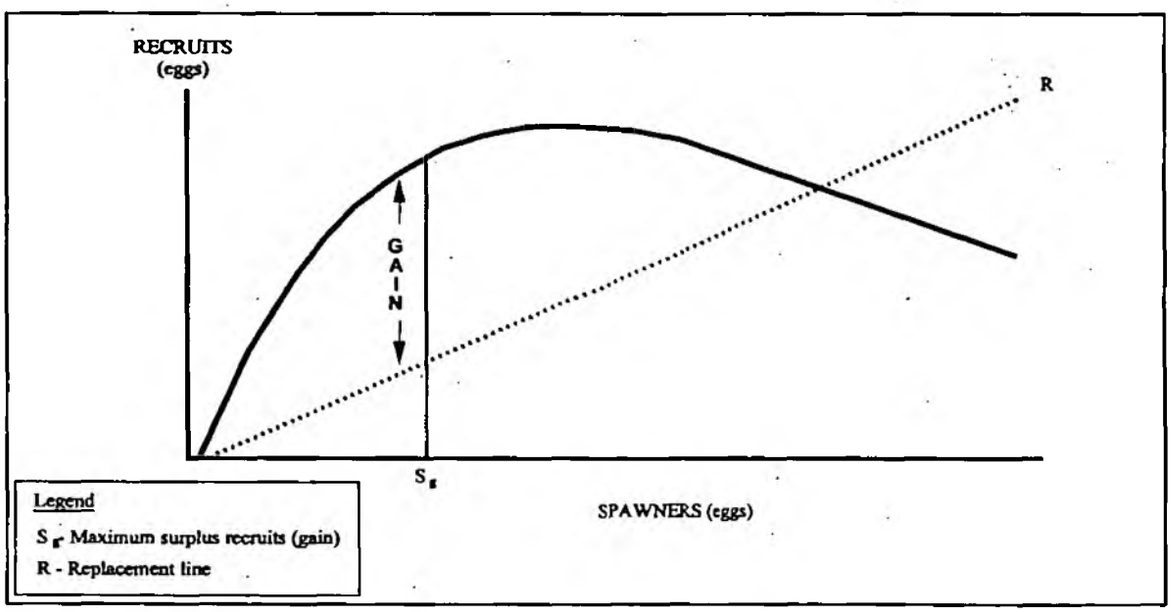
- The first objective of the Salmon Management Strategy is that:

"Individual salmon stocks and the environment in which they live should be managed to optimise recruitment to home water fisheries."

This objective needs to be expressed in terms of biological targets. To do this nationally requires a common approach to the setting of targets and the assessment of compliance across the Agency's regions (Environment Agency, 1996a).

- Several types of target can be set for the management of salmon. However, the International Council for the Exploitation of the Seas (ICES) has recently recommended that spawning stock at maximum gain should be the standard target defining the **Minimum Biological Acceptable Level (MBAL)** of a stock's abundance to assure its continuation.
- The relationship between spawners and recruits can be summarised as a stock-recruitment (S-R) curve **Figure (11).** The replacement line (R) represents the relationship between recruits and spawners and the difference between this and the S-R curve is referred to as "gain". These are the surplus fish (recruits) potentially returning to the system above the level required to replace the spawning stock that generated them. Maximum Gain S_g, is thus a mathematically unambiguous point on the curve.

Figure 11 - Diagrammatic stock recruitment curve



- MBAL has been definitively calculated for only one river in the UK – the River Bush, Northern Ireland. The target egg deposition for the Bush (563 eggs per $100m^2$ of "usable" habitat) is used as a benchmark which can be transported to other rivers using a system

devised by the Water Research Council (WRc). This is designed to take account of differences in stock composition (e.g. proportion of grilse and MSW salmon) and quality of juvenile habitat when transporting the target from the donor river (Bush) to the recipient river.

- MBAL has been adopted by the Environment Agency as the target most closely describing the objectives of the Salmon Strategy.

Table 10 - Parameters used to calculate the River Tavy salmon spawning target.

TARGET	VALUE
Maximum Gain (Sg)	**287 eggs 100 m^{-2} or 1.97 million eggs**
Spawners Equivalent to Sg egg target	**610**
Total Rod catch equivalent to Sg target	**90**
Declared rod catch equivalent to Sg target	**82**

Parameters used to calculate the above:
Wetted area available to salmon = 684,996 m^2
Marine Survival (to high seas fishery) = 22.3%
Fecundity = 5,585 eggs per female
Females = 57.5%
Post rod fishery mortality = 9 %
Rod exploitation = 14 %
Rod catch declaration = 91 %

- The calculation of the River Tavy salmon spawning target is summarised in Table (10). The spawning target corresponds to a total of 287 eggs per 100m^2 of the total wetted surface area of the River Tavy that is available to salmon. This equates to a total of 1.97 million eggs for the available wetted area of the whole catchment.

- The calculation of the wetted area available to salmon was estimated from length and width measurements taken directly from the River Tavy. Inaccessible tributaries where salmon are known to be absent have been excluded from this calculation. These included the Withill Stream upstream of the series of water falls and Cholwell Brook upstream of the natural falls.

- For the calculation of the spawning targets the catchment is split into habitat classes according to altitude and stream order (number of confluences with other tributaries). Within each habitat class at least three width measurements are taken, not more than 1 km apart. These widths measurements are then used to estimate the wetted area of river.

