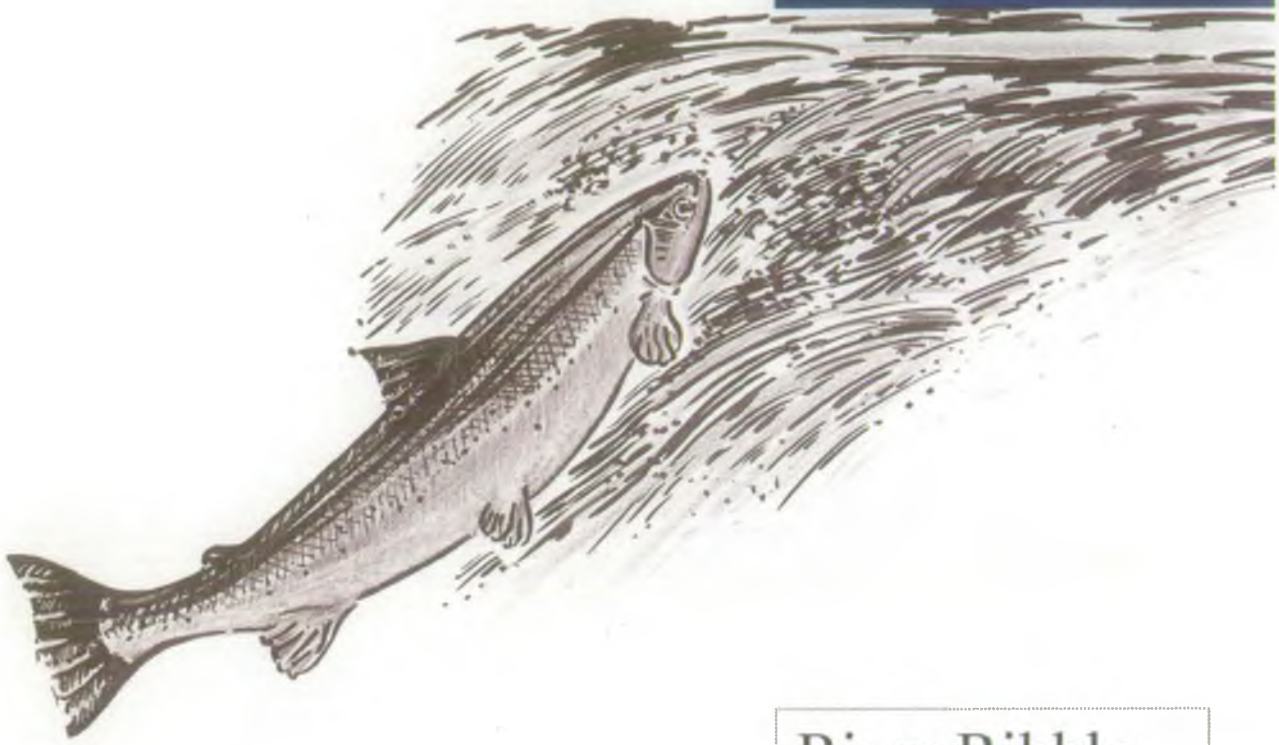
SALMON Action Plan CONSULTATION



River Ribble

September 1999

ENVIRONMENT AGENCY

EXECUTIVE SUMMARY

The River Ribble is one of the most heavily fished rivers in England and Wales, with historically high catches of salmon by both rods and estuarine nets. Over recent years net catches have reduced dramatically and most anglers and netsmen perceive that the Ribble salmon stock has declined.

The target egg deposition rate for the River Ribble, which should produce the maximum number of surplus fish returning to the system, has been estimated at 8.5 million salmon eggs. This will require 2,932 adult salmon to escape capture by rods and nets and survive to successfully spawn. Under current rates of rod and net exploitation, the target egg deposition will occur at a declared rod catch of 1,211 salmon and a declared net catch of 335 salmon.

Analysis of rod catch data suggests that the river has not met its target egg deposition in the period 1989 to 1997. A number of potential problems are raised in this document which may be responsible for the rivers failure to meet its target. Those with a high priority are considered to be:-

Issue	Limiting Factors	Options	Cost
Farming Practices	Existing farming operations can have detrimental effects on salmon populations and whole river ecology.	Encourage a change in farming practices to improve water quality and riparian habitat.	Approx. £12,000 pa
Lack of data on in-river populations	Difficulty in determining accurate egg deposition rates.	Gather and analyse more accurate data on catches and stocks. Electric fishing surveys of juvenile and spawning habitat.	Approx. £12,000 pa Approx. £20,000
In-river obstructions	Man made and natural obstructions prevent access to spawning and nursery areas.	Make man made obstructions passable and remove natural blockages where appropriate.	From approx. £2,000 to £60,000 per obstruction

The Environment Agency currently spends approximately £200,000 per year on fisheries work on the River Ribble. Government Grant in Aid (GIA) funds the majority of activities on salmonid fisheries with rod and net licence income contributing 14% of the total. The Government has reduced GIA by 50% over recent years.

The Environment Agency will work in partnership with everyone who shares our common goals, to secure funding and achieve the objectives of this Plan.

CONTENTS

PART 1 INTRODUCTION.

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

The Strategy concentrates on four main objectives for the management of salmon fisheries in England and Wales. These objectives (below) are primarily aimed at securing the well being of the stock but in doing so, will strive to improve catches and any associated economic returns to the fisheries.

* Optimise the number of salmon returning to homewater fisheries.
* Maintain and improve the fitness and diversity of salmon stocks.
* Optimise the total economic value of surplus stocks.
* Ensure the necessary costs are met by beneficiaries.

These four objectives will be addressed through local **Salmon Action Plans (SAPs)** which will be produced for each of the principle salmon rivers in England and Wales by the year 2001. Each plan will review the status of the stock and the fisheries on a particular river, seek to identify the main factors limiting performance, draw up and cost a list of options to address these, and consult with local interest groups.

A new concept introduced by SAPs is that of setting '**spawning targets**' to assess stock and fishery performance. This will provide a more objective approach than has previously been possible. The processes of target setting and compliance assessment are developing and are likely to be improved upon in coming years. Nevertheless, the targets described in this document represent a sound starting point for using this technique in the management of salmon stocks in England and Wales. It 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 Internationally.

In delivering each SAP it is essential that the Environment Agency seeks the support of local fishery owners and other interested parties. This collaborative approach is vital to secure the best way forward for our salmon rivers at a time when stocks are considered to be at an historic low, environmental pressures continue, and funding for salmon fisheries is diminishing. This document is presented for consultation. It will be circulated widely and is open to change and refinement in the light of comments received.

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 issues raised by local plans will cascade to Regional and National Plans which will focus 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.

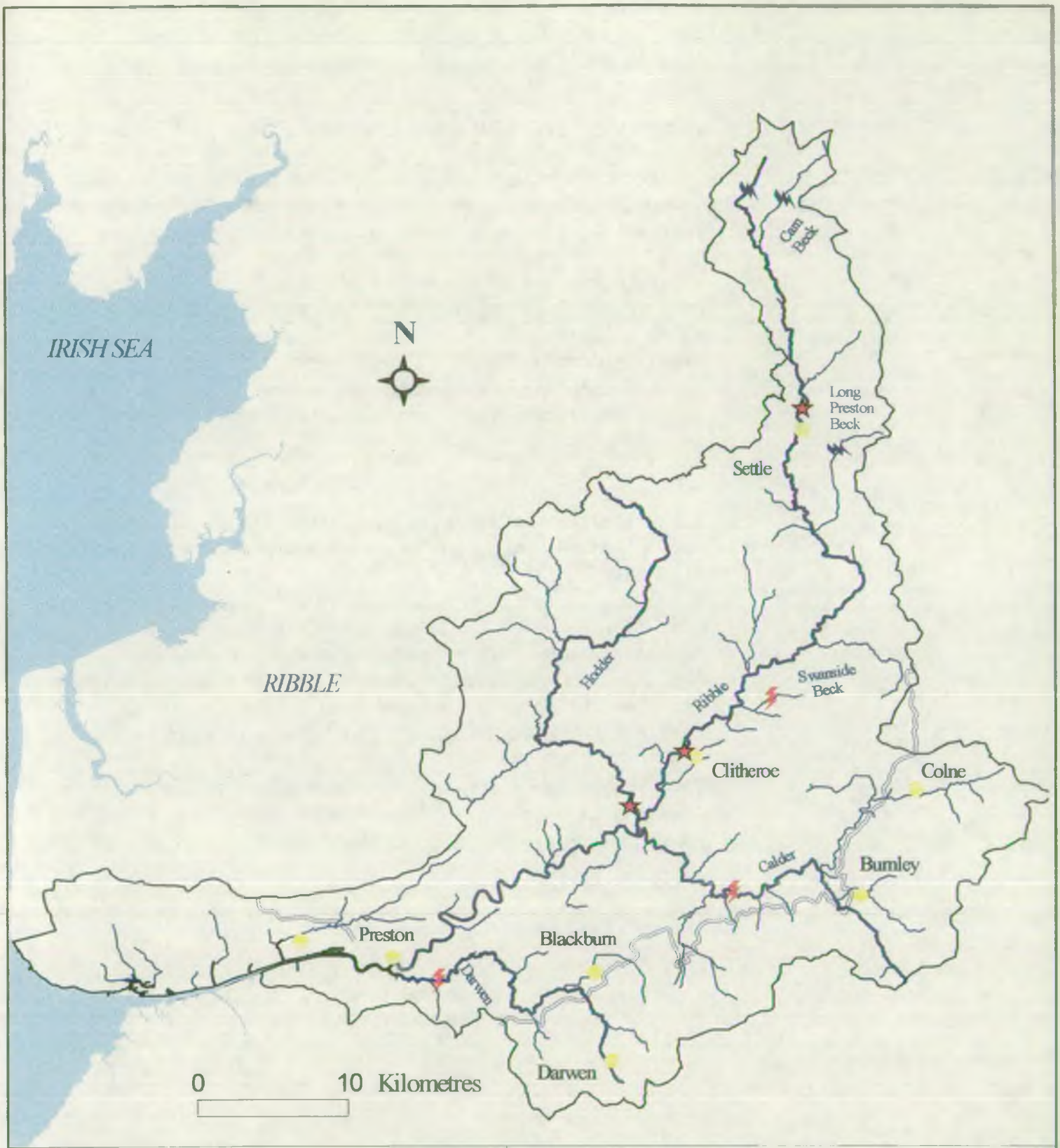
The River Ribble rises at Newby Head Moss (NGR SD 793845) in the Pennines, at an altitude of 422 metres. The river then passes through the Yorkshire Dales National Park and the Forest of Bowland, before entering the Irish Sea to the west of the town of Preston, a total distance of 110 km from source to sea (Map 1).

The middle stretch of the Ribble is joined, to the south of Clitheroe, by two major tributaries. The River Hodder rises in the Forest of Bowland and is heavily abstracted from for drinking water supplies. The River Calder is a river in recovery and has many polluting sources from minewater, contaminated land run-off and sewage discharges.

Two further large tributaries enter the Ribble in its lower reaches downstream of the tidal limit. The River Darwen drains the conurbations of Darwen and Blackburn and meets the Ribble at Preston. The River Douglas drains the conurbations of Wigan and Skelmersdale and enters the Ribble in the estuary, to the west of Preston. Major catchment descriptives are listed in Table 1.

Table 1 Catchment description.

Catchment Area	2,128 km^2
Principle land use	Predominantly pasture for cattle and sheep with industrial and urban areas particularly in the Calder sub-catchment.
River Water quality	Generally good or fair quality (River Ecosystem Classification [RE Class] 1, 2 or 3) with areas of the River Calder of poor water quality (RE Class 5).
Estuarine Water quality	Generally good (NWC class A or B).
Annual rainfall	Long term average of 888mm at Warton and 1193mm at Stainforth.
Average river flow	162 $m^3.s^{-1}$ at Samlesbury.
Major water abstractions	North West Water Ltd has 13 supply intakes, which can abstract 54 $m^3.s^{-1}$ (39 $m^3.s^{-1}$ from reservoir storage) and represent approximately 80% of the total surface water abstracted. Other major users are industry and fish farms. Groundwater is abstracted from aquifers through wells, boreholes and springs.
Underlying Geology	Predominantly Limestone and Millstone grit with Coal measures in the upper Calder catchment and an aquifer of Sherwood Sandstone in the lower Ribble.
Nature Conservation sites	Long Preston Deeps SSSI, Ribble Estuary SSSI, RAMSAR site and SPA, Plus 31 other non-riverine SSSI's.
Impassable Obstructions	Padiham Weir on the River Calder (SD 788 331) excludes 64 km of river. Roach Bridge Weir on the River Darwen (SD 595 288) excludes 40 km of river. Others exclude an approximate total 40 km of river.