- Using knowledge of inaccessible reaches and the areas that are used for spawning, the proportion of spawning occurring in each habitat class is estimated. In this way, only areas accessible to salmon are included and the preferred areas of spawning are considered.
- The average fecundity, % females and % grilse estimates for the River Tavy, are based on river specific rod catch weight data obtained from the period 1992 to 1996.

- Marine survival, post rod fishery mortality and rod fishery exploitation have been estimated from recent research information undertaken on salmon populations throughout the UK.

- It is the objective of this plan to identify and promote actions that will enable the consistent achievement of the target egg deposition on the River Tavy within future years.

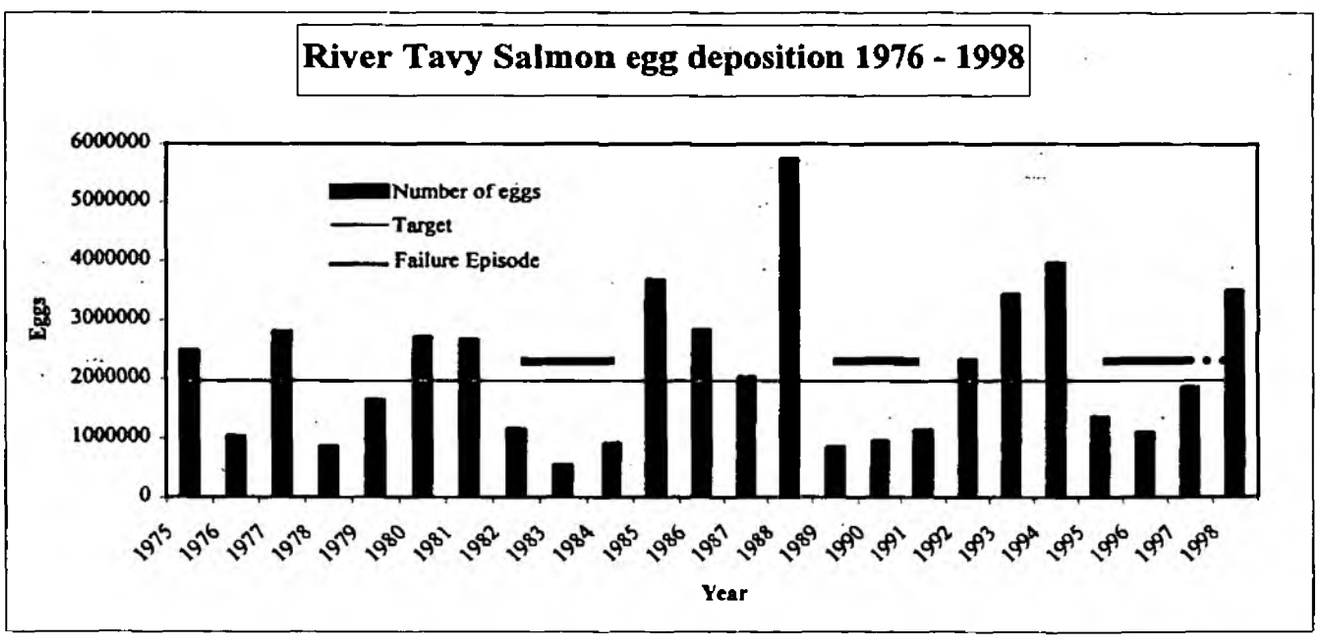
- It is realised that the current methodology used to calculate spawning targets is relatively crude. The implementation of spawning targets on a national basis will undoubtedly improve our understanding and lead to further refinement of the techniques used.

- The calculation of the current River Tavy spawning target should therefore be viewed as a first attempt.

5.1.1 Historic egg deposition and compliance assessment.

- Historic egg deposition for the River Tavy was calculated for the period 1986 to 1998, Figure(12). This has been calculated using total annual declared rod catches, in addition to estimates for rod fishery exploitation, marine survival, fecundity and post fishery mortality as shown in Table (10).

Figure 12 - River Tavy historic egg deposition compliance



- The methodology for assessing spawning target compliance has been developed by the WRc (1996). Essentially, a failure in the fishery's target occurs when either or both of the following criteria are met. They are:

  - When the calculated egg depositions within a consecutive period of more than two years (an episode) are below the target egg deposition value.

  - When the clear gap between subsequent target failure and an "episode" is less than two years.

- The graph indicates that in the last 10 years, compliance has not been met within the period 1989 to 1991 and again within the period 1995 to 1997. The Tavy is still currently classified as failing its target, and will continue to do so until there are two consecutive years of compliance. The failure period will cease if 1999 meets the target egg deposition, equating to a rod catch of 82 salmon.

- The failure within the period 1989 to 1991 can largely be explained by the fact that these years were impacted by the drought conditions experienced in 1989 and 1990. The resultant low river conditions would normally have reduced the availability of the predominant post June component of the catch to the rod anglers. In addition, low flows may also have had an impact upon juvenile survival and so reduced the run of one sea winter fish (grilse) in the following year. These factors would also reasonably explain the shortfall in the spawning target observed within the period 1995 to 1996. The failure in 1997 was seen across the country. Although river levels seemed to be higher, the number of adults returning to spawn was low

5.1.2 Expected catch.

- The historic River Tavy rod catches have been used to calculate the optimum salmon spawning targets and assess target compliance. In a similar way, the estimated optimal spawning target can also be used to calculate an equivalent rod catch. This target rod catch would therefore provide an indication that the salmon run in any one year was at a level that could meet the egg deposition target.

- On the River Tavy, the spawning target corresponds to a declared rod catch of 82 fish. This calculation assumes that the exploitation rate would remain at the 1996 rate. An increase in the exploitation rate would result in the calculation of a higher target rod catch. It is not known to what degree the Environment Agency's new salmon byelaws will affect the exploitation rate of salmon.

5.2 Freshwater Production

- The 1998 redd count survey identified that spawning salmon were spread throughout the expected range within the catchment. Adverse weather prevented a full assessment of the spawning population.

- Fry production in 1998 was lower than in recent years but within the range of historical data.

- Parr production in 1998 was excellent. The majority of sites which have historically supported parr production recorded excellent densities.

5.3 Diversity and Fitness.

- The second objective of the National Salmon Strategy states that the Agency will:

"maintain and where appropriate, improve the diversity and fitness of individual salmon stocks".

- To achieve this aim, the Agency will manage local salmon stocks, which are typically genetically distinct, in order to maintain and improve their diversity. The Agency will therefore prohibit the transfer of salmon stocks between river catchments, with the exception of where a river's stock has been lost.

- The decline of multi sea winter, spring salmon stock is of particular concern at both a local and national level. In the short term, we will attempt to protect these fish from over exploitation from both rod and net fisheries. In addition, there will be further investigations, both nationally and locally, into the reasons for their decline. The Agency will identify remedial measures to improve the abundance of the stock.

PART 6. LIMITING FACTORS.

- Factors which are currently limiting or have the potential in the future to limit the salmon stock and the salmon fishery on the River Tavy are listed below. The factors have been grouped into three major sub-headings which are as follows:

    - **Fishery** limiting factors.
    - **Biological** limiting factors.
    - **Environmental** limiting factors.

- The fishery and environmental limiting factors have been further divided into two sub groups which are:

    - **Fishery**: a) Management issue.
      b) Exploitation issues.

    - **Environmental**: a) Impacts upon the physical habitat.
      b) Impacts upon the chemical habitat.

6.1 Fishery limiting factors

a) Management issues.

- Inadequate monitoring of adult and smolt life cycle stages.
- Limited knowledge of the factors limiting juvenile survival and recruitment.

b) Exploitation issues.

- Legal Irish drift net fishery.
- Legal Licensed net fishery on the River Tavy estuary.
- Legal licensed rod fishery, particularly in relation to spring salmon.
- Illegal high seas fishery.
- Illegal coastal and estuarial fishing
- Illegal freshwater fishing.

6.2 Biological limiting factors

- Competition for spawning habitat from sea trout.
- Competition between juvenile salmonids for food.
- Competition for food at sea.
- Impact of mammalian and piscivorous predation in both marine and freshwater.
- Impact of avian predation of juveniles and smolts in both marine and freshwater.
- Impact of diseases and parasites

6.3 Environmental limiting factors.

a) Impacts upon the physical habitat.

- Impact of flows upon adult spawning distribution
- Impact of flow regulation upon juvenile habitat
- Impact of flows upon upstream migration.
- Impact of flows upon the utilisation of potential spawning tributaries.
- Impact of in stream structures such as weirs
- Impact of hydropower abstractions upon smolt migration.

b) Impacts upon the chemical habitat.

- Impact of significantly high levels of metals as a result of historic mining activity in catchment area especially in the Mary Tavy area (Cholwell Brook).

- Impact of eutrophication, resulting from Waste Water Treatment Works (WWTW) and fish farm discharges and other sources, upon instream macrophyte cover and algal production.
- Impact of acidification upon the survival of juvenile salmonids and in particular, salmon fry, (low pH from moorland geology and lack of buffering capacity).

- Impact of other chemical sanitary determinands (Dissolved oxygen, Biochemical Oxygen Demand (BOD), Ammonia etc.)

- Impact of hormones within WWTW wastewater that may impact upon sexual determination within the salmon population.

6.4 Issues

- The above list of limiting factors has been refined to those which are considered to have the most significant impact upon the salmon stock and the salmon fishery on the River Tavy. The following factors are deemed to be resolvable, although at this stage no assessment has been made of the financial cost. The issues are:

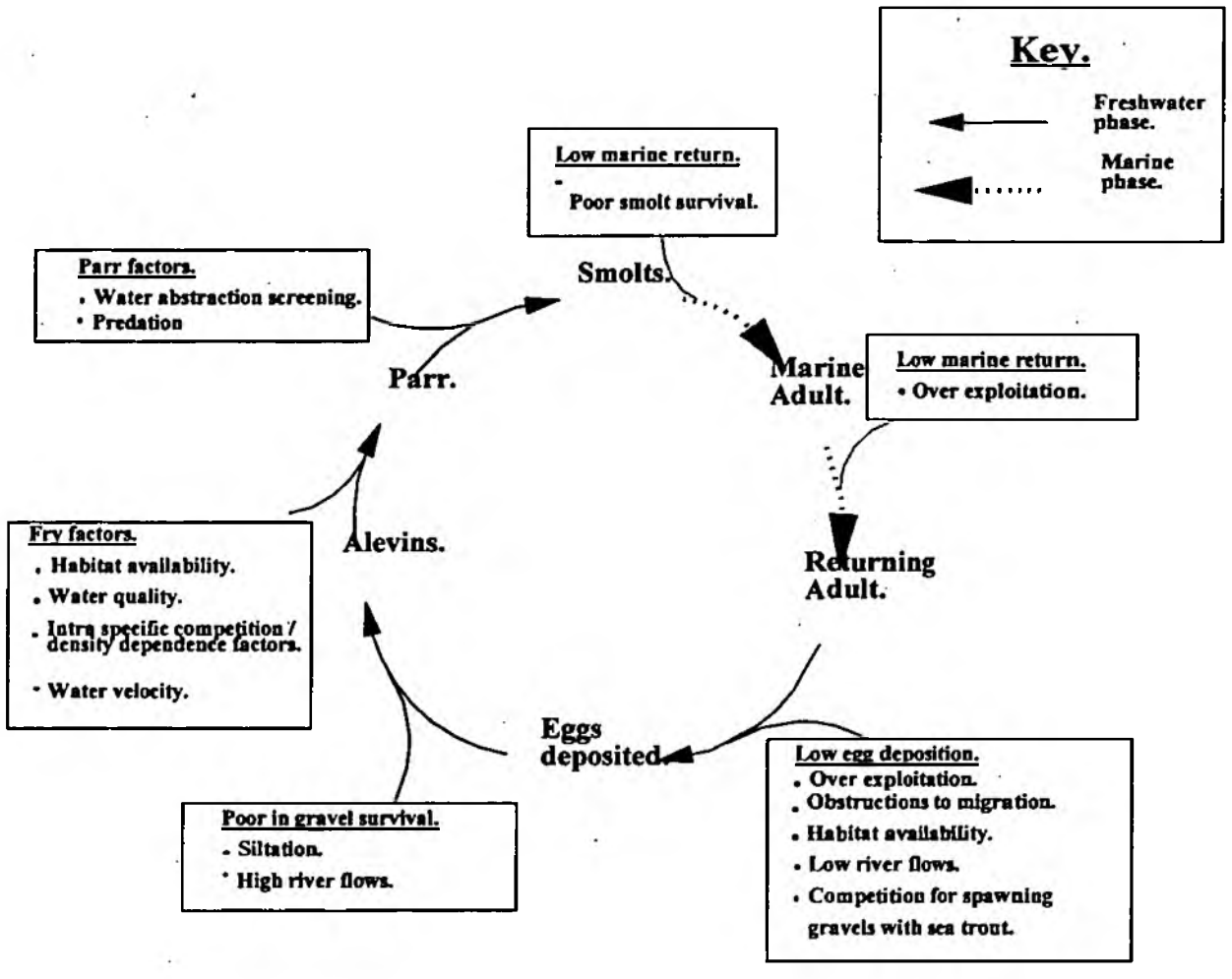
  - Licensed seine netting in the estuary.
  - Impact of flows upon adult upstream migration.
  - Impact of flows upon adult spawning distribution
  - Impact of flows on juvenile survival.
  - Limited knowledge of the factors limiting juvenile survival and recruitment
  - Illegal freshwater, estuary and coastal fishing.
  - Impact of instream structures such as weirs.
  - Loss of migrating smolts into unscreened hydropower leats.
  - Nutrient enrichment
  - Excess abstraction resulting in low flows
  - Impact of historic mining activity in Mary Tavy Region. Resulting in increase concentrations of metalliferous compounds.
  - Legal Irish drift net fishery.

- Figure (13) indicates the stages of the salmon life cycle that are subjected to these limiting factors.

- Appendix (2) provides more specific information on the factors influencing the marine phase of the life cycle.

- The limiting factors listed above, in addition to current ongoing initiatives are further discussed in Part 7. Issues and actions, (Table 11).

Figure 13 - Limiting factors impacting upon the salmon life cycle.



PART 7 ISSUES AND ACTIONS

Table 11 - Issues and Actions

ISSUE	ACTION	TIMESCALE					COST (£K) AND FUNDING SOURCES	Ref
(Priority: VH = very high, H = high, M = medium)		99/00	00/01	01/02	02/03	03/04		
Diminishing run size of pre – 1 June salmon								
Exploitation of pre 1 June salmon.	Introduce byelaw to change season	•					Agency – FER/ MAFF	TY1
	Restrictions to fishing methods	•	•	•	•	•	Agency – FER	TY2
	Voluntary bag limits						Riparian Owners/ Angling Clubs	TY3
	Introduction of catch limits (number/size).						Agency – FER	TY4
	Catch and release of early and late	•	•	•	•	•	Agency – FER	TY5
Inadequate monitoring of adult upstream migration								
Limited assessment of upstream adult migration	Verification of data from hydroacoustic fish counter at Lopwell	•	•	•	•	•	£15K Agency – FER/WR	TY6
Inadequate knowledge of factors impacting upon juvenile survival in the River Tavy								
Impact of chemical factors.	Investigate impact of hormones within WWTW effluent that may impact upon sexual determination within the salmon population	•	•				Agency – National R & D project.	TY7
	Investigate effect of other chemical sanitary determinands	•	•	•	•	•	Agency Core Work – EPr	TY8
	Perform an investigation into the cause and extent of metalliferous loadings and recommend options for reduction.						Agency/River interests	TY9
Impact of nutrient enrichment	Investigate effects of algal blooms and increased macrophyte growth due to WWTW and other sources.	•	•	•	•	•	£10K Agency – ALF Scheme	TY10
Impact of flow upon salmon migration and spawning distribution								
Impact of abstractions	Investigation of impact of flows upon salmon migration and distribution above Doublewaters (Radiotracking study).		•	•	•	•	£30K Agency – FER, WR	TY11
	Investigate effect of low flows on the chemical and physical habitat available to salmon.	•	•				Agency Institute for Hydrology - Phabsim	TY12
Exploitation of mixed salmon stocks in distant water fisheries.								
Exploitation by Irish drift nets	Assess the significance of the Irish fishery to exploitation on SW rivers.						CEFAS	TY13
	Seek further limit on Irish drift net catch of salmon entering the Tamar estuary complex.	•	•	•	•	•	MAFF / Agency / Riparian Interests	TY14