Map 1: The Ribble Catchment

ENVIRONMENT AGENCY

- Main Town
- Impassable Obstructions (Manmade)
- Impassable Obstructions (Natural)
- ★ Fish Counter

PART 3 DESCRIPTION OF THE FISHERIES.

The River Ribble contains a number of fish species that are actively sought by both rod fishermen and netsmen. Since this action plan relates to salmon, this will be the species referred to most in this document, with some reference to sea trout. The principal fisheries are described below.

Rods

* The rod fishery operates annually for salmon on the River Ribble and it's main tributary the River Hodder. It also extends into the Lower River Calder.
* Season is open from February 1st until October 31st inclusive.
* Much of the fishing is controlled by angling clubs.
* A small number of day-ticket waters for salmon, trout and coarse fishing are available.

Drift Nets

* The netting season operates from April 1st until August 31st inclusive.
* The number of nets is limited by Net Limitation Order (NLO) to six.
* Fishing is permitted at any time except between 6am on Saturday and 6am on Monday.
* The fishery operates in the Ribble Estuary seaward of a line drawn true south from the Naze, at Freckleton, up to the six mile limit.
* Nets must be unarmoured and consist of a single wall of netting not more than 140 metres in length and not more than 34 meshes deep at any point.
* The mesh size of the nets should measure not less than 82 mm knot to knot, or 328 mm around the four sides when measured wet.

Marine Nets

* This fishery will be dealt with in more detail in Section 6.2 of this report. It comprises:- Greenland Fishery, Faroes Fishery, High seas fishery in international waters, and the Irish Fishery.

3.1 Catches and Exploitation

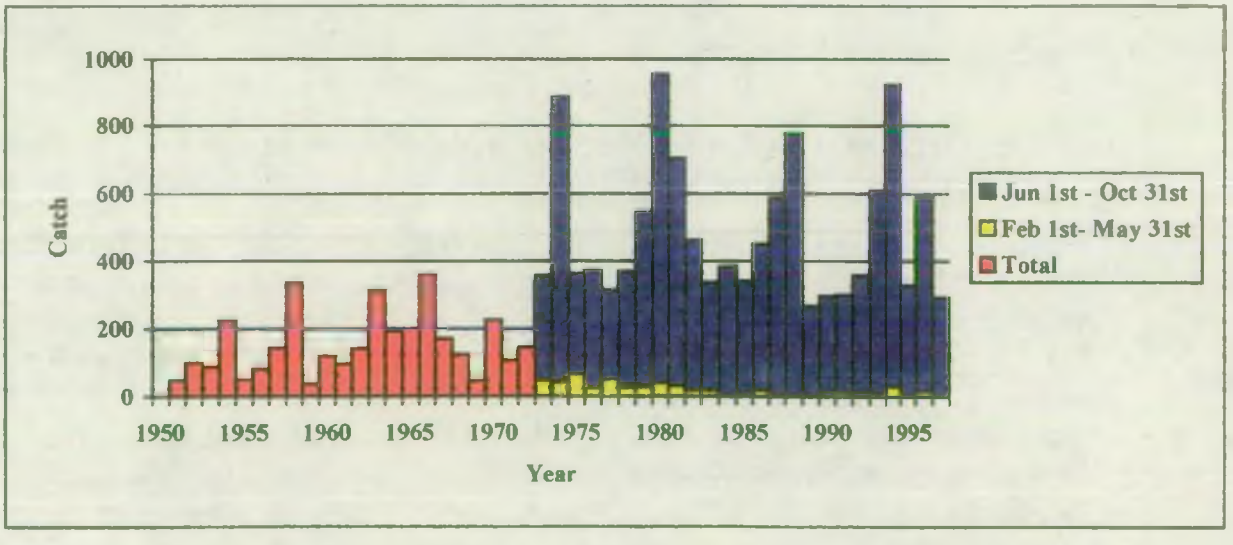
3.1.1 Salmon

Reported annual catches of salmon by both the rod and net fisheries have fluctuated widely over the period 1951 to 1997. An improvement in the catch reporting system was introduced in 1973, resulting in an increased declaration rate and requiring the month of capture to be recorded. This therefore allowed the identification of the early running stock component, i.e. salmon caught before June 1st. Prior to 1973, only a total annual catch is shown, as the month of capture was not reported.

* Prior to 1973, declared rod catches were relatively low, averaging 154 salmon per year, with annual reported catches ranging from 38 to 362.
* Thereafter, the declared annual catches increased, ranging from 268 to 956 and averaging 488 salmon per year.
* Since 1973, the pre-June rod catch has been relatively low, averaging 23 and ranging from 5 to 69 salmon per year, (Figure 1).

Fishing effort is an important determinant of catch but the extent to which these observed variations in catch are reflected by variations in fishing effort is unclear. Nationally, there has been an increase in the number of salmon anglers over this time period. In addition, the declaration of rod catches has varied over the years. For example, the declaration rate increased in 1991, following the issue of reminder letters to anglers.

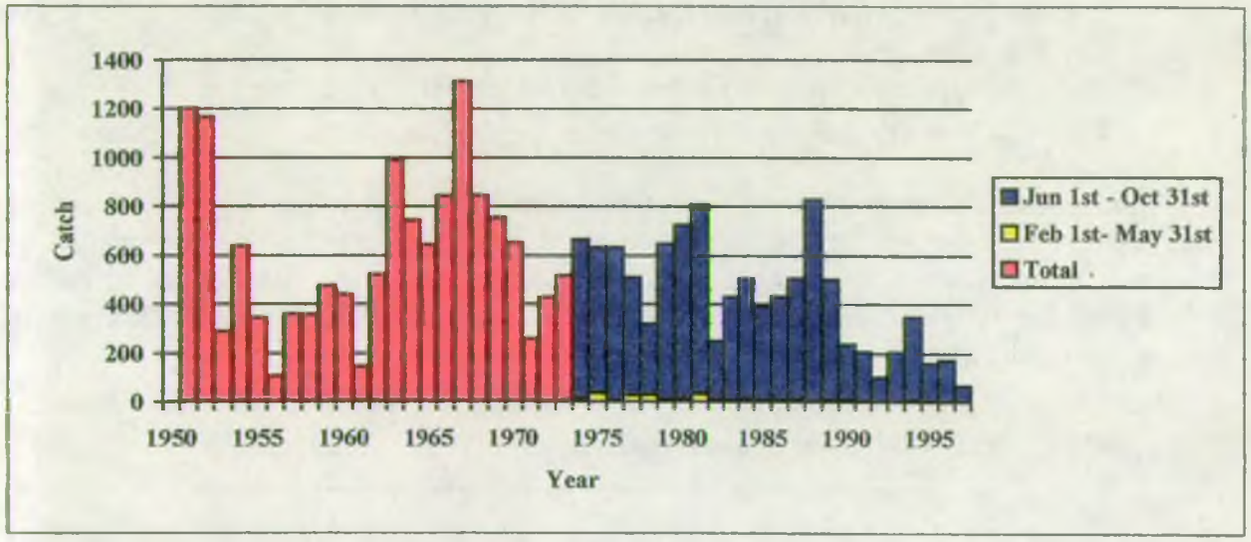
Figure 1 Declared salmon rod catches, 1951-1997.



* Declared annual net catches prior to 1973 ranged from 106 to 1314, averaging 616 salmon per year.
* Thereafter the declared annual catches decreased, ranging from 69 to 829, and averaging 433 salmon per year.
* Since 1973 the pre-June net catch has averaged 10, ranging from 0 to 33 salmon per year, (Figure 2).

The fishing effort, in terms of licences issued for the net fishery, has remained relatively constant, with six drift nets operating in the Ribble estuary for the whole period from 1951 to present.

Figure 2 Declared salmon estuarine net catches, 1951-1997.



There is a clear seasonal distribution in the declared rod catches of salmon for both the Ribble and it's main tributary, the River Hodder.

* Over the period 1993 to 1997, the average monthly rod catches for both rivers increase through the year, reaching their peak in October, (Figures 3 and 4 for the Ribble and Hodder respectively).
* On average, the declared October rod catch constitutes 50% of the annual River Ribble catch and 66% of the annual catch from the River Hodder.
* The proportion of the average catch from the Ribble that is taken before June 1st is relatively low at 3%, and is lower still for the Hodder at approximately 0.5%.
* Declared rod catches for the River Ribble are approximately six times greater than those for the River Hodder.

Figure 3 Average declared monthly rod catches - River Ribble, 1993-1997.

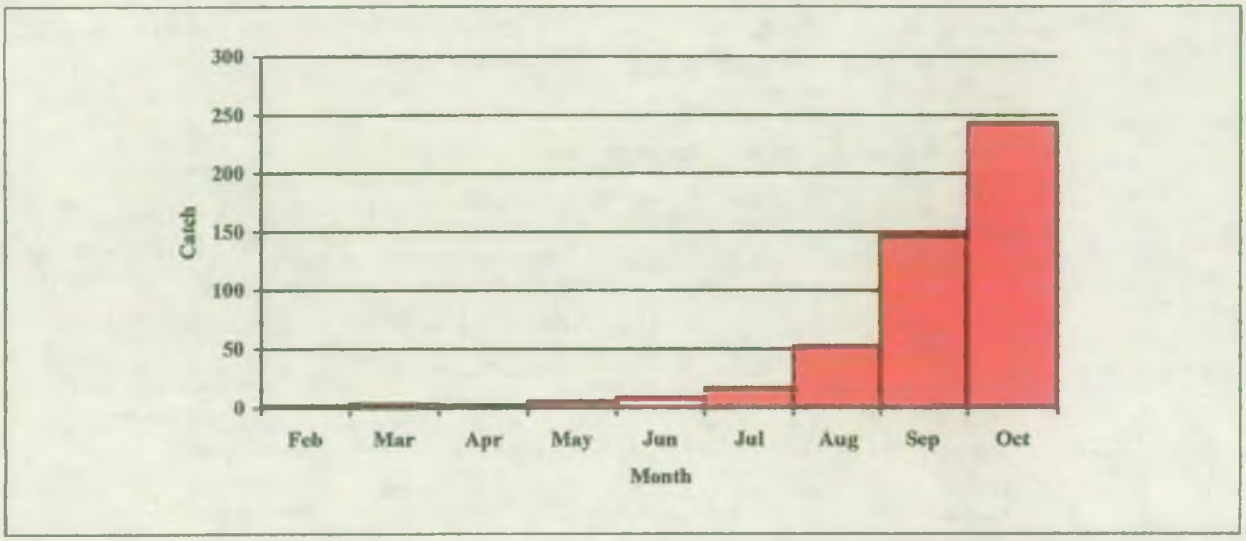
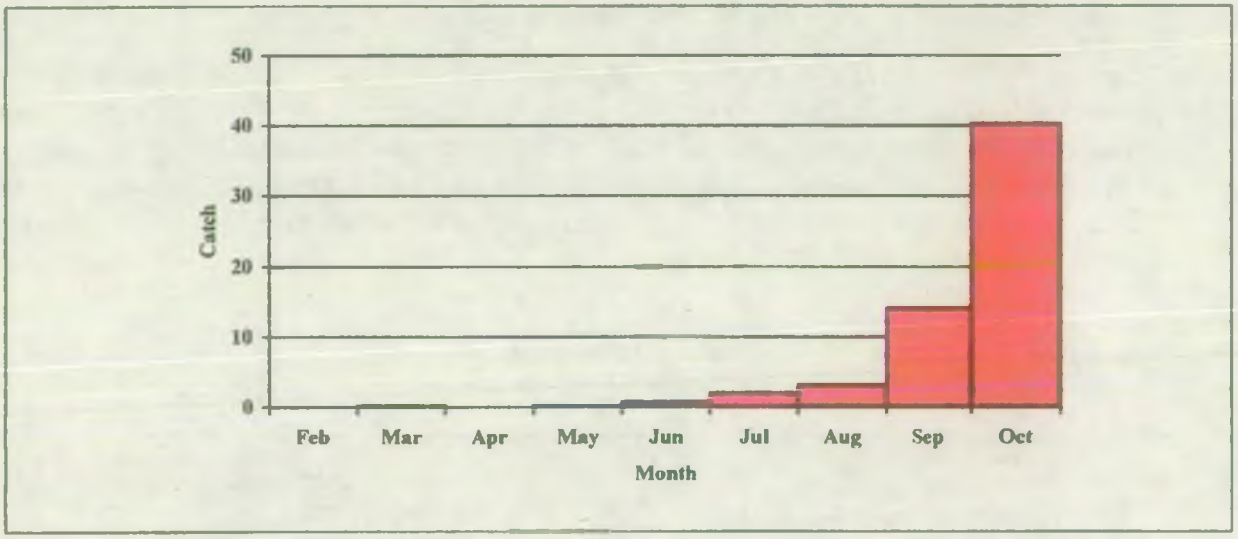


Figure 4 Average declared monthly rod catches - River Hodder, 1993-1997.



3.1.2 Spring salmon.

Catch returns suggest that spring salmon do not appear to have comprised a significant proportion of the Ribble stock. Recent catch data for both the rod and line and estuarine net fisheries on the River Ribble show that the pre-June catch (the spring salmon component) currently constitutes a small proportion (1-2%) of the total annual catch (Table 2).

Table 2 Rod and net catch summary.

	PRE-1st-JUNE CATCH		POST-1st-JUNE CATCH		ANNUAL CATCH		CATCH PER LICENCE DAY	
	1997	Mean '92-'96	1997	Mean '92-'96	1997	Mean '92-'96	1997	Mean '92-'96
RODS	7	14	278	558	293*	576†	0.021	0.052#
NETS	1	2	68	195	69	197	0.36	0.75

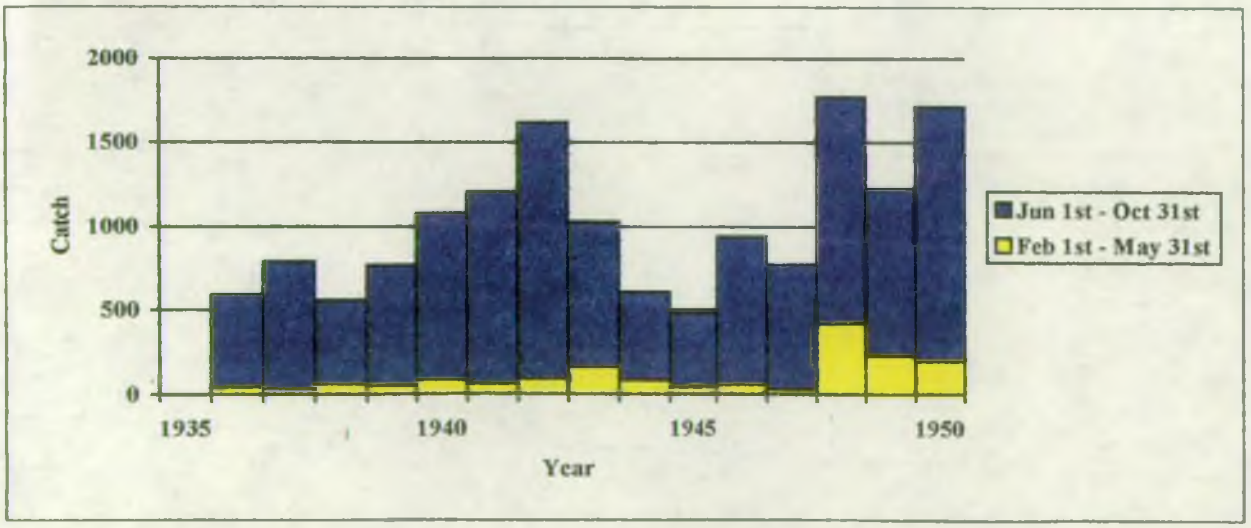
* includes 8 salmon for which date of capture was unknown

† includes 17 salmon for which date of capture was unknown

\# rod effort data not available for 1992. Mean refers to '93 to '96 inclusive

During the period 1936 to 1950, the catches declared by the estuarine nets indicate that the percentage of the annual salmon catch that was taken prior to June 1st was approximately 11%, (Figure 5). In contrast, the percentage of the annual catch that was taken before June 1st in the period 1988 to 1997 was approximately 1%. This decline in spring salmon catches suggests a decrease in the abundance of this component of the stock but may also reflect a decrease in fishing effort.

Figure 5 Declared net catches, 1936-1950.



3.1.3 Sea trout.

Sea trout form an important component of the migratory salmonid fishery on the Ribble. Both the declared rod and net catches of sea trout appear to be increasing. This is particularly true of the net catch where almost no sea trout were declared until the late 1970's. However, these may reflect an increase in fishing effort in the rod fishery or an increase in the declaration rate for both fisheries (Figures 6 & 7).

Figure 6 Sea trout rod catches, 1951-1997.

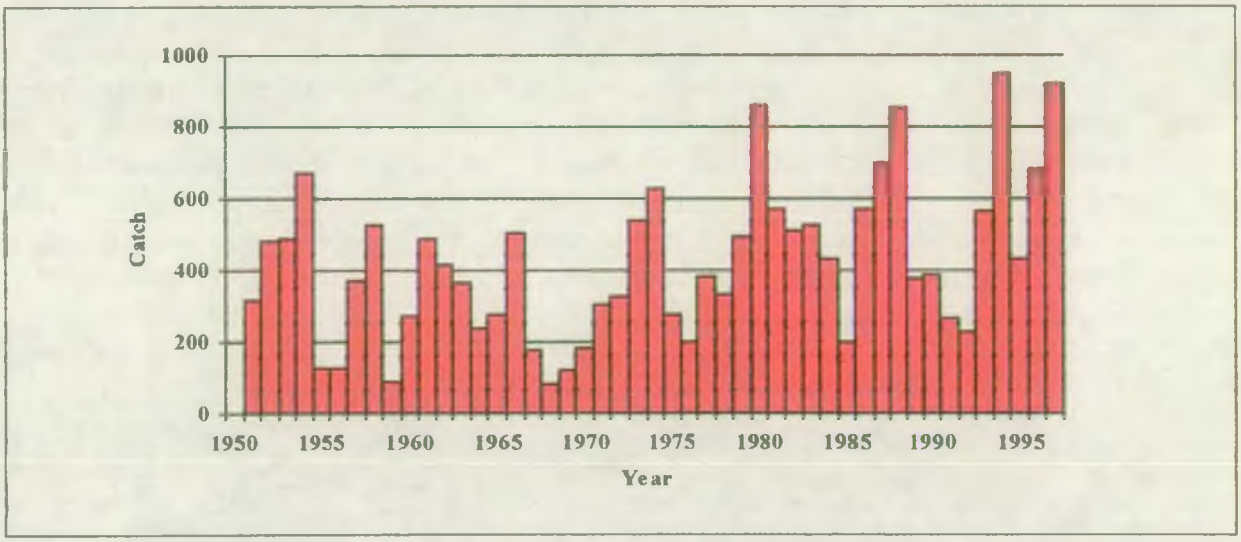
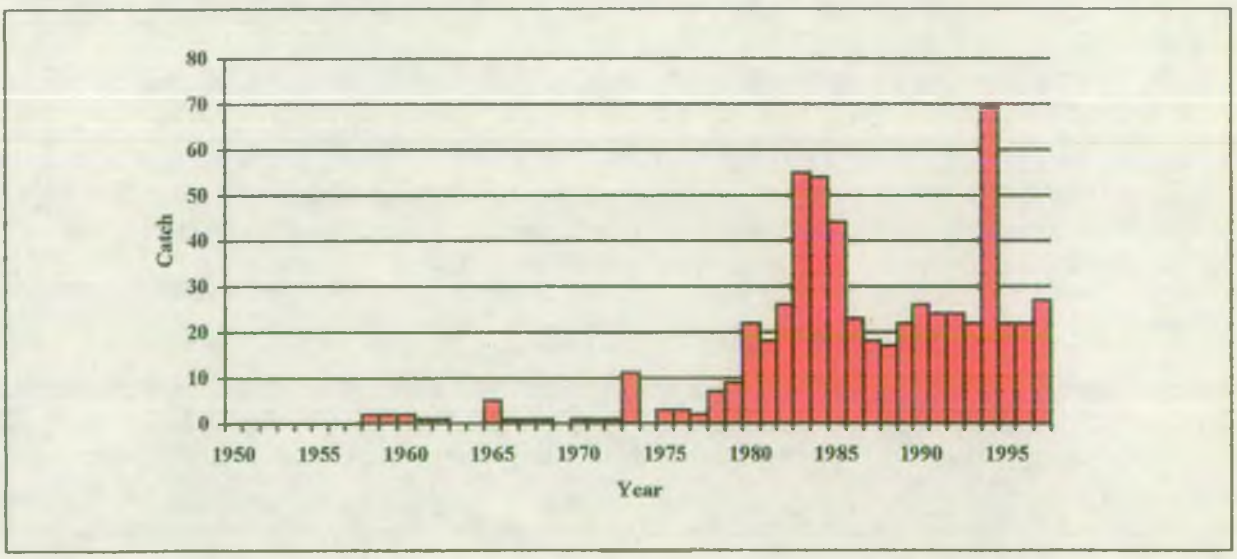


Figure 7 Sea trout net catch 1951-1997.



3.2 Participation and Fishery Value.

3.2.1. Participation.

Of the migratory salmonid rod licences that are issued nationally, approximately one quarter are issued within North West Region, which encompasses the Ribble catchment. This highlights the importance of the salmonid fisheries within North West Region but it should be recognised that not all of these anglers will be fishing the Ribble and anglers are likely to travel between Regions. The participation by resident and visiting anglers on the Ribble carries important implications for the economic valuation of the fishery. However, data are currently unavailable on the respective proportions of these two groups of anglers participating in the Ribble fishery.
The number of days fished by all anglers on the River Ribble has been determined from statutory licence returns. These are an estimate, since approximately two thirds of licence holders report their fishing effort, and participation relates to both salmon and sea trout angling. These data indicate that relatively consistent angling effort is undertaken each year (Table 3). Comparison with rod effort data from other rivers indicates that the River Ribble is one of the top five most fished rivers in England and Wales, (Source:- Salmonid and Freshwater Fisheries Statistics for England and Wales, 1997).

Table 3 Rod Fishery Participation.

NUMBER OF MIGRATORY SALMONID ROD LICENCES ISSUED (NW REGION)		NUMBER OF DAYS FISHED (RIVER RIBBLE)	
1997	Mean '94 – '96	1997	Mean '94 – '96
7681	8942	13612	12398

Participation by the estuarine drift net fishery on the River Ribble is also determined from statutory licence returns. Endorsees are able to use the licensed instrument provided that they are accompanied at all times by the licence holder or have consent from the Environment Agency if the licence holder is unable to accompany them through illness or injury. Netting effort has been relatively consistent over recent years, and also in the longer term; the number of drift net licences issued has remained at six since 1951, (Table 4).

Table 4 Drift Net Fishery Participation.

LICENSEES		ENDORSEES		TOTAL NETSMEN		TIDES FISHED	
1997	Mean '92 - '96	1997	Mean '92 - '96	1997	Mean '92 - '96	1997	Mean '92 - '96
6	6	18	16	24	22	213	313

3.2.2 Economic evaluation.

The value of a salmonid fishery depends on the perspective of those associated with it. To a hotelier near to the river it is reflected in the number of rooms booked by anglers and the prices that they are willing to pay. To an angler the worth of the fishery is reflected in the enjoyment that they receive from the activity; to a netsman it may be the profit made from the catch itself. Even those not directly involved in fishing for salmon may value the fishery and the stock that it exploits.

Environmental Economics seeks to place values on environmental activities. It is possible to approximate the Total Economic Value of the River Ribble salmon fishery from: -

* Use Values, those arising from actual use made of the fishery and dependent on the annual catch;
* Non Use Values, those not necessarily related to the annual catch.

3.2.2.1 Use values.

Value to the Fishery Owners or the Market Value of the fishing rights. This is a measure of the present value of the capitalised future nett benefit to the owners of those fisheries. It is largely a function of the average annual catch multiplied by a raising factor to account for non-declaration and by an average value per salmon. The value of fishing for other species is included within this figure and therefore it should be considered to be an estimate rather than an exact value.