ISSUE (priority H = high M = medium)	ACTION	TIMESCALE 99/00	00/01	01/02	02/03	03/04	COST (£K) AND FUNDING SOURCES	Ref
Poaching								
Size of freshwater catchment, estuary and coastal area	Maximise frequency of targeted enforcement patrols	•	•	•	•	•	Agency core work with Riparian Owners / DSFC / MAFF / MoD / Police / Customs / QHM	TY15
Number of enforcement staff and resources	Maximise number of full time and part time enforcement officers	•	•	•	•	•	Agency core work	TY16
	Maximise use of available technology	•					£ 10 K Agency	TY17
Potential mortalities at licensed, in river abstractions								
Loss of juvenile salmon at water intakes.	Install appropriate smolt screening at abstraction points	•	•	•			£ 30 K	TY18
Restrictions to upstream salmon migration								
Restrictions to fish pass facilities at Lopwell Dam.	Improve fish pass facilities at Lopwell	•	•	•			£ 30 K Agency / SWW / WCRT	TY19
Exploitation of salmon by licensed netsmen due to impact of Lopwell Dam.	Reduce number of licensed netsmen on NLO.	•	•				Agency – 20 man days	TY20
	Negotiate early retirement of netsmen.						Riparian Owners / Agency / Other interested parties.	TY21
	Annual buyback of netting time.	•					Riparian owners / Agency / SWW	TY22
Restricted access to other tributaries from permanent structures.	Assess restrictions to access and formulate improvement works where feasible.		•	•	•	•	Agency – EPr / FER	TY23
Assess the impacts of temporary structures ('trash' dams) and remove where necessary.	Sensitive removal of 'trash' dams	•	•	•	•	•	Agency – Ongoing core work	TY24
Interspecific competition between salmon and sea trout.								
Impact upon spawning success and juvenile survival.	Investigate the interspecific competition that exists between the two species at various life cycle stages.						Agency	TY25

Key to Agency Sections:
FER – Fisheries, Ecology & Recreation
Epr – Environment Protection
WR – Water Resources

Other Parties:
MAFF – Ministry of Agriculture Fisheries & Food
DSFC – Devon Sea Fisheries Committee
MoD – Ministry of Defence
SWW – South West Water
WCRT – Westcountry Rivers Trust
QHM – Queen's Harbour Master.
CEFAS – Centre for Environmental, Fisheries and Aquatic Science.

PART 8. FUNDING THE PLAN

8.1 THE FUNDING BACKGROUND

- The Environment Agency currently spends about £9 million on salmon and sea trout fishery management, of which about 12% comes from rod licence income and 2% from net licences. 82% will come from Government grant in aid (GIA) during 1997/98. GIA continues to decrease, and a 5% reduction to £7.4 million occurred in 1997/98. The GIA for 1998/9 remains constant at £7.4 million but there is no increase for inflation. This is, in effect a 3-4% cut in the level of funding. Therefore, the Agency must look to secure funding from other sources to achieve objective four of the salmon strategy.

- At present there is a proposed cut in grant in aid for the year 2001/2002 of £1.5 million which will affect the fisheries work in England. If this comes into being there will have to be a reduction in the amount and range of work that we are able to do.

- The salmon action plan is a vehicle for promoting this and should creatively explore all avenues for alternative funding such as:

- Direct beneficiaries, i.e. riparian owners and angling clubs
- Local businesses.
- English Nature.
- Local wildlife trusts (Royal Society for Nature Conservation (RSNC))
- County Councils
- European community (through the Habitats Directive, LIFE Fund)
- National Lottery
- Millennium Fund
- Cross funding from other Agency functions
- Mitigation funds from SWWSL
- Sports Council
- The Tourist Board

8.2 CURRENT ACTIONS.

- In March 1996, the Freshwater Tamar and Tributaries Catchment Action Plan was published. This document identified many actions that are currently being performed by the various functions of the Environment Agency within the River Tavy catchment.

- The Cornwall Area Fisheries team budget for 1999/2000 is approximately £590,000. The budget will support 20 full time staff and 10 part time fisheries staff. A recent estimate indicated that 70% of the budget is used to fund work on salmonids. The majority of this work is performed on the rivers Tamar, Tavy, Lynher, Yealm, Plym Fowey and Camel.

- Fishery management activities that are currently ongoing or have recently been performed on the River Tavy are listed in Table (12). These activities represent work performed for the benefit of both salmon and sea trout. The activities have been funded by Agency

sources as outlined in section 8.1. In order to carry out the initiatives outlined in Table (11), further funding is required from non Agency Fisheries function sources.

Table 12 - Current activities undertaken by the Environment Agency within the River Tavy catchment.