Value to the anglers or Anglers' Consumers' Surplus. This is the difference between what the anglers are willing to pay for their fishing and what they actually pay at the moment. Calculations of this value vary widely between rivers. A crude estimate would be that it is equivalent to the market value of the rod fishery when capitalised.
These aspects of the salmon fishery value are calculated in Table 5.

Table 5 Value to fishery owners (Market value) and to salmon anglers (Anglers' Consumers' surplus).

Mean declared rod catch 1996-97	Mean total rod catch 1996-97 (assume 91% declaration)	Mean Regional value per salmon	Market (capital) value to rod fishery	Ratio of Anglers' Consumers' Surplus : Market Value	Anglers' Consumers' Surplus
441	484	£7,000	£3.4 million	1:1	£3.4 million

Value to the netsmen. This is based on the average prices paid for both salmon and sea trout in 1995 and subtracting the costs of operating the fishery in respect of fuel, mooring charges, licences etc. (calculated as 40% of the gross revenue). This value is then capitalised to produce a nett profit and is calculated in Table 6.

Table 6 Value to the estuarine netsmen.

Species	Mean weight of declared catch '93-'97	Price per Kg	Gross revenue	Nett profit	Capitalised nett profit
Salmon	856 Kg	£3.30	£2,800	£1,700	£12,000
Sea trout	86 Kg	£2.50	£215	£130	£900

The minimum nett economic value of the River Ribble fishery is calculated as the sum of these use values and can be estimated at approximately £6.8 million, (Table 7).

Table 7 Fishery Nett Economic Value.

VALUE	£
To fishery owners	3.4 million
To salmon anglers	3.4 million
To netsmen	13,000
Minimum Nett Economic Value	6.8 million

3.2.2.2 Non use values.

Determination of non-use values is difficult and beyond the scope of this report. However, they cannot be taken to be negligible. Non use values can be defined as: -

* **Bequest Value**. The benefit accruing from the knowledge that others might benefit from the salmon fishery in the future.
* **Existence Value**. The benefit gained by the general public from the knowledge that there are salmon in the River Ribble regardless of whether they ever actually see a fish.
* **Option Value**. The willingness to pay to safeguard the salmon population in the River Ribble for the option of using it at a future date.

3.2.2.3 Impact on the economy.

A further way of expressing the value of a salmon fishery is to consider the economic activity generated with respect to employment and income in a fishery area. At around £20 million per year, the total expenditure by salmon anglers in England and Wales is of little significance to the national economy. It could however, be significant to the local economy in salmon angling areas (accommodation, food and drink, angling permits, tackle etc.).

It has been estimated that salmon anglers spend, on average, £40 per day's fishing in England and Wales. From this, it is possible to gain a crude estimate of the value to the local Ribble economy of the salmon fishing, using the number of days fished and accounting for non-declaration. This generates an estimated total annual expenditure in excess of three-quarters of a million pounds. This calculation is shown in Table 8.

Table 8 Anglers annual expenditure.

Mean declared days fished '96-'97	Mean total days fished '96-'97 (66% declaration of effort)	Expenditure per day	Total expenditure
12,922	19,383	£40	£775,000

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

In order to effectively manage the salmon stock of the River Ribble it is vital that the current stock composition is known. Salmonid populations have historically been monitored by a number of different means and at a number of different lifestages.

Spawning * By redd counting, to identify the distribution and extent of spawning.

Juveniles * By electric fishing surveys, to evaluate juvenile distribution and abundance

Adults
* Automatic Logie 2100A resistivity fish counters record the number of upstream and downstream moving adults at Waddow Weir (SD 735426) and Locks Weir (SD 817654) on the River Ribble, and at Winckley Hall (SD 711384) on the River Hodder, (Map 1). Validation work on the Waddow Weir counter has shown it to have greater than 90% accuracy.
* By monitoring of rod and net catches, allowing the estimation of exploitation rates and spawning escapement (using automatic fish counter data).
* From anglers log books and salmon scale samples to generate information on the stock composition and areas of the catchment-where fish are caught.
* Regular trapping of adult salmonids at Waddow Weir will generate important information on the composition of the salmonid stock.

4.1 Adult salmon run.

An accurate assessment of both the timing and magnitude of the adult salmon migration into the river is vital for the effective management of the stock. Available data from the automatic fish counters, analysis of catches, angler's logbooks, salmonid scale returns, and trapping studies enable the adult stock to be assessed.

4.1.1 Scale sample returns.

Salmon scales have been received from anglers, netsmen and from trapping studies over recent years. The majority of juveniles smolt after two years in freshwater and the majority of adults return as grilse, after one sea-winter, (Table 9).

Table 9 Salmon scale samples.

	Age at smolting (sample size 170)				Winters spent at sea (sample size 427)			
	1	2	3	not known	1	2	3	previous spawner
%	10	74	6	10	71	26	1	2

4.1.2 Anglers log book returns.

From 1994 to 1996 (inclusive) a log book scheme has operated on the Ribble catchment whereby anglers recorded the date, location and fishing method along with details of the salmonids that they had caught on each fishing trip, throughout the year.

Information from this source can be used to identify the proportion of the total salmon catch taken in different areas of the catchment, assuming that those anglers returning logbooks are representative of the total Ribble angling population. This information is vital for the rivers Ribble and Hodder where a significant proportion of the annual salmon catch is taken downstream of the automatic fish counters. Analysis of data from these returned logbooks (sample size = 266 salmon) in the period 1994 to 1996 indicates that: -

* 34% of the total salmon catch is taken in the River Ribble below its confluence with the River Hodder.
* 10% of the total salmon catch is taken in the River Ribble between the confluence with the River Hodder and the fish counter at Waddow Weir.
* 31% of the total salmon catch is taken in the River Ribble above Waddow Weir.
* 25% of the total salmon catch is taken in the River Hodder.

Analysis of the reported catch from the log books can also help in the apportionment of automatic fish counter data into the salmon and sea trout stock components for different months of the angling season.

4.1.3 Timing of run.

The automatic fish counters at Waddow Weir and Winckley Hall operate some distance above the tidal limit and can only count the salmon run after approximately 44% of the rod catch has been taken. The Locks Weir counter is sited a considerable distance above the Waddow Weir counter and counts salmonids that are destined for the upper reaches of the catchment only.

Accurate data for Waddow Weir fish counter is available from 1994 to 1997 inclusive. During high flows, some fish will bypass the Winckley Hall counter, although this does not occur during normal summer flow conditions. Accurate counter data for the River Hodder is available for the years 1996 and 1997 inclusive. The counter data from Waddow Weir and Winckley Hall has been apportioned into salmon and sea trout using information from anglers logbook entries on the numbers and sizes of fish caught in different months of the fishing season (sample size 266 salmon, 271 sea trout).

* There is a small run of salmon past both counters in the months before June. That this run is not mirrored in the rod catch suggests that fishing effort is minimal in this early part of the season.
* The main salmon migration past both counters commences in June with one sea-winter grilse followed by a run of multi sea-winter salmon in the later summer months.

The low flows and drought conditions over recent years will almost certainly have had an affect on salmon migration. This may explain, to a certain extent, the low numbers of migrating fish recorded in August and September, particularly in the River Hodder. The percentage of the annual ~~salmon~~ migration at Waddow Weir and Winckley Hall is shown in Figures 8 and 9 respectively and summarised in Table 10.

Figure 8 **Percentage of annual salmon migration at Waddow Weir, River Ribble, (1994-1997).**

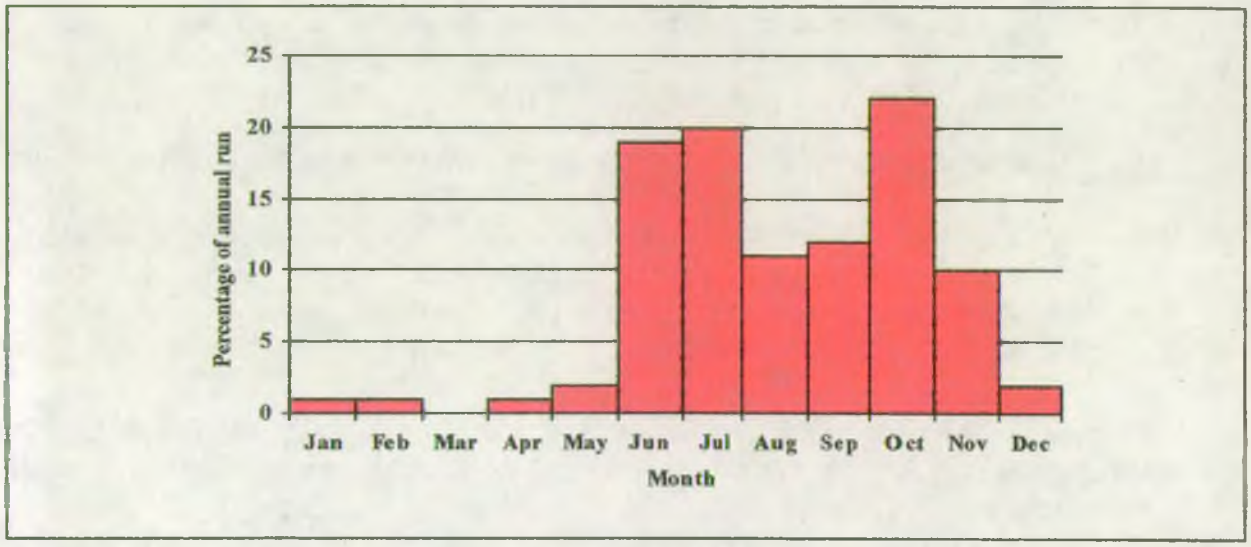


Figure 9 **Percentage of annual salmon migration at Winckley Hall, River Hodder, (1996-1997).**

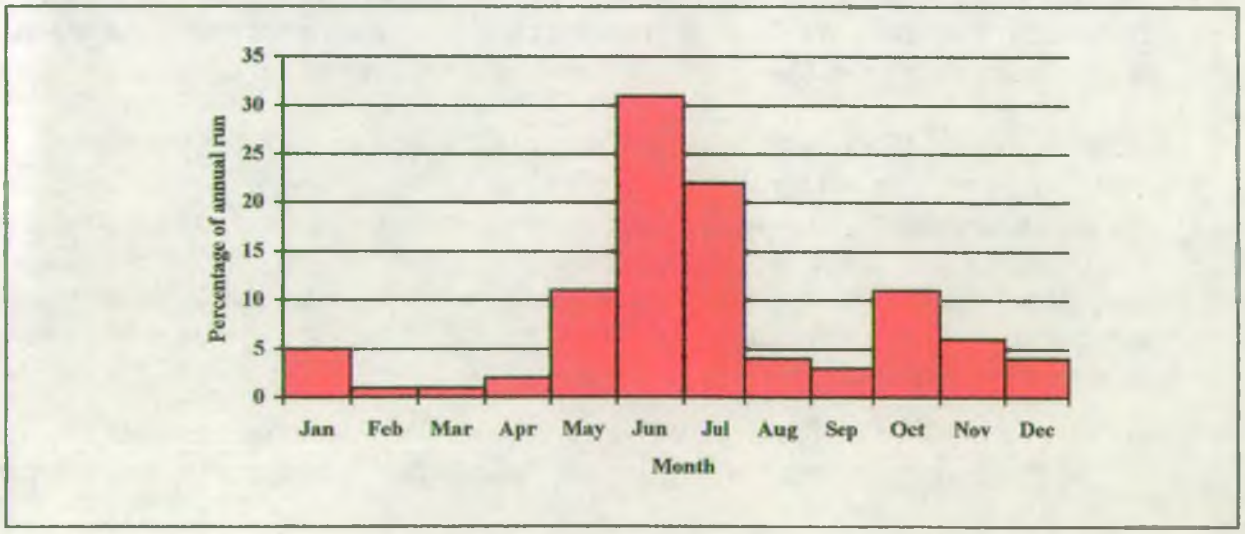


Table 10 Run size and timing.

METHOD	PRE-1st JUNE		POST-1st JUNE		ANNUAL	
	1997	Mean '94-'96	1997	Mean '94-'96	1997	Mean '94-'96
Waddow Weir counter	52	12	269	542	321	554
Winckley Hall counter	175	N/A	859	N/A	1034	N/A

4.1.4 Taste Tainting of Salmon Flesh.

Some salmon and trout from the Ribble system have been reported as having a "diesely" or "muddy" taste since at least 1980. The number of these incidents has increased since the issue was highlighted in The Ribble Fisheries Management Plan (NRA 1990).
In 1996 the Environment Agency employed a team of Environmental Consultants to: -

* Examine the existing tainting reports.
* Collect samples for taste testing and chemical analysis from different areas of the catchment.
* Review published literature to determine likely sources of the tainting substance.

Fish taken from different areas of the Ribble catchment were purchased from or donated by anglers and netsmen for chemical analysis and testing by a special "Taste Panel". Sediment samples were taken from the river and analysed for tainting chemicals.

The results confirm that a significant proportion of salmon (68%) and trout (88%) were tainted, including some caught in the Ribble estuary. The exact chemical causing the taint proved more difficult to identify and it seems probable that a range of substances is responsible. The substance originally thought to be responsible, phenol, was not found to be present in sufficient quantities, whilst hydrocarbons which were found in fish tissue and sediment could not be positively attributed to a taint by the taste panel.

Although further work is required to identify the compounds responsible and sources of the taint, there have been no reported incidents in 1997. This may be because of the generally poor fishing season, low salmon stocks and reduced catches in 1997, or the problem may have been addressed by the Environment Agency Water Quality Function or the contaminators themselves.

4.2 Juvenile Abundance.

There have been a number of electric fishing surveys of the juvenile salmonid populations in the River Ribble and it's tributaries. Surveys have been undertaken on the Upper River Ribble (Walsingham 1993), River Hodder (Walsingham & Clifton-Dey 1993), and the Skirden Beck system (Clifton-Dey *et.al.* 1995).

These surveys indicate, in general, that salmon fry densities were poor, except in Croasdale Beck on the River Hodder and Long Preston Beck on the River Ribble, both of which had fair fry densities, (20 to 40 fry per 100 m^2). Densities of salmon parr were generally poor, except on Croasdale, Easington and Langden Becks on the Hodder system and both Long Preston Beck and the Lower Skirden Beck on the Ribble, (5 to 40 parr per 100 m^2). These results suggest that one or more of the following may be responsible: -

* A lack of spawning in the years preceding the electric fishing surveys.
* Low survival of eggs and/or juveniles in the years preceding the surveys.
* Poor habitat quality for spawning and/or juvenile rearing.

Electric fishing survey data for the Ribble and Hodder have been analysed according to the National Fisheries Classification System (NFCS) and reported at a level of classification that converts the salmon juveniles into total salmon parr equivalents. The NFCS compares the fish abundance data for each site with a national database of abundance, allocating each site to one of five abundance categories that each represents one fifth of the national data. For example, if a site falls within the top fifth of national sites it will be classified as category A; a site in the bottom fifth will be classified as category E. A summary of this information is shown in Table 11 and Map 2. Analysing the Ribble and Hodder data in this way shows that: -

* Juvenile salmon were absent from 37% of the sites surveyed.
* A further 47% of Ribble and Hodder sites fall within the lower fifth of national sites for juvenile salmon (category E).
* Less than 4% of sites were categorised as Fair to Good (categories C to A).

Table 11 Juvenile salmon abundance.

CATCHMENT	% SITES IN EACH JUVENILE ABUNDANCE CLASS (numbers in brackets represent the number of sites in each category)					
	A Good	B	C Fair	D	E Poor	F Absent
HODDER (70 sites)	2.86 (2)	2.86 (2)	0 (0)	12.86 (9)	45.71 (32)	35.71 (25)
RIBBLE (60 sites)	0 (0)	1.67 (1)	0 (0)	8.33 (5)	50.00 (30)	40.00 (24)
Total (130 sites)	1.54 (2)	2.31 (3)	0 (0)	10.77 (14)	47.69 (62)	37.69 (49)

Map 2: Juvenile Distribution and Abundance

ENVIRONMENT AGENCY

Juvenile Survey Data
Fisheries Classification System

Colour Code	Class	Description
	A	GOOD
	B	
	C	FAIR
	D	
	E	POOR
	F	ABSENT
	NOT FISHED	UNCLASSIFIED

4.3 Distribution of spawning and utilisation of the catchment.

The principle spawning areas for salmon and sea trout on the River Ribble catchment are indicated in Map 3. For salmon, these constitute: -

* The main River Ribble from the confluence with Swanside Beck to the confluence with Cam Beck.
* The main River Hodder from the confluence with Croasdale Beck to the River Ribble confluence.
* There is also some limited spawning on the larger tributaries of the Ribble.

In terms of numbers of redds, the Hodder system currently generates more spawning than the Ribble: a feature reflected in the higher annual counts of salmon entering the Hodder.

These spawning areas mentioned above constitute approximately 50% of the total habitat available to salmon in the River Ribble system. At first sight this figure appears to be very low. However, a further 30% of available habitat is found on the River Ribble downstream of its confluence with the Hodder. This does not appear to be a significant spawning area. Most of the non-main river spawning areas used by salmon are also shared and dominated by trout spawning.

There are a number of areas where salmon production is likely to be below the optimum potential. These areas and the factors thought to have caused low productivity are indicated in Table 12.

Table 12 Problem areas in the Ribble system.

River system	% of total habitat available	Spawning utilisation by salmon	Juvenile abundance	Potential problems
River Dunsop	2%	Little use	Few fry or parr present	Water abstraction, limited spawning gravel, in-river structures.
Langden Beck	2%	Some spawning	Fry and parr in lower reaches	Water abstraction, low flows, in-river structures
Skirden Beck	3%	Some spawning	Some fry and parr in lower reaches	Low flows, limited spawning gravels

Map 3: Principle Spawning Areas

ENVIRONMENT AGENCY

Principle Spawning Areas		
KEY		Salmon
		Sea Trout
		Both
		Unclassified River
		Main Town

In addition to these areas there are a number of smaller areas (each constituting up to 1% of the available habitat) which could potentially be significant spawning and rearing habitat but which have problems of siltation, over grazing of the banks by stock, or poor water quality. These include: - Long Preston Beck, Croasdale Beck, and Swanside Beck, which is considered to have been formerly one of the best salmon-producing becks in the catchment.

Throughout the Ribble system, the factors that are likely to cause low juvenile production are:-

* Availability of suitable spawning and nursery habitat, the lack of riparian vegetation and in-river habitat, and the effects of farming practices on nursery habitat and water quality.
* Water abstraction by North West Water intakes (especially on the Hodder system) or abstraction of groundwater from boreholes. These significantly reduce river flow particularly in summer months, causing a reduction in habitat area, an increase in water temperature and a reduction in dissolved oxygen. Reduction of flow in early spring can lead to the drying out of salmon redds.

A combination of these two factors on the Hodder system, combined with the effects of Stocks Reservoir on low flows and siltation immediately downstream, severely restricts the salmon rearing potential of the main River Hodder constituting 20% of the total available salmon habitat of the whole catchment. Similar problems on the Ribble upstream of Paythorne Bridge restrict 17% of the total available habitat.

PART 5 ASSESSMENT OF STOCK AND FISHERY PERFORMANCE.

5.1 Spawning Targets.

The spawning target seeks to maintain catches to the fisheries, whilst safeguarding spawning stocks. The target corresponds to the Minimum Biologically Acceptable Level (MBAL) of spawning escapement which the International Council for the Exploration of the Sea (ICES) are seeking to establish for all rivers in the North East Atlantic, in order to facilitate more effective management of high seas fisheries. **The aim of management is to regularly exceed the MBAL, rather than considering it as an actual target to be achieved.**

The procedure used to calculate the River Ribble target has been "transported from" (i.e. modelled on) that generated for the River Bush in Northern Ireland. The Bush is one of the few rivers in Europe where the relationship between the number of salmon eggs deposited and the number of smolts produced is known. Information about this relationship takes many years to gather. The "transportation" procedure has been developed by the Water Research Centre (WRc) and takes into account differences in juvenile rearing habitat between the two rivers. The target also accommodates local differences in stock characteristics, such as marine survival and the relative proportions of 1SW and MSW fish.

An egg deposition target of 8.5 million eggs has been estimated for the River Ribble and relates to the 3.51 million square metres of river habitat considered accessible to adult salmon. This egg target is equivalent to a density of **242 eggs per 100m^2**. In order to achieve this egg deposition target: -

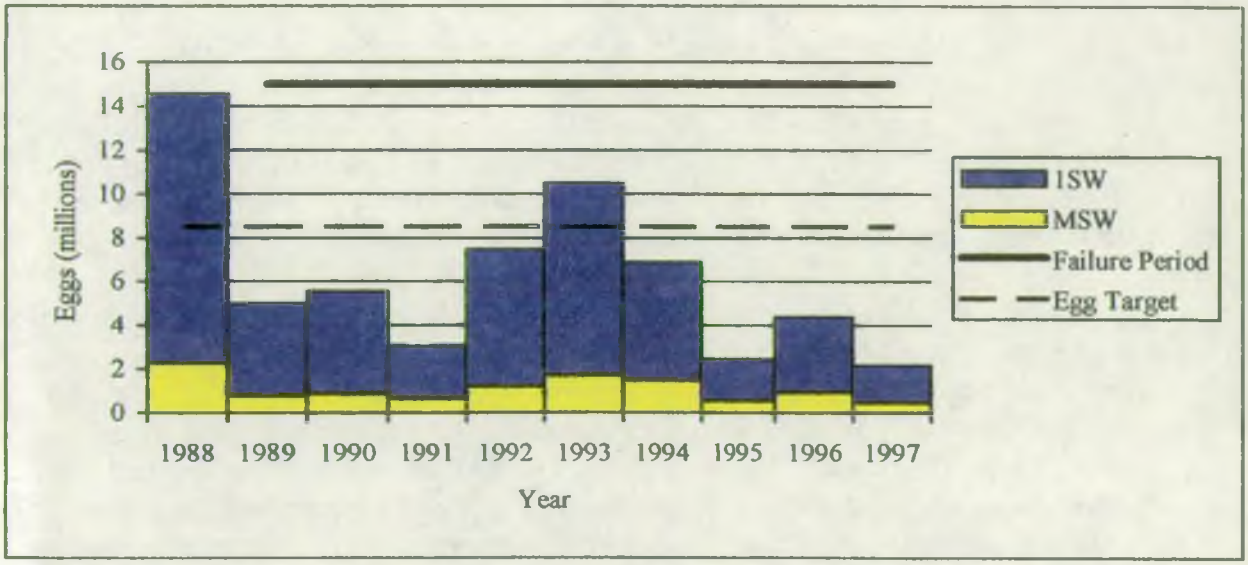
* **1,510 female salmon are required to spawn successfully**. The fecundity of River Ribble salmon being estimated at 5,631 eggs per female (based on standard length fecundity equations by Pope *et al.* 1961).

* **2,932 fish must survive the fisheries to spawn** (51.5% of the River Ribble salmon stock is female).

5.1.1 Egg Target Compliance Assessment and Interpretation.

Accurate counter data for both Waddow Weir and Winckley Hall has only been available since 1996. For years prior to 1996, declared rod catches provide the best available data for the assessment of egg target compliance. Rod catches can be related to the number of salmon present in a river although variation in angling effort, river conditions and declaration rates can affect this relationship significantly. The estimated egg deposition by 1SW and MSW salmon based on declared rod catches since 1988 is shown in Figure 10. These estimates are based on the assumption that the angling exploitation rate has remained the same over this period. However, there are great uncertanties associated with using current data to estimate historic egg deposition because of likely changes in both the stock and the fisheries in this time.

Figure 10 Estimated egg deposition of 1SW and MSW salmon from rod catch data, 1988-1997.



Because fish abundance can fluctuate widely over time, a compliance test has been developed (also by WRc) to identify failures on a statistical basis. This examines performance in blocks of three years with the sequence of egg shortfall or surplus in each block determining whether a "failure", "near miss" or "pass" has occurred. For example, one or no shortfalls in a three-year period would constitute a clear pass, whereas three shortfalls would constitute a clear failure.

However, for intermediate scenarios the rules become more complex, such that sequences of 'shortfall - shortfall - surplus' or 'surplus - shortfall - shortfall' constitute a near miss but 'shortfall - surplus - shortfall' constitutes a failure. This occurs because there is a significant possibility that the near miss scenarios could result from a single poor year class in freshwater that affects adult returns in two consecutive years, whereas the fail sequence is more likely to result from a more lasting impact. An additional rule states that once a failure has occurred, the next block of three years to be examined should not start until immediately after the failure sequence.