Activity	Work continuing or undertaken on the River Tavy to date
Enforcement	• **Anti-poaching patrols in tidal waters** • **Anti-poaching patrols in freshwater** • **Byelaw monitoring and enforcement** • **Rod and licence checks**
Monitoring	• **Juvenile salmonid monitoring** • **Catch return analysis** • **Redd counting** • **Hydroacoustic fish counter validation and development**
Regulation	**Controlling the activities of others:** • **Development and planning liaison.** • **Abstractions and discharge consents.** • **Fish Stocking consents.** • **Licensed net fishery buyback.**

8.3 COLLABORATIVE FUNDING.

- There are a number of potential sources of collaborative funding potentially available to the Agency; Examples include the National Lottery, European Union sources and development agencies. Assistance from these sources has yet to be obtained for Agency work although such funding has been secured on other rivers within the UK. For example, EU funding was secured for habitat reinstatement work performed on the River Tweed.

- In many instances, it may prove to be more successful for the beneficiaries of the work to apply directly for funds. The Agency would provide advice and support for such applications.

PART 9. THE CONSULTATION PROCESS.

Step	Consult with	Means	Aim	Timescale
1	South West regional fisheries.	Circulate copy of draft plan.	Quality check; Ensure regional consistency.	Oct. 99
	Area Management Team.	Circulate copy of draft plan.	Account for cross functional comments. Ensure approval and agreement by RMT.	Oct. 99
	National salmon group.	Circulate copy of draft plan.	Quality check; Ensure consistency across agency.	Oct. 99
2	RFERAC	Circulate agreed draft plan to members for direct comment	Raise awareness and publicise process; Receive initial comments; initiate external consultation; Amend plan if necessary.	Oct. 99
3	External interest groups: AEG, Tavy fishing clubs and associations, riparian owners, Net licensees, South West Rivers Association, West Country Rivers Trust, Game Conservancy Trust, English Nature, CEFAS, SWWSL, Fisheries Forum	Press releases and circulation of draft documents to known contacts	• Raise awareness of and publicise consultation process. • Provide opportunity for all interests to review and comment	Nov 99 onwards

PART 9. THE CONSULTATION PROCESS.(Contd.)

Step	Consult with	Means	Aim	Timescale
4	Review feedback. Redraft plan and extend/amend responsibilities section.	Project team.	Account for external comment; accommodate accepted new issues and proposals for actions.	Feb 00
5	Respondents and interested parties.	Consultation meeting .	Finalise issues and actions for Final Plan	Feb 00
6	RFERAC, AEG and NSG.	Submit final plan to all groups.	Final endorsement.	March 00
7	RMT.	Submit final plan.	Final endorsement.	March 00
8		Publish and publicise final plan.	Achieve wide ranging awareness of plan and commitment to it.	April 00

PART 10. APPENDICES.

APPENDIX (1)

Spawning Targets in salmon management.

- In setting spawning targets, the Environment Agency is following the recommendation of NASCO (1995) and drawing on extensive experience in the use of targets for salmon management in North America since 1977. The basic rationale behind this approach is outlined below.

- The main reason for using targets in salmon management is to provide an objective standard against which to assess the status of the river's salmon stock. The standard is selected to ensure the long term sustainability of the stock and the fishery it supports. The principle is simple. The numbers of salmon a river can produce (and consequently the catches which result) are a function of the quality and quantity of accessible spawning and rearing area. This is why, in general, big rivers have larger catches and have correspondingly bigger total spawning requirements than small rivers. Thus, for any given size of river there should be a preferred or optimum level of stock which the target seeks to define.

- There are three stages in the use of targets: setting the target, estimating actual egg deposition and assessing compliance against the target. The procedures used are described in detail elsewhere (Environment Agency, 1996a).

- The Environment Agency defines targets in terms of optimum spawning levels, expressed as egg deposition (eggs laid per $100m^2$, or the total number of eggs per river). This is because spawning level is regarded by salmon biologists as the primary factor controlling the number of smolts likely to come out of a river section. On average, more eggs deposited means more smolts being produced, up to some level beyond which output levels off or may even decrease. This occurs because young salmon are strongly territorial and there is a maximum number that a river section can support. This level of production is often referred to as the carrying capacity. If data is available, then for a given river a curve can be plotted showing the change in smolt production (or adult "recruiting" back to fisheries) accompanying increasing spawning stock level. This is known as a "stock-recruitment" (S-R) curve. A characteristic feature of such curves, even when numbers are accurately and precisely measured, is the wide variation in recruitment which occurs at any one stock level; this is mainly due to the effects of random factors influencing survival.

- The target chosen for SAPS is derived from one recommended by NASCO which defines, from an S-R curve, that level of spawning which maximizes the sustainable catch (total catch, comprising all marine and freshwater fisheries), and it is termed the Minimal Biologically Acceptable Level (MBAL). If exploitation rate increases above the sustainable catch level then, although catch may temporarily increase, the stock will eventually reduce. Thus, MBAL is a threshold spawning level below which it is inadvisable to go. Indeed, in order to give some leeway on the estimate it is preferable to establish a long term spawning level rather higher than MBAL to insure against the effects of unforeseen exceptional events leading to low survival.

- Some buffer is incorporated into the statistical compliance procedure adopted in SAPS, but it may be felt that more insurance is desirable. This should be a local management decision and depends on circumstances. For example, particular uncertainty over the deposition estimates may lead a manager to set a higher target to reduce risk of the potentially damaging effect of overfishing.

- Because S-R curves are not available for most rivers, the procedures use one taken from the River Bush in Northern Ireland, where long term studies have given a working model of the relationship between spawners and recruits. The shape of a S-R curve is controlled by the productivity of the freshwater habitat and the survival rate. So, correcting for these features allows the Bush model to be transported to other rivers. This gives an improved approximation of a river-specific target.