Accepting the potential inaccuracies in the calculation of historical egg deposition rates from rod catches, in the most recent reporting period 1995-1997, the River Ribble failed its target by a significant amount (Figure 10). In the previous reporting periods (1989-1991 and 1992-1994) the river also failed its target.

5.1.2 Fishery Performance at Target Spawning Levels

The rates of exploitation by the rod and net fisheries were estimated using data from Waddow and Winckley fish counters and the declared catches, (Table 13).

Table 13 Exploitation rates based on counter data and declared catches.

Method	Year	Corrected catch	Rod Catch downstream of counters	Total Count	Total salmon available to fishery	Exploitation Rate	Mean
NETS	1996	191*	285	1480	1956	10%	7.5%
	1997	77*	142	1410	1629	5%	
RODS	1996	647#	285	1480	1765	37%	29%
	1997	322#	142	1410	1552	21%	

* assuming a net catch declaration rate of 90% # assuming a rod catch declaration rate of 91%

For an average rod exploitation rate of 29% (Table 13) and an average 10% in-river natural mortality, the total rod catch which implies that the 2,932 fish have escaped capture is 1,331 salmon. This equates to a declared catch of 1,211 salmon, assuming a catch declaration rate of 91%. Similarly, a declared net catch for target spawning would be 335 salmon. **It must be stressed that these are not targets for the fisheries, merely indicators of the likely rod and net catches at the target spawning level.** If these catches are not achieved, it suggests that salmon are not present in sufficient numbers to attain the spawning target. These data are summarised in Table 14.

Table 14 Rod and net fishery performance at the target spawning level.

TARGET	VALUE
Maximum Gain (MG) egg target	242/100m^2 or 8.5 million eggs
Spawners equivalent to MG egg target	2,932
Total rod catch equivalent to MG egg target	1,331
Declared rod catch equivalent to MG egg target	1,211
Total net catch equivalent to MG egg target	372
Declared net catch equivalent to MG egg target	335

Parameters used to calculate above: -

GIS Useable Area = 351 hectares	Rod fishery exploitation = 29%
Fecundity = 5,631 eggs per female	Rod catch declaration rate = 91%
Females = 51.5%	Net fishery exploitation = 7.5%
Natural in-river mortality = 10%	Net catch declaration rate = 90%
Marine survival (to high seas fisheries) = 13%	

The rod catch of 1,211 salmon that is indicative of the spawning target being met is dependent upon a catch declaration rate of 91%. However, as recently as 1990, the declaration rate was estimated at only 50%, at which levels the declared catch that reflected target spawning would be 666 salmon. Given these values, historic rod catches, (Figure 1), suggest that the Ribble has seldom met or exceeded its spawning target. However, prior to 1973 catch declaration rates appeared to be particularly low, making the rod catch a poor indicator of historic salmon abundance, and hence egg deposition, for the Ribble during this period.

The declared net catch is likely to be a better measure of historic compliance since a fixed number of nets have operated in the Ribble estuary since 1950. The number of tides fished by these nets is likely to have varied over the years, however this variation is assumed to be relatively low. The historic data, (Figure 2), indicates that declared catches were well above the 335 pertaining to target spawning throughout the "good years" of the 1960s and also for most years in the 1970s and 1980s, assuming a consistent catch declaration rate of 90% throughout this period.

Since monthly catch records were instigated in 1973, spring salmon have constituted, on average, approximately 5% of the annual rod catch and 2% of the annual net catch for the Ribble. Spring salmon do not therefore appear to have formed as significant a component of the stock of the Ribble as they have done in other local rivers, such as the Lune and the Eden.

Separate spawning targets can not yet be produced for 1SW and MSW salmon. However, the issue of maintaining and improving stock diversity and fitness is one of the cornerstone objectives of the salmon management strategy. Overall compliance with target spawning will not preclude the use of fishery management measures to achieve this.

Salmon destined to return to the River Ribble system are also exploited by a number of other fisheries. These operate around the coasts of Ireland, the Faroe Islands, and Greenland (see Section 6.2). Attempts have been made to quantify the impact of these fisheries through a programme of micro-tagging smolts prior to their seaward migration. Approximately 140,000 hatchery-reared salmon smolts were micro-tagged and released into the River Ribble system between 1987 and 1992. Of these, twenty three were recaptured as returning adults in the River Ribble, eight in the River Hodder, ten by the Irish drift nets, and one each from the Faroes and Greenland fisheries, an overall catch rate of 0.03%. These returns are insufficient to determine the effect that non-Ribble fisheries are having on the returning adult stocks. A limited micro-tagging programme continued on the Ribble system until 1996. Nationally, the programme now is largely restricted to a few river systems where wild smolts are trapped and tagged, (eg. the River Test and the River Dee). Returns from wild smolts would be expected to be higher than those from hatchery reared juveniles, enabling a more accurate estimation of exploitation by marine fisheries.

5.2 Freshwater Production

Aside from reducing exploitation in order to meet spawning targets, management must also aim to optimise egg to smolt survival in the freshwater phase. This may require improvements to environmental quality in terms of water quality and quantity and also as physical habitat.

The majority of salmon spawning in the Ribble system occurs in the middle and upper reaches of the main river, the upper and mid-catchment tributaries and particularly in the River Hodder system. However, salmon fry and parr densities in these areas tend to be poor, suggesting that the habitat is under-utilised.

Areas found to contain good juvenile salmon densities are likely to have included some of those that were previously stocked with hatchery-reared fry and autumn parr. This may well have supplemented the natural juvenile production from spawning and, combined with good habitat and water quality, produced the densities found. However, many other areas of the catchment were also stocked prior to the electric fishing surveys but were not found to contain juvenile salmon densities above a poor or fair classification. This suggests that the introduction of salmon juveniles was not the most effective means of increasing freshwater production in these areas.

5.3 Diversity and Fitness

5.3.1 Sea Age Composition

There is no evidence to suggest that the sea age composition of the Ribble salmon stock has changed over the years. However, a change has been apparent in the relative abundance of the various sea age groups in the total annual run - in particular a decline in the abundance of early running MSW salmon and a dominance of later running 1SW salmon. This shift from early to late running salmon is not unique to the Ribble but has been observed throughout rivers of the NE Atlantic.

5.3.2 Stock Enhancement

Enhancement stocking of juvenile salmon into the Ribble system has been conducted for many years in order to supplement natural spawning and increase the numbers of returning adults. Approximately 130,000 fed fry and 30,000 0+ parr were released annually into the Ribble system between 1988 and 1997. In addition, smaller numbers of 1+ parr and smolts (approximately 5000 of each) were occasionally stocked during this period. Production from the latest of a number of Agency hatcheries, at Witcherwell, ceased in 1997 following a decision by the Environment Agency Board. This decision was taken following the recent publication of evidence suggesting that salmonid stocking was not cost effective (R&D note 353) and was not a sustainable management practice.

Evidence from the River Leven catchment shows that salmon populations are genetically different even within small sub-catchments (McCubbing and Hartley 1994). This evidence was not available when historic stocking programmes were undertaken. The potential effects following the long-term introduction of hatchery reared salmon are changes to the natural balance causing:-

* reduced stock vigour,
* a disruption in the genetic structure of the population
* possible change in stock composition.

It is possible that a reduction in the genetic diversity of the Ribble salmon stocks caused by stocking may be responsible for the changes in composition of the Rivers Ribble and Hodder salmon stocks through time. Pre-June catches, although never a major component, appear to have declined, as have the multi sea-winter stocks of salmon. However, this is a feature of salmon stocks across England and Wales and is therefore more likely to be related to national or global conditions such as changes in climate, sea temperatures and land-use practices.

PART 6 LIMITING FACTORS.

The return of salmon stocks to the River Ribble will depend on the survival of fish at sea, in the estuary and in freshwater. The freshwater stage of the lifecycle is where the Environment Agency has most control and therefore has the greatest potential for positive management.

6.1 Freshwater phase.

There are a number of factors that are believed to limit the production of River Ribble salmon in freshwater; these are discussed in Table 15. Some of these have been present for many years (e.g. the effects of land drainage) others are relatively recent but equally pernicious (e.g. the effect of new synthetic pyrethroid sheep dips which killed all the invertebrates along 10km of main River Ribble in 1997).

Table 15 Factors believed to limit freshwater production.

Factor	Effect	Life stage affected
Changing Farming Practices Land drainage, intensification, and the use of chemical pesticides and herbicides	Rapid run-off from land may cause a change in river flow resulting in: siltation, erosion, river widening and washout of redds and juveniles. General farming practices may reduce habitat and water quality in important spawning and nursery areas.	Adults and juveniles
Poor fry and parr production Lack of riparian vegetation and in-river nursery habitat	Overgrazing by cattle and sheep increases the eroding effects of high flows and reduces salmonid nursery habitat	eggs, fry, parr
Avian predation	Increased numbers of fish-eating birds	fry, parr
Exploitation of adults In-river, estuarine and high seas fisheries may be unsustainable	Spawning escapement and egg deposition targets not achieved.	Adults and juveniles
River flows Low flows caused by drought and abstraction for potable and agricultural supply	Reduces habitat, increases river temperature, decreases oxygen. Creates obstacles to migration and enhanced exploitation.	Adults and juveniles
High flows caused by land drainage	see points above on farming practices and juvenile production	Adults and juveniles
Impassable obstructions. Man made and natural obstructions	Man made weirs (eg. at Padiham) can impede migration to large areas of suitable spawning and nursery habitat. Natural and man made obstructions in spawning becks can seriously reduce production.	Adults and juveniles

6.2 Marine phase.

Natural mortality - Advice to NASCO suggests that natural mortality during the marine phase, although variable has been increasing over the last 5-10 years. Fewer smolts are therefore surviving to become adult salmon. Changes in ocean climate may be a factor. The abundance at sea, of salmon that would return as multi-sea-winter fish, is strongly related to the availability of sea water 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 & Friedland 1996).

Greenland fishery - A net fishery has operated on the West Coast of Greenland since the 1960s. Catches peaked in 1971 at 2689 tonnes. Since 1976, only Greenland vessels have operated in this fishery and the catch has usually been limited by a quota agreed at NASCO. Since 1993 the quotas have been related to estimates of the pre-fishery abundance of salmon and these have been declining. Approximately 15% of the catch is thought to be derived from rivers in England and Wales. In 1993 and 1994, the fishery did not operate, the netsmen being paid not to fish. As a result approximately 5000 additional multi-sea-winter salmon were estimated to have returned to England and Wales in each subsequent year (Potter 1996). In 1995 and 1996, catches in the Greenland fishery were 81 and 70 tonnes respectively.

Faroes fishery - Also developed in the 1960s, this fishery uses baited long-lines. The catch peaked at 1027 tonnes in 1981 but subsequently has been controlled by an annual quota. Unlike Greenland this quota has not been directly related to salmon abundance. Since 1990, the permitted quota has been 550 tonnes but this has never been taken. From 1992, commercial fishing has ceased due to compensation payments and only a research fishery has operated, which now takes approximately 5 tonnes per year. Potter (1996) crudely estimated the number of extra salmon that returned to homewaters due to the reduction in this fishery. For all of England and Wales this amounted to approximately 1200 salmon each year, of which 750 would have been grilse.

International fishery - An unregulated high seas fishery operates in international waters by countries who are not signatories to the NASCO convention. Annual catches are thought to be between 25 and 100 tonnes, comprising predominantly European stocks.

Irish fishery - The reported catch of salmon in Ireland increased from approximately 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. Approximately three-quarters of the Irish salmon catch, (some 700 tonnes in 1995), is currently taken by the drift nets. Tagging studies indicate that these nets take a significant, though variable proportion of the stock of salmon destined for English and Welsh rivers. For rivers in the south and west (e.g. Test, Taff and Dee) approximately 10-20% of the stock is thought to be taken by the Irish drift nets. For stocks from rivers in the north (e.g. Eden and Wear) the level of exploitation is likely to be less, perhaps 5%. The catch comprises mainly, but not exclusively, grilse. The Irish Government has recently announced additional controls on the driftnet fishery, including delaying the season until June 1st and restricting fishing to daylight and within 6 miles. These measures may reduce exploitation on English and Welsh stocks. However, there is no intention, as yet, to phase out this mixed stock fishery.

PART 7 ISSUES AND ACTIONS.