- It is most important to recognise targets for what they are - valuable, objective reference points to guide managers in local stock assessment and a standard framework to report stock status nationally. Moreover, although spawning targets have been internationally accepted as a good working practice for some years, there is still a need for improvements in understanding and methodology.

- Numerous factors *could* lead to misinterpretation of a target set for a whole river. A particular problem is the possibility of stock structuring on large rivers which in theory might require targets to be set for different stock components originating from different parts of the catchment and having different age, run and exploitation characteristics. Currently, such tight sub-catchment management is impracticable, although special measures to protect or enhance run components, particularly spring-running fish, must be brought in when they are shown to be necessary. It may be possible for some rivers to define objectively separate spawning targets for grilse and multi sea-winter fish, and this is the subject of continuing research.

- Therefore, nominal "passing" or "failing" of targets *in isolation* does not guarantee a correct management decision. Professional scientific judgement, combined with consideration of the full range of other factors acting on a fishery is essential to come to the correct conclusions.

APPENDIX (2)

Limiting factors in the marine phase of the salmon life cycle.

- **Natural mortality**: Advice to NASCO suggests that in general there is an overall decreasing trend in survival during the marine phase over the last 5-10 years. Fewer smolts are therefore surviving to become salmon. Changes in ocean climate may be a factor. The abundance at sea of salmon which would return as multi-sea-winter fish is related to the availability of ocean at temperatures preferred by salmon (6-8 °C). The amount of such suitable thermal habitat has been lower in the 1980s and 1990s than during the 1970s (Reddin and Friedland 1996).

- **Greenland fishery:** There has been a net fishery on the west coast of Greenland since the 1960s. Catches peaked in 1971 at 2689 tonnes. Since 1976, only Greenlandic vessels fish it and the catch has usually been limited by an quota agreed at NASCO. Since 1993 the quota has been related to estimates of the pre-fishery abundance of salmon which have been declining. The fishery exploits only salmon that would have returned to Europe or North America as multi-sea-winter (MSW) fish. Prior to recent negotiated reductions in the quota for this fishery, the exploitation rate on the MSW component of English and Welsh stocks was estimated to be in the region of 10-20 per cent. In 1998, only a subsistence quota was allowed, amounting to 11 tonnes of which 2-3 tonnes were probably of european origins, mostly from the UK and Ireland. Current levels of exploitation of English and Welsh MSW salmon by this fishery are therefore at very low levels.

- **Faeroes fishery**: Also developed in the 1960s, this fishery uses long-lines. The catch peaked at 1027 tonnes in 1981 but exploits salmon of mainly northern European origin. Since 1991, the Faeroes quota, agreed at NASCO, has been bought out by the North Atlantic Salmon Fund.
  Prior to these buybacks, tag recoveries indicated that exploitation of salmon of English or Welsh origin were very low, perhaps 1 per cent. Since the buybacks began only a small research fishery has operated, in some years. Currently exploitation is therefore negligible.

- **Irish fishery:** The reported catch of salmon in Ireland increased from about 700 tonnes in the 1960s to a peak of over 2000 tonnes in the mid-1970s. This coincided with the expansion of a coastal drift net fishery. Of the Irish salmon catch, some 600 tonnes in 1998, probably more than half is taken by the drift nets. In 1997, new regulations were introduced restricting fishing to daylight within 6 miles of the coast and delaying the start of drift netting until 1 June. Tagging studies indicate that prior to these regulations, the Irish drift nets took a significant though variable proportion of the stock destined for English and Welsh rivers. Exploitation rates were low (~1%) for stocks in the north east of England, higher (~5%) for rivers in the north west and highest (perhaps 10-20%) for rivers on the south coast of England and Wales. The effects of the new regulations on the level of exploitation have not been assessed.

- **International fishery**: An unregulated high seas fishery operates in international waters by countries who are not signatories to the NASCO convention. In 1995, annual catches are thought to be 25 to 100 tonnes, comprising predominantly European stocks. Diplomatic efforts by NASCO have been made to restrict landings of these catches. There is no evidence that this fishery still operates, although surveillance has been limited.

- **Impact of fisheries for other species**: The potential catch of salmon post-smolts in marine fisheries continues to be a matter of concern. The fishery with the greatest potential for such a by-catch is probably the mackerel fishery near the Faeroes and in the international area of the Norwegian Sea. There is very little evidence that post-smolts are caught but the problem is difficult to assess.
  The British Government has proposed measures to ban sandeel fishing along the east coast of England and Scotland. This would principally be to protect certain bird species but it might also benefit stocks of salmon and sea trout.

PART 11. GLOSSARY

Accessible habitat: The total area of the catchment accessible to adult salmon.

Alevins: Juvenile salmon during the life stage between hatching and absorption of the yolk sac, whereupon they become free swimming and referred to as fry.

Broodstock: Adult salmon removed from the river catchment, to provide eggs/sperm, to produce artificially reared juveniles.

CEFAS: The Centre for Environment, Fisheries and Aquatic Science, formally known as the Directorate of Fisheries Research (DFR) section of MAFF. Involved with salmon research and data collation at national and international levels.

CPLD: Catch per Licence Day. This is calculated using the catch data and number of days fished recorded by anglers on their licence returns. The total number of fish caught is divided by the number of days fished. This statistic is comparable on a yearly basis and is essentially, a measure of fishing success, i.e. number of fish caught per unit of effort applied.