The main issues that are thought to limit the salmon production in the River Ribble are listed in Table 16. A number of options for improving the situation, the individuals or organisations that are competent to address these issues and a tentative approximation of the associated costs are also given. This list is not definitive and a number of issues or actions may be added or removed from the final plan following the consultation period.

Many of these issues are true of most upland river systems in England and Wales and require long term solutions, possibly with input from the British Government or the European Union. This is particularly true of issues involving farming practices where the impacts of the Common Agricultural Policy must be taken into account.

In the shorter term, although the Environment Agency has decided that it will no longer undertake enhancement stocking of salmonids, it has initiated or been a partner in a number of projects to improve the riparian habitat which it believes to be both cost effective and sustainable management.

To this end the Environment Agency will: -

* Continue to identify and ameliorate limiting factors affecting juvenile salmonid production in spawning areas.
* Assist in the preparation of a bid by the Ribble Catchment Conservation Trust for approximately £31 thousand of European funding under the Leader II Scheme.
* Collaborate with FWAG on the Agency's Sustainable River Management project, a scheme to encourage riparian fencing and assist in claiming for grants in North West Region.
* Provide input and funding to the Bowland Initiative and secure £90 thousand for riverine habitat improvement work in the Lancashire uplands from this scheme. The work of a FWAG officer, financed by the Agency, will continue under this £2.1 million scheme.
* Work with the Yorkshire Dales Millennium Trust to secure funding for riverine habitat improvements within the Yorkshire Dales National Park from January 2001.
* Continue to offer advice, and help where possible, to angling clubs and land owners wishing to fence areas of riverbank in order to encourage riparian vegetation, or who wish to improve in-river habitat for spawning adults and/or juveniles.
* Work in partnership with farmers and their local FWAG officer who will help and advise them on subsidies available for activities that will improve the riparian and in-river habitat for fisheries and wildlife.

It must be remembered that the resolution of these issues is an ongoing action and will take many years.

Table 16. Issues and Proposed Actions.

No	ISSUE	LIMITING FACTORS	OPTIONS	RESPONSIBILITY		ESTIMATED COST	DURATION OF ACTION					
				Lead	Other		98	99	00	01	02	Future
1.	Farming Practices.	Impact of land drainage on river flows and siltation.	Where appropriate, carry out intensive surveys and ecological monitoring to identify and quantify inputs.	Agency	LU Tech help	Approx. £2,000 pa.	.....	.....	.....	.....	.....	.....
		Impact of slurry and chemical fertilisers. Impact of cattle access and poaching of banks.	Continue farm inspections and where necessary carry out farm pollution control plans to identify and rectify point sources of farm pollution.	Agency Farmers	MAFF HSE	)))) EP Lead) Approx	.....	.....	.....	.....	.....	.....
		Impact of synthetic pyrethroid sheep dips.	Promote sustainable/best management practices including campaign on environmental effects of sheep dips.	Agency FWAG		) £10,000 pa))	---	---				
2.	Lack of data on in-river populations.	Information needed on: -					.....	.....	.....	.....	.....	.....
		Run sizes at fish counters.	Continue gathering accurate counter data.	Agency		Approx. £5,000 pa	.....	.....	.....	.....	.....	.....
		Rod catches below fish counter sites.	Analysis of declared catch returns and log books.	Agency	RFA AC's	Approx. £1,000 pa	.....	.....	.....	.....	.....	.....
		Exploitation rates by rods and nets.	Analysis of counter and catch data.	Agency		Approx. £1,000 pa	.....	.....	.....	.....	.....	.....
		Juvenile population densities.	Electric fishing survey of spawning and nursery habitat.	Agency		Approx. £20,000	.....	.....	.....	.....	.....	.....
		Stock composition.	Programme of trapping twice a month at Waddow weir during season. Analysis of scale samples from trap, rods & nets.	Agency	RFA AC's	Approx. £5,000 pa	.....	.....	.....	.....	.....	.....
		Salmon egg deposition.	Use of data gathered above.	Agency		minimal						

No	ISSUE	LIMITING FACTORS	OPTIONS	RESPONSIBILITY		ESTIMATED COST	DURATION OF ACTION					
				Lead	Other		98	99	00	01	02	Future
3	In-river obstructions.	Man made obstructions prevent successful migration.	At least a dozen known weirs and intakes present in the catchment without suitable fish passes. Weirs on the River Calder prevent access to 100 hectares of habitat.	Agency RCCT	EAGGF 5b fund	From approx. £2,000 to £60,000	.....	.....	.....	.....	.....	.....
		In-river blockages by fallen trees.	Over eighty known blockages impede access to spawning and nursery grounds.	Agency RCCT	EAGGF 5b fund	Approx. £1,000 each	.....	.....	.....	.....	.....	.....
4	Low flows.	Abstraction by NWW and agriculture, particularly in River Hodder system.	Reduce any further abstractions and review existing abstractions.	Agency		Solution dependant	.....	.....	.....	.....	.....	.....
			Discussions with NWW concerning review of abstractions within Hodder system currently on-going.	Agency NWW		Minimal	.....	.....	.....	.....	.....	.....
5	Exploitation by rods and nets.	Lack of spawning fish results in failing the target egg deposition rate.	Reduce net catch by changes to gear, season, times of operation or Net Limitation Order.	Agency		))) Up to) £70,000	.....	.....	.....	.....	.....	.....
			Reduce rod catch by bag limits, catch and release or byelaws to change length of season or fishing method.	Agency	AC's	)))	.....	.....	.....	.....	.....	.....
6	Lack of juvenile habitat.	Poor riparian vegetation leading to degradation of bankside habitat, accelerated rates of erosion and siltation, and reduced visual, wildlife and fisheries value.	300km of fencing, 75km tree planting and 15km erosion control identified. Increase tree and bankside vegetation by: -									
			Collaborative works following bid for European monies.	Agency RCCT	AC's RFA	Bid in excess of £1 million	---	---	---	---		
			Sustainable Rivers Management Project to promote fencing and creation of mature bankside vegetation.	FWAG Agency	RO MAFF AC's	£25,000 pa	---	---	---	...		

No	ISSUE	LIMITING FACTORS	OPTIONS	RESPONSIBILITY		ESTIMATED COST	DURATION OF ACTION					
				Lead	Other		98	99	00	01	02	Future
6	Lack of juvenile habitat (cont.).	Lack of, or damage to in-river spawning and nursery habitat.	Cleaning of gravels and in-river improvements in conjunction with work parties from angling clubs. Advice and contributions to angling clubs concerning in-river works.	Agency RFA AC's Agency		Advice/ manpower/ supervision Advice from Agency officer	....	....	....	....	....	....
7	High seas and Irish drift net fisheries.	Marine exploitation rate of River Ribble stock unknown.	Continue to monitor with national microtagging programme particularly to assess the impact of the Irish Drift Net fishery following recent constraints imposed on this fishery.	Agency MAFF		No direct cost to the Ribble	.....	....	.....	.....	.....	.....
8	Avian predation on juveniles.	Populations impacted by increased levels of predation by goosanders and cormorants.	River Ribble is part of National research programmes. Await guidance following completion of project.	MAFF	Agency RSPB	£1 million (Nationally)	---	---				
9	Salmon poaching.	Uncontrolled illegal fishing could seriously reduce numbers spawning.	Continue to operate effective enforcement measures including anti poaching patrols and targeting outlets buying poached fish.	Agency		Approx £30,000 pa on Ribble anti-poaching	.....	....	.....	.....	.....	.....
10	Spring salmon.	Unknown if stock component still present.	Collect and analyse available data from clubs. If present identify spawning and nursery areas for protection.	AC's Agency Agency AC's		Data analysis and report Approx. £5,000	--- ---	--- ---	---	---		
11	Salmon flesh tainting.	Unknown if problem still present in Ribble stocks.	Collect information from anglers/netsmen on continuing problem. Continue project to identify sources.	Agency AC's Agency	RFA RFA	Minimal Up to £50,000	--- ---	--- ---	--- ---	--- ---	---	

Key to Table 16

AC's	Angling Clubs
Agency	Environment Agency
EP	Environmental Protection (Agency Function)
FWAG	Farming and Wildlife Advisory Group
HSE	Health and Safety Executive
LU	Lancaster University
MAFF	Ministry of Agriculture, Fisheries and Food
NFU	National Farmers Union
NWW	North West Water Plc
RCCT	Ribble Catchment Conservation Trust
RFA	Ribble Fisheries Association
RO	Riparian Owners
RSPB	Royal Society for the Protection of Birds
.....	Ongoing action
---	Completion of action

PART 8 FUNDING THE PLAN.

8.1 The funding background.

Objective 4 of the "Salmon Action Plan for England and Wales" states: -

"The necessary costs of managing migratory salmonid fisheries should be met by the beneficiaries (nets, rods, riparian owners and the general public) and where schemes adversely affect these fisheries, any mitigation or restoration costs should be met by the promoter or polluter"

The Environment Agency currently spends approximately £9 million per year on the national management of salmon and sea trout. Approximately 12% of this sum is raised from the sale of rod licences and 2% from net licences. The majority of the money arises from Grant In Aid from government. This GIA continues to decrease.

These reductions in Government GIA ensure that the Environment Agency alone is unlikely to be able to secure the resources necessary to fund all of the issues detailed in Section 7. Alternative funding sources and partnerships with interested parties will have to be sought if the Plan is to be successful. It is hoped that this Action Plan will both promote the activities that should be encouraged on the River Ribble in order to conserve the stock for future generations and also focus interested parties as to where they might find alternative funding for work of their own.

The costs of resolving the issues detailed in this Plan are very high and are well beyond the capabilities of any single body. However, with the possibility of funding from the European Union much of the proposed work could be undertaken in a short time period. Without this funding, a partnership of interested bodies and a timescale of approximately 10 years is needed to conserve the stock for future generations. The Environment Agency will continue to help in any way that it is able to by the provision of funds or advice to interested parties.

8.2 What we are doing now.

The Fisheries Function of the Environment Agency North West Central Area has an annual budget of approximately £630,000. This is used to cover all fisheries activities in the area and to pay the wages of all the fisheries staff. An approximate breakdown of how a proportion of this money was spent on the River Ribble in the 1997/98 financial year is given in Table 17. It should be remembered that this breakdown reflects the conditions and activities of that year only and may change as priorities alter in previous or subsequent years.

Table 17 Activities of the Fisheries Function on the River Ribble, 1997/98.

Activity	Description	Costs (£)
Enforcement and Regulation	Licensing and enforcement as required by the Salmon and Freshwater Fisheries Act (SAFFA), Salmon Act, Water Resources Act, Diseases of Fish Act and Environment Act.	85,000
Monitoring/Technical	Monitoring of fish populations and provision of technical advice to operations.	28,000
Emergency Operations	Fish rescues and pollution incidents.	24,000
Rearing and Stocking	Collection of broodstock, stocking-out costs and proportion of Witcherwell Hatchery budget.	57,000
Promotion and Liaison	Production of annual reports and costs of liaison meeting.	£2,000
Habitat	Maintenance of fish passes, habitat improvements.	£5,000
Maintenance	Buildings and equipment.	£16,000
Training	Legal, operational and technical.	£4,000
Total		£221,000

8.3 Collaborative funding.

In order for this Salmon Action Plan to be successful it is vital that alternative sources of funding and resources are sought. Investigations should be made with a view to securing funds from: -

* The European Union,
* The formation of a Fisheries Trust,
* Fishery owners, Fishery Associations, and the Riparian Charge,
* Recovery of costs for damage to salmonid fisheries,
* Sponsorship,
* Licence revenues that reflect expenditure on migratory salmonids,
* Identify enhancements to the programmed work of other Agency functions,
* The National Lottery Millennium funds.

PART 9 CONSULTATION PLAN.

9.1 Timetable for consultation.

The following timetable is proposed for consultation of this Salmon Action Plan.

Table 16 Consultation Schedule.

Stage	Timescale
Draft to Salmon Sub-Group	June 1999
Draft to Area Fisheries Staff	June 1999
Consultation Document to RFAC and AEG	September 1999
Consultation Document to Agency Staff	September 1999
Launch of Consultation Document	September 1999
Responses from Consultation Document	January 2000
Launch of Salmon Action Plan	March 2000

9.2 Consultee List.

* Relevant Environment Agency staff,
* North West Central Area Management Team,
* RFAC & AEG,
* National Salmon Group,
* Ribble Fisheries Association,
* River Ribble Angling Clubs, and Netsmen,
* Large land owners, Estate trustees, Owners and Agents,
* North West Water Ltd,
* Local newspapers and media,
* Local government,
* ADAS, MAFF, English Nature, CPRE, RSPB, FWAG Lancashire Wildlife Trust, Countryside Commission, English Heritage, Royal Society for Nature Conservation, Yorkshire Wildlife Trust, The National Trust, Freshwater Biological Association etc.
* Lancaster University, Liverpool University, IFE.