Exploitation: Removal of stock through legal / illegal fishing.

EC/EU: European Community/ European Union. As members of the EC/EU we are obliged to act upon European law, issued in the form of Directives.

Escapement: The stock remaining after exploitation.

Fecundity: The total number of eggs produced by one mature female.

Fry: Juvenile life stage between alevin and parr, where the alevin becomes free-swimming and actively hunts for food.

FTE: Full Time Equivalent - Equates to one fulltime member of staff

GIS: Geographic Information System, a computer programme used to estimate river channel lengths/width from high resolution digital maps.

ICES: International Council for the Exploration of the Seas. The mission of ICES is to collate, research and report data on the international status of salmon stocks.

MBAL: Minimum Biologically Acceptable Level. Defines, from a stock- recruitment curve, that level of spawning which maximises the sustainable catch (total catch, comprising all marine and freshwater fisheries).

Microtag: A coded wire tag of 1.5 mm long and 0.25mm diameter, inserted into the nasal cartilage (snout) of fish. Detectable in live fish, but only readable after removal.

Parr: Juvenile life stage, following fry, where the fish exhibit characteristic parr marks/bars as dark vertical stripes upon their flanks.

RE1,RE2: The targets for managing water quality are known as River Quality Objectives (RQOs); these are based on the River Ecosystem (RE) classification scheme. RE1 is described as water of very good quality suitable for all fish species, and RE2 is water of good quality suitable for all fish species.

Redd: Salmon 'nest' in river bed. Dug out of gravel/stony beds by spawning adults, with eggs deposited in displaced material.

Run: The number of adult salmon ascending, or smolts descending, a given river in a given year.

Siltation: Deposition of waterborne suspended solids in/on the river bed. Siltation blocks gaps between substrate particles, preventing the through passage of water, necessary for egg survival.

Smolt: Life stage between freshwater parr and seawater 'adult' phase, where parr undergo a process of pre-adaption to a saltwater environment. As a part of this process, smolts acquire a characteristic silver appearance, similar to adult salmon, prior to migration down river and out to sea.

Substrate: The composition of the river bed.

SWWSL: South West Water Services Limited.

The Agency: The Environment Agency, successors to the National Rivers Authority (NRA).

WRc: Water Research centre.

Year class: The population of salmon, of all life stages, resulting from one year's spawning.

PART 12. REFERENCES.

Cornwall River Board (1957) Seventh Annual Report.

Edmonds, E.A. et al (1975) British Regional Geology, South West England. N.E.R.G., Inst. of Geological Science, HMSO, London, 136pp.

Environment Agency (1996a). Salmon Action Plan Guidelines. Version 1 Bristol. (Unpub.).

Environment Agency (1996b) The Tamar Estuary and tributaries Local Environment Agency plan Consultation Report.

Environment Agency (1997) Fisheries catch statistics - 1995, Salmonid and Freshwater Fisheries Statistics for England and Wales.

Environment Agency (1998) Fisheries catch statistics - 1996, Salmonid and Freshwater Fisheries Statistics for England and Wales.

Environment Agency (1999) Fisheries catch statistics - 1997, Salmonid and Freshwater Fisheries Statistics for England and Wales.

National Rivers Authority (NRA) (1992) Fisheries catch statistics - 1991, Salmonid and Freshwater Fisheries Statistics for England and Wales.

National Rivers Authority (NRA) (1993) Fisheries catch statistics - 1992, Salmonid and Freshwater Fisheries Statistics for England and Wales.

National Rivers Authority (NRA) (1994a) Fisheries Classification Scheme - A guide for users. R&D Note 206.

National Rivers Authority (NRA) (1994b) Fisheries catch statistics - 1993, Salmonid and Freshwater Fisheries Statistics for England and Wales.

National Rivers Authority (NRA) (1995) Fisheries catch statistics - 1994, Salmonid and Freshwater Fisheries Statistics for England and Wales.

National Rivers Authority (NRA) (1996) A Strategy for the management of Salmon in England and Wales.

Potter, E.C.E. (1996). Predicted increases in the returns of multi-sea-winter salmon to home waters following the reduction in fishing at Faeroes and Greenland.

Radford (1984) The economics and value of recreational fisheries in England and Wales. Portsmouth Polytechnic.

Radford A.F, Hatcher A.C and Whitmarsh D.J (1991). An economic evaluation of salmon fisheries in Great Britain. Summary of a report prepared for the Ministry of Agriculture, Fisheries and Food. Portsmouth Polytechnic.

Reddin, D. and Friedland, K. (1996). Declines in Scottish spring salmon and thermal habitat in the Northwest Atlantic: How are they related?

Russell, I.C., Ives, M.J., Potter, E.C.E, Buckley, A.A and Duckett, L. (1995) Salmon and migratory trout statistics for England and Wales, 1951- 1991. Fisheries Research Data Report No. 38. MAFF 1995, 252 pp.

Solomon, D.J. (1993) Water Intakes on the Rivers Tavy and Teign. Consideration of requirements and design criteria for fish screens. Report for the National Rivers Authority – South West Region.

Solomon, D.J. (1997) The impact of flow and abstraction on the migration of salmon in the River Tavy. Analysis of radio tracking results 1991-1995.

Small (1988) Exploring data provided by angling for salmonids in the British Isles. P81-91. Catch effort sampling strategies; their application in fisheries management. Edited by I. Cowx publ. Fishing news books. Blackwell Scientific publications.

WRc (1981) Principles of statistical compliance.

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