IF YOU HAVE ANY COMMENTS ON THIS SALMON ACTION PLAN PLEASE SEND THEM IN WRITING TO THE LUTRA HOUSE (PRESTON) OFFICE

PART 10 GLOSSARY OF TERMS.

available habitat	the total area of the catchment accessible to adult salmon.
alevin	juvenile salmon at stage from hatching to end of dependence on yolk sac as primary source of nutrition.
automatic fish counter	electronic equipment that records the number and size of fish migrating over electrodes implanted into fish passes.
broodstock	mature adult salmon and sea trout taken from the river after the angling close season to provide eggs and milt for hatchery reared juveniles.
buffer strips	areas adjacent to the river channel where natural vegetation is allowed to thrive. This reduces the chemicals and particulates (silts) contained in surface water runoff from surrounding land entering the river.
brown trout	freshwater resident form of the trout species *Salmo trutta.*
cumecs	measure of river flow, cubic metres per second.
drift net	type of net that is released from or attached to a boat and is free to drift with the wind or tide.
EC/EU	European Community/European Union. As members of the EC/EU Britain is obliged to act upon European law, issued in the form of Directives.
electric fishing	method of sampling juvenile populations in rivers by passing low voltage through water and stunning the fish.
endorsees	persons authorised to use licensed netting instruments if they are accompanied at all times by the licence holder, or if they have the consent of the Agency.
exploitation	removal of stock through legal and illegal fishing.
escapement	stock remaining after exploitation.

fecundity	average number of eggs per mature female.
fry	juvenile salmonid at stage from independence of yolk sac as primary source of nutrition to dispersal from the redd.
GIS	Geographic Information System, computer system designed to calculate river lengths from high resolution digital maps.
grilse	salmon which returns to freshwater in order to spawn after one winter in the sea.
haaf net	net mounted on wooden frame and held in path of migrating fish.
ICES	International Council for the Exploration of the Sea.
juvenile	fry, parr and smolt lifestages.
kelt	spent or spawned salmon up until the time that it re-enters salt water.
maximum gain	a spawning target which maximises potential catch levels.
MBAL	Minimum Biologically Acceptable Level: - the minimum level of stock abundance that ensures its continuation.
microtag	coded metal wire inserted into nasal cavity of fish and used to determine exploitation rates in homewater and distant water fisheries.
multi-sea-winter salmon	salmon which has spent two or more years at sea.
NASCO	North Atlantic Salmon Conservation Organisation.
parr	juvenile salmonid at stage from dispersal from redd to migration as smolt.
rainbow trout	non indigenous trout of the species *Oncorhynchus mykiss.*
redd	area of gravel on the river bed in which salmon or trout eggs have been laid.
run	migration of adults into freshwater.

run timing	the time fish enter fresh water and move up the river.
salmon	general term for the species *Salmo salar*, also a more specific term for a fish which has returned to fresh water after two or more winters at sea.
sea-age	the number of winters that a salmon has spent in the sea.
sea trout	migratory form of the trout species *Salmo trutta.*
seine net	wall of netting used to encircle.
siltation	deposition of suspended solids on the river bed which can block gaps between gravels and prevent adequate water movement for the survival of eggs within redds.
smolt	fully-silvered juvenile salmonid migrating or about to migrate to the sea.
trap	method of catching migrating fish in order to sample them without damage.

APPENDICES

Appendix I References.

Clifton-Dey, D. & Walsingham, M. (1993). Report on the 1992 Stock Assessment of the Hodder Catchment. NRA Technical Report NRA/NW/FTR/94/9.

Clifton-Dey, D., Walsingham, M., Deed, C. & Talbot, G. (1995). Report on the 1993 and 1994 Stock Assessments of the Skirden Beck System, on the River Ribble. NRA Technical Report NRA/NW/FTR/95/2.

Clifton-Dey, D. & Walsingham, M. (1995). Report on the analysis of salmon scale samples returned by anglers on the Rivers Ribble and Hodder. NRA Technical Report NRA/NW/FTR/95/11.

Environment Agency (1997). River Lune Salmon Action Plan Consultation Document.

Environment Agency (1998). River Lune Salmon Action Plan.

McCubbing, D.J.F. & Hartley S.E. (1994). Management options for a multi-stock Atlantic salmon (*Salmo salar* L) resource in a Lake District catchment. In:- Proceedings of the Institute of Fisheries Management 25th Annual Study Course.

National Rivers Authority (1992). The Ribble Fisheries Management Plan.

National Rivers Authority (1994). The Identification of Cost-Effective Stocking Strategies for Migratory Salmonids. R&D Note 353.

National Rivers Authority (1996). A Strategy for the Management of Salmon in England & Wales. NRA1996.

Pope, J.A., Mills, D.H. & Shearer, W.M. (1961). The fecundity of Atlantic salmon (*Salmo salar*). Freshwater and Salmon Fisheries Research 26, 1-12.

Potter, E.C.E. (1996). Predicted increases in the returns of multi-sea-winter salmon to home waters following the reduction in fishing at Faroes and Greenland. p67-86. In:- Enhancement of Spring Salmon. Proceedings of a Conference at the Linean Society of London, 26 January 1996. Editor: D. Mills. Publ. Atlantic Salmon Trust.

Reddin, D. & Friedland, K. (1996). Declines in Scottish spring salmon and thermal habitat in the Northwest Atlantic: How are they related? p45-66 In:- Enhancement of Spring Salmon. Proceedings of a Conference at the Linean Society of London, 26 January 1996. Editor: D. Mills. Publ. Atlantic Salmon Trust.

Walsingham, M. (1993). Report on the 1992 Stock Assessment of the Upper Ribble Catchment. NRA Technical Report.

Appendix II Life cycle of the salmon.

Salmon spawn in the main river Ribble and its tributaries in the autumn and winter, burying their eggs in disturbed gravel nests called redds. Spawning sites are generally selected at the tail of pools, where the flow of water accelerates both above and through the gravel. In spring the eggs hatch and the alevins remain in the gravel for several weeks feeding off their yolk sac before emerging from the gravel as fry. These fry take up feeding territories in the stream and become parr.

After two or occasionally three years, the parr undergo a major physiological change in spring, abandoning their feeding territories and migrating downstream. They leave the river as smolts and enter the sea to feed for one, two or occasionally three years around the coast of the Faroe Islands and Greenland before returning to the same rivers and streams where they were spawned. Fish that return to freshwater after one year at sea are called grilse, others that have spent two or three years at sea are termed multi sea winter salmon or simply salmon. After spawning most of these fish, termed kelts, die although a few do survive, return to sea and make a second spawning migration the following year.

River Ribble sea trout have a life cycle in many respects similar to that of salmon. They are spawned in freshwater and spend two years as parr before smolting and migrating to sea. Sea trout remain in coastal waters during the marine phase of their life cycle and return to freshwater in the early summer months on their spawning migrations. Unlike salmon, sea trout often survive spawning, returning to sea and spawning again in consecutive years.

Appendix III Spawning targets in management.

In setting spawning targets, the Environment Agency is following the recommendation of NASCO (1995) and drawing on an extensive body of 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 that result) are a function of the quality and quantity of accessible spawning and rearing habitat. 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, 1996).

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 be produced in a river. On average, more eggs deposited means more smolts being produced, up to some level beyond which the output of smolts reaches a limit or may even decrease. This occurs because young salmon are strongly territorial and a stream can therefore only support a finite number of juveniles. This level of production is referred to as the carrying capacity.

If data are 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 a S-R curve, that level of spawning which maximises the sustainable catch (total catch, comprising all marine and freshwater fisheries), and it is termed the **M**inimal **B**iologically **A**cceptable **L**evel (**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 ensure 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 S-R curves 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.

Stock Recruitment (SR) Curves - An Explanation

The first objective of the Salmon Management Strategy states that

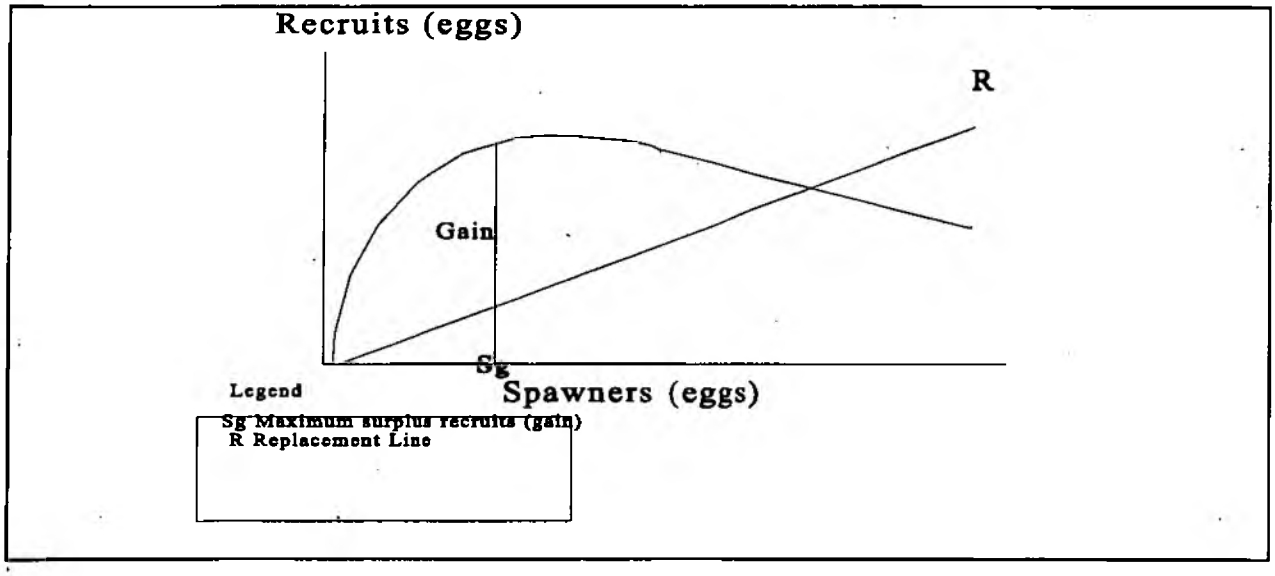
> *"Individual salmon stocks and the environment in which they live should be managed to optimise recruitment to homewater fisheries."*

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

Although several types of target can be set for the management of salmon, ICES (1995) has 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. MBAL has been adopted by the Environment Agency as the target most closely describing the objectives of the Salmon Strategy, whilst recognising that, due to a natural stock variability and environmental influences, the target should be regarded as a minimum.

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 (Sg) is thus a mathematically definable, unambiguous point on the curve.

Figure 11 Diagrammatic stock recruitment curve.



NORTH WEST REGION ADDRESSES

REGIONAL OFFICE
Environment Agency
PO Box 12
Richard Fairclough House
Knutsford Road
Warrington WA4 1HG
Tel: 01925 653 999
Fax: 01925 415 961

NORTH AREA OFFICE
Environment Agency
Ghyll Mount
Gillan Way
Penrith 40 Business Park
Penrith
Cumbria CA11 9BP
Tel: 01768 866 666
Fax: 01768 865 606

CENTRAL AREA OFFICE
Environment Agency
Lutra House
Dodd Way
Walton Summit
Bamber Bridge
Preston PR5 8BX
Tel: 01772 339 882
Fax: 01772 627 730

SOUTH AREA OFFICE
Environment Agency
Appleton House
430 Birchwood Boulevard
Birchwood
Warrington WA3 7WD
Tel: 01925 840 000
Fax: 01925 852 260

Internet World Wide Web www.environment-agency.gov.uk

For general enquiries please call your local Environment Agency office. If you are unsure who to contact, or which is your local office, please call our general enquiry line.

ENVIRONMENT AGENCY GENERAL ENQUIRY LINE
0645 333 111

The 24-hour emergency hotline number for reporting all environmental incidents relating to air, land and water.

ENVIRONMENT AGENCY EMERGENCY HOTLINE
0800 80 70 60

ENVIRONMENT AGENCY

HO-9/99-1800-D-BEVE Printed on Clovercoat